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Chapter 1
1 Overview

Petra is a standalone solution for data management, manipulation, visualization and integration of geological, geophysical and engineering data. You can quickly visualize results using mapping, cross-sections, seismic interpretations, log plots, cross-plots, 3D visualization, and production and reservoir analysis. IHS offers two versions of Petra:

- Petra 2014 Standard
- Petra 2014 Workgroup

**Petra 2014 Standard**

Designed to support single-user or small team interpretation workflows.

Petra Standard Edition's reliable, easy to use capabilities make it the ideal platform for customers who are looking for an all-encompassing geological solution for their exploration, development, and production analysis needs, with limited IT or administrative overhead.

**Petra 2014 Workgroup**

Designed to support large teams working concurrently on shared Petra projects, including simultaneous data loading workflows.

Petra Workgroup Edition provides scalability, database management, and user permissions management for customers who require workgroup support and performance solutions. This solution typically requires increased IT support and is more suited for larger companies with many users.

Petra Workgroup can be run in either Shared or Private mode.

In **Shared Mode**, Petra uses an external database server which must be installed separately.

In **Private Mode**, Petra uses an internal database server built into Petra’s Main Module. This internal database server needs no special installation.

**Petra Modules**

IHS 2014 Petra is composed of a Main module and several specialized tool modules. The Main module provides most of the well data viewing, editing functions, and calculation options. Main also launches the other tool modules and coordinates inter-task communication between the tools.
Related Topics
Customer Care

1.1 Customer Care

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Hours of Operation:
   Monday-Friday 8:00 am to 6:00 pm

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Support: customercare@ihs.com
Licensing: Petralicensing@ihs.com

1.2 Petra Modules

Main Module
The Main module provides the basis for all functions in PETRA. Projects are created, opened and closed from Main. Unlike other modules, the Main Module is always open. Main provides screens for viewing and modifying all well data, including header information, formation tops, user defined z data, and production data. Main provides many data calculation functions, including isopach, footage summations from log data, production cumulative values, and user-defined equation evaluations.

Map Module
The Map module displays a highly-customizable map of the project area. This can include wells, culture data, bubble maps, and attribute maps. The Map Module also creates grids of geological surfaces or any other data that varies aerially.

Cross Section Module
This module displays cross sections of well data. These cross sections usually display digital or raster wireline logs, and are commonly used to correlate formation tops across a field. The Cross Section Module has more options for customization, and is generally better suited to presentation quality images.

Spreadsheet Module
This module creates a spreadsheet of wells versus information in the database. Each
well forms a row, with the selected header data, zone data, or formation top as a column.

**Log Cross Plot Module**

This module creates a cross plot between two or three digital log curves. The area covered by the petrophysical relationship of the curves can be used to encode specific lithologic or fluid relationships.

**Z Cross Plot Module**

This module creates a cross plot between 2 zone or formation tops. The Z Cross Plot Module can calculate a variety of regression equations or create polygons based on the cross plot relationship.

**Histogram Module**

This module creates a histogram of a selected digital log curve. This log curve can be filtered by other log curves, by depths, or by formation tops.

**Monthly Production Analysis Module**

This module displays monthly production data for individual wells. This module can also predict reserve estimates.

**Production Group Plot Module**

This module displays aggregate monthly production for one or multiple wells. This production can be normalized by reservoir and start date/earliest max production to provide an "average" producer for a specified reservoir.

**Thematic Mapper Module**

This module imports, displays, and manipulates ESRI Shape Files based on attribute data. The Thematic Mapper Module can then send the results to the Mapping Module's overlay feature.

**3D Visualizer Module**

This module displays well paths, grids (most commonly of geological surfaces), and overlay data in an interactive three dimensional environment.

**Slip Logs Module**

This module displays two or more raster logs horizontally for formation top correlation.

**Log Correlation Module**
Like the Cross Section Module, this module displays wireline logs for several different wells. With fewer display options, this module is geared to rapidly correlate formation tops across a field.

**Directional Well Module**

This module is useful both for planning horizontal wells and for displaying log and well data for existing horizontal wells.

**1.3 Workgroup 2014 Database Server**

Petra Workgroup Edition provides scalability, database management, and user permissions management for customers who require workgroup support and performance solutions. Designed to support large teams working concurrently on shared Petra projects, including simultaneous data loading workflows.

2014 Workgroup requires increased IT support and is more suited for larger companies with multiple users.

Petra Workgroup can be run in either Shared or Private mode.

In **Private Mode**, Petra uses an internal database server built into Petra’s Main Module. This internal database server needs no special installation.

In **Shared Mode**, Petra uses an external database server which must be installed separately. This single database server directly manages all data requests and changes to each project’s database, performs project repairs and maintenance, establishes users and permissions (“roles”), and delivers user settings. In Private Mode, uses an internal database server built into Petra’s Main Module.

Though the database server itself can only run in a Windows environment, project database files can reside on a Windows or Linux platform, or a Network Attached Storage (NAS) device. To use a network location for the database location, you may
have to edit the service properties to log on with an account that has permissions to read and write to that directory.

Related Topics

Installing Workgroup Database Server
Workgroup Database Server Admin Tool
Workgroup Modes

1.3.1 Installing Workgroup Database Server

The first step to install the Database Server is to run the latest version of PetraEDBServer_X.Y.EXE (where the EDB version is X.Y) on the desired computer. Though the database server itself can only run in a Windows environment, the storage requirements can reside on a Windows or Linux platform, or a Network Attached Storage (NAS) device.

1. Run the latest version of PetraEDBServer_X.Y.EXE (where the EDB Version is X.Y) on the desired server. From the Welcome screen, select “Next.”

2. On the Install Folder window, set the location of the Database Server executable files.
   a. The default location is C:\Program Files\IHS\ElevateDB Server (Unicode)\. This default is highly recommended.
   b. Once the Database Server’s installation location is set, select “Next.”
3. On the Project Database Folder window, set the location of the project database files. The default path is C:\ProgramData\Elevate Software\Elevate DB Server (Unicode)\Configuration.

   a. Select “Change” to set a new location. (User preferred option).

   b. On the Change Current Destination Folder window, navigate to the desired location for the Petra projects. This can either be a location on the local computer, or on the network.
Changing the location of Petra project databases

To use a network location for the database location, you may have to edit the service properties to log on with an account that has permissions to read and write to that directory.

Network drives must use UNC pathing (\Shared1_svr\PetraProjects) rather than drive mapping (Z:\PetraProjects).

c. Once the location is set, select “OK” to return to the Installation Wizard.

d. Select “Next.”

Finalizing the location of Petra project databases

4. On the Initial Status screen, make sure the “Start ElevateDB Server” is on, and select “Next.”
Starting the ElevateDB Server

5. Select “Install” to begin the installation.

Finishing the installation

The database server runs as a Windows Service, which will start automatically and function in the background with little to no user interaction. As a Windows Service, the database server runs as EDBSRVR on the Services Tab of the task manager. To start and stop the service, right click the service on the Task manager and select either “Start Service” or “Stop Service.”

The Petra Database Server runs as “EDBSRVR” on the Windows Task Manager Services Tab

Once the database server is installed, use the Project Migration Tool to upgrade legacy v3 projects. Alternatively, the Database Server Admin Tool can run before migration to perform some tasks that don’t need a project, including creating a DB Server List, adding users, and changing passwords (particularly the default administrator password).

1.3.1.1 Managing Private Mode Projects

Private projects sometimes need routine maintenance. Petra’s Private mode uses a simplified version of the Database Server Admin Tool to back up and restore projects, update project databases, and perform table maintenance. There are a two slightly
different ways to open the Private Mode’s Petra Server Admin Tool.

- In an open project, select Project>Settings>Open Server Admin Tool.
- With no open project, select Project>Open Server Admin Tool.

**Project Management Tab**

The Project Management Tab displays information on the migrated Petra projects. Importantly, this section also handles database versions, project maintenance, and backups. The central list provides a short summary of project name, well count, project version, and descriptions. This list will always include a “Master” project that the database server uses as a template for Petra project tables. The far right column provides more detailed project information or maintenance options.

**Project Information Tab**

The Project Information Tab displays the basics of a Petra Project on the Petra Database Server, including the database and public folder pathways, as well as the original creator and migration date.

![The Petra Server Admin Tool’s Project Management Tab (Project Information)](image)

- **DB Path** – This entry shows the path for the database root folder.
- **Project Public Path** – This entry shows the public path for the project. The "Edit" button modifies the Project Public Path.
- **Created By** – This entry shows the project creator.
- **Creation Date** – This entry shows the project’s creation date.
- **Migration Date** – This entry shows the project’s migration date.
DB Maintenance Tab

The Maintenance Tab performs some of the basic project maintenance tasks, including updating, cloning, and backing up project databases. This tab also handles project database table repairs.

![The Petra Server Admin Tool's Project Management Tab (DB Maintenance)](image)

Project Database DB Version

Update - As Petra changes in the future, the way a Petra project stores data in tables may also change. This button upgrades project databases to the latest version. As part of the upgrade process, the Server Admin Tool creates an optional backup of the project. To disable the backup, select the “Skip Backup Before Updating” option.

Verify – This option goes through the entire database to confirm that the project’s table structure is correct. If there’s a problem select the “Table Maintenance” tool.

Delete Selected Project – This option deletes the project data stored on the DB server. This option also can erase the entire project folder.

Table Maintenance

The “Table Maintenance” button opens the Project Maintenance window, which controls some of the more common database procedures, including table verification, repair, and optimization. This tool handles table index problems that usually show up as “Access Violation” errors.
Verify Selected – This option goes through the checked tables in the database to verify its table structure is correct. More specifically, this tool finds mismatches between the table index and the actual numbers of tables. The Verify Selected option will remove the check on project tables with no problems, leaving only the tables with problems checked.

Repair Selected – This option searches through the checked tables and verifies database integrity and consistency. This tool fixes the database table relationships. Before attempting any database repair, make sure to close the project.

Optimize Selected – This option is intended for routine project maintenance. Deleting data from the database sometimes leaves empty slots in the tables. Much like defragmenting a hard drive, the Optimize tool eliminates empty spaces by copying all valid data to a temporary file, sorting the data, and then replacing the original file with the temporary file. Indexes aren't normally rebuilt whenever data is added or deleted from the DAT file, so they can get slower with time. The Optimize Selected tool rebuilds the index file using the current dataset and can make querying data more efficient.

Clone Project Database

The Petra Server Admin Tool creates a copy of the selected project in the project list. This clone can either reside on a different server, or the same server (with a different name).

Destination Server – This dropdown sets the destination of the copied project. In Private Mode, this dropdown will always read “PrivateMode.”

New Project Name – This option sets the name of the copied project. By default, the Server Admin Tool adds “COPY_” to the beginning of the selected project's name.

Project Database Backups
Create New – This option creates a new backup of the selected Petra project database. This includes the project database and database-server-stored individual user settings. This backup will not include external files (like grids and *.MAP/*.CSP settings files).

Note that these backups are automatically stored on the Petra database server.

Restore – This option overwrites the existing active project with the backup. This will overwrite all public and private Petra project data modified since the backup. This includes all “public” data like well data, zones, tops, and logs, as well as “private” data like map settings, cross-section settings, and preferences. Restoring from backup will not affect external files (like grids and *.MAP/*.CSP settings files).

Delete – This option deletes the selected backup.

Full Project Backup Tab

The Petra Server Admin Tool can create entire project backups. The Full Project Backup creates a copy of the entire public folder and zips it up into a single *.PBF file.

Backup File - This option creates the name and location of the project backup file. Select the button and navigate to the desired *.PBF file.

Ignore OVERLAY Folder – This option excludes the project’s OVERLAY folder from the backup file.

Ignore IMAGES Folder - This option excludes the project’s IMAGES folder from the backup file.

Overwrite if Backup Exists – By default, the Petra Server Admin Tool will not overwrite an existing backup with the same name in the same location. This option forces the backup to overwrite the existing backup.
Session Management Tab

The Petra Session Management tab lists and terminates active sessions on selected database servers.

A session is an active connection to the database server. In addition to a background session for every user, each open module has its own session. As an example, a user working with the Map Module, the Main Module, and the Cross-Section Module will have 4 total sessions.

The button refreshes the active sessions for the connected servers. Note that the Session Management Tab will remain blank until this button is selected.

The button kills the selected session. When a Petra module crashes or closes unexpectedly, it can leave an open session with the database that prevents the user from reconnecting to the project. Though a session will timeout on its own after a period of inactivity (120 seconds by default), the button terminates the selected open session so the user can reconnect immediately.

Logs Tab

Petra keeps two kinds of database server records: migrations and database updates, and other server events.

Petra Logs Tab

The Petra Logs Tab displays project migration and database update logs. The button...
button refreshes “Log Filename” list of the available records on the connected servers. Petra stores these logs as: Process-Username — YYYY-MM-DD_HH.MM.SS. Note that the Petra Log Tab will remain blank until this button is selected. The dropdown on the top of the screen trim the list of logs to include project migration, database updates, or all.

Migration logs can also contain “Dropping orphaned record” lines. These records indicate that the Migration Tool has fixed any orphan records not removed during the Pack step in project preparation. Migration and DB update logs are also stored externally in the Support/Logs folder inside the Project Databases folder.

Server Log Tab

The Server Log Tab displays a record of database server events, including user activity and errors. The button refreshes the log for the connected servers. Note that the Server Log Tab will remain blank until this button is selected. The buttons on the top of the screen trim the log to just include the last 24 hours, last week, or last month.

The server log has a maximum file size, which will eventually truncate old messages
The Petra Server Admin Tool’s Server Log Tab

This screen contains columns for the error code, the function, a timestamp, the relevant user, the IP address, and a longer description of the event. To sort by the various columns, select the column header once for ascending order and twice for descending order. For more information on error codes, see: http://www.elevatesoft.com/manual?action=topics&id=edb2sql&section=appendix_error_msg

1.3.2 Workgroup Modes

Petra Workgroup 2014 can run in two separate modes:

- **Shared Mode** - is designed for networked projects used by multiple simultaneous users. In Shared mode, Petra Workgroup uses an external database server. This external database server is installed separately - generally on a dedicated machine.

- **Private Mode** - uses an internal database server built into the Main Module. This internal database server is installed along with Petra Workgroup and needs no separate installation. Users who do not ever plan on using Shared mode do not need an external database server.

After logging in and opening a project, the processes of importing well data, interpreting logs, picking tops, and making maps and cross-sections all remain the same as previous versions.

In large multi-user environments, most users will be assigned a username and password by a network or IT administrator. For more information on creating user ID and passwords, see the Database Server Admin Tool.
Shared Mode is designed for networked projects used by multiple simultaneous users. This mode uses an external Petra Database Server to coordinate how users read and write to the same project database.

After logging in and opening a project, users won't notice any difference with earlier versions of Petra. The processes of importing well data, interpreting logs, picking tops, and making maps and cross-sections all remain the same as previous versions.

Petra Workgroup uses a different database requiring older Petra project database tables to be upgraded or “migrated” with the Project Migration tool. This utility automatically installs with the Petra Workgroup installation. A project only needs to be migrated once. Migration does not erase any data from the original v3 project,
and leaves it intact. The migration process only applies to the database tables. External files, such as overlays and grids, are not affected.

There are a few different ways to open the Project Migration Tool.

- On the Windows Start Menu, select IHS>Petra>Project Migration Tool.
- Select the “DB Migrator” button on the Select Project to Open window within Petra (See the Opening and Using Petra Projects section of this manual)
- With no active project, select Project>Launch DB Migrator on the Menu Bar at the top of the Main Module.
- The Project Migration Tool is a standalone application, ElevDB Migrator.EXE. This executable file is located inside the ElevateDB Migrator folder in the Petra Database Server path, as well as in the Petra Standalone and Petra Server path.

The Project Migration Tool can be installed and run on any computer as a standalone application with Petra_4X_Migrator.EXE (with the PetraVersion = 4.X).

Though this tool can remotely migrate projects on any server connected to the network, it’s generally best to run the migration process on the computer where the ElevateDB Server is installed.

The Migration Tool automatically looks in the Petra v4 installation’s “Parms” directory for projects. After loading the projects, the tool lists all the available projects by name, project path, INI path, shared status, and status.
Server Address – This option sets the IP address or hostname of the database server. To migrate projects on a local machine, set this field to localhost or 127.0.0.1.

Server Port – This option sets the port of the database server. To migrate projects on a local machine, set the port to 12010.

EDB Login – This option sets the username.

Password – This option sets the password. The username and password will need the appropriate permission. Brand new DB servers will only have a single administrator user at first. EDBLogin: Administrator; Password: EDBDefault

Auto-Drop Existing DBs – This option automatically replaces projects with the same name already on the Database Server.

For Invalid Project Names – This option determines how the Migration Tool handles projects with names that start with a number or exceed the 40 character limit.

- The “Skip Migration” option completely skips the migration.
- The “Prompt user for new name” requests a new name for the project.
- The “Automatically truncate and/or prefix name with:” both truncates characters beyond the 40 character limit and/or adds a prefix for project names that start with a number.

1.3.2.1.2 Opening Shared Mode Projects

Select the Petra Project to Open window displays all migrated projects on the available servers. These projects are listed in a spreadsheet with columns for name, description, the last opened date and time, the server name, server IP, and server
port. There’s an additional column to the far left for “favorites.” Selecting the star next to a project name designates a project as a favorite project, making it more visible and easier to pick.

Marking a project as a favorite marks the project with a star for every user using the same Petra installation.

The Select the Petra Project to Open window

In addition to opening projects, this window has a few other options:

Cancel – This option closes the “Select the Petra Project to Open” window and returns to the Main Module.

Info – This option displays information about the selected project, including map projection, access history, and folder pathways.
Project information

Refresh – This option refreshes the projects available from the Petra Database Servers.

Server Mgmt – This option opens the Petra Server Manager, and is primarily used to add or remove available Petra Database Servers.

Change Login – This option changes the username and password used to login to the Petra Database Server. Different user names may have different access privileges.

Open DB Migrator – This option opens the Shared Mode’s Project Migration Tool.

# Wells – This option adds a column displaying the total well count for each project.

Filter – This option filters the available projects. To set a search criterion, select whether the projects will be filtered by name, description, or server with the dropdown menu. Next, enter the desired search term and select the “Filter” button. To remove search criteria, select “Clear.” The “Favorites Only” option only displays projects with a favorites star.

1.3.2.1.3 Creating New Shared Mode Projects

Creating a new project from scratch involves setting the following:

- Project name
- Description
- Location of public and private directories
- Database server
Creating a new project also sets the locations of the public and private folders. Recall that the public folder contains common and shared external files (GRIDS, IMAGES, OVERLAY, etc.) while the private folder contains user-created files (like WSN lists, import templates, or settings files) that customize Petra’s appearance and behavior. Private folders should be separated both by user and by project.

1. Select the button on the toolbar at the upper left corner of the Main Module.
2. On the Create New Petra Project window, select the “Create a New Project” option.

3. Create a name and description for the project, and select the desired database server for the project.

This list displays the available database servers from the Petra DB Servers List. To add or drop servers from this list, select “Server Mgmt.” Changing the servers here will change the available servers for all users on this installation, so the file may be locked by an IT administrator.

Recall that the database server can use roles to restrict what users can do, including the ability to create new projects. To change login, select the “Change Login” button.
Setting the name and description of the new project

4. Establish the project folder. The project folder is also known as the public database path.

5. Set the destination of the personal parameters folder - also known as the private parameters path.
Setting the private parameters folder for shared project

6. Review the settings, and select the “Finish” button to create the new project.

Creating the new project

1.3.2.2 Workgroup Private Mode

Private Mode is designed for projects that won't be shared. Private Mode trades the ability to share projects between multiple simultaneous users for an easier setup and maintenance. In a large multi-user environment, Private Mode can be useful for creating temporary “sandbox” projects for testing imports or working with data without affecting a primary production project.

In Private mode, Petra Workgroup works very similarly to Petra Standard. Though Petra Workgroup still has a database server, it is built into the Main Module and does not need to be separately installed. Additionally, this mode always stores projects locally on the host computer.

After opening a project, most users won't notice any difference with earlier versions of
Petra. The processes of importing well data, interpreting logs, picking tops, and making maps and cross-sections all remain the same as previous versions.

Related Topics:
- Migrating Projects in Private Mode
- Opening Private Mode Projects
- Creating New Private Mode Projects
- Managing Private Mode Projects

1.3.2.1.2 Migrating Projects in Private Mode

Private Mode users launch the Project Migration Tool directly within Petra. When running Petra in Private Mode for the first time, the program checks for locally stored non-shared projects, and prompts you to open the Migration Tool.

To open the Migration tool inside Petra’s Private Mode:

- Select the “DB Migrator” button on the Select Project to Open window within Petra (see Opening Private Mode Projects)

- With no active project, select Project>Launch DB Migrator on the Menu Bar at the top of the Main Module.

The Migration tool displays a list of projects from the Petra v3 installation’s “Parms” directory. This list displays the available projects by name, project path, INI path, shared status, and status. To migrate projects from a different installation, select the button and navigate to the Petra “Parms” folder containing the desired project INI files. Next, select the “Load Projects” button.

Select the desired projects to migrate with the check boxes on the left side of the list. Select the “Migrate” button to migrate the projects to the Database server. This process copies the data inside the project to the database save location and establishes the links to the database server.
The Migration Tool in Private Mode. Note that shared projects cannot be selected for migration.

Auto-Drop Existing DBs – This option automatically replaces projects with the same name already on the Database Server.

For Invalid Project Names – This option determines how the Migration Tool handles projects with names that start with a number or exceed the 40 character limit.

- The “Skip Migration” option completely skips the migration.
- The “Prompt user for new name” requests a new name for the project.
- The “Automatically truncate and/or prefix name with:” both truncates characters beyond the 40 character limit and/or adds a prefix for project names that start with a number.

1.3.2.2.2 Opening Private Mode Projects

The Select the Petra Project to Open window displays all migrated projects on the available servers. These projects are listed in a spreadsheet with columns for name, description, the last opened date and time, the server name, server IP, and server port. There’s an additional column to the far left for “favorites.” Selecting the star next to a project name designates a project as a favorite project, making it more visible and easier to pick.
In addition to opening projects, this window has a few other options:

**Cancel** – This option closes the “Select the Petra Project to Open” window and returns to the Main Module.

**Info** – This option displays information about the selected project, including map projection, access history, and folder pathways.

**Refresh** – This option refreshes the projects available from the Petra Database.
Servers.

Open DB Migrator – This option opens the Private Mode’s Project Migration Tool.

# Wells – This option adds a column displaying the total well count for each project.

Filter – This option filters the available projects. To set a search criterion, select whether the projects will be filtered by name, description, or server with the dropdown menu. Next, enter the desired search term and select the “Filter” button. To remove search criteria, select “Clear.” The “Favorites Only” option only displays projects with a favorites star.

1.3.2.2.3 Creating New Private Mode Projects

Creating a new project from scratch involves setting the name, description, shared status, and the location of public and private directories.

When choosing a name, remember that the name will show up in Petra as well as in the project’s file folder. The description will show up in the Main Module as well as on some maps, so it’s a good idea to give a few seconds thought to what you want displayed, rather than just hammering in “ASDF.”

Creating a new project also sets the locations of the public and private folders. Recall that the public folder contains common and shared external files (GRIDS, IMAGES, OVERLAY, etc.) while the private folder contains user-created files (like WSN lists, import templates, or settings files) that customize Petra’s appearance and behavior. In Private Mode, all private parameters are stored in the project Parms folder.

Projects created in Private mode are limited to a single user.

1. Select the button on the toolbar at the upper left corner of the screen. This starts the Create New Petra Project wizard. Select the “Create a New Project” option.

2. Create a name and description for the project
3. Establish the project folder. Petra will store both project data and private parameters in this directory under a folder using the project name.

**Most private mode users will use the default C:\geoplus1\Projects directory.**

4. Select the “Finish” button to create the new project.

**1.3.3 Active Directory**

Petra can use the Active Directory (AD) directory service to establish and maintain
Petra Database Server users and roles. When using AD, the database server automatically creates Petra users from AD usernames and assigns roles from AD groups. This method can use Kerberos authentication for additional security. From a user’s perspective, Petra automatically logs in with the user’s AD credentials, which translates to one fewer username/password to manage. Petra installations with AD enabled in the Petra.ini file can ONLY connect to Petra Database Servers with AD enabled.

Active Directory requires Petra v4.0.6 or higher, PetraEDBServer v1.03 or higher, and a domain using Active Directory.

Configuring the Petra Database Server with edbsrvr.INI

Enabling AD on the database server requires a few modifications to the server’s edbsrvr.INI file. With a default installation, this file is in the “C:\ProgramData\Elevate Software\...” folder, and can be edited in any basic text editor. Alternatively, use the Petra Server Admin Tool’s EDB Server Maintenance tool and select “open ini file.”

The following entries should be in the [Server] section of the edbsrvr.INI file.

Active Directory Enabled=1 – This line enables and disables AD on the server. Set this to “1” to enable Active Directory, and “0” to disable Active Directory.

Active Directory SPN=host/computer_name - See the Working with SPN section for more information on how to set this up.

Active Directory Override Users=Administrator,EDBProc,Billy – This line creates a list of users that can access the Petra Database Server without using AD authentication. At a minimum, this line should include the “Admin User” mentioned below and the “Proc_Username” user (see Petra.INI section).

Admin User=Administrator – The database server needs administrative rights in order to copy and modify users from the AD groups. This line simply lists a user in the “Administrators” role. This user must be listed in the “Active Directory Override Users” list mentioned above.

Admin Password=EDBDefault – This entry sets the password for the administrator user.

IHS recommends creating another administrative account for this edbsrvr.INI file, or at least changing the default password. The edbsrvr.INI file stores an administrator username and password in plain text, so consider taking extra precautions when assigning read/write permissions to this file.

Mapping AD Groups to Petra Database Server Roles

A mapping file connects user AD groups to database server roles. The database server uses this mapping file to slot AD users into different roles, which can change as
their group changes. This mapping is stored in AD_EDB_GroupMappings.XML in the same location as the edbsrvr.INI file, and can be setup and modified through the Petra Server Admin Tool. If AD is enabled on the Petra Database, the Server Admin Tool will have a new button on the User Management Tab.

Selecting that button opens the Active Directory to EDB Mappings tool. To add a line, select the green “+” button. To drop a line select the red “-” button. To establish a relationship, type in the Petra Database Server roles (EDB Roles) and the associated AD group. Note that this can be a one-to-many mapping – a role can be fed from multiple groups.

When done, click “Save” and you will get a notification explaining which roles will be added or dropped to complete the mappings. Select “Yes” to complete the changes. Once this is done, any user from one of these AD Groups will be able to login to Petra and be automatically created (if doesn’t already exist) and assigned to the mapped Petra Database Server Roles.

**Configuring the Petra Installation with Petra.INI**

In addition to configuring the Petra Database Server, enabling AD requires a few modifications to the Petra’s configuration file, Petra.INI. This file isn’t created automatically, so it’s necessary to either create it from scratch or copy the sample Petra.INI located in the PetraSRV\PARMS folder to the Petra installation directory.

[ActiveDirectory] Section
Enabled=1 - Set to '0' to disable AD

SecurityPackage=Kerberos - Though other security packages (NTLM & Negotiate) are available, IHS recommends Kerberos.

Delegate=YES/NO - Please refer to Microsoft SSPI documentation for an explanation of this option. Default is ‘NO’.

MutualAuth=YES/NO - Please refer to Microsoft SSPI documentation for an explanation of this option. Default is ‘NO’.

[EDB] Section

Proc_Username=EDBProc – This line sets a username that is ONLY used to make initial contact with the Petra Database Server before AD Authentication. This user should NOT be added to any roles which have access to your Petra Project Databases. This user must exist in the “Active Directory Override Users” list mentioned above.

Proc_Password=EDBProc – This line sets password for the “Proc_user” mentioned above.

1.3.3.1 SPN


Petra does not automatically register SPN's with AD. Instead, Petra uses the SPN listed in the edbsrvr.INI file’s “Active Directory SPN” line. This line can be set up in a couple of different ways:

The EDBSrvr service is set to “Log On As” local system

In this scenario, the edbsrvr.INI setting should simply be set to “host/computer_name”, where computer_name is the name of the computer running the Petra Database Server. This SPN is registered by default for any AD computer and there is no need to register it manually.

The EDBSrvr service is set to “Log On As” a specific user account

This scenario requires a SPN registered for the specified specific user account. By default, AD does not register any SPN's for User Accounts. IHS recommends registering the SPN the following way: “PetraKrbHost/user_name”, where user_name is the user the SPN is registered to and is the same user as the EDBSrvr service is using.

Registering an SPN

Please see MSDN documentation (link above) for information on registering an SPN, however below is a quick tutorial on viewing, registering, and deleting SPN's on your
Perform these commands from the command prompt with an account with AD Admin access

// lists all SPN's registered to a given User
setspn –L UserName

// lists all SPN's registered to a given Computer
setspn –L ComputerName

// Adds the SPN “PetraKrbHost/UserName” to the given User
// after verifying no duplicates exist
setspn –S PetraKrbHost/UserName UserName

// delete the SPN “PetraKrbHost/UserName” from the given User
setspn –D PetraKrbHost/UserName UserName

1.3.4 Workgroup Database Server Admin Tool

The following information only applies to Petra Workgroup 2014.

The Petra Server Admin Tool performs some database setup and most routine maintenance. This includes creating server lists, managing users and roles, backing up and restoring projects, and controlling individual Petra connections to the database server or “sessions.” The Petra Server Admin Tool can be used at any time after installation. Run before migration to perform some tasks that don’t need a project, including creating a DB Server List, adding users, and changing passwords (particularly the default administrator password).

There are a few different ways to open the Petra Server Admin Tool:

- On the Windows Start Menu, select IHS>Petra>Server Admin Tool.

- The Petra Server Admin Tool is a standalone application, PetraServerAdminTool. EXE. This executable file is located inside the Petra Database Server path, as well as in the Petra Standalone and Petra Server path.
When it first opens, the Petra Server Admin Tool has no active connections to a Database Server. Note that the “Servers” list on the left side of the screen is blank.

1.3.4.1 EDB Server Maintenance

The EDBServer Maintenance button on the menu bar at the top of the Petra Server Admin tool opens the EDB Server Maintenance tool. This tool controls a few additional options for the server, including changing the server port, opening the Services Management Console, and opening the Database Server’s configuration edbsrvr.INI file.
Server Port – This entry sets the Petra Database Server’s port. By default, this entry is set to 12010. Make sure to select the “Save Changes” button and restart the Database Server.

Configuration Path – This entry displays the location of the Petra database files. This entry cannot change, and is just for display only.

Services

The Services button on the top of the Server Maintenance Tool opens the Microsoft Service Maintenance Console. This can be useful for stopping and restarting the ElevateDB Server to apply changes to the database.

Open INI File

The Open INI File Button opens the Petra Database Server configuration file, edbsrvr.ini. For more information on these configuration settings, see:

The Database Server configuration file, edbsvr.INI

1.3.4.2 Server Management Tab

The Server Management Tab provides an overview of the users and projects on the currently available servers.

User Sync

This tool copies users from one server to another. You must be connected to at least two servers to use User Sync. Copying users requires a login with administrative privileges on both servers. To sync a user:

1. Select the two desired servers from the respective dropdown lists.

2. To copy a user from one server to another, select the relevant user name and select the adjacent “>” or “<” button. In the example below, the username “Dana”
has been copied from the “LocalHost” Server to the “ProjectServer.”

3. Select the Save icon and then close the Sync Users window.

Role Sync

This tool copies roles from one server to another. Copying roles requires a login with administrative privileges on both servers. To sync a role:

1. Select the two desired servers from the respective dropdown lists.

2. To copy a role from one server to another, select the relevant role and select the adjacent “>” or “<” button. In the example below, the “GeoTechs” role has been copied from the “LocalHost” Server to the “ProjectServer.”

3. Select the Save icon and then close the Sync Roles window.
1.3.4.3 Project Management Tab

The Project Management Tab displays information on the selected Petra database server’s projects. Importantly, this section also handles database versions, project maintenance, and backups. The central list provides a short summary of project name, well count, project version, and descriptions. This list will always include a “Master” project that the database server uses as a template for Petra project tables. The far right column provides more detailed project information or maintenance options.

Project Information Tab

The Project Information Tab displays the basics of a Petra Project on the Petra Database Server, including the database and public folder pathways, as well as the original creator and migration date.
DB Path – This entry shows the path for the database root folder.

Project Public Path – This entry shows the public path for the project. The “Edit” button modifies the Project Public Path. It’s recommended to use UNC pathing (`\Shared1_svr\PetraProjects \`) rather than drive mapping (`Z:\PetraProjects`).

Created By – This entry shows the project creator.

Creation Date – This entry shows the project’s creation date.

Migration Date – This entry shows the project’s migration date.

Maintenance Tab

The Maintenance Tab performs some of the basic project maintenance tasks, including updating, cloning, and backing up project databases. This tab also handles project database table repairs.
Project Database DB Version

**Update** - As Petra changes in the future, the way a Petra project stores data in tables may also change. This button upgrades project databases to the latest version. As part of the upgrade process, the Server Admin Tool creates an optional backup of the project. To disable the backup, select the “Skip Backup Before Updating” option. Keeping the Master project updated insures that new projects are created with the most current database version.

**Verify** – This option goes through the entire database to confirm that the project’s table structure is correct. If there’s a problem select the “Table Maintenance” tool.

**Delete Selected Project** – This option deletes the project data stored on the DB server. This option also can erase the entire project folder; however, the project INI file in the program Parms folder (C:\geoplus1\Parms) is still retained.

Table Maintenance

The “Table Maintenance” button opens the Project Maintenance window, which controls some of the more common database procedures, including table verification, repair, and optimization. **This tool handles table index problems that usually show up as “Access Violation” errors.**
The Table Maintenance Tool

Verify Selected – This option goes through the checked tables in the database to verify its table structure is correct. More specifically, this tool finds mismatches between the table index and the actual numbers of tables. The Verify Selected option will remove the check on project tables with no problems, leaving only the tables with problems checked.

Repair Selected – This option searches through the checked tables and verifies database integrity and consistency. This tool fixes the database table relationships. Before attempting any database repair, make sure all users are out of the project. See Appendix B for more information on how to forcibly kick users out of a project.

Optimize Selected – This option is intended for routine project maintenance. Deleting data from the database sometimes leaves empty slots in the tables. Much like defragmenting a hard drive, the Optimize tool eliminates empty spaces by copying all valid data to a temporary file, sorting the data, and then replacing the original file with the temporary file.

Indexes aren't normally rebuilt whenever data is added or deleted from the DAT file, so they can get slower with time. The Optimize Selected tool rebuilds the index file using the current dataset and can make querying data more efficient.

DB String Cleanup

Most projects which were migrated to the new database prior to Petra v4.0.5 stored some text fields inefficiently. This utility recovers disk space caused by this inefficiency. Depending on the project, the amount of disk space which can be recovered will vary from a few kilobytes to gigabytes. Projects migrated using Petra v4.0.5 or later will not benefit from running this cleanup.

Analyze - This option runs a query to see how much disk space can be cleaned up. The total amount is listed in the lo file displayed at the bottom of the window.
The DB String Cleanup window’s Analyze tool

Cleanup - This option optimizes the affected tables. Note that the process can take a significant amount of time on large projects. Once the database records are updated, this tool runs an optimization process each affected table to complete the process and recover disk space. The optimize portion can be skipped by unchecking the checkbox; however, the disk space will not be recovered until a database optimization is complete.

Clone Project Database

The Petra Server Admin Tool creates a copy of the selected project in the project list. This clone can either reside on a different server, or the same server (with a different name).

Destination Server – This dropdown sets the destination of the copied project.

New Project Name – This option sets the name of the copied project. By default, the Server Admin Tool adds “COPY_” to the beginning of the selected project’s name.

Project Database Backups

Create New – This option creates a new backup of the selected Petra project
database. This includes the project database and database-server-stored individual user settings. This backup will not include external files (like grids and *.MAP/*.CSP settings files). Note that these backups are automatically stored on the Petra database server.

Restore – This option overwrites the existing active project with the backup. This will overwrite all public and private Petra project data modified since the backup. This includes all “public” data like well data, zones, tops, and logs, as well as “private” data like map settings, cross-section settings, and preferences. Restoring from backup will not affect external files (like grids and *.MAP/*.CSP settings files).

Delete – This option deletes the selected backup.

Full Project Backup Tab

The Petra Server Admin Tool can create entire project backups. The Full Project Backup creates a copy of the entire public folder and zips it up into a single *.PBF file.

Backup File - This option creates the name and location of the project backup file. Select the button and navigate to the desired *.PBF file.

Ignore OVERLAY Folder – This option excludes the project’s OVERLAY folder from the backup file.

Ignore IMAGES Folder - This option excludes the project’s IMAGES folder from the backup file.

Overwrite if Backup Exists – By default, the Petra Server Admin Tool will not overwrite an existing backup with the same name in the same location. This option forces the backup to overwrite the existing backup.
1.3.4.4 User Management Tab

Petra v4 distinguishes between different users to deliver personal parameters (such as map settings) and to restrict permissions with “roles.” Petra defines a role as a set of permissions to read and write to individual projects, as well as the ability to create new projects from scratch. Only users in the “Administrators” role can edit users and roles.

Petra’s Database Server can use an Active Directory network to create users and dynamically maintain roles.

All Users List

The Users List creates, modifies, and removes new users from the Petra database server. Selecting a specific user changes the tab to reflect the detailed settings for the individual user, including the user name, description, and obscured password.

The Petra Server Admin Tool’s User Management Tab

- To create a new user, select the “+” button at the top of the All Users List, and enter the new name, description, and password.

- To delete an existing user, select the “X” button at the top of the All Users List.

- To modify an existing user, select the desired user from the All Users list, and select the “Edit” button on the right side of the screen. Select “Save” after editing.
Adding a new username with a description and password

Roles List

The Roles List creates, modifies, and deletes roles. Each role defines a set of permissions for a set of projects, which provides a great deal of flexibility. Selecting a role changes the far right part of the screen to reflect the detailed permissions of the role. This screen indicates the name and description of the selected role, as well as the specific read/write permissions for each project. Permissions are additive. Any user in a role with permission to create and/or delete projects will be able to create new projects regardless of permission set in their other roles.

By default, Petra’s database server has two roles: “Administrators” and “Public.” Administrators have read/write access to all projects on the server and can create new projects. Public users, by default, can read (but not change) all existing projects, as well as create new and delete existing projects. New users are automatically put into the Public role. Editing the Public role changes the default permissions for all users. Changing the “New Project Defaults” in the Public role changes the default read and write permissions for new projects.

Users can't be dropped from the Public role. To restrict users creating and deleting projects, remove that functionality from the Public role and create another dedicated role with the create new projects/delete existing projects options enabled.
To add a new role, select the “+” button at the top of the Roles list and enter a name and description.

To delete an existing role, select the “X” button at the top of the Roles List.

To edit the selected role, select the “Edit” button, make the desired changes, and select the “Save” button.

The Roles List also contains the usernames associated with each role. Selecting the triangle or plus to the left of the role name expands the tree to display all users in that role.

To add a new user to a role, drag the selected user from the All Users List into the desired role.

To remove a user from a role, drag the user inside the Roles List back into the All Users List, or to the box at the bottom of the Roles List.

1.3.4.5 Session Management Tab

The Petra Session Management tab lists and terminates active sessions on selected database servers. A session is an active connection to the database server. In addition to a background session for every user, each open module has its own session. As an example, a user working with the Map Module, the Main Module, and the Cross-Section Module will have 4 total sessions.

![The Petra Server Admin Tool’s Session Management Tab](image)

- This button refreshes the active sessions for the connected servers. Note that the Session Management Tab will remain blank until this button is selected.
- This button kills the selected session. When a Petra module crashes or closes unexpectedly, it can leave an open session with the database that prevents the user from reconnecting to the project. Though a session will timeout on its own after a period of inactivity (120 seconds by default), the button terminates the selected open session so the user can reconnect immediately. In an emergency, kill can also be used to remove users prior to performing a repair.

1.3.4.6 Logs Tab

Petra keeps two kinds of database server records: migrations and database updates, and other server events.

Petra Logs Tab

The Petra Logs Tab displays project migration and database update logs. The button refreshes the “Log Filename” list of the available records on the connected servers. Petra stores these logs as: Process-Username –YYYY-MM-DD_HH.MM.SS. Note that the Petra Log Tab will remain blank until this button is selected. The dropdown on the top of the screen trims the list of logs to include project migration, database updates, or all.
that the Migration Tool fixed orphan records not removed during the Pack step in project preparation.

Migration and DB update logs are also stored externally in the Support/Logs folder inside the Project Databases folder.

Server Log Tab

The Server Log Tab displays a record of database server events, including user activity and errors. The button refreshes the log for the connected servers. Note that the Server Log Tab will remain blank until this button is selected. The buttons on the top of the screen trim the log to just include the last 24 hours, last week, or last month. The server log has a maximum file size, which will eventually truncate old messages.

![The Petra Server Admin Tool's Server Log Tab](image)

This screen contains columns for the error code, the function, a timestamp, the relevant user, the IP address, and a longer description of the event. To sort by the various columns, select the column header once for ascending order and twice for descending order. For more information on error codes, see:

http://www.elevatesoft.com/manual?action=topics&id=edb2sql&section=appendix_error_msg

1.3.4.7 Jobs Tab

The Jobs Tab schedules regular project backups and repairs.
Create Job – This option opens the “Create A New Job” dialog.
Alter Job – This option modifies the selected job.
Rename Job – This option renames the selected job.
Delete Selected Job – This option deletes the currently selected job.
Copy Job – This option creates a copy of the currently selected job.

Adding and Modifying Jobs

The Create New Job button creates a new job on the server, while the Alter Job button modifies an existing job. The process of creating and modifying a job are very similar. Both the Create New Job and Alter Job buttons open the same three windows: general tab, definition tab, and scheduling tab. These tabs name the job, select the specific process and Petra project, and schedule the time and occurrence of the job.

General Tab

The General Tab sets the name and description of the job. The example below shows a job that will back up all projects nightly.
The Definition Tab

The Definition Tab sets the specific process and project for the job. A single job can either create a new backup of a project, or repair a working project. Next, select the desired project or all projects. The example below will affect all projects on the database server.

The Scheduling Tab

The Scheduling Tab sets the job’s interval and timeframe.

Interval – This dropdown sets the job’s frequency. Options here include once, hourly, daily, weekly, monthly, and “every.”

The “Every” option repeats the job by a set number of minutes, hours, days, or weeks, starting at the time specified by the “Between” option below. Note that the number of minutes, days, hours, or weeks needs to be specified in round numbers. Additionally, the “Weekly” option performs the job on specified days of the week.

From/To – These two options set the calendar date range for the job. Note that dates can be entered manually, or selected on a dropdown calendar.

Between/And – These two options set the timeframe of the job. Note that times can be entered manually, or with the up/down windows to the immediate right of each time.
1.4 Petra Standard 2014

Petra Standard edition is designed to provide the same features as Workgroup but in a single-user or small team interpretation environment. The processes of importing well data, interpreting logs, picking tops, and making maps and cross-sections all remain the same as the Workgroup version.

Related Topic

Internal DBI Database

1.4.1 Internal DBI Database

Petra 2014 Standard and Workgroup private mode use an internal database that stores each project’s internal database files in a series of tables named for the data type. Again, each table has three files, though the file extensions now all have an
“EDB” prefix: *.EDBBib, *.EDBTbl, and *.EDBIdx. These project database files are stored in a single folder; in Shared Mode the folder reflects the name of the project, while in Private Mode the folder name is DB4. In the screenshot below, the Tutorial project has a “TUTORIAL” folder that contains all the table files.
Chapter 2
2 Installing & Configuring Petra

There are three separate components to the installation and configuration of Petra:

- SW Installation
- Licensing
- Database (Internal or Database Server)

**SW Installation**

There are two types of installation; standalone and network. The type of Installation only affects the location of Petra's executable files. Both allow projects to be shared between multiple users.

**Licensing**

Petra can run with one of two licensing methods: a network license manager or a hardware “bitlock”. Licensing is managed using the Config.EXE utility for both license types.

**Database**

- Petra 2014 Standard and Workgroup Private mode both use an Internal Database
- Petra 2014 Workgroup Shared mode uses a Database Server

2.1 Petra Installations

Both Petra Standard and Workgroup editions support standalone and network installations. The type of installation only affects the location of Petra's executable files and does not affect project sharing between multiple users.

One advantage of network installations is the ease of updates; Network installations only require a single network server to be updated. Standalone installations require each individual workstation to be updated.

**Standalone Installation**

For standalone installations run the Petra standalone installer

- Petra 2014 Standard, " ALLDI SKS. exe"
- Petra 2014 Workgroup, "PETRASTANDALONE. exe"
Program files will be stored in "C:\Geoplus1" by default. IHS recommends that you always use the default directories.

Network Installation

Network installations require both a server and client installation.

Petra Server Installation

A network installation stores Petra executable files are installed on a single network file server accessible to all Petra users. Petra's network server installer, "server.EXE" installs the files in C:\PetraSRV by default. The location of the network executable files is often referred to as the Petra "system path."

Petra Client Installation

With a network installation, each individual workstation requires a "client" to be recognized by the server. Petra's client installer, "client.EXE", installs the files in "C:\Geoplus1" by default. Once installed, "Config.EXE" is run to specify the network program path, client path and licensing method.

2.2 Upgrading from V3.x to Workgroup 2014

Petra Workgroup 2014 provides a dedicated database server that controls how users read and write to the database tables. This single database server directly manages all data requests and changes to each project's database, performs project repairs and maintenance, establishes users and permissions ("roles"), and delivers user settings.

Petra Workgroup can run in two separate modes: Shared and Private.

In Shared Mode, Petra uses an external database server. This server needs to be installed separately.

In Private Mode, Petra uses an internal database server built into Petra's Main Module. This internal database server needs no special installation.

Quick Start Guides

Shared Mode Quick Start Guide

Private Mode Quick Start Guide

After the installation completes the new Petra icon: 🎨 displays on the desktop.
Total v4 Upgrade vs Concurrent v3 and v4 Installations

IHS recommends a total upgrade to v4 rather than running simultaneous v3 and v4 Petra installations. Though it is possible, it adds more complexity to the v4 upgrade process. It also introduces the potential for lost data; changes (such as picked tops) made in v3 projects do not automatically propagate to v4 projects, and vice versa.

During the installation process, if the installer detects an older version of Petra, the Question window changes whether the install will upgrade Petra v3 to v4 or create concurrent Petra v3 and Petra v4 installations:

“Yes”: this option completely uninstalls and automatically overwrites the existing installation with no further user input. IHS recommends this option.

“No”: this option leaves the old version of Petra in place and concurrently installs the new version in a different location. See here for information on concurrent installations.

Selecting whether to overwrite Petra v3 or install v4 in a different location

2.2.1 Updates

Petra updates periodically contain changes and additions to the database tables. If an updated version of Petra is used to access a shared project, older versions of Petra may no longer be able to access that project.

All Petra seats within an organization should be updated at the same time. If the organization prefers to test new versions of Petra before general release to all users, it is best that testing be done with dedicated testing projects rather than projects that the organization wishes still be accessible to older versions of Petra.

Updates for both standalone and network installations are available at:

Network Updates

- PetraServer.EXE, updates the Petra network program files. These files are typically located in the "petrasrv" folder on the network drive.

- PetraClient.EXE, updates the Petra Client on individual workstations. Since the client only links to the server installation, it’s rare for the client to need updating.
Standalone Updates

Standalone copies of Petra are updated from the web using either "alldisks.exe" or "petraup.exe" download files.

- Petraup.EXE contains just the essentials for updating the Petra program files for an existing standalone installation.
- Alldisks.EXE contains all of the files to update Petra with the exception of the bitlock drivers.

Upgrading Versions

For more detailed information on updating Petra v3 to v4, see here.

2.2.2 Upgrading to V4 (Private & Shared Mode)

Quick Start Guide

Install the Database Server

- Run PetraEDBServer_X_Y.EXE (EDB Version = X.Y)
- Set database installation and database storage paths
- Set logon information for Elevate DB Service (only if storing projects on a network drive)

Install Petra v4

- For standalone Installations, run PetraStandalone.EXE
- For server/client Installations run PetraServer.EXE on the desired server, and run PetraClient.EXE on all client computers
- Use Config.EXE to set up licensing and networking

Migrate Projects to v4 (PetraProjectMigrator.EXE)

- Make good backups of projects before migrating
- Run a database repair, optimize, and pack on the desired projects
- Select the desired projects in the old Petra Project Directory
- Set the server address, port, and logon to the new database server
Setup the Database Server (PetraServerAdminTool.EXE)

- Set up database server list
- Connect to the database server
- Add users and roles

Open and Use v4 Projects

- Log on to the database server
- Migrate the private parameters, or create new private parameters
- Select a location for the private folder

2.2.3 Upgrading to V4 (Private Mode Only)

Private Mode Quick Start Guide

Install Petra v4

- For standalone Installations, run PetraStandalone.EXE
- For server/client Installations run PetraServer.EXE on the desired server, and run PetraClient.EXE on all client computers
- Use Config.EXE to set up licensing and file structure.

Migrate Projects to v4 using the Private Mode Migration Tool within Petra

- Be sure to have good backups of projects before migrating
- Select the desired projects in the old Petra Project Directory

Open and Use v4 Projects

- After migrating, refresh the project list and select the project to open.

2.2.4 Concurrent v3 and v4 Installations

Important:

- Changes to the old v3 project database after migration WILL NOT automatically propagate to the newer v4 project.
- Post-migration changes to the old v3 project must be exported and manually imported into the newer v4 project.
The key to concurrent installations is to bypass the v4 installer’s automatic uninstall and overwrite of older versions of Petra Standalone, Client, and Server. Selecting “No” on this window will leave the older v3 installation alone and create a separate installation of v4 in a different location.

“Yes” installs over the existing copy of the Petra Server, while “No” installs v4 to a different location.

The Petra v4 installer places bypassed installations by default into C:\geoplus4 (Petra Standalone and Client) and C:\petrasrv4 (Petra Server) to avoid installing into older versions of Petra’s default installation locations.

2.3 Petra Licensing

Copies of Petra can run with two different licensing methods: a “bitlock” or a network license manager. Config.EXE sets up licensing for both bitlock and network licenses.

Bitlocks

A bitlock (also known as a “dongle”) is a hardware device that fits into the computer’s USB port. Much like the key in a car, Petra will not start without this device and will shut down when removed. Bitlock licensing is simple and works well for offsite/field work, but can make sharing software licenses between different users difficult since the physical bitlock needs to be shared around an office.

Network Licenses

With a network license, users obtain a license from a license manager program running on the network. If a license is available, then Petra runs normally. If a license is not available or there is no network connection to the server, Petra will not run. In contrast to a bitlock, a network license manager requires a network connection to work but can make sharing licenses between multiple users in different locations much easier.
The license manager does not have to be installed on the same server where the Petra program files reside but must be visible from the user’s workstation.

### 2.4 Config.EXE

Config.EXE changes the parameters of an individual standalone or client Petra installation. This utility is automatically installed during the Petra client installation and is located in the same subdirectory as the Petra client software. It automatically runs as part of the client software installation, but can also be run later to change any of the parameters.

![Petra's configuration program, Config.EXE](image)

**System Path** – This entry sets the location of the Petra executable files. By default, this is C:\Petrasrv

**Client Path** – This entry sets the location for each client installation. By default this is C:\Geoplus1.

**Project Path** – This entry sets the default location for newly created projects.

**Parms Path** – This entry sets the default location of user-specific private parameters.

**Security Key Type** – For bitlock-based licensing, this entry selects between a RainbowNetC or a NetHASP license.

**Obtain Petra License From** – This option sets whether Petra looks for a license from a network server or a bitlock/unlock code.

**Obtain PetraSeis License From** – This option sets whether PetraSEIS looks for a license from a network server or a physical bitlock/unlock code.
In the example below, the server software is on `\server1\petrasrv`, the client software is on `c:\geoplus1`, the default path for the public or shared part of the projects is `\server2\geoplus\projects`, and the default path for each individual's private parameters starts at `\server2\geoplus\users`.

### 2.5 Geoplus.INI

Geoplus.INI stores user-specific data like window sizes, and the previous projects opened. For standalone installations, this file will be in the installation directory. For client\server installations, geoplus.INI will be in the client directory.

![Geoplus.INI File Example](image)

**Figure 1: An example of a Geoplus.INI file**

**[STARTUP]**

The Startup section modifies how Petra first loads up. Most users will never need to change the variables in this section.

- **VerSize**, **WindoLeft**, **WindoTop**, **WindowD**, **WindoHT**, **WindoMax** - These options set the starting location of the Main Module.
- **PrevVer** – This variable stores the previous installation's version number.
- **PrevProject** - This variable stores the last opened project's name.
- **CurrProject** – This variable stores the current project name.
- **HideWelcome** – Setting this option to “1” hides the Petra welcome screen.
- **ProjectListSortType** – This option sets how Petra sorts the projects on the project open screen. Setting this option to “0” sorts projects alphabetically, while setting this
option to “1” sorts projects by the last used date.

**ProjectListSortOrder** – This option sets how Petra sorts the projects on the project open screen. Setting this option to “0” sorts projects in an ascending order (A to Z, recently used to less recently used), while setting this option to “1” sorts projects in descending order (Z to A, less recently used to most recently used).

**Editor** – This option sets the executable for the default text editor.

**SkipUpdateCheck** – Setting this option to “1” forces Petra to skip looking for updates.

Example

```
[STARTUP]
VERSIZE=1
WNDOLEFT=1763
WNDOTOP=158
WNDOWD=1344
WNDOHT=675
WNDOMAX=0
PREVVER=3.6.0
PREVPROJECT=C:\geoplus1\PARMS\MEXICO.INI
CURRPROJECT=C:\geoplus1\PARMS\MEXICO.INI
HIDEWELCOME=0
PROJECTLISTSORTTYPE=0
PROJECTLISTSORTORDER=0
EDITOR=NOTEPAD.EXE
SKIPUPDATECHECK=0
```

**[WMS]**

The WMS section stores the URL, username, password, and layer of the last WMS server accessed in the Map Module. This makes it easier for the user to reconnect to the last server they were using. For servers that don’t need authentication, the user and password remains blank.

Example

```
[WMS]
url=http://gaia.inegi.org.mx/NLB/mdm5.wms
user=
password=
LayerList=SATELLITE
```

**[PLOT]**

The Plot section controls how Petra plots maps and cross-sections.

**HideDateStamp** – Setting this option to “1” hides the date stamp at the bottom of
maps and cross-sections.

Example

```
[HIDEDATESTAMP=0]
```

### 2.6 PETRA.INI

Petra.INI stores installation-wide settings like notifications and licensing. **Importantly, this INI file also controls some important administrative functions, including controlling who can delete wells or change map projections.**

This file isn't created automatically, so it’s necessary to either create it from scratch or copy the sample Petra.INI located in the PetraSRV\PARMS folder. To affect only a single project, save Petra.INI inside the project’s root directory. To affect every project used on a Petra installation, save Petra.INI to the Petra installation directory.

#### [GENERAL]

The General section sets a few system-wide options on how Petra interacts with external programs and services.

- **AllowRememberLogin** – This option sets whether Petra provides an option to remember the last user logon. Setting this option to “NO” disables caching the user name and password.

- **ShowWebsite** – By default, Petra has a link to the download website built into the Help dropdown on the top of the Main Module. Setting this option to “NO” disables this link.

- **Notify** – Setting this option to “YES” hides the license expiration notice shown during
MJDelaySec – This option sets the length of time (in seconds) that Petra waits and retries to receive direct connect raster logs from MJ LogSleuth.

AdminPswd – This option sets a password on the entire project. Only users with the password can open the project.

LICUncNames – Setting this option to “YES” forces Petra to use UNC (Universal Naming Convention) paths rather than LFS (Local File System) when working with log or map images. UNC syntax describes network paths with double slashes and names (such as \ComputerName\SharedFolder\Resource), while LFS syntax uses drive letters.

UserApplName – Petra can launch an external application and pass the selected well UWI to it. This option sets how the application’s name appears in Petra’s menu. Note that this entry has a maximum of 30 characters. This option can be overridden by a client’s geoplus.ini file.

UserApplPath - This option sets the path and filename of the external application. This option can be overridden by a client’s geoplus.ini file.

BingMap – This option overrides the default URL for Bing maps available on the Location Tab of the Main Module. The default is http://www.bing.com/maps/

Bing_WGS84_DatumShift – Bing’s maps use the WGS84 reference datum. By default, Petra recalculates the LatLons from the project reference datum into WGS84 before it sends the LatLon to Google maps. Setting this option to “NO” forces Petra to send the raw LatLons directly from the project.

SaveDefaultProjection – Setting this option to “YES” prevents any user from creating a system-wide default map projection file. Note that these files are kept in the system params folder as DefProjection.BIN or DefProjection1.BIN.

AllowUserProjection – Setting this option to “NO” prevents users from creating user-defined coordinate systems under the “Standard” Coordinate System Tab in the Map Projection Settings window.

BkgndScan – Setting this option to “YES” will tell Petra to scan every project’s well locations to compute the LatLon extents. These limits are stored in each project’s INI.
file.

**BkgndScanTime** – This option sets the amount of time (in minutes) Petra waits between project extent scans. By default, Petra waits 30 minutes.

**SkipUpdateCheck** – By default, Petra checks for newer versions at every startup. Setting this option to “YES” skips this check.

**AllowPrivateMode** - Setting this option to "YES" will allow users to run Private Mode locally. Setting this option to "NO" will disallow private mode.

**HideLoginDialog=**YES/NO - Setting this option to "YES" will attempt to hide the Login screen when possible, such as when the "Remember My Password" option is selected or when using Active Directory. Note that the login screen will still appear when Petra needs a username and password.

**Example**

```
[GENERAL]
SHOWWEBSITE=NO Prevents users from using link to www.geoplus.com WEB Site
; NOTIFY=NO Turns off Maintenance Expiration message
; MJDELAYSEC=15 - Sets Petra’s delay for MJ LogSleuth
; ADMINPSWD=SFTY3RD - Sets an administrative password for the project
; LICUNCNAMES=YES - Used to allow UNC names for LIC files.
USERAPPLNAME=Company Document Manager
USERAPPLPATH=\geoapps\welldocs\software\mgr.exe
; MODIFYPLACESBAR=NO
; GOOGLEMAP= http://maps.google.com/maps
; GOOGLE_WGS84_DatumShift=NO
; SaveDefaultProjection=NO
; AllowUserProjection=NO
; BKGNDSCAN=YES
; BKGNDSCANTIME=30
; SKIPUPDATECHECK=NO
```

**[USERSOURCE]**

By default, Petra treats all users in a project equally. All users have the power to delete or change all data and to change map projections – in short, all users have the power to irreparably destroy a project. The UserSource section creates a system of user source codes that effectively limits what an individual can do. Only administrators can delete wells, change the reference datum or coordinate system, globally delete data, or modify any tops other than their own.

To change user names while inside a project, select **Project>Settings>Set User Source Code...** and enter the appropriate user name.
Enabled – This option enables administrators and regular users. Set this to 1 to enable administrators.

Blanks – This option controls how formation tops with blank source codes are handled. When this option is set to 0, all users can modify a top with a blank source code. When this option is instead set to 1, only administrators can modify a top with a blank source code.

Adminlist – This line sets the user source codes for administrators. Administrative users should be separated by commas with no spaces. In the example below, “tdw, bob,hlm” sets three users as administrators: tdw, bob, and hlm.

Example

[USERSOURCE]
; BLANKS=0 - everyone can modify a top if it has a blank source code
; BLANKS=1 - no one can modify a top if it has a blank source code unless they are a member of the ADMINLIST
; ENABLED=1
BLANKS=1
ADMINLIST=tdw,bob,hlm

[LOGARC]
This section onfigures how Petra retrieves logs with LogTech software.

Program – Normally, Petra uses the user registry to find the LOGARC retrieve executable. This option overrides the pathway for the LOGarcve.exe

Example[LOGARC]

PROGRAM=\geoapps\LOGARC\LOGarcve.exe

[NOTICE]
Petra can display a couple of different kinds of notices. The “broadcast notice”
displays for a few seconds when Petra first starts up, while the “kill notice” warns users for a few seconds before Petra forcibly shuts down.

**User Broadcast Notice**

Though most of the formatting like text size and color is controlled by the actual document, Petra.INI has a few additional settings that change how the broadcast notification works.

**UBCWaitSec** – This option sets the length of the notice in seconds. Users can close the notice at any time with the “close” button on the bottom of the notice.

**SoundFile** – This option adds a sound file that plays whenever the notification opens. Set the path and file name of the wave file, or just the name of the wave file if it’s in the installation directory.

**NotifyKill**

Though most of the formatting like text size and color is controlled by the actual document, Petra.INI has a few additional settings that change how the kill notification works.

**KillWaitSec** – This option sets the number of seconds the kill notice will display before closing Petra.

**KillSound1** – This option sets the filename and pathway of the sound file that plays when the notice first appears.

**KillSound2** – This option sets the filename and pathway of the sound file that plays once per second while the kill notice is counting down.

**KillSound3** – This option sets the filename and pathway of the sound file that plays when the kill notice closes and forcibly shuts down Petra.

**General Notice Settings**

**BackColor** – This option sets the RGB values for both the kill notice and the broadcast notice background. By default, this option is set to 255, 255, 255 for white. In the example below, the values for other colors are added as comments.

**Example**

```
[NOTICE]
;SOUNDFILE=<wave file>
UBCWAITSEC=30

KILLSOUND1=<wave file> Sound file to play when notice appears
KILLSOUND2=<wave file> Sound file to play once per second
KILLSOUND3=<wave file> Sound file to play when removing notice
```
KILLWAITSEC=30        Seconds to display user notice before closing

BACKCOLOR=255,255,255
; BACKCOLOR=250,0,0        Red
; BACKCOLOR=250,40,70      Pink
; BACKCOLOR=0,255,0        Green
; BACKCOLOR=0,0,255        Blue
; BACKCOLOR=255,255,0      Yellow
; BACKCOLOR=40,135,250     Light blue
; BACKCOLOR=212,212,212    Light Grey
; BACKCOLOR=255,255,255    White

[NETLOGIN]

The Netlogin section controls FlexLM licensing and stores a record of users entering and exiting Petra projects.

FlexLM

FlexLM – Set this option to “YES” to enable a FlexLM license.

FlexLMLicPath – This option sets the FlexLM port and machine hostname.

FlexLMDaDataLic – This option enables Petra "data access" licenses for data transfer. By default, data transfer occupies a Petra license.

Project Access Log

The project access log keeps a record of users logging into and out of the projects used on the specific Petra installation. This file is ordered bottom to top, with the most recent activity at the beginning of the file and the oldest activity at the bottom. Note that this file can be easily cut and archived - Petra will create a new "LogFileName" the next time someone logs in or out of Petra.

Example

Larry Harvey, 8/28/2006 5:22:52 PM, Closed:
    c: \geoplus1\projects\SoonerDemo
Larry Harvey, 9/5/2006 3:43:02 PM, Opened:
    c: \geoplus1\projects\SoonerDemo

LogProjectAccess – This option turns on the logging feature. Set this option to YES, and establish a valid file pathway with the LogProjectAccess option to start logging.

LogFileNamex – This option sets the pathway for the Note all users must have read/write access to this log file.

Example
[NETLOGIN]
;------------------------------------------------------
; to enable network flexlm licensing use the following
; two keywords. Needed is the Port and machine hostname
; where flexlm is running.
;
FLEXLM=ENABLED
FLEXMLMLICPATH=27000@petraserver
FLEXLMDATALIC=YES

;------------------------------------------------------
; ****LOGIN LOG FILE****
; Network version login monitoring log file. This file
; will contain date-time stamp of each time a user
; acquires or is denied a Petra network license.
;------------------------------------------------------
; uncomment and put path to common location that
; all users have read/write access to
;
LogFileNamem=\server1\petrasrv\petralogin.txt
;
; set LogProjectAccess=YES to have the user's project name added to
; the login file to track opening and closing Petra projects
LogProjectAccess=YES

[IMPORT]

LASPath – This option sets the default folder path for importing LAS files.

RasterPath – This option sets the default folder path for importing raster logs and calibration files.

IHS (US) raster logs

IHSLogNDXRootFolder - This option sets the path of the folder containing the LIC and TIF files.

IHSLogNDXDBFolder – This option sets the path of the folder containing the IHS catalog database files (tblLogs.dat and tblLogs.idx)

LICCat.exe

LicCatalog - This option sets the path and name of the catalog database file (DBIsamdatabase with no extension) created by LICCat.exe. This catalog can be used for batch import of LIC files.

Example

[IMPORT]
LASPATH=
RASTERPATH=
IHSLOGNDXROOTFOLDER= H:\LOGDATA
IHSLOGNDXDBFOLDER=H:\LOGDATA\IHS_ENERGY\Rock Mountains\database
LICCATALOG=

[MAPTEXT]
The MapText section sets a message that’s printed at the bottom of every Petra-produced map. This can be useful for displaying a copyright or disclaimer.

**TextHt** – This option sets height of the text. Petra uses 0.065 inches by default, which works out to be about a 5 point font.

**Position** – This sets the relative position of the text along the bottom of the map. This option accepts “LEFT”, “CENTER”, or “RIGHT.” By default, Petra uses “CENTER.”

**Line1** – This option sets the actual text. Note that you can actually set several lines (e.g. Line1, Line2, Line3…)

Example

[MAPTEXT]
TEXTHT=.1
POSITION=LEFT
LINE1=Property of XYZ Energy
LINE2=Copyright 2011
LINE3=All Rights Reserved

[ENERDEQ]
The ENERDEQ section controls how Petra accesses the US part of IHS Direct Connect. These parameters are usually only needed for intranet installs of the data server or if your company has a proprietary version of the IHS database.

**URL** – This option sets the URL of the IHS Web Services server.

Example

[ENERDEQ]
url=https://webservices1-2.ihsenergy.com/WebServices

[IHSCAN]
The IHSCAN section controls how Petra accesses the Canadian part of IHS Direct Connect. These parameters are usually only needed for intranet installs of the data server or if your company has a proprietary version of the IHS databases.
WELLSERVER – This option sets the URL of the Canadian IHS Web Services server.

WELLPORT – This option sets the port address of the Canadian IHS well data server.

SERVER – This option sets the server address of the Canadian IHS well data server.

PORT – This option sets the port address of the Canadian IHS well data server.

HIST22 – Canadian well locations can have slightly different locations based on different versions of the Alberta Township System (for example, ATS2.6 vs ATS2.2). By default, Direct Connect uses the most up-to-date grid. This option instead requests well locations (when available) based on the older AST2.2 grid.

For NAD27 projects, when HIST22=NO (or is blank) Petra downloads the most recent well locations based on the ATS2.6 grid for Alberta, the BC2.0 grid for British Columbia, the MLI07 grid for Manitoba, and the STS25 grid for Saskatchewan. Setting HIST22=YES will force Petra to download historical well locations based on the ATS2.2 grid.

For NAD83 projects, well locations are only available in BCTS20 for British Columbia, MST0305 for Alberta, MTS10 for Manitoba and STS25 for Saskatchewan. Setting HIST22=YES does not apply for projects in NAD83.

Note that the HIST22 setting will be reported at the top of all log files for Canadian Direct Connect well data downloads.

Example

[IHSCAN]
;SERVER=petra.ihsenergy.com
;PORT=5557
;WELLSERVER=petra.ihsenergy.com
;WELLPORT=555
;CANADACHGDATE=YES

[WMS]

The WMS section creates a predefined list of WMS servers. Petra can store multiple server names, usernames, passwords, and descriptions in different “groups.” Each group is separated by a numerical suffix at the end of each option (shown as a “#” in the descriptions below). Put another way, for each different WMS server url, username, password, and description, put a different number at the end of the option. These numerical suffixes don’t need to be consecutive, in order, or start at 1; they just need to be different for different servers.

URL# - This option sets the URL address of the WMS server.

Description# - This option creates a description of the server. This description can be up to 256 characters.
User# - This option sets the username for the WMS server. Many servers don't require a username or password authentication. When working with these servers, leave the user name and password blank.

Password# - This option sets the password for the specified username for the WMS server. Many servers don't require a username or password authentication. When working with these servers leave the user name and password blank.

ConnectTimeout - This option sets a timeout in msec when connecting to WMS service.

Example

[WMS]
url1= http://130.88.200.176/ecwp/ecw_wms.dll?
request=GetCapabilities&service=wms
user1=RFROST
password1=SFTY3RD
description1=Image Web Server
url2= http://198.96.62.209/wms/cascader?REQUEST=getCapabilities&service=wms
description2=Fusion
ConnectTimeout=5000

[DEFAULT]

The DEFAULT section sets company-wide settings to control Petra Map Module default settings. It’s sometimes necessary to reset the Map Module (Project>Settings>ResetModule on the menu bar at the top of the Main Module) before these options take effect in existing projects.

Map_DirSurvEnable – This option sets the default for how directional wells are displayed in the Map Module. Setting this option to “TRUE” turns on directional wells, while “FALSE” turns off directional wells. Note that an individual user can always change their specific setting with Wells>Directional Survey>Enable on the menu bar at the top of the Map Module.

Map_OvlyAutoSaveMins – This option sets the default length of time in minutes between when Petra automatically saves the overlay file.

Map_OvlyAutoSaveLvls – This option sets the total number of backup autosaved overlays.

Map_GridDir – This option sets the pathway to a default grid folder.

Example

[DEFAULT]
MAP_DIRSURVENABLE=FALSE
[HTTP]

The HTTP section allows an administrator to set company-wide settings for accessing the internet. These parameters are not required to be entered.

**ConnectTimeout** – This option sets an optional timeout when connecting. The default is 60,000 msec.

**SendTimeout** – This option sets an optional timeout when sending request. The default is 30,000 msec.

**ReceiveTimeout** – This option sets an optional timeout when receiving response. Default is 30,000 msec.

Example

[HTTP]
ConnectTimeout=120000
SendTimeout=60000
ReceiveTimeout=60000
Chapter 3
3 Petra Projects

Petra stores all the data relevant to a particular geographical area in a single project. When sharing projects, all concurrent users of the project have immediate access to all changes made by all other users. Some spreadsheet displays contain a local copy of the data, so it may be necessary to refresh the spreadsheet to see the latest changes.

For single user projects, the project and parameter data may reside entirely on your local disk if so desired.

How Does Petra Store Data?

Petra is a set of tools designed to work with a central project database. Petra stores project data in database tables and in external folders. Users sticking with the default file locations should have few problems with file structure.

For a much more detailed explanation, see Project Data Architecture.

What Data does Petra Store?

Wells

After setting a map projection and the units of measurement, adding wells is generally the first step to importing data into a project.

Every well in the Petra database has a different "Unique Well Identifier" (UWI). The UWI is a 1 to 20 character identifier and is typically the API number of the well.

When a well is imported into the Petra database, it's automatically assigned a unique "Well Sequence Number" (WSN). The WSN is simply the order in which the well was brought into the database; the first well imported has a WSN of 1, and the 1051st well in the database has a WSN of 1051.

Selecting Wells

Prospects

A prospect is a smaller subset of the wells in a project, and are useful for focusing on a smaller area of interest. Changes made to the database while in prospect mode will affect the wider project as a whole. This includes adding or deleting wells, modifying logs, editing zone information, importing data, or map projection changes.

Zones

Petra defines a “zone” as a specific interval defined by a discrete top and a base. Usually a zone’s top and base are defined by specific formation tops so that the zone
covers a consistent lithostratigraphic unit. Inside each zone, Petra stores a “Data Item” such as isopach, net pays, or log measurements that relate to that zone. Since zones and their data items are shared across all wells in a project, this method of organizing data makes storing and mapping single-value data for a specific formation much easier. As an example, mapping all the isopach values for a specific formation is much easier when the values are all stored in one common zone data item for each well.

**Using the Zone Tab**

**Zone Maintenance**

---

**Intervals**

*Interval data* stores data to a specific depth interval that doesn't fit well with the traditional zone concept, such as data that is too fine (such as core descriptions) or too coarse (such as mud weights or biostratigraphic information) to fit inside two formation tops. Petra stores interval data in tables and fields similar to a spreadsheet.

**Logs**

Log curves come in two major types - digital and raster. Digital logs are the actual values for the curves, while raster logs are simply the depth calibrated scanned images of paper logs. These curves can be displayed on the Cross Section and log calibration modules, as well as used in some calculations. Users can administrate and modify these logs on the Main Module's *Rasters Tab* and *Logs Tab*.

**Formation Tops**

Petra stores *formation top* data with a combination of name, source, depths, quality,
and time. Petra attempts to calculate the SS and TVD based on the active datum and directional survey data.

Production Data

Petra stores monthly production streams from the selected well on the well list. The raw data can be viewed and edited on the Main Module's Production Tab. The Monthly Production Analysis Module analyzes a single well's production stream and estimates EUR from a decline curve. The Production Group Plot Module analyzes multiple wells' production streams. The group plot tool can sum multiple wells together, average them, or time-normalize multiple wells to a single starting date.

IP and Fm Tests

Petra stores Initial Pressure or Formation Tests in the database, and are available on the Main Module's IP Tests Tab and the FM Tests Tab.

3.1 File Architecture

Petra stores project data in a series of tables, external public folders, and private folders.

Project Tables

Petra stores each project’s internal database files in a series of tables named for the data type. This data includes wells, digital logs, and zone data.

Petra uses a dedicated Windows database server that mediates how every user reads and writes to the database tables. In Shared Mode, Petra uses an external database server. In Private Mode, however, Petra uses an internal database server built into Petra’s Main Module.

Public Folders
Each project has a single master folder called the “Project Folder.” This project folder is always named after the project, and contains several folders including GRIDS, IMAGES, OVERLAY, and PARMS. These folders are Petra’s default storage location for shared external files.

A Private Mode project folder

**Private Folders**

Private files are external files created by an individual user that customizes Petra’s behavior and appearance. This includes *.MAP and *.CSP files, import templates, color bars, and WSN lists.

A user’s private folder

### 3.1.1 Project Tables

Petra stores each project’s internal database files in a series of tables named for the data type. These project database files are stored in a single project folder that reflects the name of the project. In the screenshot below, the Tutorial project has a “TUTORIAL” folder that contains all the table files.
As an example, well data for a v3 project is stored in the WELL.EDBIDX, WELL.EDBBLB, and WELL.EDBDAT files. A table index file (*.EDBIDX) keeps track of where data is stored in a table’s associated data (*.EDBDAT) file. The Binary Large Object (*.EDBBLB) actually contains the data.

Petra reads and writes to these tables with a dedicated project database server. This database server also performs project repairs and maintenance, establishes users and permissions (“roles”), and delivers user settings.

3.1.2 Project Public Folders

Public files are often shared between users and are a common part of a project. Related public files share a single folder for a project; overlay files in a project, for example, often share a single OVERLAY folder for that project.

For clarity of terminology, Petra (by default) stores public files (like grids and raster logs) in a set of “public folders.” Each project has a single master folder called the “Project Folder.” This project folder is always named after the project. The network location of the project folder is the “public path.”

The Public Project folder takes the name of the project, and contains several folders including GRIDS, IMAGES, OVERLAY, and PPARMS. The GRIDS folder is the default location of all contour grids created in the Map Module. The IMAGES folder is the default location for raster images and their associated *.LIC files. The OVERLAY folder is the default location for Map Module overlay files. Importantly, the GRIDS, IMAGES, OVERLAY, and SHAPES folders are optional; it’s perfectly reasonable to establish alternate locations for this data.
In addition, Petra creates the REPORTS and SHAPES folders when a relevant task is performed in the project. More specifically, Petra creates a SHAPES folder when a user opens the Import Shapefiles tool in the Map Module. Petra creates the REPORTS folder when a user creates a report, such as during a LAS import.

For projects migrated from earlier versions of Petra, the Project Public File directory will remain the same. For new projects created in Petra v4, the default directory is in the PROJECTS folder inside the Petra installation folder.

3.1.3 Project Private Folders

Private files are external files created by an individual user that customizes Petra’s behavior and appearance. This includes *.MAP and *.CSP files, import templates, color bars, and WSN lists.

For clarity of terminology, Petra (by default) stores an individual’s private files in a “private folder.” The network location of a user’s private folder is the “private path.”

Each private folder should be separated both by user and by project. Petra creates an individual private folder named by project, so it’s generally best to create a separate directory for each user. This will generally look something like USERNAME/PROJECT. The private folder acts as the default location for *.MAP and *.CSP files, import templates, WSN lists, and other user-created files.
For projects migrated from earlier versions of Petra, the user's private pathway will remain the same. For new projects created in Petra v4, the default directory is in the PROJECTS folder inside the Petra installation folder; for multi-user projects, changing this path to a different location is usually a good idea.

3.2 User Broadcast Notice

The User Broadcast notice message can be useful for notifying all users of maintenance outages, users group meetings, or for a “tip of the day.” The notification will close on its own after a user-defined number of seconds, or a user can select the “close” button at the base of the notify screen.

To create a notice, create a Rich Text File document with Microsoft Word or Microsoft Wordpad, and save the file as “Notify.RTF.” Placing this file in the installation subdirectory (by default PetraSRV) will display the notification for every user using that installation. Placing the notification file in the root folder of a project will only display the message to users opening that specific project. The notification message can be displayed at any time by selecting Help> Show Notice Message on the menu bar at the top of the Main Module.
Though most of the formatting like text size and color is controlled by the actual document, Petra.INI has a few additional settings that change how the broadcast notification works.

UBCWaitSec – This option sets the length of the notice in seconds. Users can close the notice at any time with the “close” button on the bottom of the notice.

SoundFile – This option adds a sound file that plays whenever the notification opens. Set the path and file name of the wave file, or just the name of the wave file if it’s in the installation directory.

3.3 NotifyKill

The Kill Notice forcibly closes Petra for all users, which is sometimes necessary for project table maintenance. To create a notice, create a Rich Text File document with Microsoft Word or Microsoft Wordpad, and save the file as “KillNotify.RTF.” Placing this file in the installation subdirectory (by default PetraSRV) will shut down Petra for every user on that installation. Placing the notification file in the root folder of a project will shut down Petra users in that particular project. Petra will also refuse to run (as shown on the example below on the right) while notifykill.RFT remains in the project or installation folder. Note that Petra comes with a copy of XNOTIFYKILL.RTF in the installation directory – removing the “X” from the beginning of the file name enables the kill notice.

Figure 1: The default “kill notice” screen (left), and Petra refusing to run while KillNotify.RTF is in the directory (right)

Though most of the formatting like text size and color is controlled by the actual document, Petra.INI has a few additional settings that change how the kill notification works.
**KillWaitSec** – This option sets the number of seconds the kill notice will display before closing Petra.

**KillSound1** – This option sets the filename and pathway of the sound file that plays when the notice first appears.

**KillSound2** – This option sets the filename and pathway of the sound file that plays once per second while the kill notice is counting down.

**KillSound3** – This option sets the filename and pathway of the sound file that plays when the kill notice closes and forcibly shuts down Petra.
Chapter 4
4 Main Module

Organized into a list of wells on the left and a series of tabs on the right, each tab section displays details of a specific data type for the well. Clicking on different wells in the well list provides the details in the tab sections. Any data in the tabbed sections may be modified by simply typing over the data. Each tab contains a "save" button which must be clicked to change the data in the database. Petra will automatically prompt you to save the data if you change data then click to another well. Unlike other modules, the Main Module is always open.

Getting Started

Setting a Map Projection
Importing Data
Exporting Data
Selecting Wells
Using the Main Module Tabs
Using the Main Module Toolbar

Opening Other Petra Modules
Map Module
Cross Section Module
Spreadsheet Module
Log Cross Plot Module
Z Cross Plot Module
Histogram Module
Monthly Production Analysis Module
Production Group Plot Module
Thematic Mapper Module
3D Visualizer Module
Slip Logs Module
Log Correlation Module
Directional Well Module

Advanced Tools
System Settings
Compute Functions
Advanced Volumetrics (Deterministic & Monte Carlo)

4.1 System Settings

Petra Program Options
System Colors
Reset Module
Tab Colors
Password Protect Project
User Source Code
4.1.1 PETRA Program Options

Petra’s Program Options control many of the details on how Petra runs. Note that changing these aspects can change how all users interact with Petra.

To open the Program Options screen, select Project>Settings>Program Options on the menu bar at the top of the Main Module, or select CTRL + O while the Main Module is selected.

**General Tab** - This tab controls many of the details on how Petra runs.

**Font/Graphics Tab** - This tab controls how Petra displays text and “transparent” colors.

**Well List Synchronization Tab** - This tab controls how Petra synchronizes wells between different modules.

**Files Tab** - This tab controls how Petra interacts with external text and image files.

**Locks Tab** - This tab locks well data, locations, and the project map projection.

**UWI Search Tab** - This tab controls which characters Petra ignores when searching for UWIs.

**DBI Tab** - This tab controls the amount of memory allocated to each module.

**Public Tab** - This tab controls how Petra works with multiple users.

4.1.1.1 General Tab

The General Tab changes a variety of settings for Petra as a whole. To open the Program Options tool, select Project>Settings>Program Options on the menu bar at the top of the Main Module. Alternatively, select CTRL + O when the Main Module is
active.

**PETRA Program Options**

**The General Tab**

*Hide Startup Welcome Screen* - This option hides the Welcome screen which allows you to open the previously accessed project, open an existing project, or create a new project. Instead, Petra will display the main screen in the closed project state. To open a project or create a project, use the menus or speed buttons.

*Hide Plot Date Time Stamp* - By default, Petra plots a small label in the lower left corner of all printed graphics showing the date and time the output was produced. Use this option to enable or disable the date-time label.

*Use Formation Top Aliases with Zone Definitions* - This option determines whether or not to apply top aliases when converting a zone interval to depths.

*Remember Previous Directory Path For Import/Export* - With this option selected, Petra will remember the location of the last file imported or exported, and use that pathway when the import or export dialog reopens.

*International Project Area (Non-US)* - With this option set, the main well and location tabs will not show US state-county and location buttons.

*Remember Previous Screen Positions* - This option keeps dialog screens stay in the previous location on the screen after moving them. This is particularly useful with dual monitors.

*Disable Well Symbol Translation During Import* - The "SymTrans.DEF" file is used to translate well symbol codes during data import. For example, a PI symbol code of 2GAS will be translated to simply GAS in the data base. Use this option to disable such translation.
Fast Well Deletions - When this option is deselected, Petra removes all records in all database tables associated with the deleted well. Slow well deletions free up unused space, but can take a long time to complete. The Fast Well Deletions option, on the other hand, removes the reference to the deleted well (so it appears to be deleted), but does not actually remove the records in the database so the database continues to use the same amount of space on a hard drive.

Track Main Module Well Selection On Map - This option highlights the well selected in the main module on the Map Module. This feature works best with dual monitor setup where you have the main on one screen and the map on another.

Do Not Use "Blocks" for DXF Symbol Output - Check this option if you are creating DXF files from a map or cross-section and the application that will read the DXF file cannot handle DXF "blocks" generated for well symbols.

Force DB Buffer Refresh - This option disables the caching or buffering of database table updates. Importing data can be slowing with this option enabled.

Enable Zone Item Aliases - Zone data item aliases are enabled when this option is checked. Zone item aliases perform like formation top aliases, allowing multiple sources of equivalent zone items to be searched based on a prioritized listed.

Disable Use of Logging File (PetraLog.txt) - Check this option to suppress writing logging messages to the project's log file. Examples of logging messages are when wells are deleted or when the map projection changes.

Use Public Parms Folder for Template Files - This option can be used to control the default folder used when saving/loading various template files. Either the Private or Public Parms folder will be used.

Suppress Save Prompt In Main - Check this option to suppress the prompt you receive when changing between wells or tabs after changing data. Changes are saved automatically.

Use Buttons on Main Tab - With this option checked, the main screen will display the data "tabs" with a button style instead of the normal tabs. With buttons, it is sometimes easier to see which tab you're on.

Disable Use of Logging File - By default, PetraLog.TXT stores a comprehensive log file of changes made in the project. This list includes map projection changes, well and seismic line deletions, and loading or saving overlays. This option disables this log.

Display Lat-Lon and XY with Extended Precision - With this option enabled, the Main Module will show LatLon and XY values with more more decimal places on the Location Tab.

Substitute TD for Missing Zone Base Values - This option forces Petra to use the total depth (TD) as a substitute for missing zone base values. This can have a significant effect on calculations that use zone boundaries, including isopach and log calculations.
Always Start with All Wells Selected in Main and Map - By default, the Main and Map Modules open with the same set of wells selected when the module was closed. With this option selected, the Map Module and Main Module will start up with all wells in the project selected.

Disable 10-12-14 Digit API Matching (Exact UWI Match Enforced) - During imports, Petra normally attempts to match 10, 12, and 14 digit API numbers from the input file with a 10, 12, or 14 digit well currently stored in the database. This will deactivate they checking and require imported wells to match the UWI exactly.

Include Quality Code for Tops and Zone Items "Active Only" Mode - This is a display feature for the Main module's Tops and Zones tab.

Allow Data Import While In Prospect Mode - This option allows Petra to import data while a prospect is selected, rather than the full set of wells in the project.

Disable Open/Save Dialog "Favorites" Buttons - When importing data, the Windows "open dialog" screen is used. Petra modifies this dialog to add "favorite" buttons that allow you to quickly access the Desktop folder, the last used import folder, the Petra project folder, and the project's PARMS folder. You should disable (Check this item) this feature if your PC configuration causes a "place0 error"

Skip Petra Update During Startup - By default, Petra notifies users of available updates. This option disables this notification.

Lat-Lon Displayed As

This option changes how latitude and longitude values are displayed. "Decimal Degrees" will display as 25.00325, -95.34054, etc. "Deg-Min-Sec" displays as 25:00:11.7 and -95:20:25.95. Note that users can enter LaLlon values by typing in either format.

Dates Displayed As

This option changes how dates are displayed. Dates can be displayed as MM/DD/YYYY or DD/MM/YYYY

4.1.1.2 Font/Graphics Tab

The Font/Graphics Tab changes how Petra displays default text and lines. To open the Program Options tool, select Project->Settings->Program Options on the menu bar at the top of the Main Module. Alternatively, select CTRL + O when the Main Module is active.
The Font/Graphics Tab

Default Font - This dropdown sets the default font for plotted text.

Print WHITE Text As - Normally, white text on the screen is plotted as black when printed. This option causes the white text to remain white when printed. Use this option when you need white text to appear on top of images.

Generate Black & White Plots Only - This option overrides all color plotting to the printer so that all colors are converted to black.

Transparent Color Fill Optimizer - This option controls how transparent color fill on top of raster log images is handled by plotter drivers. Some plotter drivers cannot transparent fill directly, so Petra has alternative methods to generate the fill. The "Direct Fill" method should be used whenever possible. If problems arise in cross-section raster log pay intervals or tops shading, first try the "Indirect Fill" method, and if that does not work, use the "Disabled" method. When the optimizer is disabled, plot files will become significantly larger.

Graphics Character Set - This dropdown sets whether Petra uses an English or Russian character set.

User Pen Sizes - These entry boxes set the line thickness for user pen sizes. These pen sizes appear in the Map and Cross Section overlays.

4.1.1.3 Well List Synchronization Tab

The Well List Synchronization Tab controls how different modules share selected wells. To open the Program Options tool, select Project>Settings>Program Options on the menu bar at the top of the Main Module. Alternatively, select CTRL + O when
the Main Module is active.

By default, Petra’s different modules can work with different subsets of wells in the project. As an example, the Main Module can have all wells selected, the Map Module can have only the wells below a certain depth selected, and the Cross Section Module can have only a handful of wells along a dip line selected. This tab establishes how different modules "send" and "receive" their list of selected wells.

Modules with a check in the "send" column will broadcast its list of selected wells to modules with a check in the "receive" column. Note that wells with both "send" and "receive" selected will broadcast well lists to other modules, but will not change their own selected wells when other modules change.

4.1.1.4 Files Tab

The Files Tab controls how Petra opens text files and saves image files (like raster logs). To open the Program Options tool, select Project>Settings>Program Options on the menu bar at the top of the Main Module. Alternatively, select CTRL + O when the Main Module is active.
The Files Tab

System Text Editor Name - This sets the executable file name of the text editor used by Petra to view or edit various text files and reports. Typical choices here are Notepad.EXE or Write.EXE.

Image Files - When the "Store Image Files With Full Path Name" option is selected, Petra stores a full path and along with the image name. In contrast, when the "Store Image Files As File Name Only and Use Search Path(s) Below" option is selected, Petra will store only the file name in the database and resolve the full name using the search path. The advantage to using a search path is that projects may be moved to a different drive and still find the images.

Alternate Path For LIC Files - When the the "Store Image Files As File Name Only and Use Search Path(s) Below" option is selected, Petra will automatically look for LIC files in this same directory. This entry sets an alternate path for LIC files.

Image File Drive Mapping - This option performs completely replaces image location drive letters. This can be useful when moving a project to a different network or when standardizing drive mapping between two different workstations.

4.1.1.5 Locks Tab

The Locks Tab helps prevent changes to well data, locations, and the project map projection. To open the Program Options tool, select Project>Settings>Program Options on the menu bar at the top of the Main Module. Alternatively, select CTRL + O when the Main Module is active.
The Well List Synchronization Tab

Enable Well Data Field Locking - When this option is selected, users can lock specific well data fields. Locked data items cannot be changed until they are unlocked. To lock a zone data item, select the zone or zones and right click to select lock/unlock for this well/all wells. Alternatively, locking also responds to keyboard commands.

CTRL + L - Lock item for this well
CTRL + U - Unlock item for this well
ALT + L - Lock item for all wells
ALT + U - Unlock item for all wells
Enable Digital Log Locking - When this option is selected, users can lock specific
digital logs. Locked data items cannot be changed until they are unlocked. To lock a
digital log item, select the log or logs and right click to select lock/unlock for this well/
all wells. Alternatively, locking also responds to keyboard commands.

CTRL + L - Lock log for this well
CTRL + U - Unlock log for this well
ALT + L - Lock log for all wells
ALT + U - Unlock log for all wells
Well Location Locking

Well locations can be locked for all wells or for individual wells. Once a well's location is locked, it cannot be changed, either by import or manual edit until the location is unlocked.

Automatically Lock Location After Manually Modified - This option automatically locks a well's location after it has been manually edited. This prevents later well location changes due to importing data later.

Lock All Locations - This option locks all well locations in the project.

Unlock All Locations - This option unlocks well locations. The unlock function will prompt you whether you to unlock all wells or only those wells that were not individually locked. Here, selecting "Yes" will unlock all wells, including wells that were locked with the global "Lock All Locations" button and wells that were manually locked. Selecting "No" will only unlock wells that were locked with the the global "Lock All Locations" button; wells that were manually locked will remain locked.

Unlocking all locations ("Yes") or only the wells not locked individually ("No")
Lock Map Projection

This option locks the project's map projection. This prevents a user accidentally changing the projection with the Map Projection Settings tool or by importing a Petra Project File (*.PPF).

4.1.1.6 UWI Search Tab

This screen changes how Petra imports and sorts wells by UWI. To open the Program Options tool, select Project>Settings>Program Options on the menu bar at the top of the Main Module. Alternatively, select CTRL + O when the Main Module is active.

### The UWI Search Tab

**Remove Special Characters from Imported UWIs to Match with DB UWIs** - This option sets special characters that should be removed from UWI values. These values are removed during import.

**Sort UWI Values As** - This option changes how Petra sorts UWIs.

"**Numeric**" Sort: 1, 10, 11, 12, 2, 3, 4, 5, 6 7, 8, 9

"**Alphanumeric**" Sort: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

4.1.1.7 DBI Tab

The DBI Tab controls how Petra uses the available system memory. To open the Program Options tool, select Project>Settings>Program Options on the menu bar at the top of the Main Module. Alternatively, select CTRL + O when the Main Module is active.
active.

![PETRA Program Options](image)

**The DBI Tab**

**DBI DataBase Client Cache Optimization** - This option sets the amount of memory used by the DBI database engine for local (client-side) caching. The default value (minimum setting) is usually sufficient. Be careful not to exceed your system's memory capabilities. Over commitment of memory to the database cache could result in extensive use of the system's virtual memory, i.e., swap file or create "out-of-memory" errors during data import.

**Do Not Cache Table Buffers on Client** - This option improves performance only on very old hardware. Any personal computer built after 1990 will run much better without this option checked.

**4.1.1.8 Public Tab**

The Public Tab controls how Petra works in a multi-user environment. These options will affect all users of a project. To open the Program Options tool, select **Project>Settings>Program Options** on the menu bar at the top of the Main Module. Alternatively, select CTRL + O when the Main Module is active.
Disable Overlay "File In Use" Feature - The overlay file-in-use feature is an overlay file sharing notification mechanism. Activate the overlay file-in-use feature when you want all users in a project to be notified if they load an overlay file that another user has already loaded. When this feature is in effect, the first user that opens a particular overlay file is considered to be the "owner" of the file. The owner is the only user that can modify that overlay file, that is, there are the only user that can overwrite that file. All other users in the project will be prevented from overwriting the overlay file. They can, however, save their changes using a different overlay file name. Changes by non-owners are only allowed if the actual owner closes the file or exits Petra without updating the overlay file.

Force Use of UPPERCASE Text for Database Items - This option forces zone database items to all use uppercase text.

Disable Map Projection Convergence Angle Correction to Directional Survey Data - This option disables the convergence angle correction for directional wells. When this option is selected, Petra assumes all directional surveys are oriented to GRID NORTH.

Save New Raster Log "LIC" Files to Same Folder as Raster Image - Normally, Petra users can save a raster's *.LIC file to any location on a network. This option forces LIC files into the same location as the raster image.

Always Prompt for External File Lat-Lon Datum during Import/Export - When this option is selected, Petra will always require the user to enter the external file's reference datum during import. This can help prevent data from accidentally being loaded with a different reference datum.
Add New Well Limiter Feature - This global or public parameter can be used to restrict or limit the maximum number of wells that can be added to a project during a "session" by a user. (note - each time you open a project you are in a new session). For example, if you activate this option and set the limit to 3 new wells, then you can add 3 new wells but when you try to add the 4th new well, a warning message appears and no more wells will be added. If you close and re-open the project, i.e., a new session, you will be able to add 3 more new wells. When you set or change this option, you must close and re-open the project before the changes will take effect. Use this feature with caution as you might wonder why you are unable to add wells to your project. This option could be used to prevent accidentally adding 1000's of wells during an import process when you really only wanted to update wells.

Save System Map Projection - This option saves the current map projection as a default for all future projects created on the installation.

4.1.2 System Colors

The System Color and Style Definitions window sets the color, line thickness, and line style for "Picture Elements" in different Petra modules. These Picture Elements include graph lines, titles, borders, and grids.

To open the System Color and Style Definitions window, select Project>Settings>System Colors on the menu bar at the top of the Main Module.
To change a Picture Element, select the specific line and select a screen color, plotter color, thickness, and style.

**Picture Element List** - Petra's Picture elements are grouped by module. As an example, map elements are listed separately from cross-section elements. Choose the picture element to customize by clicking on the Picture Element list box.

**Screen Color** - Change the element's screen color by clicking on one of the screen palette color cells.

**Plotter Color** - Change the element's plotter color by clicking on one of the plotter palette color cells.

**Line Thickness** - Choose the element's line thickness from "narrow", "normal", "wide" or "extra wide".

**Line Style** - Choose the element's line style of "solid", "long dashes", "short dashes", "dot-dashed", "dotted" or "alternating" (every other pixel).

### 4.1.3 Well Symbols

The Well Symbols window changes how Petra interprets and displays the codes already assigned to the wells.

This changes how every symbol code in the project appears on the Main and Map Modules. Note that this window does not change an individual well's symbol - to change an individual well's symbol see the [Main Module's Wells Tab](#).

A well symbol code is a 1 to 8 character value that encodes the general type of well. In the screenshot below, gas wells have a well symbol code of "GAS." Petra uses a set of "well descriptions" to assign well symbols and colors to different kinds of wells on the Main and Map Module. In the screenshot below, Petra uses a "GAS" description to draw a red gas well symbol.

To open the Well Symbols window, select **Project->Settings->Well Symbols** on the menu bar at the top of the Main Module.
The Well Symbols window

Current Well Description List - This list shows all the well descriptions currently in use in the project.

Symbol Code - This box displays the currently selected well description's symbol code.

Scale Factor - This box sets a scale factor for well symbols on the Map Module. This option can range from 0 to 10, where 1 is a normally sized well symbol.

Description - This entry creates a brief description of the well symbol.

Available Symbols - This list displays the available well symbols. There are 315 available symbols.

Screen Color Selection - This option sets the display of the symbol on the screen.

Plotter Color Selection - This option sets the display of the symbol on the screen.

Restore - This button reload the screen with the last saved well symbol descriptions.

Save - This button saves the well descriptions to an external file.
Load - This button loads an external well descriptions file into the project.

New Description - This button adds a "new symbol" well description at the bottom of the Current Well Description List.

Drop Description - This button deletes the currently selected well description.

Modifying an Existing Well Symbol
To modify the well symbol descriptions, select the desired well symbols under the "Current Well Descriptions" list box. The symbol code, description and symbol icon are shown in the "Symbol Definition" on the right. Here, change the description, code, scale factor, symbol, or colors. Click the APPLY button to replace the current symbol description with the new values.

Adding New Well Symbols
To add a new well symbol description, click the New Description button to add a new row to the current description list entitled "new symbol." Next, on the "Symbol Definition" part of the screen, change the description, code, scale factor, symbol, or colors. Click the APPLY button to replace the current symbol description with the new values.

Deleting Well Symbols
Select the desired well symbol, and select the "Drop Description" button.

4.1.4 Reset Module
The Reset Module completely resets one or more Petra modules. This can be useful for troubleshooting.

To open the Reset Module, select Project>Settings>Reset Module on the menu bar at the top of the Main Module.
Resetting a module completely removes any user settings. If possible, it's a good idea to attempt to save any user-created settings in an external template file (such as *.MAP or *.CSP files).

To reset a module, select the desired module or modules and select the "Reset Modules" button on the right of the screen.

### 4.1.5 Tab Colors

The Tab Colors window changes the **Main Module’s Tabs** from a default grey to a user-selected palate.

To open the Tab Colors window, select **Project>Settings>Set Tab Colors** on the menu bar at the top of the Main Module.
You should keep your tab colors fairly light so the tab label will show through.
The Tab Colors window lists the Main Module's tabs in a list. Note that this tool automatically opens with a default color scheme.

**Clear Current** - This button removes the current color from the currently selected tab, and returns it to grey.

**Clear All** - This button removes the current color scheme from all tabs, and returns them to grey.

**System Defaults** - This button resets the tabs to the default rainbow color scheme.

**Load Template** - This button loads an external tab color file.

**Save Template** - This button saves the current color scheme to an external tab color file.

**Interp. Missing** - This button interpolates tab colors between the top and bottom color. Note that this tool will not interpolate between a selected color and the default grey.

To change a color, first select and double-click the desired tab to open a color selection window. Here, select the desired color either from the basic colors on the left, or the extended colors on the right. Select "OK" to change the color and return to
the Tab Color window. Again, select "OK" on the Tab Colors window to save the changes.

4.1.6 Password Protect Project

The Password Protect Project window adds a password to a project. Users cannot open the project without the password.

To open the Tab Colors window, select Project>Settings>Password Protect Project on the menu bar at the top of the Main Module.

Adding a Password - To add a new password, simply enter the new password into both the "New Password" and "Confirm Password" entry boxes. Finally, select the "OK" button.
Adding a new password

Changing a Password - To change an existing add a new password, first select the "Add or Change Project Password" option. Next, enter the new password into both the "New Password" and "Confirm Password" entry boxes. Next, enter the old password into the "Current Password" entry box. Finally, select the "OK" button.

Removing a Password - To remove an existing password, first select the "Remove Project Password" option. Next, enter the old password into the "Current Password" entry box. Finally, select the "OK" button.
4.1.7 User Source Code

User source codes identify the user to the application. This can either control user permissions (if enabled in Petra.INI) or just create default source codes for new formation tops (default setting).

To change user names while inside a project, select Project>Settings>Set User Source Code... and enter the appropriate user name.

Enabled in Petra.INI

Enabling user source codes separates individuals into two classes: administrators and regular users. Only administrators can delete wells, change the reference datum or coordinate system, globally delete data, or modify any tops other than their own. Petra Database Server usernames override user source code privileges.

Not Enabled in Petra.INI

By default, all users are treated equally and can delete or change all data and change map projections. User source codes only serve as a default source for new tops.

4.2 Importing Data

Petra projects can import a wide variety of different kinds of data from a variety of formats.

Common Import Options

- Selected Wells vs. All Wells
- Fm Substitution Files
- Elevation Translation Codes
- Add New Wells and/or Update Existing wells
- Locking and Unlocking Data Fields
Protecting Data Fields

**Working with Different Map Projections**
- Importing LatLon Data
- Importing XY Data

**Well Data**
- 297 "Flat" File
- IHS Direct Connect (US and Canada)
- IHS Direct Connect (International)
- Landmark Standard 29 Files
- Generic ASCII Data

**Production Data**
- 298 File
- IHS Direct Connect Production Data
- Generic ASCII Data

**Digital Logs**
- LAS
- Batch LAS
- LIS
- Generic ASCII Data

**Raster Logs**
- IHS Direct Connect
- Uncalibrated TIF files

**Interval Data**
- Tabular Data

**Map Data**
4.2.1 Common Import Options

There are a few importing options that are common to different importing methods. These tools are designed to better import imperfect datasets and to manage how Petra treats overlaps between the database and the imported file.

**Selected Wells vs. All Wells** - Petra generally only updates the wells selected in the Main Module. Before importing anything, make sure you know which wells are selected.

**Formation Substation Files** - A formation substitution file converts formation top names in the data file to a user-set name.

**Elevation Code Translation Files** - An elevation code translation file converts non-standard elevation codes to standard elevation codes that Petra can read.

**“Add New Wells” and “Update Existing Wells”** - “Add New Wells” creates new wells when the imported data has a UWI/API code that is not in the Petra database. “Update Existing Wells” overwrites the project database with the imported data.

**Locking and Unlocking Data Fields** - Petra can selectively “lock” data items and fm tops. Data inside locked fields cannot be changed at all, including by manually overwriting the field, performing a calculation, or with importing new values.

**Protecting Data Fields** - Petra can selectively “protect” data items and fm tops. New data will not overwrite a protected field during import. In contrast to a “locked” field, “protected fields” can be overwritten by manually typing in new values or through calculations.

4.2.1.1 Selected Wells vs. All Wells

Petra can work with any user-selected subset of wells at a time. Petra modules are independent and can each work with entirely different sets of wells.

It’s possible for the Main Module to select every well in the project, the Map Module to select only wells of a certain depth or greater, and the Cross Section Module to work with only a few wells along a dip line.

When importing some kinds of data, it’s important to be aware of the wells that are currently selected in the module you’re using.
4.2.1.2 FM Substitution Files

Commercial data sources and different interpreters can use a variety of different names for the same formation. For simplicity, it’s sometimes useful to translate one or more formation names into a single, preferred name during import. A "formation substitution" file lists the preferred formation name followed by variations of that name. As an example, listing DSAND with the variant 602DKOTD will change all 602DKOTD to DSAND. **Importantly, any name not translated by the substitution file will remain as is. Some importers can use the substitution filter as a filter; formation tops not on the substitution file are skipped.**

Substitution files are a simple text ASCII file, and can be created with a text editor like Notepad or Wordpad. The file consists of a list of preferred names followed by the variants of that name. Every line has a prefix of “1” or “2”, where "1" represents the preferred name and “2” represents the variants.

```
1AAQP
200002
13675 SAND
20003675S
1ALMA & CROMWELL
2000AACL
1ANHYDRITE
2000ANDR
1ANHYDRITE 1
2000ANDR1
1ANHYDRITE STRINGER
2000ANDRS
```

A fm substitution file using IHS formation translations

Substitution files can also use the wildcard characters "*" and "?" to look for multiple variations of a name. Similar to DOS and Windows, the "*" can stand in for any number of characters, while the "?" can only stand in for one character. As an example, “ABC*” will translate any name that begins with ABC to the preferred name, while “ABC?” will translate only 4-letter names starting with ABC.

```
1COTTON VALLEY
2BOSSIER
2C V*
2COTTON VALLEY*
1JACKSON
2CADDELL
2EOCENE
1WILCOX
2CARRIZO
2WILCOX*
1CLAIBORNE
2COCKFIELD
2QUEEN CITY
2SPARTA*
2YEGUA
```
Elevation Translation Codes

The datum of a well can be important for accurately estimating subsea depths. There are a few standard codes for the different elevation measurements, such as “KB” for Kelly bushing, “DF” for derrick floor, “GR” for ground, and SEIS for the seismic datum.

Petra can correct for non-standard elevation codes during import with an elevation code translation file. An elevation code translation file lists the standard elevation codes followed by the non-standard variations reflecting the same actual elevation. As an example, listing GR with the variant GL will change all GL to GR – thus importing the datum value correctly into Petra. Importantly, any name not translated by the substitution file will remain as is, and won’t necessarily be recognized by Petra as a reference datum.

Substitution files are a simple text ASCII file, and can be created with a text editor like Notepad or Wordpad. The file consists of a list of preferred names followed by the variants of that name. Every line has a prefix of “1” or “2”, where “1” represents the preferred name and “2” represents the variants.

1KB
2KB
1DF
2DF
1GR
2GR
2GL
1SEIS
2ES

Add New Wells/Update Existing Wells

There are a couple of options on how Petra handles overlaps between the imported data and the existing database. The “Add New Wells” option tells Petra to create new wells where there’s no match between the UWI/API in the imported data and the database. When this option is deselected, Petra will not create new wells during import.

The “Update Existing Wells” option tells Petra to overwrite the database with the imported data. When this option is deselected, Petra will not overwrite the database with the imported information, including null values.
4.2.1.5 Locking and Unlocking Data Fields

Before importing new data, it’s sometimes useful to selectively lock down data items and formation tops. Locked data items and tops are highlighted in red, and will not change until they are unlocked.

To lock a single data item or fm top, go to the Zones Tab or FmTops Tab on the Main Module. Here, right-click the desired data item or top. The bottom of this pop-up menu gives the option to lock or unlock the selected item or top for either the single well or for all selected wells. The “selected wells” option will only work on the wells selected in the main module, and not for all wells in the entire project.

Note that there are keyboard shortcuts for all these operations as well:

Ctrl + L - Lock Item for This Well
Ctrl + U - Unlock Item for This Well
Alt + L - Lock Item for Selected Wells
Alt + U - Unlock Item for Selected Wells

A locked KB elevation field

4.2.1.6 Protecting Data Fields

“Protecting” data fields is a good way to preserve the existing values in a project database during an import. In contrast to “locked” fields that don’t change for any reason, protected fields only resist being overwritten while importing data. It’s still possible to change these values by manually overwriting values or by performing a calculation.

To protect data fields, select Project->Import->Protect Data Fields from the menu bar at the top of the Main Module. This screen provides a list of standard well header
information including well name and number. To add tops or other zone data items select the “Choose Items” button on the right side of the screen.

In this menu, select the relevant zone and data item and select the “>” button to add it to the “Selected Zone Items” list on the right side of the screen.

4.2.2 Working With Different Map Projections

- Importing data with a different LatLon reference datum
- Importing data with a different XY coordinate system

4.2.2.1 Import New LatLon-Based Data

It’s fairly common that new data will use a different map projection than existing project.

Fortunately, most oil and gas data are based on latitude and longitude. When importing LatLon-based data, it only matters that the reference datums match. As a reminder, Petra uses the project’s coordinate system to automatically calculate XY values.

If these reference datums don’t match, it’s necessary to select the reference datum of the new data. With the new data’s reference datum selected, Petra can account for and automatically recalculate the imported data’s latitude and longitude to match the project’s reference datum. To set the import data’s reference datum, select Project>Settings>Set Datum Shift for Importing Data … Here, select the reference datum for the incoming data.

In the example below, the incoming well data’s Lat-Lons are based on the NAD27 reference datum, while the project is based on the NAD83 datum.
4.2.2.2 Import New XY-Based Data

As mentioned earlier, XY data has already gone through both steps of the projection process. In other words, the location is calculated to a reference datum-dependent LatLon and then to a coordinate system-dependent XY. Without latitude and longitude, Petra can’t use the project’s coordinate system to recalculate correct XY values. Therefore, when importing pure XY data, it’s important to make sure both the reference datums and coordinate systems match.

Petra can recalculate the XYs of data inside a project including well locations, and overlays. Instead of changing an entire project to the data’s projection only to import the new XY data and change the entire project back to the old projection, a less risky way is to create a new, temporary project in the new data’s projection.

First, create a new project using the new data’s map projection. This project doesn’t need to include any of the old data from the old working project. Next, import the new data into that temporary project. Petra now has the data and can calculate LatLons from the XYs. Next, change the temporary project’s projection to be compatible with your full project, making sure to recalculate the locations. Finally export the data out of the temporary project. This leaves the new data in a usable projection. Finally, import the newly-reprojected data into the full project.

4.2.3 Import IHS Well Data (297 File)

The 297 file is one of the most common well data formats. The 297 file is an updated version of the legacy PI 197 Well Export format. Generally, these files are exported from an IHS CD-ROM or database.

297 files contain a comprehensive set of well information, including well header information and locations. 297 files also include IHS formation tops. These tops use formation codes that combine a numerical code for the formation’s age and an abbreviation of the formation name (see the appendix for more information). As a rule of thumb, older (and usually stratigraphically lower) formations have larger numerical
prefixes. As an example, 602TMPL is above 604SNNN. Petra stores this information in an internal project database.

To import a 297 File, select Project>Import>IHS 297 Well Data (Fixed or Comma)… on the menu bar at the top of the Main Module.

File Tab
Options Tab
IHS Source Codes Tab
FM Substitute Tab
IHS Tab
Misc Tab
Elev Trans Tab
Dir Survey Tab

4.2.3.1 297 File Tab

The 297 importer File Tab sets the basic parameters on the data loaded into the project database.

To open a file, select the “Browse” button and navigate to the desired file.

Scan File For Tops – This option examines the file for formation tops. Scanning tops creates the FM Tops Tab, where the tops in the file appear.

Display Report Showing Imported Wells – This option generates a text file showing the results of the import.
4.2.3.2 297 Options Tab

The 297 importer Options Tab sets the basic parameters on the data is loaded into the project’s database.

![The 297 file import File Tab](image)

**Well Options** – These boxes govern whether the importer adds new wells, or updates selected wells already in the project database.

**Data To Load** - These options set which data is imported. The available data includes:

- General Well Header Data
- Locations
- Directional Survey
- Datum Elevation
- Gross Perfs from IPTests
- Deptailed Perfs
- Production Tests (IPs)
- Formation Tests (DSTs)
- Cored Intervals
- Formation Tops
- Cored Intervals

**Ignore Source Codes** – IHS formation tops are coded by their origin: 1 for driller
tops, 2 for sample tops, 3 for log tops, and 4 for tops that have been modified by IHS. As such, the same top name can occur a few different times with different sources. This option only brings in a single copy of the top — generally the import will bring in the highest source code with the highest quality.

**Lat Lon Source** — Particularly in Texas, IHS locations sometimes have a source code that reflects the origin of the latitude and longitude. This option loads location source data into the “Misc Location Information” field on the Main Module’s Location Tab.

**All Other Data** — IHS data has a catch-all field containing a variety of miscellaneous information. This option loads location source data into the “Misc Location Information” field on the Main Module’s Location Tab.

**Put Lease in Well Name** — This option adds the lease name as a suffix to the well name.

**Update Historical Operator** — This option updates operator information. More specifically, this option copies the operator to a null historical operator entry whenever the operator changes.

**Use Alt ID for UWI** — IHS generates AltIDs for wells without a UWI number. This option tells Petra to use the AltID when the regular UWI is missing, and is on by default. Deselecting this option will prevent Petra from loading wells without UWIs into the project.

**Copy IPTests as Gross Perfs** — This option copies the top and base of IP tests as a perf interval. This can create very large “gross” perf intervals in the imported wells.

**Copy Detailed Perfs From Treatments** — This option copies the top and base of each treatment as a perf interval. This can create a large number of small perfed intervals in the well.

**Load N.E. Locations** — This option loads the NorthEast locations. This data is available on the “US N.E. Loc” button on the Main Module’s Location Tab.

**Compute LatLon from NE Ref Loc** — This option uses the NorthEast location to recalculate the well’s LatLon.

**Update Blank Header Fields Only** — By default, importing a 297 file overwrites all header fields. This option only imports data from the file into blank header fields.

**Load All Data into Initial Completion** — This option loads information from multiple completions (normally separated by the last couple digits of a 14 digit API number) into the single primary completion.

### 4.2.3.3 297 IHS Source Codes Tab

IHS formation tops are coded by their origin: 1 for driller tops, 2 for sample tops, 3 for log tops, and 4 for tops that have been modified by IHS.

Petra will only load tops with selected source codes. By default, all check boxes are selected for import.
4.2.3.4 297 FM Substitute Tab

This tab sets up a formation substitution file. For more information on formation substitution files, please see Formation Substitution Files under Common Import Options.

4.2.3.5 297 IHS Tab

The IHS Tab sets a few more options on how Petra loads the 297 file.
Load DST Remarks – This option loads DST test miscellaneous comments in the DST remarks fields.

Load Well Class and Lahee Class into Well Zone Table – This dropdown sets how Petra loads the well class into the project. The “Do Not Load” option completely ignores the well class, the “Load Code Descriptions” option loads the full description, while the “Load Codes Only” option only loads the well class code.

Concatenate PI Remarks with Current Well remarks – This option leaves the current well remarks in place and simply appends the PI remarks to the end. When this option is deselected, Petra will overwrite the well remarks with the PI remarks. This is particularly useful with the “Load Last Drilling Narrative into Zone Item” option, which only loads the last line into the Well DREM data item.

Formation Top Repeats – This dropdown sets how the importer handles multiple formation tops for a single well. The “Ignore” option will overwrite successive listings, and only keep the first top in the file. “Rename” will add each repeated top with a numerical suffix. “Add as Repeat Top” loads the multiple tops as a repeat tops available on the Repeats Tab on the FmTops Tab in the Main Module.

Convert Depth Values from Feet to Meters – This option automatically converts all depth measurements from feet to meters.

Load “Actual Bottom Hole Reference Location” (S1 Record) – This option loads the bottom hole reference location from the S1 record.

Load “TVD Value” (S1 Record) – This option loads the TVD from the S1 record.

Load Direction Indicator to Well>DIR_IND – 297 files commonly have an indicator flag for directional and deviated wells. This option loads the indicator flag to the “DIR_IND” data item in the WELL zone.

Skip Blank Well Status Codes – When “Add New Wells” is selected, Petra will add all new wells in the file that aren't found in the database. This option skips wells with
“LOC” and “START” well status codes, which keeps permitted wells out of the database.

Skip Wells with no Surface Lat-Lon Location – With this option selected, Petra will not import wells with without a surface Lat-Lon.

Load IP and DST Data with Missing Top-Base Depths – This option will force Petra to load IP and DSTs with no tops and bases. You'll have to add the top and bases manually for these tests to show up on cross-sections.

Load Last Drilling Narrative into Zone Item – This option only loads the last line into the Well DREM data item. This is particularly useful with the “Concatenate PI Remarks with Current Well remarks” option, which will only update the drilling narrative instead of completely overwriting it.

Add New Wells Using 14/12/10 Digit API Number – This option sets the API number format for new wells. By default, Petra can recognize the same well in 14, 12, and 10 digit formats. Put another way, Petra won't duplicate wells just because it has a different API number format.

Default Dir Survey Orientation – This option sets the default directional survey orientation to either “True North” or to “Grid North.”

Always Compute DIR Survey TVDs from Dip-AZM If Present – This option recalculates the BHL location for directional and deviated wells from the directional survey data. Note that this will overwrite the reported BHL.

Source for MISC IHS Zone Items – This option adds an IHS source code for other IHS zone items created when importing the 297 file.

### 4.2.3.6 297 Misc Tab

The Misc Tab sets the source code for perfs loaded from the 297 file. By default, the source code is blank.
4.2.3.7 297 Elev Trans Tab

This tab sets up an elevation substitution file. For more information on formation translation files, please see Elevation Translation Codes under Common Import Options.

4.2.3.8 297 Dir Survey Tab

This tab sets the location of directional surveys imported from the 297 file.

By default, Petra can load the directional surveys into “Actual” or “Planned”, though you can change the survey definitions with the “Survey Def Maintenance” button.

4.2.4 Import ASCII Data File

The Generic ASCII File tool is one of the most useful tools in Petra, since it can load
a wide variety of data. Petra stores this information in an internal project database. Especially for corrupted or oddly-configured datasets, it’s often useful to first work with the dataset in a spreadsheet program like Microsoft Excel. The UWI (or API number) field must be defined for every row of data. This tool can import data from either tabular (fixed column) or character-delimited ASCII data files.

In addition to the file format, ASCII files can store data in two fundamentally different ways. One method is to store all information about a single well on a single row, where different columns reflect different pieces of information. In the example below (left), each well is a single row, and the petrophysical measurements for that well are in the columns to the right. The other method is to store each data item and identifier in its own row, such that there can be multiple rows for a single well. In the example below (right), each line has an API number, a top name, and a MD value. Note that some wells have multiple rows for different Dakota Sand tops.
### Table 1: DSAND GROSS, DSAND NET, DSAND PHIA

<table>
<thead>
<tr>
<th>API</th>
<th>DSAND GROSS</th>
<th>DSAND NET</th>
<th>DSAND PHIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24.5</td>
<td>12</td>
<td>0.13</td>
</tr>
<tr>
<td>2</td>
<td>1.88</td>
<td>0.08</td>
<td>0.01</td>
</tr>
<tr>
<td>3</td>
<td>27.5</td>
<td>18.5</td>
<td>0.14</td>
</tr>
<tr>
<td>4</td>
<td>25.5</td>
<td>23.5</td>
<td>0.12</td>
</tr>
<tr>
<td>5</td>
<td>25.5</td>
<td>13</td>
<td>0.11</td>
</tr>
<tr>
<td>6</td>
<td>24.5</td>
<td>12</td>
<td>0.12</td>
</tr>
<tr>
<td>7</td>
<td>27.5</td>
<td>22</td>
<td>0.13</td>
</tr>
</tbody>
</table>

### Table 2: TOP MD

<table>
<thead>
<tr>
<th>API</th>
<th>TOP MD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6430</td>
</tr>
<tr>
<td>2</td>
<td>6310</td>
</tr>
<tr>
<td>3</td>
<td>6392</td>
</tr>
<tr>
<td>4</td>
<td>6274</td>
</tr>
<tr>
<td>5</td>
<td>6355</td>
</tr>
<tr>
<td>6</td>
<td>6325</td>
</tr>
<tr>
<td>7</td>
<td>6404</td>
</tr>
<tr>
<td>8</td>
<td>6257</td>
</tr>
<tr>
<td>9</td>
<td>6350</td>
</tr>
<tr>
<td>10</td>
<td>6287</td>
</tr>
<tr>
<td>11</td>
<td>6294</td>
</tr>
<tr>
<td>12</td>
<td>6372</td>
</tr>
<tr>
<td>13</td>
<td>6178</td>
</tr>
<tr>
<td>14</td>
<td>6258</td>
</tr>
<tr>
<td>15</td>
<td>6380</td>
</tr>
<tr>
<td>16</td>
<td>6286</td>
</tr>
<tr>
<td>17</td>
<td>6296</td>
</tr>
<tr>
<td>18</td>
<td>6370</td>
</tr>
<tr>
<td>19</td>
<td>6606</td>
</tr>
<tr>
<td>20</td>
<td>6147</td>
</tr>
<tr>
<td>21</td>
<td>6252</td>
</tr>
<tr>
<td>22</td>
<td>6330</td>
</tr>
<tr>
<td>23</td>
<td>6285</td>
</tr>
<tr>
<td>24</td>
<td>6357</td>
</tr>
<tr>
<td>25</td>
<td>6229</td>
</tr>
<tr>
<td>26</td>
<td>6318</td>
</tr>
<tr>
<td>27</td>
<td>6200</td>
</tr>
</tbody>
</table>
To open the Generic ASCII File, select Project>Import>Generic ASCII (Spreadsheet)... on the menu bar at the top of the Main Module. Alternatively, select CTRL + T when the Main Module is selected.

Import ASCII Data Window Tabs

- Import File Tab
- Data Format Tab
- Options Tab
- Locations Tab
- Fm Substitution Tab
- PDCum Tab
- Pay Data Tab
- Units Tab
- Velocity Tab
- Elevation Translation Tab
- Protected Tab

How To Guides

- Importing Log Curves from ASCII Files
- Importing Monthly Production from ASCII Files

4.2.4.1 ASCII Import File Tab

The Import File Tab selects the desired file for import. Select the “Open File” button and navigate to the desired file.
4.2.4.2 ASCII Data Format Tab

The Data Format Tab establishes the link between data in the import file and the project database. Put another way, this screen tells Petra how to read the file and store the data in the appropriate place in the database.

Data Record

Once a file is selected on the Import File Tab, the “Data Record” window on the bottom of the screen shows a portion of the selected file. This section displays two consecutive data records. You can scroll through the record window with the up and down arrows on the right side of the screen. You can also scroll left or right through the record with the scroll bar at the bottom of the record window.
Number of Records Per Well - This option sets the number of data records pertaining to a single well.

Records to Skip Before 1st Well - This option skips header or comment lines at the beginning of the data file. Click the "Set Skip" button to set the number of skipped records based on the record currently in the data record window.

Field Definitions

Select the appropriate file format on the File Format dropdown. Recall that this tool can either use tabular (fixed column) or comma/tilde-delimited type ASCII data file. Columnar files separate different data entries with empty space. Comma- and tilde-delimited files, on the other hand, separate different data entries with characters. Petra distinguishes between different entries on a row with specific start and stop column numbers.

To add a field definition for a comma- or tilde-delimited file, select the desired field in the Data Record window. Note that Petra counts the number of commas to establish a Field Number. Next, select the relevant data type on the set of dropdown menus on the right. Select the “+” add button to add the definition to the "Field Definitions" list box.

To add a field definition for a columnar file, swipe relevant data field on the Data Record window. Note that Petra fills in the “Start Column” and “End Column.” Next, select the relevant data type on the set of dropdown menus on the right. Select the “+” add button to add the definition to the "Field Definitions" list box.

In both cases, to modify a field definition, use the replace button to replace the currently selected field definition with the selected entry on the import file and data type. To drop a field from the list, select the desired definition and select the “-” drop button.

"Implied Decimal Places" – This option scales imported values by multiples of 10. As an example, a 1 here will divide the incoming data by 10 and a 2 will divide the incoming data by 100. This is useful for changing values expressed as percentages.
(1-100%) into values expressed as decimals (0-1).

**Saving and Loading Field Definition Templates**

Since creating a long list of field definitions can be tedious, it’s a good idea to save your work. Petra can save these column and field definitions as a template “Format File” with a *.FMI extension. By default, Petra stores template files to the private parms directory. To save a field definition template file, select the Save button. To load a pre-existing format template, select the Load button.

### 4.2.4.3 ASCII Options Tab

The Options Tab controls how Petra loads overlapping data between the project and the imported file.

**Over Write With Incoming Nulls** – Normally, Petra won’t overwrite a value in the database with a null from the import file. This option instead forces Petra to overwrite a value in the database with nulls from the import file.

**Update Blank Well Header Locations, Tops, and Zone Items Only** – This option will only copy data from the imported file into blank entries.

**Replace Current Perfs, Cores, IPs, DSTs, and Casing with Imported Data** - By default, Petra attempts to only add new Perfs, Cores, IPs, DSTs, and Casing entries to the project. This option instead completely erases all the existing entries in the project and adds Perfs, Cores, IPs, DSTs, and Casing from the import file.

**Append Well Remarks If Loaded** – By default, Petra overwrites the well remarks in the project with those from the import file. This option just appends well remarks rather than completely replacing them.

**Convert Canadian UWIs to Standard 16 Character Form** – This option converts 14
digit Canadian API numbers to 16 character API numbers during the import.

**Load All Data To Primary Completion Well Only** - With this option selected, Petra only imports primary completions with API numbers ending in 0000. Data from other completions (0001, 0002, etc) are merged with the primary completion. For 16-character Canadian UWIs, the first 14 characters are used.

**Add Multiple Top Values as Repeated Tops** - This option saves multiple formation tops for the same well as “repeat tops” in Petra database.

**Well Update Mode** - This dropdown selects how Petra loads new wells and treats wells already in the local database. “Add New Wells to Database and Update Selected Wells” will both create new wells, and overwrite the selected data for wells already in the database. “Add New Wells Only” will create new wells, but will not overwrite any data in wells already in the database. “Update Selected Wells Only” will overwrite selected data for wells in the project, but will not create new wells.

**Numerical “NULL” Values Are Indicated By** – Petra recognizes the most common null placeholder, “-999.25”, on its own. This option sets the non-standard strings of text or numbers Petra should recognize as null values.

**Date Format In Import File** – This option sets the formatting of dates in the import file.

**Remove the Following Characters From the UWI** – API numbers are commonly broken up by dashes, slashes, or other characters. This option removes non-standard characters from the UWI before loading them into the project.

**Load “Zone Item Name and Value” into ZONE** – For datasets where each data item is its own row, this option sets the destination zone for the selected data items. Note that these datasets can only put data into a single zone at one time.

**Print Hdr List** – This option creates and prints a list of the well header items.

### 4.2.4.4 ASCII Locations Tab

The Locations Tab sets the format of location data, and how Petra calculates LatLons and XYs. This tab also sets a few options for how Petra loads directional survey data.
**Latitude-Longitudes are in SEPG1 format (DDDDMMSSSS) -** Normally, latitude and longitude values are decimal degrees. This option imports LatLon values in the SEGP1 standard format consisting of degrees, minutes and seconds (DDDDMMSSSSZ, where D=Deg, M=min, S=Sec, Z=N,S,E,W).

**Convert Lat-Lon to XY** – This option recalculates the XYS based on the imported LatLons. This option is set by default. When both LatLon and XYS are imported, Petra preferentially uses LatLons to overwrite XYS.

**Convert XY to Lat-Lon** – This option recalculates LatLons based on the imported XYS. When both LatLon and XYS are imported, Petra preferentially uses LatLons to overwrite XYS.

**Compute Surface Lat-Lon When Importing NE Location Ref and Offsets** – This option recalculates surface LatLons based on the NE locations and offsets.

**Positive Valued NW Location Offsets are Measured From** - This option changes how location offsets are measured. Positive XYS can either refer to “South and West” or “North and East”

**Directional Survey Data**

**Directional Survey Angles are DDMMSS Format** – Normally, directional survey inclinations are in decimal degrees with 0 as straight up and down and 90 as flat. This option imports directional survey inclinations as degrees, minutes and seconds (DDDDMMSSSS).

**Extend Survey to TD During Import** – This option projects the directional survey data out to TD. For MD-DIP-AZI based surveys, Petra will project to TD using the last survey’s dip and azimuth. For TVD-EW-NS based surveys, Petra will project to TD using an average of several previous points to calculate an azimuth and inclination.

**Calculate Bottom Hole Location From Survey** – This option recalculates the bottom
hole location from the directional survey data. Note that this will overwrite the reported BHL.

Import Directional Surveys into: - This option sets the location of directional surveys from the imported file. By default, Petra can load the directional surveys into “Actual” or “Planned”, though you can change the survey definitions with the “Survey Def Maintenance” button.

Load Directional Survey with Grid Orientation Set to - This option sets the default directional survey orientation to either “True North” or to “Grid North.”

4.2.4.5 ASCII FM Substitution Tab

This tab sets up a formation substitution file. For more information on formation substitution files, please see Formation Substitution Files under Common Import Options.

The generic ASCII Fm Substitution Tab

4.2.4.6 ASCII PDCum Tab

The PDCum tabs controls how Petra imports and updates cumulative production data. In general, Petra attempts to add to existing production cums by matching the name, top and base in the imported data to cumulative values in the project. Without a good match, Petra will add a new cumulative production line to the database.
Ignore Dates When Updating PDCUM Tables – By default, Petra uses dates to match production data. This option instead forces Petra to ignore the PDCUM dates and update the tables, potentially creating new PDCUM lines.

Use FmName Only to Match Existing Records – This option forces Petra to only use formation name to match production cums in the imported data to production cums already in the project.

Protect (Do Not Modify) ALTNAME on Existing Records – This option protects the alternate name on the existing records and prevents it from being overwritten by the imported data.

Substitute Top for Missing Base Values – This option copies the depth of the top of the PDCum to the base when the base is missing.

Substitute Base for Missing Top Values - This option copies the depth of the base of the PDCum to the top when the top is missing.

4.2.4.7 ASCII Pay Data Tab

The Pay Data Tab sets a source code for all imported pay intervals. This can be useful for distinguishing between pre-existing pay intervals and those brought in during the import.
4.2.4.8 ASCII Units Tab

The Units Tab controls how Petra interprets feet and meters for directional survey data and Fm Tops. If the units in your project are the same as the units in your data, you can leave the defaults.

Directional Survey Units

Change offset XYs – This option converts directional survey XY offsets in meters to feet, or from feet to meters.

Change Depth Units – This option converts directional survey depths in meters to feet, or from feet to meters.

Fm Top Depths
Convert FmTops Depth Units – This option converts the depths in the imported file to feet or meters. By default, Petra assumes that these units in the imported file are the same as the units in the project and does not perform a conversion.

4.2.4.9 ASCII Velocity Tab

The Velocity Tab controls how the importer brings in seismic velocities. **Note that you can only bring in a single seismic velocity at a time.**

![The generic ASCII Velocity Tab](image)

Depth Units – This option sets the units of the depths in the file to feet or meters.

Time Units – This option sets the specific format of the time. Time can either be 1-way or 2-way, and can either be in seconds or milliseconds.

Import Data into Velocity Function – This option sets the destination of the imported velocity function. The “+” button adds a new velocity function to the database.

Default Datum – This option sets the default datum for the seismic velocity. By default this entry is set to 0.

Default Replacement Velocity – This option sets the default replacement velocity. By default, this option is set to 5000.

Make this the ACTIVE Velocity Function – This option sets the imported velocity as the “active” function.

4.2.4.10 ASCII Elevation Translation Tab

This tab sets up an elevation substitution file. For more information on formation translation files, please see Elevation Translation Codes under Common Import Options.
4.2.4.11 ASCII Protected Tab

This tab sets certain types of data in the project as “protected.” When importing data, Petra will not overwrite protected data. Unlike “locked” data, protecting data here is only relevant for importing data; protected data can still be manually overwritten.

4.2.4.12 Import Monthly Production From Tabular File Format

The import tabular monthly production file function is used to load monthly production from a tabular or fixed column type ASCII data file. Files containing multiple records per well can be imported. Data for multiple wells may be imported from a single file if the file has a column containing the well's unique well identifier (UWI).
Load Production Into Well -

This drop down box defines which well will receive the imported production data. This is only required whenever the UWI field is missing from the imported data file.

File To Import -

Click the "Open File" button to select the import file using the standard Windows file dialog.

Field Definitions -

One defines the data fields to be imported by setting the starting and ending column numbers and record number. Then the field is associated with either a year, month or a Zone data item. The Year and Month fields must be defined. Multi-well data file must have the UWI# field defined.

The field is then added to the list box by clicking the add button. Fields can be modified by clicking the replace button. Drop a field from the list by clicking the drop button. Once the format (column and field definitions) has been defined, the "Save" button will write the format to a disk file which can be used again by selecting the "Load" button.

Loading Production By Producing Formation Name

You can load monthly production data streams for individual formation names into the OIL, GAS and WTR or any user defined name. You must have the formation name as one of the data columns. Select and identify the oil data column as "OIL", the gas column as "GAS", the water column as "WTR". These are the predefined system production streams. Set the "Prefix" values for each of the three stream types. The oil, gas and water production streams will be loaded under a prefixed formation name. For example, If the formation name data column contained the following (api, fm,year,month,oil,gas,wtr):

03033123450000,HALE,2001,05,20,250,2

then the oil stream would be loaded into O_HALE, the gas into, G_HALE, and the water into W_HALE.

For user defined streams, such as INJ, create a new stream item called INJ. When the import pointed to this INJ stream, the actual stream name that is loaded is INJ_fmname. In the above example, this would INJ_HALE.

Dragging the mouse across a scrollable data record can set columns. Two records of the actual data file are shown.
Data Record -

This section primarily is used to scroll through the data file and select data field columns. Use the up and down arrows located to the right of the record window to read forward or backward in the file. The data record can be scrolled left or right by placing the cursor in the record window and using the left or right cursor keys.

Records to Skip Before 1st Year - This option allows header or comment records to be skipped at the beginning of the data file prior to the first true data record. Click the "Set Skip" button to set the number of skipped records based on the record currently in the data record window.

4.2.5 Import Landmark Standard 29 File

The Landmark Standard 29 format is a well data format associated with Landmark interpretation software. Standard 29 files are almost always exported from a preexisting Landmark project, rather than provided by data vendor. A Standard 29 file is a defined format that includes well header data, tops, curves, location information, and directional surveys. Petra stores this information in the project database.

To import a Landmark Standard 29 file, select Project>Import>Landmark Standard 29 Format on the menu bar at the top of the Main Module.

Options Tab

The Options Tab controls which data is brought into the project, as well as how Petra loads overlapping data between the project and the imported file.
The Landmark 29 Options Tab

Well Options – These boxes govern whether the importer adds new wells, or updates selected wells already in the project database.

Data To Load

General Well Header Data - This option imports general well header data, which includes well names and numbers.

Locations - This option imports location data from the file.

Directional Survey – This option imports directional survey data from the standard 29 file. Note that directional surveys can be brought in as TVD as well

Datum Elevation - This option imports well reference datum. This is most often used to calculate top SS values.

Detailed Perfs - This option imports perf information from the file.

Formation Tops - This option imports the formation tops from the file.

Log Curves – This option imports digital log curves from the file. The “Rename Duplicate Curves” option adds a “_1” suffix to repeat curves.

Misc Tab

The Misc Tab sets the source code for perfs loaded from the Standard 29 file. By default, the source code is blank.

Dir Survey Tab

© 2014
This tab sets the location of directional surveys from the 297 file. By default, Petra can load the directional surveys into “Actual” or “Planned”, though you can change the survey definitions with the “Survey Def Maintenance” button.

![Image of the Landmark 29 Dir Survey Tab]

**The Landmark 29 Dir Survey Tab**

### 4.2.6 IHS Enerdeq Direct Connect

With an active subscription, Petra can use IHS’s Direct Connect to download well data, production data, and raster data. Direct Connect requires an Enerdeq License (User ID and Password) authorized to access the Petra Direct Connect feature. This access must be gained by contacting your IHS Account Manager. If you do not know who your Account Manager is then contact one of the sources listed below:

- IHS Enerdeq Support - email CustomerCare@IHS.com or call 1-800-447-2273, option 1

#### Direct Connect Well Data (US & Canada)

Direct Connect well data includes header information, FmTops, and other completion information. This data is functionally equivalent to importing an IHS 297 file.

#### Direct Connect Well Data (International)

Direct Connect well data includes header information, FmTops, and other completion information. This data is more variable due to different reporting standards.

#### Direct Connect Production Data

Direct Connect production data contains allocated and unallocated monthly production.
This data is equivalent to importing an IHS 298 file.

**Direct Connect Raster Data**

Direct Connect rasters

### 4.2.6.1 Direct Connect Well Data (US & Canada)

The Direct Connect Tool is one of the easiest ways to import well data from IHS’s well databases. With a subscription, an internet-connected computer can update the existing wells in a project or populate a blank project with wells inside a rectangular area. The end result of using Direct Connect is the same as importing a 297 file - the only real difference is that this method always has the most updated information, and there’s no need to manage 297 files.

Direct Connect data includes header information, FmTops, and other completion information. Header information includes things like well name, operator, field name, TD, and other data about the well. FmTops contain the definition and depths of specific geological tops and other contacts encountered in the well. Completion information includes data like casing diameters, tests, and perfed intervals.

Petra loads these values into the project database by each well’s Unique Well Identifier (UWI). During importing, Petra compares the UWIs in the dataset to the UWIs in the project. When Petra finds a match, (by default) it updates the well. When there is no match, Petra (by default) creates a new well.

Direct Connect operates on two different databases (US and Canada, and International) with two different tools. Even though the user interface is different between the US and Canada Direct Connect and the International Direct Connect, the functionality is very similar.

To open the Direct Connect import tools, select **Project>Direct Connect>Import Wells** from IHS Direct Connect.

**Direct Connect Well Data (US and Canada)**

*Selecting Wells or an Area of Interest*

*Import Options*

*Queries*

*Reports*

*Saving to a 297 File*
4.2.6.1.1 DC Wells and AOI Tab

Petra can either update pre-existing wells in a project or add completely new wells inside a rectangular “Area Of Interest.” For the Direct Connect module to update existing wells, the UWIs inside the project need to match the UWIs stored in IHS’s database.

**Use MAP View to Set AOI and Download UWI List…** - This option updates wells and adds new wells inside a rectangular “Area Of Interest.” This option is probably the most useful for new, blank projects or for expanding an existing project. Whether this map covers Canada (Left) or the continental US (Right) depends on the “Project Area” set in the Map Projection Settings.

**Make AOI and UWI list from Currently Selected Wells…** - This option establishes an AOI based on the extent of the currently selected wells. This option will search the geographic AOI and add new wells not in the project’s database. This option is great for updating a project to include wells drilled since the last update.

**Make UWI List from Currently Selected Wells…** - This option updates only the wells currently selected in the Main Module. This option will not add new wells.
4.2.6.1.2 DC Import Options Tab

The Direct Connect Import Options Tab controls most of the details on what information Petra imports into the project.

To open the Direct Connect import tool, select **Project>Direct Connect>Import Wells** from IHS Direct Connect.

The US/Canada Direct Connect Import Options-General Tab

**General Tab**

**Fm Tops Tab**

**Formation Substitution Tab**

**Source Tab**

**Elevation Translation Tab**

**Directional Survey Tab**
4.2.6.1.2.1 DC Import Options Tab - General

Well Update Mode

Well Update Mode – This section has two dropdown menus that govern how Petra loads new wells and treats wells already in the local database. The top menu selects between “Add New Wells to Database” and “Do Not Add New Wells to Database.” The bottom menu selects between “Do Not Update Any Wells, Update Only Wells Selected in Main Module, and Update Any Well in the Database.”

Add New Wells Using – This option controls the configuration of new well API numbers. New wells can either have 10, 12 or 14 digit API numbers. Note that the 13th and 14th digit signify different completions; selecting 10 or 12 digit APIs will merge data from different completions together.

Data to Load

This section provides a list of data types to be imported.

Misc Options

This section contains a list of additional data types and special conditions used during import.

Restrict Wells by Last Update Date – This option restricts the update to only those wells that have been updated since the “the "Last Change Date" shown on the "Wells and AOI" Tab. Note that Direct Connect will download all selected wells from the web server, but only those wells that have been updated by IHS since will actually be imported into the project.
Load Data Into Initial Completions Only – With this option selected, Petra only imports primary completions with API numbers ending in 0000. Data from other completions (0001, 0002, etc) are merged with the primary completion. For 16-character Canadian UWI's, the first 14 characters are used.

Skip IC numbers (Load API Numbers Only) – This option forces Petra to only import API numbers.

Use NAD83 Locations (Canada only) - If your project datum is set to NAD83 or NTV2, then setting this option will read the NAD83 locations from the server. Otherwise, the NAD27 locations are automatically converted to NAD83.

Update BLANK Header Fields Only - The following fields are updated when they are blank in the project database:

- Well Name and Well Number
- Operator and Historical Operator
- Lease Name and Lease Number
- Fm at TD
- Producing Fm
- Field Name
- TD and TVD
- Elevation
- Platform, Water Depth, Whipstock Depth
- Geol Province
- Directional Indicator
- Spud Date, Comp Date, Permit Date, Rig Release Date
- Abandoned Date, First Report Date, Last Activity Date
- Lat Lon Source
- Surface and Bottom Hole Lat and Lon

Update Historical Operator If Blank – This option copies the operator in the project into the historical operator entry when updating the well’s operator. Note that this option will only change blank historical operator entries.

Use Lease Name as Well Name – This option uses the well’s lease name as the well name.

Store Well Name in Well Label – This option stores the well name field into the well label field.
Build Well Labels Using Predefined Template – This option uses the "Build Well Labels" default template to create well labels in the project.

Load Last Drilling Remark into Zone Item (WELL.DRILLREM) – By default, Petra completely overwrites the DRILLREM data item in the WELL zone. In contrast, this option only stores the last drilling remark record. Note that the entire contents of the DRILLREM item will be over written with the last remark.

Add CORE Remarks to Well Header Remarks – This option adds core record remarks to the well remarks displayed on the main well tab.

Do Not Load Fm Bases – This option disables loading formation base values.

Use Fm Top Repeats – This option saves multiple formation tops for the same well as "repeat tops" in Petra’s database.

Ignore Fm Top Source Codes – With this option, the project does not distinguish between the different HIS source codes. If two sources are present for the same top, the project will only keep the last one loaded.

Include Engineering Completion Detail Perfs (CANADA DB Only) – This option adds "completion" records as detailed perfs.

Copy Production Tests Into Perfs (Gross) – This option uses the top and base of each production test (IP test and others) to create a perf record in the database. This can create large gross interval perfs.

Copy Treatments Into Perfs (Detail) – This option uses the top and base of each production test treatment record to create a perf record in the database. This can create detailed perfs.

Set PERF Source from IHS Data Source – This option adds source codes based on the data type used for the perf interval.

GRSPRF  - Gross Perfs
DETPRF  - Detailed Perfs
IPTTST   - Perf created from IP or production test
TREAT    - Perf created from prod test "treatment" record
ENGCOMP  - Perf from Engineering Completion record

Load IP and DST Data with Missing Top or Base - Normally, tests without a top and base are not loaded into the project. This option brings all tests into the project.

Use Completion Date If Test/Perf Date is Missing - This option causes each test and perf record to use the well's completion data for undated tests/perfs. All perfs imported for a well at the same time will have the same completion date, which can cause confusion when storing multiple completions in the same API number.
Compute LatLon From NorthEast Footage Ref - This option only applies to area in the United States that use the "NorthEast" location criteria. The surface Lat-Lon location will be computed using NE footage locations.

Load Directional Indicator into Well->DIR_IND - Use this flag to store a value such as V, D or H in the Well Zone item called DIR_IND.

Convert Depth Values from FEET to METERS – This option converts the depths from feet to meters during import.

Store Untranslated Well Symbol Code in WELL.ORIGSYMCODE - The raw symbol code text is stored in the Well zone item called ORIGSYMCODE.

Default Survey Orientation to GRID North instead of TRUE North - Normally, IHS directional survey data is oriented toward True North. Use this option to set the survey orientation flag to Grid North for all wells loaded.

Produce Detailed Load Report - The report file displayed at the end of the import process will contain a very detail listing of all data imported.

4.2.6.1.2.2 DC Import Options Tab - Fm Tops

This screen restricts the formation tops brought into the project. Selecting the "Download Top Selection List" creates a list of all Enerdeq’s formation top names for the selected of UWIs. Depending on the number of wells, this request can take several minutes to complete. Note that the list also shows the number of occurrences for each formation top.

The US/Canada Direct Connect Import Options - Fm Tops Tab

4.2.6.1.2.3 DC Import Options Tab - Fm Subst

This tab sets up a formation substitution file. For more information on formation substitution files, please see Formation Substitution Files under Common Import
Options.

The Import Options Source Tab sets the source code for perfs, zones, and tops loaded from the IHS database file. IHS formation tops are coded by their origin: 1 for driller tops, 2 for sample tops, 3 for log tops, and 4 for tops that have been modified by IHS. As such, the same top name can occur a few different times with different sources. This option only brings in a single copy of the top – generally the import will bring in the highest source code with the highest quality.

This tab sets up an elevation substitution file. For more information on formation
translation files, please see Elevation Translation Codes under Common Import Options.

The Import Options Dir Survey tab sets the location of directional surveys from the 297 file. By default, Petra can load the directional surveys into “Actual” or “Planned”, though you can change the survey definitions with the “Survey Def Maintenance” button.

The query tab uses queries created and saved by the Enerdeq Browser. Importantly, Petra does not provide a direct link to create queries; it only accesses
queries created with your userid.

The Report Tab shows the progress of the import from Direct Connect.

The 297 Tab saves a local copy of the data from the IHS database as a 297 file. Select “Browse” to navigate to the destination of the file.
4.2.6.2 Direct Connect Well Data (International)

Much like the domestic Direct Connect tool, the International Direct Connect Tool populates projects with well data from IHS’s international database. This database can either update the existing wells in a project, or populate a blank project with all wells inside a rectangular area. **It is important to set a reasonable quadrant and map projection before using International Direct Connect.**

To open the module, select **Project>Direct Connect>International** from the menu bar at the top of the Main Module.

Petra can either update pre-existing wells in a project or add completely new wells inside a rectangular “Area Of Interest.” For the Direct Connect module to update existing wells, the UWIs inside the project need to match the UWIs stored in IHS’s international database.

**All wells in Petra Project** - This option updates all wells stored in the currently selected project. This option will not add new wells.
Selected UWIs in Petra Main - This option updates only the wells currently selected in the Main Module. This option will not add new wells.

Previously Saved UWI File - This option updates wells from an already existing UWI file. To use this option, select the relevant button and navigate to the UWI file with the “Browse” button.

Area of Interest - This option updates wells and adds new wells inside a rectangular “Area Of Interest.” As such, this option is probably the most useful for new, blank projects or for expanding an existing project. To use this option, select the “Area of Interest” button and enter the latitude and longitude boundaries of the area of interest (using the WGS84 datum).

Setting an “area of interest”

Note that selecting “OK” will close the “Area Of Interest” window, and return to the Direct Connect tool. Petra will logon to IHS’s International Web services to count the number of wells inside the area. In the example below, 33 wells are inside the area. The report will read something like:

After setting an AOI, Petra gets a well count from the IHS database

After selecting the wells, the International Direct Connect tool will display the number of selected wells. Selecting the “Import Wells” button will import the wells directly into the project. The Direct Connect tool imports wells in blocks of 100 wells.

4.2.6.3 Direct Connect Production Data

The Direct Connect Tool is an easy way to import production data from IHS’s databases into the wells in a project. Using Direct Connect to import production data is very similar to importing a 298 file – the only difference is that Direct Connect’s data
is always the most updated.

Petra loads these values into the project database by each well’s Unique Well Identifier (UWI). During importing, Petra compares the UWIs in the dataset to the UWIs in the project. When Petra finds a match, (by default) it updates the well.

To open the Direct Connect Production Tool select Project>Direct Connect>IHS US Enerdeq or Canada>Import Production from IHS Direct Connect from the menu bar at the top of the Main Module.

Method Window
General Tab
Totals Tab
Formations Tab
PdCums Tab
Leases Tab
P/Z Tab
Fm Subst Tab
Query Tab

4.2.6.3.1 DC Prod Method Window

The Method Selection screen sets how the Direct Connect Production tool selects how the data should be imported.

Selecting wells to update with the Direct Connect Production tool

The options include using the wells selected in the Main Module, all wells in the project, a preselected WSN list file, selecting by data criteria, or a stored Enerdeq query. Note that it’s also possible to reselect the wells later.

This screen can also filter the wells based on when the production was updated. This
can be useful for accelerating the process by only changing only wells that are actively producing.

### 4.2.6.3.2 DC Prod General Tab

The General Tab sets which production streams are loaded into Petra.

#### Production Streams

- **Load Production into Standard OIL, GAS, WTR (WELL ZONE)** – This option loads the total production data into OIL, GAS, and WTR streams. Note that this option sums production from all formations together into a single stream.

- **Load Production into Individual Formation Names** – This option creates separate production streams for each formation. The Formation Tab selects the imported formation production streams, and the annotation for the individual oil, water, and gas streams.

#### Type of Production Loaded

This dropdown sets which data are loaded into the project. Petra can import monthly production streams, cumulative production values, or both.

#### Method to Apply Lease Production to Individual Wells

- **Load Production into First Well Only Listed in Lease** - This option stores production only to the first well listed in the lease. Only use this option if the 298 file only has single-well leases.
Load Production into Each Well in the Lease – This option divides the production for the lease by the number of wells in the lease. As an example, in a lease containing 6 wells, each well receives 1/6th of the production.

Load Production into Each Well in the Lease – This option stores the total production for the lease in every well in the lease. In a lease containing 6 wells, each well receives all of the production – potentially multiplying the actual production.

Fluid Types (Streams) to Load

These boxes set which fluid types are loaded, and how they are named. Note that Petra automatically creates streams named OIL, GAS, WTR. For a different production stream names, select the button, and create a new monthly production definition.

Creating a new monthly production definition

The Options Tab sets a few additional options for how Petra uses the production data.

Load Production into INITIAL COMPLETION Wells Only – By default, Petra brings in production from different completions as different wells. This option instead stores
production only to the primary completions (where the API number ends in 00).

**Update OPERATOR and Save Current Operator as Historical Operator** – When there’s a difference between the current operator in the project and the current operator in the 298 file, this option copies the operator in the project to the historical operator field and overwrites the operator field with the data in the 298 file.

**Load Producing Fm Name into Well Header** – This option updates the database’s producing formation (Prod. FM on the Well Tab in the Main Module) with the entry from the production data.

**Store Current Status into WELL Zone as PD STATUS** – This option creates a data item called “PD STATUS” in the WELL zone. This text field stores I for inactive wells and A for active wells.

**Update Well SYMBOL CODE with Primary Product Code** – This option changes the well’s symbol code displayed on the map based on the Primary Product Code in the 298 file.

**Store GATHERER in WELL Zone as GATHERER** – This option creates a data item called “GATHERER” in the WELL zone. This text field stores the name of the gas gatherer.

**Skip Lease Name Checking** – When updating production, Petra checks the entire list of lease names when it can't match based on formation name. This can take a long time depending on the size of the data set. This option skips this process.

**Display Detail Info in Report** – This option displays all monthly production values on the import report.

**Update Non-Blank Lease Number with UNIT WELL SERIAL NUMBER** – This option overwrites lease numbers with unit well serial numbers.

**Do not use “A” in prefix/suffix to designate Allocated Production** – By default, Petra adds an “A” to allocated production. This option drops the A, making allocated production indistinguishable from regular unallocated production.

**Use 12/10 Digits for Matching Initial Well Completions** – This option matches the first 12 or 10 digits of the API/UWI when loading production from multiple completions into the initial well completion.

4.2.6.3.4 DC Prod Totals Tab

The Totals Tab stores information from the production data to zone data items. Each data item is a fluid type prefix and the formation name. As an example, the Oil from the Dakota D is stored as “O_602DKOTD” by default.
Zone for storing Totals – This dropdown selects the zone that will contain the cumulative production data items.

CUM OIL – This option sets the prefix for cumulative oil values. By default it is “O.”

CUM GAS – This option sets the prefix for cumulative gas values. By default it is “G.”

CUM WTR - This option sets the prefix for cumulative gas values. By default it is “W.”

Lease Name – This option sets the zone data item for storing the lease name.

Lease Well Count - This option sets the zone data item for storing the lease well count.

Prod ID - This option sets the zone data item for storing the production ID.

This tab lists the formations in the database and their production stream counts. This tab also establishes the names used in the formation-specific production streams.
The Count/Name list shows all the formations in the 298 file, and is populated after scanning the file. If nothing appears here make sure to select the “Scan File” button on the Files Tab. Note that Petra lists the formation production data base on total number of streams. Petra will only load the formations selected here.

FM NAME From – This dropdown sets how the formation production streams are named. These streams can use the standard IHS Fm Name Code, the description, the age code, or the reservoir name.

Prod Stream Name Qualifier – This option sets the prefix or suffix used to signify the different fluid types. By default, Petra uses O, G, W, and D to signify oil, gas, water, and days on. Petra can set these qualifier characters as a prefix or as a suffix to the name.

4.2.6.3.6 DC Prod PdCums Tab

This section allows the selections on how cumulative production values are loaded into the PDCUM tab.
Do Not Store in PdCum DB - This will not store any data into the ProdCum tab.

Store in PdCum Data using ProdID as FmName - Cums are loaded by ProdID for individual leases/wells. The ProdId is stored in the FMNAME column and the formation name will be stored into the ALTNAME column under the ProdCum tab. Each lease will have an entry regardless of formation name.

Store in PdCum Data using ProdID as AltName - CUMS are loaded by FMNAME for individual leases/wells. The ProdId is stored into the ALTNAME column and the formation name will be stored into the FMNAME column under the ProdCum tab. Each lease will have an entry regardless of formation name.

Store in PdCum Data using FmName Only - CUMS are loaded by FMNAME. Any duplication of the formation names will be summed together and stored as a single entry. The ProdId is NOT captured in this selection.

4.2.6.3.7 DC Prod Leases Tab

The Leases Tab displays the available leases in the database file. Here, select the lease names you want to load.
4.2.6.3.8  DC Prod P/Z Tab

The P/Z Tab has a few options on capturing P over Z data for gas wells.

Load P/Z Gas Cum Data – This option loads P/Z, Gas Cum, and BHP data. When this option is deselected, these data streams won’t load into the project.

P/Z – This option sets the name for P over Z pressure.

Gas Cum – This option sets the name for the gas cumulative volume.

BHP – This option sets the name for the bottom hole pressure.
4.2.6.3.9 DC Prod Fm Subst Tab

This tab sets up a formation substitution file. For more information on formation substitution files, please see Formation Substitution Files under Common Import Options.

The Direct Connect Production FmSubst Tab

4.2.6.3.10 DC Prod Query Tab

The Query Tab retrieves wells from saved IHS Enerdeq queries, and uses those wells to import production data.

The Direct Connect Production Query Tab

Retrieve IHS Enerdeq Queries… - This option gets the saved Enerdqeq queries for the current logon. In the example above, the “Sooner” query was saved in Enerdeq
and now appears on the list.

Run Query – This option reruns the query in Enerdeq.

4.2.6.4 Direct Connect Raster Logs

On the Main Module, select Project>Direct Connect>IHS Logs>Raster… from the menu bar at the top of the screen.

**Downloading the Catalog**

First, select the button on the upper left hand side of the screen. Petra compares the UWI/API numbers of the wells currently selected in the Main Module to IHS’s raster database. Wells with matches are shown in the spreadsheet taking up most of the screen, with different wells are separated out by color. Note that main pass logs are in green, while shorter repeat passes are highlighted in red.
This spreadsheet lists the available raster logs for each well with columns for UWI, Service, Method, Log Type, Hole Type, Scale, Run, Top, Base, Units, Type, Date, Cat ID, TifNumber and URL.

UWI – This is the Unique Well Identifier. For the US, this will generally be the well’s API number.

Service – Service is the service name as recorded on the raster log header by the service company. To save room in Petra, only the mnemonic is loaded into the Group Name, but the long name is displayed inside [square brackets] for your reference.

Method – Method indicates which logging method was used to record the data. For example, Neutron Porosity vs. Sonic Porosity.

Log Type – Log Type indicates the global type of log, for example resistivity or porosity.

Hole Type – This field indicates whether the scanned log is an open hole or cased hole log.

Scale – This is the inch scale of the scanned log. The most common scales are 1”, 2”, and 5” logs.

Run – For wells with multiple logging runs, this indicates whether the log is a main pass (MP) or repeat pass (RP) log.

Top – This gives the top depth calibration point.
**Base** – This gives the bottom depth calibration point.

**Units** – This indicates whether the log is measured in feet or meters.

**Type** – Type indicates whether the log is recorded in true vertical depth (TVD) or measured depth (MD).

**Date** – This gives the logging date as recorded in the log header.

**Cat ID, TifNumber, URL** – These three columns are utilized by Petra to reference the image.

**Filters**

This option filters the available logs by scale, hole type, units, and depth type. Note that the “Depth Units” check boxes include logs recorded in the relevant depth unit. As an example, clearing the “meters” box will drop all logs recorded in meters. When both the Meters and Feet boxes are checked, logs recorded in both meters and feet will be included.

**Build Group Names From**

In the top right-hand corner of the dialog, the “Build Group Names From:” option sets how Petra will create the Group Names in the project. **To avoid duplicate entries, it’s best to be consistent with the naming convention.** The available options come from various combinations of Service, Method, Log Type, and Hole Type.

- **Service**
- **Service + Method**
- **Service + Method + LogType**
- **Service + Method + LogType + HoleType** (default)

- **Method**
- **Method + LogType**
- **Method + LogType + HoleType**

- **LogType**
- **LogType + Method**
- **LogType + Method + HoleType**

**Overlapping Raster Log Names**

Petra will use the naming criteria set in the “Build Group Names From” drop down when comparing raster logs from this screen to what’s already in the Petra project. Selecting a different group name method from this drop down will change what constitutes an overlapping raster log name and how this drop down works. In all
cases, using a different naming convention creates a large administrative headache.

**Add New Calibrations Only (do not replace existing ones)** - This option adds new LIC files and does not replace any existing LIC files. Practically, this option preserves changes made to existing raster log depth calibrations and headers/footers/scales, while still loading in new raster logs. If the “Build Group names From” drop down is different than how logs were previously imported, this option will create an entirely new (though duplicate) set of raster logs, though the preexisting log images will not change.

**Add New and Replace Existing Calibrations** - This option adds new LIC files and replaces all existing LIC files. Put another way, this option erases all changes made to raster log depth calibrations and headers/footers/scales in the project and adds new logs. If the “Build Group names From” drop down is different than how logs were previously imported, this option will create an entirely new (though duplicate) set of raster logs and no existing calibrations will be replaced.

**Replace Existing Calibrations (do not add new ones)** - This option only updates existing LIC files, but does not add any new logs. Practically, this erases all changes made to the log depth calibrations and headers/footers/scales, but does not add new logs. If the “Build Group names From” drop down is different than how logs were previously imported, this option will not update any calibrations.

**Downloading LIC files vs. Downloading LIC Files and Images**

This drop down determines how Petra downloads and stores data. The two options are: “Download LIC Files Only (Images Kept on IHS Server)” and “Download LIC and IMAGES (Copy Images to Disk).”

**Download LIC Files Only** - This option delivers a copy of the image over the internet as needed, and temporarily stores the image file in RAM until the project closes. The only thing that remains stored in the project is IHS’s LIC file, which contains depth calibration points as well as a “header” that generally covers the log scale on the image. Importantly, adjustments made to the image’s depth calibration points or to the header are preserved inside the project’s LIC file. Since the image file is never permanently stored, however, changes to the image such as straightening and rotating are not preserved.

The chief advantage of this method is that the large log image files remain on IHS servers rather than being stored locally, which can save significant file space and reduce the need for database management. This method, however, requires an always active internet connection in order to download the images. Slow internet connections and company networks can greatly degrade performance, translating to long, frustrating waiting times.

**Download LIC and IMAGES (Copy Images to Disk)** - This option delivers a copy of the image and LIC file and stores a permanent copy in the Petra project’s IMAGES folder. All changes made to the LIC file (including depth calibration changes and
headers/footers) and to the actual image file (including rotating and straightening) are preserved.

The chief advantage of this method is that the log images are always available, regardless of the internet connection. The fact that the logs are stored locally means there is a greater demand for network storage space and a greater attention to database management.

**Downloading Selected Logs**

Once the desired images have been selected and options have been set in the three drop down boxes, click on “Import Logs” to download either the LIC files or the LIC files and image files to the Petra project. The raster group names will be created and loaded into the Raster tab of your Petra project.

### 4.2.7 Import IHS Monthly Production (298 File)

The “EZ” loader is the IHS recommended tool for importing production data into a Petra project.

For simplicity and to avoid errors, the EZ loader completely overwrites the existing production streams and cumulative production values.

To open the 298 EZ Loader, select Project>Import>298 EZ Loader… from the menu bar at the top of the Main Module.

- **Files Tab**
- **General Tab**
- **Options Tab**
- **Totals Tab**
- **Formations Tab**
- **PdCum Tab**
- **Leases Tab**
- **P/Z Tab**
- **Fm Subst Tab**
298 EZ Files Tab

The files tab selects the 298 file, and how the data should be imported. It’s possible to load unallocated data, allocated data, or both allocated and unallocated data at the same time. Selecting the type of import creates an entry box (or entry boxes) for the 298 file location.

Load UN-ALLOCATED Production File Only – This option only loads unallocated data. Selecting this option creates only a single entry box for the import file location.

Load ALLOCATED Production File Only – This option only loads allocated data. Selecting this option creates only a single entry box for the import file location. Allocated production will have a “A” prefix.

Load and SUM UNALLOCATED and ALLOCATED Production Files Together – This option loads unallocated and allocated data simultaneously. There will be two entries for the two files: Allocated and Unallocated.

When importing Texas data, use the “Allocated and Unallocated” option. For Texas data, oil completions are only imported from the allocated data and gas completions are only imported from the unallocated data. For wells completed as a gas well and later recompleted as an oil well in the same formation, this import option will sum the two together. Louisiana data can use either the “Allocated or Unallocated” option.
Production Streams

Load Production into Standard OIL, GAS, WTR (WELL ZONE) – This option loads the total production data into OIL, GAS, and WTR streams. This option sums production from all formations together into a single stream.

Load Production into Individual Formation Names – This option creates separate production streams for each formation. The Formation Tab selects the imported formation production streams, and the annotation for the individual oil, water, and gas streams.

Type of Production Loaded

This dropdown sets which data are loaded into the project. Petra can import monthly production streams, cumulative production values, or both.

Method to Apply Lease Production to Individual Wells

Load Production into First Well Only Listed in Lease - This option stores production only to the first well listed in the lease. Only use this option if the 298 file only has single-well leases.

Load Production into Each Well in the Lease – This option divides the production for the lease by the number of wells in the lease. As an example, in a lease containing 6 wells, each well receives 1/6th of the production.

Load Production into Each Well in the Lease – This option stores the total production for the lease in every well in the lease. In a lease containing 6 wells, each well receives all of the production – potentially multiplying the actual production.

Fluid Types (Streams) to Load
These boxes set which fluid types are loaded, and how they are named. Note that Petra automatically creates streams named OIL, GAS, WTR. For a different production stream names, select the button, and create a new monthly production definition.

![Image of setting a new fluid type]

**4.2.7.3 298 EZ Options Tab**

The Options Tab sets a few additional options for how Petra uses the production data.

![Image of the 298 EZ Options Tab]

**Load Production into INITIAL COMPLETION Wells Only** – By default, Petra brings in production from different completions as different wells. This option instead stores production only to the primary completions (where the API number ends in 00).

**Update OPERATOR and Save Current Operator as Historical Operator** – When there’s a difference between the current operator in the project and the current operator in the 298 file, this option copies the operator in the project to the historical operator field and overwrites the operator field with the data in the 298 file.

**Load Producing Fm Name into Well Header** – This option updates the database’s producing formation (Prod. FM on the Well Tab in the Main Module) with the entry from the production data.

**Store Current Status into WELL Zone as PD STATUS** – This option creates a data
item called “PD STATUS” in the WELL zone. This text field stores I for inactive wells and A for active wells.

Update Well SYMBOL CODE with Primary Product Code – This option changes the well’s symbol code displayed on the map based on the Primary Product Code in the 298 file.

Store GATHERER in WELL Zone as GATHERER – This option creates a data item called “GATHERER” in the WELL zone. This text field stores the name of the gas gatherer.

Skip Lease Name Checking – When updating production, Petra checks the entire list of lease names when it can’t match based on formation name. This can take a long time depending on the size of the data set. This option skips this process.

Display Detail Info in Report – This option displays all monthly production values on the import report.

Update Non-Blank Lease Number with UNIT WELL SERIAL NUMBER – This option overwrites lease numbers with unit well serial numbers.

Do not use “A” in prefix/suffix to designate Allocated Production – By default, Petra adds an “A” to allocated production. This option drops the A, making it indistinguishable from regular unallocated production.

Use 12/10 Digits for Matching Initial Well Completions – This option is only used when loading production into initial well completions only.

4.2.7.4 298 EZ Totals Tab

The Totals Tab stores information from the production data to zone data items. Each data item is a fluid type prefix and the formation name. As an example, the Oil from the Dakota D is stored as “O_602DKOTD” by default.
Zone for storing Totals – This dropdown selects the zone that will contain the imported cumulative production data items.

CUM OIL – This option sets the prefix for cumulative oil values. By default it is “O.”

CUM GAS – This option sets the prefix for cumulative gas values. By default it is “G.”

CUM WTR - This option sets the prefix for cumulative gas values. By default it is “W.”

Lease Name – This option sets the zone data item for storing the lease name.

Lease Well Count - This option sets the zone data item for storing the lease well count.

Prod ID - This option sets the zone data item for storing the production ID.

4.2.7.5 298 EZ Formations Tab

This tab lists the formations in the 298 file and their production stream counts. This tab also establishes a formation substitution file and sets the names used in the formation-specific production streams.

The Count/Name list shows all the formations in the 298 file, and is populated after scanning the file. If nothing appears here make sure to select the “Scan File” button on the Files Tab. Note that Petra lists the formation production data base on total number of streams. Petra will only load the formations selected here.

Refresh with Translations – This option applies the active formation substitution file to the formation names in the 298 file. Importantly, if a formation substitution file is used once, it should always be used again.

FM NAME From – This dropdown sets how the formation production streams are
named. These streams can use the standard IHS Fm Name Code, the description, the age code, or the reservoir name.

**Prod Stream Name Qualifier** – This option sets the prefix or suffix used to signify the different fluid types. By default, Petra uses O, G, W, and D to signify oil, gas, water, and days on. Petra can set these qualifier characters as a prefix or as a suffix to the name.

### 4.2.7.6 298 EZ PdCum Tab

This section allows the selections on how cumulative production values are loaded into the PDCUM tab.

![Image of the 298 EZ PdCum Tab](image)

**Do Not Store in PdCum DB** - This will not store any data into the ProdCum tab.

**Store in PdCum Data using ProdID as FmName** – This option stores cumulative values by ProdID for individual leases/wells. The ProdId is stored in the FMNAME column and the formation name will be stored into the ALTNAME column under the ProdCum tab. Each lease will have an entry regardless of formation name.

**Store in PdCum Data using ProdID as AltName** – This option stores cumulative values by formation name FMNAME for individual leases/wells. The ProdId is stored into the ALTNAME column and the formation name will be stored into the FMNAME column under the ProdCum tab. Each lease will have an entry regardless of formation name.

**Store in PdCum Data using FmName Only** – This option stores cumulative values by FMNAME. Any duplication of the formation names will be summed together and stored as a single entry. The ProdId is NOT captured with this option.
4.2.7.7 298 EZ Leases Tab

The Leases Tab displays the available leases in the 298 file. Here, select the lease names you want to load. If nothing appears here make sure to select the “Scan File” button on the Files Tab.

![The 298 Leases Tab](image)

4.2.7.8 298 EZ P/Z Tab

The P/Z Tab has a few options on capturing P over Z data for gas wells.

![The 298 EZ P/Z Tab](image)

**Load P/Z Gas Cum Data** – This option loads P/Z, Gas Cum, and BHP data. When this option is deselected, these data streams won’t load into the project.

**P/Z** – This option sets the name for P over Z pressure.

**Gas Cum** – This option sets the name for the gas cumulative volume.

**BHP** – This option sets the name for the bottom hole pressure.
4.2.7.9 298 EZ Fm Subst Tab

This tab sets up a formation substitution file. For more information on formation substitution files, please see Formation Substitution Files under Common Import Options.

![Figure 138: The 298 EZ Fm Subst Tab](image)

4.2.7.10 298 EZ Status Tab

The Status Tab displays the progress of the import.

![Figure 139: The 298 EZ Status Tab](image)

4.2.8 Import LAS Log Data File

The most common digital log format is the LAS file, which was codified as a standard by the Canadian Well Logging society in 1990. LAS files store log data about a single well in a single file with a multipart header at the top. The header has
several different parts, each of which is prefixed by a tilde (~).

- ~V - contains version and wrap mode information
- ~W - contains well identification
- ~C - contains curve information
- ~P - contains parameters or constants
- ~O - contains other information such as comments

It’s also not uncommon for LAS files to contain top information in a ~T section.

To import LAS files, select Project>Import Logs From>LAS File from the menu bar at the top of the Main Module.

Import File Tab
Depths Tab
Options Tab
Import Headers Tab
Import Tops Tab
Units Tab

4.2.8.1 LAS Import File Tab

The Import File Tab shows the LAS header information and the available log curves in the LAS file. Select the curves you want in the project on the “Select Curves To Import” list on the right side of the screen. Note that you import any curve as a different name by double-clicking the curve name.
4.2.8.2 LAS Depths Tab

The Depths Tab restricts the depth range, units of measurement, and sample rate of imported log curves.

Restrict Depths – This transformation sets the upper and lower limit of the imported log data. Log data outside this range won’t be imported into the Petra project. The depth interval can be specified in measured depth, TVD, or relative to formation tops.

To set depths by tops or by a specific depth range, select the “Set Depth From Range” button. Next, select the “Set Range” button. In the Set Depth Range box, select the relevant top, MD, or TVD button. For MD and TVD, select the relevant button and enter the adjacent depth in the entry field. For tops, select the desired top from the “Fm Top Name” dropdown box. Notice that an offset can also be added or subtracted to the fm top; this offset will include data points above or below the actual fm top depth.

To set depths by a zone’s interval definition, select the desired zone on the “Set Upper and Lower Depths From Zone” dropdown menu. Note that the WELL zone by default covers -1M MD to +1M MD, so it should cover the entire footage of all wells.

Load Every N’th Sample – This option decimates the data to only keep every N’th sample. Setting this value to 2, for instance, would only load every other sample. Setting this value to 5 would only load every 5th sample. By default, this option is set at 1 to load every sample in the curves.
**Resample to Sample Rate Below** - This option resamples logs based on the number of feet/meters per sample set in the “Imported Data Sample Rate” entry box. This sample rate will use the depth units in the log curves. As an example, 5 feet per sample results in one sample every 5 feet. Setting this field to 0.5 feet per sample results in a sample every half foot.

**Load Only Samples that are Multiples of Sample Rate Below** – This option only loads samples from the curves that are a multiple of the “Imported Data Sample Rate.” As an example, with a sample rate of 1, Petra will only load data at 1 foot intervals.

**Convert Depth Units and Load as** – This dropdown imports the curves in a different depth interval. “As Is” leaves the MD values as is and does not convert any depths. The “Feet” option converts log curves measured in meters to feet. The “Meters” option converts log curves measured in feet to meters.

### 4.2.8.3 LAS Options Tab

The Options Tab controls how Petra handles overlaps between curves already in the database and the selected LAS file. This tab also enables a few options for loading non-standard or oddly-formatted LAS files.

**Import Mode** – These options control how Petra handles overlaps between curves already in the project database and the LAS file. The “Add or Replace” option allows for the creation of new logs and will completely replace any overlapping curves in the database with the LAS file data. “Add New Logs Only” only creates new logs; when there’s an overlap between the database and the LAS file, the database won’t change. “Merge into Existing Logs” does not create any new curves in the database, and will merge data from the LAS file with the curves already in the database. This merge operation can either prefer old values, non-null new values, or all new values. “Add or Rename” allows for the creation of new logs, and will rename overlapping curve names with a numerical suffix (like GR_1). For this example, select “Add or Replace Logs.”

**Load Complete LAS HEADER Section as a Text Block** – This option stores the log header as a block of text.
Enable Sample Rate Round Off Correction Algorithm – Problems with rounding usually cause missing depths in the curve. This option corrects for depth round off errors caused by a non-standard sample rates (such as 0.1524), which are usually a consequence of converting logs measured in one depth unit into a different depth unit.

Disable Error Scanning and Repair – By default, Petra scans for potential bad characters in the curve data and looks for data that is not space delimited. These conditions are not corrected if this option is checked.

Interpolate Missing Depths – This option interpolates values over missing intervals in the LAS file. This interpolation simply repeats the last good value. Note that there are more interpolation options inside Petra’s “preview” window available in the Main Module.

Remove Special Characters From API Number - This option removes any nonnumeric characters from the API number in the LAS file. Embedded blanks are converted to underscores prior to matching wells in the database.

Scan Depths and Use Minimum Sample Rate Found – This option scans the depths and determines the minimum sample rate.

Append Following Source To Curve Name – This option appends text to the end of the loaded curves’ names.

4.2.8.4 LAS Import Headers Tab

The Import Headers Tab imports header information into the project zone data items.

The LAS Headers Tab

To use this tool, select an entry from the LAS file in the “LAS Header Data” list on the left. Next, select the relevant well data entry or zone data item from the dropdowns on the lower right corner of the screen. Next, select the “Add To List” button.

4.2.8.5 LAS Import Tops Tab

Some LAS files contain formation tops. The Import Tops Tab selects which tops are
brought into the project.

4.2.8.6 LAS Units Tab

This tab converts metric-imperial units for sonic and density logs, and decimal-percent for porosity logs.

Convert Sonic (usec/ft) to usec/m - This option converts sonic logs in imperial units to metric units.

Porosity Units Conversion – Percentages can be expressed on a 0-1 scale or on a 0-100 scale, which can make calculations more difficult. This option converts curves with PU, %, V/V, PCNT, PERC, or VOL. By default, the “Do Not Convert Porosity” option is selected, which does not make any changes. The “Convert Porosity to Percent (0-100)” multiplies the curve by 100; the “Convert Porosity to Decimal (0-1)” divides the curve by 100.

Density Log Units Conversion – This option converts density units between imperial and metric units. By default, the “Do Not Convert Density Logs” option is selected,
which does not make any changes. The “Convert KG/M3 to gm/cc” converts metric
density curves to use imperial units. The “Convert gm/cc to KG/M3” converts imperial
density curves to use metric units.

4.2.9 Import Batch LAS

Petra can load in multiple LAS files in a single batch. This is useful for new projects,
but can lead to difficulty when a single well has multiple LAS files.

- Files Tab
- Options Tab
- Depths Tab
- Headers Tab
- Tops Tab
- Filter/Rename Tab
- Units Tab

4.2.9.1 Batch LAS Files Tab

The Files Tab sets the list of LAS files that will be imported into the project. The
easiest way is to drag and drop the LAS files into the “Files To Import” window.
Selecting the “Explorer” button opens a Microsoft File Explorer window, while the
“Browse” button opens a dialog box to select one or more LAS files.

![The LAS Batch File Tab](image)

4.2.9.2 Batch LAS Options Tab

The Options Tab controls how Petra handles overlaps between curves already in the
database and the selected LAS file. This tab also enables a few options for loading
non-standard or oddly-formatted LAS files.
Curve Update Mode – These options control how Petra handles naming overlaps between curves already in the project database and the LAS files. The “Add New Curves and Replace Existing Curves” option allows for the creation of new logs and will completely replace any overlapping curves in the database with the LAS file data. “Add New Logs Only” only creates new logs; when there’s an overlap between the database and the LAS file, the database won’t change. “Add New Curves and Merge into Existing Logs” allows for the creation of new logs, and will merge data from the LAS file with the curves already in the database. This merge operation can either prefer old values, non-null new values, or all new values. “Add or Rename” allows for the creation of new logs, and will rename overlapping curve names with a numerical suffix (like GR_1). For this example, select “Add or Replace Logs.”

Enable Sample Rate Round Off Correction Algorithm – This option corrects for depth round off errors caused by a non-standard sample rates (such as 0.1524), which are usually a consequence of converting logs measured in one depth unit into a different depth unit.

Disable Error Scanning and Repair – By default, Petra scans for potential bad characters in the curve data and looks for data that is not space delimited. These conditions are not corrected if this option is checked.

Interpolate Missing Depths – This option interpolates values over missing intervals in the LAS file. This interpolation simply repeats the last good value.

Remove Special Characters From API Number - This option removes any nonnumeric characters from the API number in the LAS file. Embedded blanks are converted to underscores prior to matching wells in the database.

Scan Depths and Use Minimum Sample Rate Found – This option scans the depths and determines the minimum sample rate.

Match UWIs if there is at Least a XX Percent Match – Since this tool can bring a large number of LAS files at once, this tool allows some flexibility in matching UWI/API numbers from the LAS files to those in the project. By default, Petra looks for an 80% match between the LAS UWI/API and the project well’s UWI/API.
Read Headers as Version – This option sets the version number for the LAS files. For reference, LAS version 1.2 was introduced in 1990, and LAS version 2.0 was introduced in 2009. When in doubt, an individual LAS file’s version is listed at the beginning of every file.

Load all Logs into Original Well Completions – By default, Petra loads the curve names into the well that matches the LAS file’s API/UWI number. This option instead loads the curves into the primary completion.

Append Following Source To Curve Name - This option appends text to the end of the loaded curves’ names.

4.2.9.3 Batch LAS Depths Tab

The Depths Tab restricts the depth range, units of measurement, and sample rate of imported log curves.

Restrict Depths – This transformation sets the upper and lower limit of the imported log data. Log data outside this range won’t be imported into the Petra project. The depth interval can be specified in measured depth, TVD, or relative to formation tops.

Setting depths

To set depths by tops or by a specific depth range, select the “Set Depth From Range” button. Next, select the “Set Range” button. In the Set Depth Range box,
select the relevant top, MD, or TVD button. For MD and TVD, select the relevant button and enter the adjacent depth in the entry field. For tops, select the desired top from the “Fm Top Name” dropdown box. Notice that an offset can also be added or subtracted to the fm top; this offset will include data points above or below the actual fm top depth.

To set depths by a zone’s interval definition, select the desired zone on the “Set Upper and Lower Depths From Zone” dropdown menu. Note that the WELL zone by default covers -1M MD to +1M MD, so it should cover the entire footage of all wells.

Convert Depth Units and Load As - This dropdown imports the curves in a different depth interval. “As Is” leaves the MD values as is and does not convert any depths. The “Feet” option converts log curves measured in meters to feet. The “Meters” option converts log curves measured in feet to meters.

Resample Incoming Curves to Common Rate – This option resamples incoming curves to a single common sample rate. As an example, with a sample rate of 1, Petra will resample the curve data to 1 foot/meter intervals.

4.2.9.4 Batch LAS Headers Tab

The Import Headers Tab imports header information into the project zone data items.

To use this tool, select the “Load Complete LAS HEADER Section as a Text Block” button. Next, select the relevant well data entry or zone data item from the dropdowns on the lower right corner of the screen. Next, select the “Add To List” button.

4.2.9.5 Batch LAS Tops Tab

Some LAS files contain formation tops. The Import Tops Tab selects which tops are brought into the project.
The Filter/Rename Tab sets how Petra uses a “curve translation” file to rename incoming logs. Curve restriction lists establish a set of rules for how Petra renames curves from the LAS files when they come into the project. This can be useful for reducing the total number of digital log curve names in a project.

Curve translation files are relatively simple – they just establish the name of the curve as it appears in the LAS files and the desired name in the project. As an example, Reeves wireline logs name their gamma ray curves as “GRGC.” Creating the entry, “GRGC=GR” will rename all “GRGC” as “GR.” The example below (right) shows a curve translation file.

**Rename Curves** – This option tells Petra to use the translation file to rename the curves.

**Restrict Import to Curves Listed in Translate File** – By default, Petra will import all curve names in all files, but will rename the curves on the curve translation file. This
option makes the import more restrictive; only the curves on the curve translation file are imported.

4.2.9.7 Batch LAS Units Tab

This tab converts metric-imperial units for sonic and density logs, and decimal-percent for porosity logs. For the porosity curve decimal-to-percent correction, Petra uses the units listed in LAS file header’s curve information.

Porosity Units Conversion – Percentages can be expressed on a 0-1 scale or on a 0-100 scale, which can make calculations more difficult. This option converts curves with PU, %, V/V, PCNT, PERC, or VOL. By default, the “Do Not Convert Porosity” option is selected, which does not make any changes. The “Convert Porosity to Percent (0-100)” multiplies the curve by 100; the “Convert Porosity to Decimal (0-1)” divides the curve by 100.

Density Log Units Conversion – This option converts density units between imperial and metric units. By default, the “Do Not Convert Density Logs” option is selected, which does not make any changes. The “Convert KG/M3 to gm/cc” converts metric density curves to use imperial units. The “Convert gm/cc to KG/M3” converts imperial density curves to use metric units.

4.2.10 Import Log Curves From ASCII File

Though most log curves are stored in the *.LAS format, some log curves are stored as *.TXT or *CSV files. The Import Log Curves tool imports digital log curves from non-LAS ASCII files. The format of the file can be either tabular in nature (fixed column) or values separated by commas (comma delimited).

This tool can also handle isolated depth-value pairs (like sidewall cores), or "from-to" intervals.
The File Tab

The File Tab sets the file, the destination well, update mode, and other basics of the data import.

Load Data Into Well - This drop down box defines which well will receive the imported log data. This list will display all the wells currently selected in the Main Module.

File To Import - The "Open File" button opens a dialog box to select the desired file. The selected file and pathway is displayed to the immediate right.

Curve Update Mode

This section defines the method for updating the existing log curve database.

Add or Replace Curves In Database - This option will add new log curves will be added to the database and imported logs will overwrite existing log curves.

Add New Curves Only - This option will only add new logs to the database. Existing log curves in the database will not be overwritten.

Merge Curves with Database Curves - This option will merge imported depth intervals into the logs already in the database curve. Additionally, new log curves will be added. The dropdown to the right controls which values are preferred.

On Merge, Old Values are Preferred - When old and new log data overlap, Petra will keep the older values already in the database.

On Merge, Non-Null New Values are Preferred - When old and new log data overlap, Petra will overwrite only nulls in the database with the newer values.

On Merge All new values are Preferred - When old and new log data overlap, Petra will overwrite older values with the newer values.
Original Data Is Sampled As

This entry determines the general type of data imported into the well.

**Constant Sample Rate** - This option imports data from the file into a continuous single curve. This option is used for wireline logs, and also for "from-to" pairs that have a continuous value "from" one depth "to" another depth (like mudweights).

**Discrete Points** - This option imports data from the file as disconnected data points. This is useful for isolated petrophysical measurements or sidewall cores. When loading discrete data, make sure to turn off the "Allow Resampling Mismatched Depths" and the "Determine Sample Rate From Data" option. On the "Sample Increment" entry, specify the smallest multiple of the depth interval. As an example, samples at foot intervals should have a sample rate of 1. Samples measured at quarter foot intervals should have a sample rate of 0.25. For sample rates below 0.05, simply type in the desired number. Note that Petra can only handle 128000 discrete points in a curve. The curve will be truncated beyond the first 128000 samples.

**Depths**

The depth section defines the depth units and resulting sample increment of the imported data.

**Units** - This option selects the depth units of the imported log curve.

**Sample Increment** - This option sets the sample rate of the curve in Petra's database in depth units per sample. The increment must be equal to or less than the rate of the imported data. If the specified rate is greater than the data rate, Petra will use the data sample rate.

**Allow Resampling Mismatched Depths** - This option will resample data samples that do not fall on even sample increments. Most commonly, uneven sample depths are caused by converting MD/TVD from feet to meters or meters to feet. When importing discrete data points, make sure this option is turned OFF.

**Determine Sample Rate From Data** - This option will search the input data file to determine what the smallest sample increment should be to store the curve without resampling it. Three methods are available:

**Using Smallest Depth Increment** - The smallest difference between any two samples will be used as the sample rate. For example, given depths 1002.20, 1003.00, 1004.05, 1004.07, the chosen sample rate will be 0.02 (difference between 1004.05 and 1004.075).

**Using Smallest Multiple of Depths** - The smallest fractional portion of all the depths is used as the sample rate. Given the above example, the sample rate will be 0.05.

**Using Start-Stop Depths and Number of Points** - The sample rate is computed by \((stop\_depth - start\_depth) / (num\_pts-1)\).
Data Tab

The Data Tab sets the specific fields and curves in the file for the import.

Log Curve - Data Record Field Definitions

Recall that this tool can either use tabular (fixed column) or comma/tilde-delimited type ASCII data file. Columnar files separate different curves with empty space; for these files, Petra distinguishes between different entries on a row with specific start and stop column numbers. Comma- and tilde-delimited files separate different curves with characters; for these files, Petra distinguishes between “fields” by counting the number of commas.
To add a field definition for a comma- or tilde-delimited file, select the desired field in the Data Record window. Next, select the relevant data type on the set of dropdown menus on the right. Select the “+” add button to add the definition to the "Field Definitions" list box. Note that Petra counts the number of commas to establish a Field Number. As an example, the Depth values are in field 1, while the GR curve values are in field 3.

To add a field definition for a columnar file, swipe relevant data field on the Data Record window. Note that Petra fills in the “Start Column” and “End Column.” Next, select the relevant data type on the set of dropdown menus on the right. Select the “+” add button to add the definition to the "Field Definitions" list box. Note that Petra counts the number of commas to establish a Field Number. As an example, the Depth values are in field 1, while the GR curve values are in field 3.
In both cases, to modify a field definition, use the replace button to replace the currently selected field definition with the selected entry on the import file and data type. To drop a field from the list, select the desired definition and select the "drop" button.

Depth 1 - Depth 1 (required) is the normal depth for single depth datasets and the "from" depth for files containing "From-To" depths.

Depth 2 - Depth 2 (optional) is the "to" depth for files containing "From-To" depths.

Format - This dropdown specifies whether the data is Columnar or Comma Delimited.

Data Record

Format - This dropdown sets whether the data type is "columnar" and organized in fixed columns, or "Comma Delimited" and separated by commas.

Null Value Indicator - Specify the text string contained in the input file that is to be interpreted as a null value.

Missing Data Tool - Specify how missing data sections (gaps between depths) are processed. Options are available to leave the gaps as null values, fill the gaps using the previous non-null value, or to interpolate good values across the gaps.

Records to Skip Before 1st Depth - This option allows header or comment records to be skipped at the beginning of the data file prior to the first true data record. Click the "Set Skip" button to set the number of skipped records based on the record currently in the data record window.

Data Window - This section primarily is used to scroll through the data file and select data field columns. Use the up and down arrows located to the right of the record window to read forward or backward in the file. The data record can be scrolled left or right by placing the cursor in the record window and using the left or right cursor
keys.

Saving and Loading Field Definition Templates

Since creating a long list of field definitions can be tedious, it’s a good idea to save your work. Petra can save these column and field definitions as a template “Format File” with a *.FMI extension. By default, Petra stores template files to the private parms directory. To save a field definition template file, select the Save button. To load a pre-existing format template, select the Load button.

Options Tab

The Options Tab controls how Petra handles characters at the beginning of UWI/API numbers in the file.

Remove the Following Special Characters From the UWI (or API#) - This entry sets the characters that Petra ignores at the beginning of the UWI/API numbers.

Report Tab

The Report Tab displays the results of the import process. Before importing a log file, this tab will be blank.
4.2.11 Import LIS Log Data File

LIS files are a fairly rare digital log format. This file format predates LAS and is based on storing data on magnetic tape; individual well logs are separated by reel, tape, and file numbers. Unlike LAS files, LIS files are binary files and can’t easily be read as ASCII text in NotePad or WordPad.

Like all digital curves, Petra loads all the selected log curves into the project database. As such, it isn’t necessary to maintain a network-accessible folder for digital log curves like it is with raster log curves.

Logs Tab
Headers Tab

4.2.11.1 LIS Logs Tab

The Logs Tab sets the basics for importing LIS files.

Load File Into Well
On this dropdown, select the well in the project where the curves will be stored.

**LIS File**

To select the LIS file for import, select the “Browse” button and navigate to the file. By default, Petra will automatically scan new files for logs and comments. To disable this scan, select the “Auto Scan” button.

**Depths**

To set depths by tops or by a specific depth range, select the “Set Depth From Range” button. Next, select the “Set Range” button. In the Set Depth Range box, select the relevant top, MD, or TVD button. For MD and TVD, select the relevant button and enter the adjacent depth in the entry field. For tops, select the desired top from the “Fm Top Name” dropdown box. Notice that an offset can also be added or subtracted to the fm top; this offset will include data points above or below the actual fm top depth.

To set depths by a zone's interval definition, select the desired zone on the “Set Upper and Lower Depths From Zone” dropdown menu. Note that the WELL zone by default covers -1M MD to +1M MD, so it should cover the entire footage of all wells.

**Load Every N'th Sample** – This option decimates the data to only keep every N'th sample. Setting this value to 2, for instance, would only load every other sample. Setting this value to 5 would only load every 5th sample. By default, this option is set at 1 to keep every sample in the curves.

**Add or Replace vs. Merge Logs With Existing Data** – These options control how Petra handles overlaps between curves already in the project database and the LAS file. The “Add or Replace” option allows for the creation of new logs and will completely replace any overlapping curves in the database with the LAS file data. “Add New Logs Only” only creates new logs; when there’s an overlap between the database and the LAS file, the database won't change. “Merge into Existing Logs” does not create any new curves in the database, and will merge data from the LAS file with the curves already in the database. This merge operation can either prefer old values, non-null new values, or all new values. “Add or Rename” allows for the creation of new logs, and will rename overlapping curve names with a numerical suffix (like GR_1). For this example, select “Add or Replace Logs.”

4.2.11.2 **LIS Headers Tab**

The Headers Tab loads header information from the LIS file into the well. Select the “Scan File” button to find header information. Next, select the header information in the window in the middle of the screen, and select the destination of the relevant headers in the file.
4.2.12 Import AccuMap Data into PETRA

Export data from AccuMap into Petra using an automated process that prompts you for AccuMap export details, launches Petra, and then prompts you for Petra import details. The spatial extents of the data are defined by the bounding wells in the list. Data includes well, production, grid, culture, Open Layers, and shapefile data in NAD83 or NAD27 format.

Export functionality is available in AccuMap using either the Detail Map menu, or Well List Manager.

Petra creates new projects by default in the directory specified in the registry. To specify a different location, add the following to the Petra.ini file found in the Petra installation location (either on the server for a network setup, or on the local machine for a standalone setup):

```
[ACCUMAP]
PRIVATE_PATH=c:\Geoplus1\Projects
PUBLIC_PATH=c:\Geoplus1\Projects
```

To import AccuMap data into Petra using a well list

1. With the Petra application closed, using AccuMap and depending on whether you want to use the Detail Map menu or Well List Manager, do one of the following:

   - **Detail Map menu**: Select **Detail Map > Well Lists > Launch Petra**, and using the Launch Petra with Well Lists dialog box that appears, select the desired well list, and then click **OK**.

   - **Well List Manager**: Select **Tools > Well List Manager**. The **Well List Manager** dialog box appears and the main menu bar options change to reflect Well List Manager options. Select **Well List Manager > Well List > Open**, and select the desired well list. Data is exported using the datum option defined in the **Datum Settings** pane of the **AccuMap Defaults** dialog box (Edit > Defaults menu). To select different options, from the **Well List**
Manager menu, select Export > Coordinate Info.
Select Well List Manager > Export > Launch Petra.

2. Using the Petra Launch Options dialog box, select import options.

3. Select the types of data to include.
   - If you select Additional User Tops, in the left window, select a user's database of tops and click Add.
   - If you select Open Layers / Shapefiles, click Select Files to display the Select Open Layers / Shapefiles for Petra Export.
Select whether to display **Open Layers** and **Shapefiles** below the **Available Files** pane, select the desired files, and then click **Add** (or simply click **Add ALL** to copy all files displayed in the **Available Files** pane), and then click **OK**.

4. Using the **Petra Launch Options** dialog box, click **OK**.

Petra automatically launches and begins importing AccuMap data. Petra displays import statistics and then prompts you to load the AccuMap data.

5. Select **Yes**.

The **Import Petra AccuMap File** dialog box appears.

![Image of Import Petra AccuMap File dialog box]

Generally the default options are appropriate; however, click below for a description of the various options on each tab:

- **Import Petra AccuMap File: Options**
- **Import Petra AccuMap File: Fm Substitute**
- **Import Petra AccuMap File: AccuMap**
- **Import Petra AccuMap File: Misc**
- **Import Petra AccuMap File: Elev Trans**
- **Import Petra AccuMap File: Dir Survey**

6. Click **OK** to dismiss the **Import Petra AccuMap File** dialog box and load the well data.
The *AccuMap Petra Production Import* dialog box appears.

![AccuMap Petra Production Import dialog box]

7. Select the desired production data to import, and ensure **Convert Canadian UWIs from "Display" to "Raw" Form** is selected on the *File* tab.

Load all of the available production streams and cumulative production values in the *Production* and *Injection* tabs. Click below for a description of the various options on each tab:

*AccuMap Petra Production Import: File*
*AccuMap Petra Production Import: Production*
*AccuMap Petra Production Import: Injection*
*AccuMap Petra Production Import: Gas Analysis*
*AccuMap Petra Production Import: Gas Composition*
*AccuMap Petra Production Import: AOF*

8. Click **OK** to dismiss the *AccuMap Petra Production Import* dialog box, and then click **OK** to dismiss the confirmation message and finish loading the well data.

The Petra *Main Module* appears when the data finishes loading.
9. Using the *Main Module*, click the **Mapping** button (**_mapping**), and click **Yes** when prompted to load AccuMap grid and culture files.

The **Import Cartographic Data** dialog box appears.

10. Select the manner in which to process imported cartographic data, and then click **Import**. Click below for a description of the various options on each tab:
- **Import Cartographic Data: File**
- **Import Cartographic Data: Limits**
- **Import Cartographic Data: Layers**
- **Import Cartographic Data: MISC**
- **Import Cartographic Data: T-R-S**
- **Import Cartographic Data: Translate**

If culture was included in the original AccuMap export, the **Import Cartographic Data** dialog box appears a second time with **AccuMap Culture File (CDF)** displayed in the **File Type** drop-down list on the **File** tab and additional tabs to review.

11. Select **Replace Current Layer Data with the Imported Data** in the **Layer Update Mode** pane and select an unassigned layer (Layer #X, where X is a sequential number), and then click **Import**.

The map appears.
4.2.13 Import Uncalibrated Raster Logs

Working with images without depth-calibration points can be labor intensive, since every image needs to depth calibrated and named.

Getting Ready

1. On the Main Module, select the Rasters Tab.

2. Select “Assign/Calibrate...” button on the lower left hand corner of the window to open the “Calibrate Log Image” tool.

3. Here, select the button on the toolbar. Alternatively, select File>Open on the menu bar at the top of the screen. Next, navigate to folder containing the images and select the desired image file. By default, Petra will look in the project’s IMAGES folder.

Opening a TIF image

It’s usually worthwhile to spend a few seconds scrolling up and down through the image to see what’s actually there. Usually, raster images store a complete copy of the scanned paper log, which can contain the same log at different scales as well as repeat sections.

Adding Depth Calibration Points

4. A scanned log is just an image, so Petra needs a way to know how the image corresponds to depth. Select the “Add” button on the right side of the screen; note that this turns the mouse pointer into a line. Click right on the 1200’ marker, and enter in the depth.
5. Scroll down the image to 5400′MD, and add another depth calibration point. Notice that Petra automatically extrapolates depths between two depth points, which are marked with thin black lines. Commercially depth-calibrated logs often have dozens of calibration points, most of which are unnecessary. Well-scanned logs that minimize image stretch really only need a few points. In our case, the calibration is pretty good for most of the depth range, but could use improvement. Add more depth calibration points where the calibration is off (around 2400′MD and 4900′MD).

6. Now that the top part of the well is calibrated, scroll to the 5” section, and add a calibration point just a little below the 5400′MD line. Put the depth in as 5401′MD.
7. Add a point at the TD marker at 6424'MD and at a few more points to get a good calibration to the image. Again, add depth calibration points where the black lines are off the 100’ intervals on the log. Notice that Petra will add thick black lines in the correlation – these are actually the tops we imported earlier.

8. Select the “-“ button to zoom out on the section. Right now, we have two sets of depth calibration points over the image: a shallow set over the 1” log, and a deeper set over the 5” log. In between, there’s a lot of extraneous information that we’d rather just cut out. Select CTRL and click somewhere in the region between the shallow and deep set of calibration points. Notice that the section goes dark, signifying that it won’t display on cross sections. In our case, this will just keep the entire section from being crammed into a tiny sliver between 5400'MD and 5401'MD, but this technique can be really useful to cut out other extraneous parts.
of an image. This technique is also useful for cutting out a repeat section between one run and the next.

9. Select the “+” button to zoom back into the image. The next step is to add scales. Petra can draw both an upper scale and a lower scale on the same cross-section. Scroll to the bottom of the depth calibration points. On the “LwrScl” section, select the “Top” and “Bottom” buttons to set the boundaries of the upper scale marker.

Next, scroll to the top of the image. On the “UprScl” section, select the “Top” and “Bottom” buttons to set the boundaries of the upper scale marker.

10. Scroll to the very top of the image. Add the top and bottom of the header with the “Top” and “Bottom” buttons in the “HDR” section.
11. The final step is to add a group name. Group names usually describe the depth-calibrated part of the image – usually by describing the scaling or the curves. Right now there’s only one group name – “DEFAULT.” On the menu bar at the top of the screen, select Group>Add or Delete Groups.

From a user-perspective, group names are a way of comparing similar raster images from one well to another. Though commercial vendors generate thousands of unique group names for every combination of tool and scale, it’s usually better to have fewer, more general group names rather than many excruciatingly exact ones. In the Image Group Name entry, type in “Induction”, and select the Add button.

12. Select the Done button. Back in the Calibration tool, use the group name dropdown and select “Induction.” Select the button to save the calibration to the group name. Behind the scenes, Petra’s actually creating a LIC file that saves these calibration points – the location of which is shown in the “Save File As” window.
4.2.14 Import Interval Data

New interval data can be brought into Petra either manually or by a tabular data import.

Adding New Data Manually

To add new intervals manually, first select the correct well in the Main Module. On the Interval Tab, select the right interval table. In the example below, the “LITH” table is selected. Finally, select the “Edit details” button in the upper right on the Interval Tab. This brings up the Edit Interval Data window for the selected interval table. Continuing with the example, the Edit Interval Data window below shows the fields for only the LITH table.

To add a new interval, enter in the Top and Base. Next, select the button to add the interval.
With the interval now added, enter in the remaining interval details and select the button to save the changes to the interval. In the example below, the Quality, Formation, and LITH Table specific fields are filled in.

To save the changes to the database, select OK. Here, Petra gives the option to save or discard ALL changes made to the selected well’s interval table. All the edits to all intervals will be ignored if you select CANCEL.

Importing Tabular Interval Data

Digital data where each row contains information about a discrete interval can be easily imported into Petra. Before attempting to import interval data, check to see if the data has a column dedicated to the UW/API. Since Petra assigns interval data to specific wells by comparing UW/API numbers, interval data without an identifying API/UWI column can’t be imported. The easiest way to remedy this is to simply open the interval data in a spreadsheet program, and add a new column for well UWI/API.

To import new digital interval data, select Project>Import>Import Tabular Interval Data... on the menu bar at the top of the Main Module. This opens the “Import Interval Data from Tabular File Format” box. Here, select the “Open File” button and navigate to the interval data’s location.
Once the file containing the interval data is opened, Petra switches to the Data Format Tab. This tab essentially links the entries in the file to specific kinds of data.

The first step is to select the interval data file’s formatting under File Format. Files can be imported into Petra in one of three formats: “Columnar”, “Comma Delimited”, or “~ Delimited.” Columnar data organizes data into fixed columns, where Petra imports data based purely on the number of characters from the left. The left screenshot, on the other hand, shows the API number as defined by columns 1 through 14.

Comma and ~ delimited data, on the other hand have no fixed column size and are instead separated by a comma or a tilde. With delimited data, Petra imports data based on the “Field” defined by the delimiter. The example below shows the same UWI/API field defined in two different ways. The right screenshot shows the API number defined as “Field (1)”, i.e. it is separated by the first comma.

Be careful when importing text as a comma delimited file. If the text has a comma in it, Petra will read that as the end of the field. The interval data stored as UWI, Top, Base, Description such as:

05123187700000, 6295, 6998, Calcareous, micaceous, clay-rich siltstone

Would only be imported as:
API: 05123187700000
Top: 6295
Base: 6998
Description: Calcareous

In other words, all the description past the first comma is cut off. This can also cause bad imports when data is beyond the comma-filled text.

The next step is to establish field definitions. Essentially this step defines which part of the file is which kind of interval data. The easiest way is to select and highlight the specific data field in the “Data Record” part of the screen, then select the type of interval data on the left. Petra can import fields for any interval table. In order to put interval data with the correct well, the UWI or API # field must be defined.

When loading the TOP and BASE of the interval, Petra assumes that the depths are in MD. To import other depths, such as SS or TVD, select the appropriate depth on the “Field is not a Depth or is MD” dropdown when establishing a field definition.

For user-defined fields (Not the TOP, BASE, DATE1, DATE2, QUALITY, FM NAME, UNITS fields), Petra can store a quality code. To import the quality code, select the “Store Field Value” dropdown menu and set it to “Store Field Quality Code.”

To add the field definition, select the “+” button. The “−” button drops the selected field definition. To modify an existing field, make the appropriate changes and select the ▶ button.

The example below shows field definitions for the data file, which include the well API, interval top, interval base, formation name, and description.
To save the field definitions and options, select the “Save” button. This option saves a *.FMI file. Selecting the "Load" button restores all the saved settings.

Most data files have some header or comments at the top. The “Records to Skip Before 1st Well” option tells Petra to skip a set number of lines before importing any well data. Click the "Set Skip" button to set the number of skipped records based on the record currently in the data record window.

### 4.3 Exporting Data

Petra can export project data to a variety of data formats. Petra's export tools are available at Project>Export> on the menu bar at the top of the Main Module.

- Export Petra Project File
- Export Petra Template File
- Export Tabular ASCII File
- Export ASCII Tops File
- Kingdom Export
- Export Zone Data
- Landmark 29 File
- Landmark OWX File
- Export Log Curves
- Monthly Production
- Directional Survey
- Top Definition
- Perfs, Cores, Casing, Liner, IP, DST
- Interval Data
- SCA - MCS Z Data
- GES Wellbase V2
- Velocity Data
- Well Remarks

#### 4.3.1 Export Petra Project File

This tool exports the data in a project to a single Petra project file (*.PPF). This is a good way of bundling a project’s data into a single large file, which can be
considerably easier to work with than an entire database file.

To create a PPF file, select Project>Export>Petra Project File (*.PPF) from the menu bar at the top of the Main Module.

On the "Select Petra Project File to Export" window, select the file name and location for the PPF file.

Data Tab

The Data Tab sets the location of the exported file, and the specific data to export from the project data.

*Export Project File To* - This entry selects the location and PPF file name. To open the windows explorer, select the "browse" button.

*Optional Data to Export* - This entry sets the specific data to include in the PPF file. This can include most data in a Petra project. Note that the "None" and "All" select none of the checkboxes and all of the checkboxes, respectively.

Dates Tab

The Dates Tab limits the some of the data included in the PPF file to data created or changed within a specific range. This includes well header information, locations, directional survey data, tops, zone data items, and digital logs. This can be useful for creating update files or backups.
Restrict Wells Exported Based On Change Date of Well header Data - This option limits the file only to well data with a header change date inside the set range. This change date is visible on the Main Module’s Well Tab. Note that the export tool will list that it’s exporting all currently selected wells, even if it is only including a small subset within the date range.

Export Well Data Items Based on Item's Change Date - This option will include all wells in the project, along with all logs, tests, and production data. It will also include all entries for all zone data items and formation tops, but these entries will only be filled with data with a change date inside the date range. Note that the export tool will list that it’s exporting all currently selected wells, even if it is only including a small subset within the date range.

From Date/Through Date - These entries set the actual date range for the export. Note that this tool uses a MM/DD/YYYY format.

Dir Survey

Petra can store multiple directional surveys (both real and planned) for any well. This tool can export any or all of the directional surveys for all wells. The Dir Survey Tab sets the specific surveys exported to the file.
Export All Surveys Available for Each Well - This option will include all surveys loaded in the project, including all active and secondary surveys.

Export 'Active' Survey Only - This option will export only the active surveys.

Export Selected Survey From List Below - This will export only surveys with the survey definition selected on the dropdown below.

Misc

The Misc Tab controls a few additional options for exporting data, including encryption and memory uses.

Encrypt Well Identifiers - PPF files are plain text files. This option encrypts the well’s UWI, well name, number, label, operator and lease. This option does not encrypt location data.
**Number of wells to process at once** - This dropdown sets the number of wells to process before writing to the PPF file. Increasing this number will increase the amount of memory used in the export.

### 4.3.2 Export Petra Template File

This tool exports the project database structure settings to a single Petra Template File (*.PTF). In essence, a template file stores an empty shell of a project containing empty zones, data items, top definitions, map projections, and other settings without wells or any actual data.

To create a PPF file, select **Project>Export>Petra Template File (*.PTF)** from the menu bar at the top of the Main Module.

On the "Select Petra Project File to Export" window, select the file name and location for the PTF file.

### Data Tab

The Data Tab sets the location of the exported file, and the specific data to export from the project data.
Export Project File To - This entry selects the location and PTF file name. To open the windows explorer, select the "browse" button.

Optional Data to Export - This entry sets the specific data to include in the PTF file. This can include most data in a Petra project. Note that the "None" and "All" select none of the checkboxes and all of the checkboxes, respectively.

Dates Tab

The Dates Tab limits the some of the data included in the PTF file to data created or changed within a specific range. This includes well header information, locations, directional survey data, tops, zone data items, and digital logs. This can be useful for creating update files or backups.

Restrict Wells Exported Based On Change Date of Well header Data - This option limits the file only to well data with a header change date inside the set range. This change date is visible on the Main Module’s Well Tab. Note that the export tool will list that it’s exporting all currently selected wells, even if it is only including a small subset within the date range.

Export Well Data Items Based on Item’s Change Date - This option will include all wells in the project, along with all logs, tests, and production data. It will also include
all entries for all zone data items and formation tops, but these entries will only be filled with data with a change date inside the date range. Note that the export tool will list that it’s exporting all currently selected wells, even if it is only including a small subset within the date range.

From Date/Through Date - These entries set the actual date range for the export. Note that this tool uses a MM/DD/YYYY format.

Dir Survey Tab

Petra can store multiple directional surveys (both real and planned) for any well. This tool can export any or all of the directional surveys for all wells. The Dir Survey Tab sets the specific surveys exported to the file.

Export All Surveys Available for Each Well - This option will include all surveys loaded in the project, including all active and secondary surveys.

Export 'Active' Survey Only - This option will export only the active surveys.

Export Selected Survey From List Below - This will export only surveys with the survey definition selected on the dropdown below.
Misc Tab

The Misc Tab controls a few additional options for exporting data, including encryption and memory uses.

**Encrypt Well Identifiers** - PPF files are plain text files. This option encrypts the well’s UWI, well name, number, label, operator and lease. This option does not encrypt location data.

**Number of wells to process at once** - This dropdown sets the number of wells to process before writing to the PPF file. Increasing this number will increase the amount of memory used in the export.

4.3.3 **Export Tabular ASCII File**

The Export Tabular ASCII File exports header and zone data items in a Petra project to an external TXT file. This file can either be column or comma delimited.
Data tab

The Data tab sets the specific zone data items for export.

Output File Group

This entry sets the name and location of the exported file. Select the Browse button to navigate to the desired directory and to select the file name.

Data Columns To Output Group

This section displays the data items that will be exported to the file. To add items to this list, use the Select Data Items.

To add a data item, select the desired item in the Select Data window. Select the “+” add button to add the definition to the "Field Definitions" list box.

To remove a data item, select the desired field in the Data Columns To Output window. Select the “-” drop button to remove the item from the Data Columns to Output list.

In both cases, to modify a field definition, use the replace button to replace the currently selected column with the selected entry on the Select Data list.

Select Data Group
Well Header/Surface Locations/Bottom Hole Locations/Mechanical/Miscellaneous

This section contains the various data types which can be exported. For each column to output, select the data in the well header list or the Z data list and click the Add button. You can change a previously selected column by clicking once on the Data Columns to Output list box, changing the data options in the "Select Data section" then clicking the Replace button. Columns can be dropped from the list using the Drop button.

Formation tops may be exported as either measured depth or subsea depth. Check the TVD Subsea Top option to export a subsea top.

The Column Width field allows you to specify the number of characters in each column.

The Decimal Places option allows to numeric columns to define the number of digits to the right of the decimal point.

The Numeric NULL Value field is used to specify a special character string to represent NULL values in the output file. The default leaves a blank field for any NULL values.

The objective is to define each column of the exported file in terms of which Petra variable, column width and numeric representation. As each column is defined, it will appear in the list box on the left. Choose the OK button when ready to export the data.

Save - This option saves the export format to an external file.

Load - This option loads an export format from an external file.

Options Tab

The Options Tab controls a few additional parameters on how Petra creates the external file.
The Export Tabular ASCII File Options Tab

Export Tops Using Aliases - This option will use top aliases for the export.

Lat-Lon as Deg Min Secs - By default, Petra exports LatLons as degree decimals. This option will instead export Latitude and Longitude as degrees:minutes:seconds.

Make File Comma Delimited - This option separates entries in the export file with commas rather than tabs.

Convert Double Single Quotes to Single Double Quote - This option converts two single quotes into a double quote.

Include Perf Type with Pefs - This option adds an additional field for perf "Type" column.

Include Perf Source with Perfs - This option adds an additional field for the perf "Source" column

Include Perf "Nbr Shots" field - This option adds an additional field for the perf "Nbr Shots" field from the Perfed Intervals detail tool.

Include Perf Remark with Perfs (first 40 chars) - This option adds an additional field for the perf "Remarks" field from the Perfed Intervals detail tool.

4.3.4 Export Kindom File

This tool exports the well data in a project to a Kingdom Petra Link folder in a SMT Kingdom project.
To create a Kingdom well data *.asc file, select Project>Export>Kingdom Export from the menu bar at the top of the Main Module.

Data Tab

The Data Tab sets the location of the exported file, and the specific data to export from the project data.

Select Kingdom Project File (.tks) - This entry selects the location of the Kindom project's *.TKS file. Selecting this project file will then populate the "Date Exported To" location.

Data Exported To - This entry shows the location of the created well data file, which will always be named "PetraData.asc"

Optional Data to Export - This entry sets the specific data to include in the well data file. This can include most data in a Petra project. Note that the "None" and "All" select none of the checkboxes and all of the checkboxes, respectively.

Select Tops - This entry selects the Select Zone Item List to add tops to the exported data.

Options Tab
Use "Common Name" From - This entry sets how Petra creates Kingdom’s "Common Name." Petra can use the database entry for Well Name, Well Label, Well Number, UWI, or Lease Name.

4.3.5 Export ASCII Tops File

The Export Fm Top Names and Values tool exports the formation tops in a Petra project to an external TXT file. This file can either be column or comma delimited.

To use the Export Fm Top Names and Values tool, select Project>Export>ASCII Tops File (UWI, FmName, Value...) from the menu bar at the top of the Main Module.

File Tab

The file tab contains the file name and export format options. Use the "Browse" button to display the Window’s file dialog box.

Output File - Use the "Browse" button to select or enter the name of the text file for writing formation tops.
Select Tops - This button opens the Select Zone Item List. Note that this list only includes tops in the FMTOPS zone. To add tops to the file, select the relevant top on the Zone Item list.

The "->" adds the highlighted top to the Selected Zone Item List.

The ">>" button adds all tops in the currently highlighted zone to the Selected Zone Item List.

The "<" button drops the highlighted top from the Selected Zone Item List.

The "<<" button drops all tops from the Selected Zone Item List.

Use Aliases - This option uses formation top aliases. If a well's value for a top is NULL, Petra will use the alias list to find a substitute "equivalent" top.

Output Tops if "Null" - Normally, NULL valued tops are not written to the export file. This option writes the user-created null value to the top instead.

"Null" Value Indicator - This option sets the value that will be written to missing NULL tops.

Format - This dropdown sets whether the exported file will have fixed columns or will be separated by columns.

Options Tab

The Options Tab sets a few additional options on the specific columns in the exported file.
The Export Fm Top Names and Values Options Tab

**Output Tops as** - Petra can export tops as MD, SS, or TVD tops. For deviated wells, the subsea value will be TVD subsea.

**Include Tops Source Code** - This option adds a column for the source code.

**Include Quality Code** - This option adds a column for the quality code.

**Include Remarks** - This option adds a column for the top remarks code.

**Include Well Header Items** - This option adds columns for the well name, number, label, operator, lease name, datum, and TD.

**Include XY Location of Each Top** - This option adds a column for the xy position of each top. For straight holes, this will be the surface location. For deviated and directional wells, Petra will use the directional survey to calculate the XY location.

**Include Top Description** - This option adds a column for the top's description.

**Include Change Date** - This option adds a column for the date of any changes made to the top.

**Include Time** - This option adds a column for the time of any changes made to the top.

**Suppress Column Headings** - This option restricts the column headings from appearing on the top of the file.

**Include Repeats** - This option includes all repeat tops.

**Output Only Tops Modified Within Date Range** - Petra records when tops in its databases are changed. This option can restrict the export to only include log curves that have been modified in between the "From Date" and the "Through Date."

### 4.3.6 Export Zone Data

The Zone Data Export tool creates an ASCII file containing one or more selected zone items.
To use the Export Zone Data tool, select Project>Export>Zone Data File from the menu bar at the top of the Main Module.

This tool is similar to the Export Tabular Ascii File tool - the key difference is this tool's ability to store every zone data item in its own row (Layout 2 on the Layout Tab) rather than in separate columns.

Data Tab
The Data Tab sets which zone data items are included in the exported file.

Output File - Use the "Browse" button to navigate to the desired location and enter the name of the exported file.

Select Zone and Items To Export
First, select the desired zone from the dropdown menu. Once a zone is selected, the list will show the data items in that zone.

The "->" adds the highlighted item to the Selected Items to Export List.

The ">>" button adds all items in the currently highlighted zone to the Selected Items to Export List.

The "<" button drops the highlighted item from the Selected Items to Export List.

Sort - This button sorts the items in the Select Zone and Items to Export List in alphabetical order.

The UP and DOWN arrows will move the highlighted item in the "Selected" list.

Options Tab
The Options Tab sets some of the details on how Petra creates the file.

Output File Format - This option sets whether the output file is "Fixed Width Columns" (blank separated) or "Comma Delimited."

When To Write Column Headings - You can have the data columns labeled each time the zone name changes or you can write the heading once at the beginning of the file.

The "Write New Heading For Each Zone" option should be used whenever the zone item names change from zone to zone. The "Write Heading for First Zone Only" should only be used when the zone item names are the same in each zone and selected in the same order.

Include Zone Item Remarks Field - This option will also export the "Text Item or Remark" field along with the data item.

Layout Tab

The Layout Tab sets the specific format of the exported file: either column-wise (Layout 1) or row-wise (Layout 2).
Layout 1 stores all information about a single well on a single row, where different columns reflect different pieces of information. In the example below (left), each well is a single row, with perf information (a flag, the total feet of perfs, the shallowest and deepest perf depths) arranged in columns to the right.

Layout 2 stores each data item and identifier in its own row, with multiple rows for a single well. In the example below (right), each line has an API number, the zone name, the data item and the value. Every wells has multiple rows for different data items.
4.3.7 Export Landmark Standard 29 File

This tool exports Petra project data to a Landmark Standard 29 file format. This file format will always include wells and well header information (like API, operator, etc), but can also include other data in the project like locations, tops, directional surveys, and curves.

To create a Landmark Standard 29 file, select Project>Export>Landmark Standard 29 Format from the menu bar at the top of the Main Module.

Export Project File - This entry selects the location and *.ASC file name. To open the windows explorer, select the "browse" button.

Optional Data to Export - This entry sets additional data to include in the file beyond well and well header information. This can include locations, tops, directional surveys, and log curves.

4.3.8 Export Landmark OWX File

This tool exports the well data in a project to a Landmark OWX format.

To create a Landmark *.OXM file, select Project>Export>Landmark OWX Format from the menu bar at the top of the Main Module.

Data Tab

The Data Tab sets the location of the exported file, and the specific data to export from the project data.
Export File - This entry selects the location of the exported file.

Optional Data to Export - This entry sets the specific data to include in the file. This can include most data in a Petra project. Note that the "None" and "All" select none of the checkboxes and all of the checkboxes, respectively.

Select Tops - This entry selects the Select Zone Item List to add tops to the exported data.

Options Tab

Use "Common Name" From - This entry sets how Petra creates the "Common Name." Petra can use the database entry for Well Name, Well Label, Well Number, UWI, or Lease Name.

Deviation Survey Format - This entry controls how the file contains directional survey data. OWX files can use either the "OWX2003" format or the "Kingdom Compatible" format.

Kingdom Compatibility For Other Records - This option changes the file format elsewhere to be compatible with Kingdom software.
4.3.9 Export Logs

Petra can export digital log curves from the database for use in other systems.

To export a log from Petra, select Project>Export>Log Curves (LAS, LIS, etc)…
from the menu bar at the top of the Main Module.

File Tab

The file tab contains the file name and export format options. Use the "Browse" button to display the Window’s file dialog box.

Output File Name

This entry sets the name and location of the exported file. Select the Browse button to navigate to the desired directory and to select the file name.

Export Format

LAS - LAS is the most common industry standard log ASCII format. This format is almost universally recognized by most oil and gas applications.

LIS - LIS is an older binary log format, and cannot be viewed in a text editor. LIS files can contain curves from multiple wells in a single data file.

Tabular - This option creates a generic ASCII text file containing log values as data columns. Petra creates *.DAT files by default, but these can be easily be renamed to *.TXT.

MORE - This option creates files specifically formatted for the MORE simulator.

RC2 - This option creates files using RC2’s ResPrep ASCII file format.

Logs Tab
This tab selects the log curves that will be included in the file.

Single well file formats (LAS, Tabular ASCII, MORE, and RC2) will have a dropdown menu to select the desired well's logs. LIS files, on the other hand, can contain multiple wells; logs selected on the "Select Log Curves To Export" will be exported for all the wells selected on the Wells Tab.

 Depths Tab

The depths tab sets the depth interval for the exported file, for export whether to export all samples or decimate the output. Depths can be selected based on measured depths, TV depths, or using formation tops. A "Sample Decimation Rate" of 2, for example, would export every other depth sample. The depths tab is also where the additional depth values are selected. Check the TVD, Subsea Depths, and/or Subsea TVD options to include these depths as log curves.
This options opens the "Set Depth Range" tool, which controls the upper and lower limits of the exported log file. Log data outside this range won't be exported to the file. The depth interval can be specified in measured depth, TVD, or relative to formation tops.

To set depths by tops or by a specific depth range, select the “Set Depth From Range” button. Next, select the “Set Range” button. In the Set Depth Range box, select the relevant top, MD, or TVD button. For MD and TVD, select the relevant button and enter the adjacent depth in the entry field. For tops, select the desired top from the “Fm Top Name” dropdown box. Notice that an offset can also be added or subtracted to the fm top; this offset will include data points above or below the actual fm top depth.

To set depths by a zone’s interval definitions, select the desired zone on the “Set Upper and Lower Depths From Zone” dropdown menu. Note that the WELL zone by default covers -1M MD to +1M MD, so it should cover the entire footage of all wells.

Sample Decimation Rate - This option decimates the data to only export every N'th sample. Setting this value to 2, for instance, would only export every other data point. Setting this value to 5 would only export every 5th sample. By default, this option is set at 1 to export every datapoint in the curves.

Additional Depth & Location Curves

Petra exports log curves as relative to measured depth. However, Petra can include TVD, SubSea, and Subsea TVD depths in additional columns alongside the traces.

Include TVD Depths - This option uses the well's directional survey points to create a curve that lists the TVD for every MD.

Include Subsea Depths - This option uses the well's active datum to create a curve that lists the SS for every MD.

Include Subsea TVD Depths - This option uses the well's active datum and directional survey points to create a curve that lists the SSTVD for every MD.

Include XY Location as a Curve - This option adds two columns for the X and Y
position of the wellbore for every MD. This option is really only useful for deviated and directional wells.

Correct Dir Survey to Grid North - This option applies the convergence angle correction to the directional survey azimuth values. This option should only be used where the survey azimuth values are oriented towards true north, rather than grid north.

Options Tab

The Options Tab sets a few additional options for LAS and Tabular formats, including null values, column width, and decimal places.

ASCII File Null Value - This option specifies the value exported for null log values. The null value for LAS files is -999.25.

Column Width - This option specifies the total width of the columns.

Number of Decimal Places - This option sets the number of decimal places to the right of the decimal point.

Drop Null Records from Ascii File - This option removes curves with only null values from the export. Curves containing a mixture of null and non-null values will still be exported to the file.

Substitute Well Label for UWI in Ascii File - When exporting the log, Petra adds a small header to the top of the file. This option swaps out the UWI for the entry in the well label.

LAS Tab  (LAS Only)

The LAS Tab adds zone data items to the LAS header, sets up batch LAS exports, format allows one of more zone data items to be placed in the file header.
Zone Header Data

Z values you want written in the ~Parameters section for the LAS file.

Include Zone Data in LAS Headers - This option toggles adding the additional zone data items and tops to the LAS file. Toggling this option saves any changes made on the "Select Zone Item List" tool, but will not include the items in the exported LAS file.

Select Zone Data For Headers... - This button opens the Select Zone Item List. To add data items and tops to the LAS file, select the relevant zone and item.

The ">" adds the highlighted item to the Selected Zone Item List.

The ">>" button adds all items in the currently highlighted zone to the Selected Zone Item List.

The "<" button drops the highlighted item from the Selected Zone Item List.

The "<<" button drops all items from the Selected Zone Item List.

Write Tops to Special "~tops" Section - By default, Petra exports all data items and
tops into the "~Parameter Block" in the exported LAS file. This option instead saves tops to a new "~tops" section of the LAS file.

Multi Well LAS Export

Export Multiple Wells (One Well per File) - Each LAS file can only contain a single wells' curves. This option creates the Wells Tab; for the multiple LAS files.

File Names Derived from - This option controls how Petra names the multiple LAS files.

Prefix - This option adds a prefix to the beginning of the filename.

Well Seq Num - This option names LAS files based on the WSN in Petra.

API Series Num - This option removes the first five digits of the API number (the
state and county code) to leave only the well series number.

Full API or UWI - This option names LAS files by the full UWI code in Petra.

Well Label - This option names LAS files based on the UWI code in Petra.

Truncate Curve Names to 4 Chars -

Do Not "Wrap" Curve Data - This option forces Petra to write every depth onto a single line, instead of wrapping onto a different line. Most applications that use LAS files won't care, but this can be useful for working with raw curve data in a spreadsheet application.

Write API into "WELL" Keyword - This option writes the well UWI/API into the LAS file's "WELL" keyword, instead of the default well name entry

Substitute Label for UWI - This option writes the well label into the LAS file's "UWI" keyword, instead of the default UWI entry.

Output Alias Name Instead of Raw Curve Name - This option attempts to rename the selected curves in the exported file based on the project's log aliases. By default, Petra exports aliased curves using the actual or "raw" curve name associated with the exported well.

Export Only those Curves with a Sample Rate of - This option will only export curves with the specified sample rate. Curves with a different sample rate will not be exported to the file.

Use Top Aliases - This option uses top aliases for the export. In practice, this option will attempt to replace the missing top with one of the other "equivalent" tops on the alias list.

Wells Tab (LIS & LAS)

This tab appears when the LIS option is selected. Select one or more wells for export. Wells which do not contain any of the selected logs will be not be written to the output file(s). Also, only the selected logs with data will be exported for a given well. Null data WILL NOT be output for missing logs.
LIS Tab (LIS Only)

Header Remark - This option simply adds a remark in the file header. LIS export format allows a comment to be placed in the file header.

MORE Tab

The MORE tab contains options used to export logs to the MORE simulator.
Write Well ID From - This option determines the well identifier written to the output file. Options include UWI, well name, well number, well label, or WSN.

RC2 Tab

The RC2 tab contains options used when exporting logs in the RC2 ResPrep format. The *.ASC files created can include directional survey data, formation tops, and log curves.

Export Deviation Survey - This option includes directional surveys in the RC2 File.

Export Tops - This button opens the Select Zone Item List. Note that this list only includes tops in the FMTOPS zone. To add tops to the RC2 file, select the relevant top on the Zone Item list.

The ">" adds the highlighted top to the Selected Zone Item List.

The ">>" button adds all tops in the currently highlighted zone to the Selected Zone Item List.
The "<" button drops the highlighted top from the Selected Zone Item List.
The "<<" button drops all tops from the Selected Zone Item List.

Generate Well ID From - This option determines the well identifier written to the output file. Options include UWI, well name, well number, well label, or WSN.

Output File Names Derived From

This option controls how Petra names and stores the RC2 files. Multiple wells are exported with each well written to a different disk file.

Well Seq Num - This option names RC2 files based on the WSN in Petra.

API Series Num - This option names RC2 files based on the UWI code in Petra.

Prefix - This option adds a prefix to the beginning of the filename.

Dates Tab

The Dates Tab restricts the export of logs to only curves modified within a date range.
Restrict Exported Logs to Those Modified Within Dates Below - Petra records when log curves in its databases are changed. This option can restrict the export to only include log curves that have been modified in between the "From Date" and the "Through Date." This can be useful for performing a bulk update of log data in other applications.

4.3.10 Export Monthly Production

Petra can export production data in the project to a few different file formats. Tabular production data is the most general purpose file format, while Production Analyst and MORE file formats are more specialized files that are most useful for the respective programs.

To export data, select Project>Monthly Production To>... from the menu bar at the top of the Main Module.

Export Tabular Production File
Production Analyst
MORE Simulator Recurrent Data

4.3.10.1 Export Tabular Production File

This tool exports the production data in a project to a tabular or comma-separated file.

To create a file, select Project>Monthly Production To>Tabular File from the menu bar at the top of the Main Module.

File Tab
File To Export - This entry sets the name and location of the exported file. Selecting the "Browse" button will open Windows Explorer.

File Format - This option sets the file format. Comma delimited files separate individual values with commas, while fixed column files separate individual values with spaces.

Do Not Output Record When All Values Are Zero - By default, Petra will export all values including months with all zero values. This option instead prevents these months from being exported to the file.
Format Date Field As - This option sets how the exported file records dates. Options include YYYY and MO columns or a single YYYYMM column.

Production Tab

The production tab has two lists: the Select Production Streams To Export list, which contains all the production streams in the project, and the Selected Streams To Be Output list, which contains the streams that will be exported to the file.

- This button adds the highlighted production stream to the Selected Streams to Be Output list.

- This button adds all production streams in the project to the Selected Streams to Be Output list.

- This button drops the production stream selected from the Selected Streams To Be Output list. This will remove the production stream from the export file.

- This button drops all production streams from the Selected Streams To Be Output list.

Years Tab
Export Production From/Through - This option limits the file only to only production data inside the set range.

Include Year 0 - Some states record historical production in a single historical year labeled "0." This option includes this historical year 0 data in the export file.

4.3.10.2 Export Production Analyst

This tool exports the production data in a project to a tabular or comma-separated file.

To create a file, select Project>Monthly Production To>Export Production Analyst from the menu bar at the top of the Main Module.

File Tab

File To Export - This entry sets the name and location of the exported file. Selecting the "Browse" button will open Windows Explorer.
Output "**NAME**" Field Using - This dropdown sets the "Name" field for the PA file format. Options include UWI or API Number, Well Name, Well Number, Well Label.

**Production Tab**

The production tab has the Select Production Streams To Export list, which contains all the production streams in the project. Highlighted production streams will export to the file.

**Years Tab**

*Export Production From/Through* - This option limits the file only to only production data inside the set range.

4.3.10.3 *Export More Simulator Recurrent Data*

This tool exports the production data in a project to a tabular or comma-separated file.

To create a file, select Project>Monthly Production To>MORE Simulator Recurrent
Data from the menu bar at the top of the Main Module.

General Tab

![Image of More Simulator - Recurrent Data Export]

Well Identifier Used By More

This dropdown selects the well identifier that the More simulator uses. The More simulator can use UWI/API, Well Name, Well Number, or Well Label.

Year Range To Export

The "From" and "Thru" entries set the year range for the data. Data outside the range will not be included in the file.

Averaging

- **1 Year Averages** - This option averages an entire year of production.
- **6 Mo Averages** - This option averages 6 months of production.
- **3 Mo Averages** - This option averages 3 months of production.
- **Monthly** - This option averages each production stream by a month.

Location

- **Surface Location** - This option sets the well's location as the surface location.
- **Bottom Hole Location** - This option sets the well's location as the bottom hole location.

MORE Simulator Recurrent File(s) Generated

- **WellLoc Plus MULTIPLE Rate Files** -
- **Single COMBINED File** -
Producers Tab

Enable Producer Phase -
Production Streams

Water Injector Tab

Enable Water Injection Phase -
Water Injection Stream -
MORE Component Name -
Date When Well Became Injector -
CO2 Injectors Tab

Enable CO2 Injection Phase
Injection Streams
Date When Well Became Injector
MORE Component Name

Parameters Tab

Layers Tab
Files Tab

4.3.11 Export Interval Data

This tool exports interval data to a comma separated value (*.CSV) file.

To export interval data, select Project>Export>Interval Data from the menu bar at the top of the Main Module.
Output File Name
This option sets the name and destination of the output CSV file. Select the "..." button and navigate to the desired location.

Interval Table Dropdown
This dropdown selects the desired interval table. The selected dropdown will populate the Selected Data Columns List immediately below.

Select Data Columns
This option controls which files get written to the output file. The file will only contain the entries with checked data columns.

Include File Value Quality - This option includes a field for each entry's quality. Note that this file value quality is different from the quality data field.

Include Lat-Lon Locat - This option will include entries for each well's LatLon in the file.

Include XY Location - This option will include entries for each well's LatLon in the file.

Adjust Locations for Dev. Survey at "Top" depth - With deviated wells, an interval's location down the wellbore can be thousands of feet away from the surface location. This can be pretty significant for mapping. This option will use a well's directional survey data to calculate the true location of the interval data for the "Include Lat-Lon Locat" and "Include XY Location" options.

4.3.12 Export Directional Survey
This tool exports the directional surveys in a project to a comma separated value (*.csv) file.
CSV) file.

To create a directional survey file, select Project>Export>Directional Survey from the menu bar at the top of the Main Module.

![Export Directional Survey(s) dialog box]

Export Directional Survey(s) To - This entry sets the name and location of the exported file. Select the Browse button to navigate to the desired directory and to select the file name.

Survey(s) To Export

Petra can store multiple directional surveys (both real and planned) for any well. This tool can export any or all of the directional surveys for all wells. This section sets which specific surveys to the file.

- Export All Surveys Available for Each Well - This option will include all surveys loaded in the project, including all active and secondary surveys.
- Export 'Active' Survey Only - This option will export only the active surveys.
- Export Selected Survey From List Below - This will export only surveys with the survey definition selected on the dropdown below.

Survey Rotation Option For Survey Option

This tool controls how Petra applies the convergence correction to the exported directional survey data.

- Rotate Output Survey to GRID North - This tool exports the surveys relative to the grid north. Grid north surveys are dependent on the map projection, and will only project correctly on maps with the same reference datum and coordinate system.
- Rotate Output Survey to TRUE North - This tool exports the surveys relative to the true north. These will not plot correctly on a map unless the convergence correction is
reprojected.

Output Survey Data As Is - This tool ignores the convergence correction and will export the surveys "as is."

4.3.13 Export Top Definition File

This tool exports the formation top definitions in a project to a comma separated value (*.CSV) file. This can be useful for standardizing formation tops across multiple projects. This definition file only contains the top name, top source, and top description set on the Add New Formation Top or Modify Zone Item Definition tools. The definition file does not contain any of the actual top values.

To create a top definition file, select Project>Export>Tops Definitions... from the menu bar at the top of the Main Module.

![Top Definition File](image)

4.3.14 Export Perfs, Cores, Casing, Liner, IP, DST

This tool exports the perfs, cores, production tests, Fm or IP tests, casing, or liner data to comma separated (*.CSV) files. Each tab exports a different csv for a different data type.

To create a PPF file, select Project>Export>Perfs, Cores, Casing, Liner, IP, DST... from the menu bar at the top of the Main Module.

Perfs Tab

The Perfs Tab exports the perfs in a project to a CSV file. Note that the Source Tab restricts the exported perfs to only those with selected source codes.
Cores Tab

The Cores Tab exports the cores in the project to an external CSV file.
Prod Tests Tab

The Cores Tab exports the production tests in the project to an external CSV file.

IP Tests Only - This option restricts the exported tests to only IP Tests.
Choke Sizes are in 64th - This option exports choke sizes in 64th of an inch.

Fm Tests (DST) Tab

The Fm Tests Tab exports the Fm Tests in the project to an external CSV file.
Choke Sizes are in 64th - This option exports choke sizes in 64th of an inch.

Casing Tab
The Casing Tab exports the casing information in the project to an external CSV file.

Liner Tab
The Liner Tab exports the liner information in the project to an external CSV file.
Options Tab

- By default, Petra only includes the UWI in the exported CSV files. This entry controls which well header information is included in the exported CSV files.

Source Tab

- This tool restricts the perf export to only perfs with specific source codes. Note that this tool does not affect cores, tests, or other data types on this export tool.
Restrict Export to Follow Source Codes - This entry enables the perf source code restriction. Only perfs with perf codes set on the entry box below will be exported to the CSV file. To use multiple codes, separate the different values with semi-colons.

4.3.15 Export SCA-MCA Z Data

This tool exports Petra project data to a *.XYZ file for SCA's Mapping Contour System.

To create a XYZ file, select Project>Export>Perfs, Cores, Casing, Liner, IP, DST... from the menu bar at the top of the Main Module.

File Tab

This entry sets the name and location of the exported file. Select the Browse button to navigate to the desired directory and to select the file name.

Z Data Tab

The Z Data Tab sets the specific zone data items and formation tops to include in the SCA-MCA file.
First, select the desired zone from the Zones and Zone Data Items menu. Once a zone is selected, the Selected Data Items list will show the data items that will be included in the SCA-MCA file.

The "<" adds the highlighted item to the Selected Items to Export List.

The ">") button removes the currently highlighted data item from the Selected Data Items list.

The ">>" button drops all items from the Selected Data Items list.

The UP and DOWN arrows will move the highlighted item in the "Selected Data Items" list.

Faults Tab

The Faults Tab controls which tops will be in the SCA-MCA file. Highlighted tops will be included, while non highlighted tops won't be included in the file.

Include Faults Selected Below - This option includes faults in the file. Deselecting this option will retain all the highlighted faults, but will not include the faults in the file.
**All/None** - The "All" button will highlight all faults in the project, while the "None" button will remove the highlights from all faults.

**Options Tab**

The option controls how Petra writes formation tops. Formation tops can be in measured depths, or in subsea TVD.

![Options Tab Image]

4.3.16 Export GES Wellsbase ASCII V2

4.3.17 Export Velocity Data

This tool exports the "active" velocity functions for the wells selected on the Main Module. Note that a well's velocity function is set on the Main Module's Other Tab.

To create a top definition file, select **Project>Export>Velocity Data** from the menu bar at the top of the Main Module.
4.3.18 Export Well Remarks

This tool exports well remarks (visible on the Main Module's Well Tab) for the wells selected on the Main Module. This tool will export the remarks to a comma separated value (*.CSV) file. Note that this tool will save multiple remarks for a single well onto multiple lines.

To export definition file, select Project>Export>Well Remarks from the menu bar at the top of the Main Module.
4.4 Map Projections

Introduction to Map Projections

A “map projection” is an attempt to portray the curved surface of the earth on a flat piece of paper or computer screen. Put another way, map projections have two parts: the reference datum and the coordinate system.

Reference Datum

A reference datum (pl: reference datums) is a known and constant surface used to calculate latitude and longitude for a point on the Earth's surface. A point’s longitude is simply the angle of degrees the point is away from the Prime Meridian. A point’s latitude, on the other hand, is the angle between the equatorial plane and a line that is normal to the reference datum. It’s worth noting that since the earth is actually a little flattened, this line actually intersects the equatorial plane a little bit away from the very center of the Earth. Since different reference datums have different shapes, a single point can have different latitude and longitude depending on the reference datum used to make the measurement.
Imagine digging a series of narrow canals across the world’s continents. The height of the water inside these canals would be sea level at zero elevation. The global surface described by this zero elevation is called the “geoid.” The geoid is actually fairly bumpy due to unequal density distribution on Earth. The example below (from the European Space Agency) shows an exaggerated model of the Earth’s geoid, where red highlights a high geoid, and blue a low geoid. The closer the reference datum fits the geoid, the more accurate the map. Fitting a single reference datum to these bumps, however, has made the process of creating a single, accurate global datum difficult.

Historically, the solution was to create a lot of different reference datums with different shapes and origins – each of which is suited only for a specific region. The figure below shows a couple of different datums relative to the Earth's geoid. Notice that the N. America datum in the example below closely models the geoid for North America, but is wildly off for the rest of the world. Likewise, the European Datum closely follows the geoid near Europe, but is greatly distorted relative to the geoid for the rest of the world. Note also that the N. American and European datums both have different shapes (known as ellipsoids) and origins.
More recently, the trend has been towards creating more and more accurate global reference datums that are applicable to the entire globe. The WGS 1984 datum (used on GPS receivers) is a common global reference datum.

Recall that a point’s latitude and longitude are calculated from the reference datum. In order to correctly plot a specific latitude and longitude on a map, it’s necessary to know the reference datum of that LatLon point. Practically, this means that not all LatLons are equivalent. A LatLon created with one reference datum won’t be compatible with a LatLon based on another reference datum. **Because of this, whenever you import any LatLon data (such as well spots or overlay data), it’s important that the reference datum of the project and new data are both known and accounted for.**

**Coordinate System**

The other part of the map projection is the coordinate system. The coordinate system essentially is a set of coordinates that transforms latitude and longitude on a globe into XYs on a flat map. The most common coordinate systems in North America are the state plane systems and UTM zones.

In a sense, these two parts of a map projection (the reference datum and the coordinate system) constitute two separate steps. First, the reference datum is used to calculate LatLons for a location on a globe. Second, the coordinate system converts this LatLon data into XYs for plotting on a flat map.

All coordinate systems, by virtue of trying to stretching a three dimensional globe onto a flat map, inherently introduce some distortion. This distortion can change the shapes of objects, distances between points, the azimuth between points, scales, or areas. All map projections are a tradeoff between different types of distortion.
As such, there is no one universal “best” projection suitable for all areas. Even for a small area, the “best” projection is still arguable. An alternative way of selecting a coordinate system is to look for a “useful” coordinate system. Things to consider include the coordinate system any collaborators are using, the coordinate system used by legacy maps of the area, and what projection your existing data uses.

4.4.1 "Standard" and "Custom" Coordinate Systems

The Map Projection Settings has two different coordinate system settings: Standard and Custom. Both the Standard and Custom Tab set a new project’s coordinate system and also reprojects an entire project to use a different coordinate system (provided the reference datum stays the same). To switch between the two select the appropriate button at the top of the screen (highlighted in red on the example below).

**Standard Coordinate Systems**

The Standard coordinate system option contains a wide variety of coordinate systems for much of the world. These coordinate systems are pre-made and are a good option for most users. Selecting a standard coordinate system will change the second tab to the "Standard Tab."

**Custom Coordinate Systems**

The Custom coordinate system mostly provides backwards compatibility for Petra projects older than October 2008. Older projects with Custom coordinate systems can either be left alone, or easily converted into the analogous Standard coordinate system. Custom coordinate systems are also useful for handling obscure or custom
coordinate systems not included in the Standard coordinate system list. These options are provided for backward compatibility with older Petra projects. Selecting a custom coordinate system will change the second tab to the "Custom Tab".

4.4.2 Map Projection Settings

A “map projection” is an attempt to portray the curved surface of the earth on a flat piece of paper or computer screen. Map projections have two parts: the reference datum and the coordinate system.

The reference datum is a model of zero elevation, which is used to calculate latitude and longitude for a point on the Earth’s surface (see the Datum Tab help screen). The coordinate system essentially is a set of coordinates that transforms latitude and longitude on a globe into XYs on a flat map (see the Standard or Custom coordinate system Tab help screen).

To view and change a Petra project’s map projection, in the Main Module select Project>Settings>Set Map Projection... or select the button on the Project Tab.

Details Tab
Custom (Coordinate System) Tab
Standard (Coordinate System) Tab
Datum Tab
Units Tab
Quadrant Tab
Map Rotation Tab
Convert Crds Tab
Lock/Unlock Tab
Advanced Tab
File Tab

4.4.2.1 Details Tab

The Details tab simply shows the project’s current map projection. The example below shows that the NAD27 reference datum is selected, along with the Oklahoma South state plane coordinate system.
The Details Tab displays the current map projection for the project.

4.4.2.2 Custom (Coordinate Systems) Tab

Petra contains two ways of selecting a coordinate system: “Custom” and “Standard.” Both the Standard and Custom Tab set a new project’s coordinate system and also reproject an entire project to use a different coordinate system (provided the reference datum stays the same).

Most commonly, the Custom coordinate system provides backwards compatibility for Petra projects older than October 2008. Older projects with Custom coordinate systems can either be left alone, or easily converted into the analogous Standard coordinate system.

Custom coordinate systems are also useful for handling obscure coordinate systems not included in the Standard coordinate system list. Additionally, a custom coordinate system can create a unique and highly accurate map projection for a small area. It’s important to note, however, that XY locations based on a custom map projection will not be compatible with XYS from standard map projections such as state planes. This can cause difficulty in giving XY locations to drillers, for example.

The Custom Tab can create and modify coordinate systems in three ways: creating a coordinate system from scratch, modifying an existing coordinate system, or creating a coordinate system based on data limits.

Projection Tab

The Projection Tab sets the specifics of the map projection.
Central Meridian - This option sets the longitude of the center of the map projection.

Latitude of Origin - This option sets the latitude of the center of the map projection.

Northern Reference Latitude - This option sets the northern reference latitude.

Southern Reference Latitude - This option sets the southern reference latitude.

Scale Factor at Origin - The scale factor is the ratio between distances in the projection and distances on the surface of the reference ellipsoid. This option sets the scale factor at the origin.

False Northing (Meters) - This option specifies the Northing/Y coordinate at the origin of the projection.

False Easting (Meters) - This option specifies the Easting/X coordinate at the origin of the projection.

Elipsoid Tab

The Ellipsoid Tab selects the ellipsoid (spheroid) model to use with the projection. The semi-major axis and inverse of the flattening are displayed. Please note that ellipsoids are not used in XY mode.
Petra stores its ellipsoid parameters in Ellipsoid.DAT, located in the installation's PARMS subdirectory. This file can be modified if extreme care is taken to maintain the format integrity.

<table>
<thead>
<tr>
<th>Ellipsoid</th>
<th>Semi-major axis (meters)</th>
<th>Flattening</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIRY, &quot;Airy 1830&quot;</td>
<td>6377563.396</td>
<td>299.3249753</td>
</tr>
<tr>
<td>AIRY, &quot;Airy 1849&quot;</td>
<td>6377340.189</td>
<td>299.324964</td>
</tr>
<tr>
<td>APL49,&quot;Appl Phys 1965&quot;,</td>
<td>6378137.000</td>
<td>298.25</td>
</tr>
<tr>
<td>AUST, &quot;Australian National&quot;,</td>
<td>6378160.000</td>
<td>298.25</td>
</tr>
</tbody>
</table>

Example text from Ellipsoid.DAT showing the code, name, semi-major axis, and flattening of several ellipsoids

State Plane Tab

On the State Plane Tab, set the appropriate name on the "Apply" button. Note that the "Details" button can be used to view the parameters prior to selection. The State Plane table contains parameter settings for both the North American Datum 1927 (NAD27) and the North American datum 1983 (NAD83).
The Coord Sys Tab

The Coord Sys Tab contains several coordinate systems from China and Israel. To use one of these coordinate systems, select one from the list and click the 'Apply' button.

Creating a Coordinate System from Scratch

After selecting a project reference datum (on the Datum Tab), select the Custom Coordinate System. On the Ellipsoid Tab, select the desired ellipsoid. Make sure the projection and associated ellipsoid match the chosen Reference Datum.
Selecting an ellipsoid for a custom coordinate system

Next, on the Projection Tab, select the specific projection type and projection parameters such as central meridian. Petra will accept LatLon values in either decimal degrees or as degrees:minutes:seconds. Note that the parameters listed will depend on the specific projection type. As an example, only the UTM projection lists UTM zones.

Selecting a projection for a custom coordinate system

Select “Save” to enact the changes. For new projects this will simply set the project’s map projection. For existing projects, saving a different coordinate system means
that the XYs of all the data will need to change as well. Make sure to select “Yes” when Petra asks to recompute XY well locations using the new map projection. See “Final Steps…” later in this help file to reproject grid files.

Changing the coordinate system changes the XY positions of wells. Select “Yes” to recompute the positions in the database.

Modifying an Existing Coordinate System

The Custom Tab also contains the coordinate system settings for the US state plane system (under the State Plane Tab) as well as Israel and China (under the Coord Sys Tab). To modify one of these existing coordinate systems, select the coordinate system from either the State Plane Tab or the Coord Sys Tab. In the example below, the Oklahoma South (NAD27) state plane coordinate systems is selected. Once you've selected the coordinate system to modify, Select “Apply” to temporarily set the coordinate system.

Selecting an existing state plane populates the other tabs with the coordinate systems values

Going back to the Custom Tab shows that all the settings for the given coordinate system are loaded in. Every one of these settings is now modifiable.
Select “Save” to enact the changes. For new projects this will simply set the project’s map projection. For existing projects, saving a different coordinate system means that the XYs of all the data will need to change as well. Make sure to select “Yes” when Petra asks to recompute XY well locations using the new map projection. See “Final Steps…” later in this help file to reproject grid files.

Changing the coordinate system changes the XY positions of wells. Select “Yes” to recompute the positions in the database.

Creating a Coordinate System Set by Data Limits

The “Set By data Limits” option creates a new map projection using the selected projection type and the extents of the wells selected in the Main Module. This option essentially “fills in the blanks” for the central meridian and latitude origin based on the extents of the selected wells.

Select “Save” to enact the changes. For new projects this will simply set the project’s map projection. For existing projects, saving a different coordinate system means that the XYs of all the data will need to change as well. Make sure to select “Yes” when Petra asks to recompute XY well locations using the new map projection. See “Final Steps…” later in this help file to reproject grid files.
Changing the coordinate system changes the XY positions of wells. Select “Yes” to recompute the positions in the database.

Final Steps for Changing the Coordinate System on an Established Project

After changing the coordinate system and the project’s map projection, there are a couple more steps to reproject other data inside a project.

Reopen the map module, and verify that the well locations and overlay files line up correctly. It might be necessary to reset the data limits to reflect the new locations of the well and overlay data. To do so, select Display->Auto Scale Mode & Map Extents From Wells.

The wells and overlay should now be lined up using the new coordinate system. The final step here is to reproject the grids. Select Contours>Grids>Convert Grid Map Projections.

The Grids Tab shows the grids contained inside the project’s GRIDS folder. To change this directory, select the Dir Tab. Next, select the grids to reproject. The MapProjection Tab shows the map projection of the grids on the left in green and the new grid map projection on the right in blue. Notice that in this example, the grid was Oklahoma North (NAD27) and will be reprojected to Oklahoma South (NAD27).

The Options Tab gives a little finer control on how the grids will be reprojected. Petra automatically stores backup copies of all reprojected grids. By default, Petra adds “NEW” as a suffix to new grids. It’s possible to change it by entering new text, but there needs to be some text here. This tab also controls how Petra resamples the existing grids to fit the new projection. You can output the newly reprojected grids as
rectangular or triangular grids.

The Dir Tab changes the directory of reprojected grids. This tool will only reproject grids within this folder. If your grids are stored in multiple folders, it’s probably best to perform this operation several times to get all different folders. To reproject the grids, select OK. Petra will review the selected grids and generate a report.

![Image](image.png)

The Options Tab (left) and Dir Tab (right)

4.4.2.3 Standard (Coordinate Systems) Tab

Petra can select a coordinate system in two ways: “Custom” and “Standard.” The Standard Coordinate Systems contains a wide variety of coordinate systems assembled by Blue Marble Geographics. This set of “Standard” coordinate systems covers the vast majority of projections used in the oil and gas industry. Both the Standard and Custom Tab set a new project’s coordinate system and also reprojects an entire project to use a different coordinate system (provided the reference datum stays the same).

The Standard Tab is primarily divided into two lists: the Coordinate System Types, and the individual Coordinate System Names.

The Coordinate System Type list on the left shows all the different kinds of coordinate systems available for the currently selected reference datum (the project’s reference datum is selected on the Datum Tab). Selecting a specific coordinate system type populates the Coordinate System Name list on the right with all the available coordinate systems. In the example below, “US State Plane 1927” is selected, which shows all available NAD27 state plane coordinate systems. In this example, the Oklahoma South state plane coordinate system is selected from the Coordinate System Name list. It’s also worth noting that the Standard Tab also has an option to create a custom, or “User Defined” coordinate system. See the end of this help file for more information on “User Defined” coordinate systems.
The Standard Tab lists the available coordinate system types and specific coordinate systems for the selected reference datum.

Select “Save” to enact the changes. For new projects this will simply set the project’s map projection. For existing projects, saving a different coordinate system means that the XYs of all the data will need to change as well. Make sure to select “Yes” when Petra asks to recompute XY well locations using the new map projection.

Changing the coordinate system changes the XY positions of wells. Select “Yes” to recompute the positions in the database.

**Final Steps for Changing the Coordinate System on an Established Project**

After changing the coordinate system and the project’s map projection, there are a couple more steps to reproject other data inside a project.

Reopen the map module, and verify that the well locations and overlay files line up correctly. It might be necessary to reset the data limits to reflect the new locations of the well and overlay data. To do so, select Display>Auto Scale Mode & Map Extents From Wells.

The wells and overlay should now be lined up using the new coordinate system. The final step here is to reproject the grids. Select Contours>Grids>Convert Grid Map Projections.
The Grids Tab shows the grids contained inside the project’s GRIDS folder. To change this directory, select the Dir Tab. Next, select the grids to reproject. The MapProjection Tab shows the map projection of the grids on the left in green and the new grid map projection on the right in blue. Notice that in this example, the grid was Oklahoma North (NAD27) and will be reprojected to Oklahoma South (NAD27).

The Options Tab gives a little finer control on how the grids will be reprojected. Petra automatically stores backup copies of all reprojected grids. By default, Petra adds “NEW” as a suffix to new grids. It’s possible to change it by entering new text, but there needs to be some text here. This tab also controls how Petra resamples the existing grids to fit the new projection. You can output the newly reprojected grids as rectangular or triangular grids.

The Dir Tab changes the directory of reprojected grids. This tool will only reproject grids within this folder. If your grids are stored in multiple folders, it’s probably best to perform this operation several times to get all different folders. To reproject the grids, select OK. Petra will review the selected grids and generate a report.

User Defined Coordinate Systems
Though the Standard Tab is primarily designed to handle a variety of standard projections, it’s also fairly straightforward to create and save custom projections. Select the “User Defined…” button on the left of the screen (highlighted in red).

This brings up the Create User Defined Coordinate System box. Here, select a name, units, datum, ellipsoid, and specific parameters for the map projection. Selecting “Save Coordinate System” creates the new projection. In the example below, the coordinate system is named “Custom Projection.”
This saves the newly created user defined coordinate system inside Petra’s database. User defined coordinate systems are listed under “User Defined” on the Coordinate System Type list on the left of the screen. Selecting the custom coordinate system will select it for the project. Select Save to save the projection for the entire project.

4.4.2.4 Datum Tab

The Datum Tab has two major functions: selecting a reference datum at the beginning of a project, and selecting the reference datum for new data imports.
The Map Projection Datum Tab

**Project Datum Reference** - This dropdown sets the project’s reference datum, which is critical to correctly projecting all well, seismic, and overlay data. After changing the datum, it’s necessary to select a coordinate system in order to save any changes.

It’s important to note that changing the project’s datum here does not reproject the entire project. Really, the only time to use this option on the Datum Tab is when setting up the project’s map projection before importing any data. To change the datum of the project, select the Advanced Tab on the Map Projection Settings box.

**Datum for Data Imports** - This dropdown automatically recalculates the imported data’s latitude and longitude to match the project’s reference datum. In the example below, the incoming well data’s LatLons are based on the NAD27 reference datum, while the project is based on the NAD83 datum.

**Project Area** - This option sets the list of available reference datums. The “Contiguous US” option lists only the datums relevant to the US, while the “International” option shows all available datums.

### 4.4.2.5 Units Tab

The Units Tab sets the units of measurement (US Feet or Meters) for the entire projects. The XY (or map) coordinates and the depth units are independent of each other.
4.4.2.6 Quadrant Tab

The Quadrant Tab corrects incorrectly positive latitude and longitude values during import. This is mostly used to change incorrectly positive longitude values for North America.

Background

The spherical surface of the Earth is divided by east-west running lines of latitude and north-south running lines of longitude. The equator that defines $0^\circ$ latitude is defined as the plane perpendicular to the Earth's axis that also contains the Earth's center of mass. The Prime Meridian that defines $0^\circ$ longitude is a arbitrary line that runs through the Royal Observatory in Greenwich, London.

By convention, the equator is $0^\circ$ latitude, with $+90^\circ$ at the North Pole and $-90^\circ$ at the South Pole. The Prime Meridian is $0^\circ$ longitude with positive longitude to the east and negative longitude to the west. The equator and the Prime Meridian therefore divide the Earth up into four quadrants. The signs of latitude and longitude distinguish between the four quadrants. Western Europe, Russia, China, and the Middle East
have positive latitude and longitude. North America, on the other hand has positive latitudes and negative longitudes. As an example, (+29.97, -95.35) is Houston, TX, while (+29.97, +95.35) is Byai Zhen near the Tibet-India border.

Despite the convention, LatLon points (particularly in North America) are prone to being reported as having positive longitudes when they should be negative. This error can cause overlay data to grossly misalign, and to effectively “flip” the east and west sides of the map. A mix of correctly and incorrectly formatted LatLons will strand some data literally in the next hemisphere.

Using the Quadrant Tab

The Quadrant Tab automatically converts incorrect positive LatLon values to the correct negative values for the selected quadrant during import. This is primarily used for projects in North America, where longitude values are commonly incorrectly reported as positive. Selecting the NW quadrant, for example, will convert all incoming positive longitude values to the correct negative longitudes, where the incorrect (+29.97, +95.35) would convert to a correct (+29.97, -95.35).

Most latitude and longitudes for the rest of the world are reported correctly. As such, users working on international projects should select the NE quadrant. This quadrant, being north of the equator and east of the Prime Meridian, has both positive latitudes and longitudes. When this quadrant is selected, no correction is made.
4.4.2.7 Map Rotation Tab

If for purely aesthetic reasons you want to have straight section lines, it’s possible to rotate the entire map projection. This process changes the map projection, and consequently the XY coordinates of all the data inside that project.

It’s important to note that the XY coordinates of data inside a rotated project will not be compatible with XYs of a project using the “same” but non-rotated projection. In other words, the XY positions of data inside a rotated Colorado North (NAD27) state plane project will not match other non-rotated Colorado North (NAD27) state plane maps. This can cause difficulty in giving XY locations to drillers, for example.

Map Rotation Angle - This option sets the angle of map rotation. Select the "Apply" button to recalculate the XYs and reproject the project.
4.4.2.8 Convert Crds

The Convert Crds Tab is a quick way to convert specific points on a map into different forms and datums. More specifically, this tab converts LatLon points to the XY (using the project’s coordinate system) and vice versa, as well as changing a single LatLon point from one datum to the next. The Convert Crds Tab has two parts: the Coordinate Projection section on the left, and the Datum Shift Sample Point section on the right.

The Map Projection Convert Crds Tab

Coordinate Projection - This section simply converts a LatLon point to a XY point (and vice versa) using the project’s saved map projection. In other words, selecting a new projection on the datum and coordinate System tab without saving doesn’t change how these numbers are calculated.

Datum Shift Sample Point - This section converts a LatLon using one reference datum to a different reference datum.

Display Calculated Lat-Lon Values As - This option selects between LatLons as Decimal Degrees and Degree, Minute, Seconds.

4.4.2.9 Lock/Unlock Tab

The Lock Tab prevents any changes from being made to the Petra project’s map projection. This lock can also be password protected.

Locking the map projection saves the currently selected map projection, so be sure to have the correct map projection selected before locking the project.
Lock Map Projection - This option locks the map projection.

Password Protect Lock - This option brings up additional dialogue boxes confirming that you want to add a password and then to actually create and confirm the password.

Notice that the tab’s name changes to “Unlock.” A locked map projection prevents changes to the quadrant correction, datum, coordinate system, map rotation, and map XY units. It’s still possible to change the import datum for correcting different reference datum-created LatLon data, as well as change the default depth units.
Unlocking the Map Projection - This option unlocks the map projection. If the project is password protected, it’s necessary to know the password.

4.4.2.10 Advanced Tab

The Advanced Tab is used to reproject the entire project to use a new reference datum and coordinate system. This involves recalculating the LatLon and XY of every wellspot, overlay layer, grid and other associated files. Make sure to have a backup of the entire project before attempting this.

Background

Reprojecting a project is not trivial. Selecting a reasonable map projection at the beginning of a project and simply correcting for the other reference datum-based data with the Datum Tab will largely prevent the need to reproject an entire project.

A “map projection” is an attempt to portray the curved surface of the earth on a flat piece of paper or computer screen. Map projections have two parts: the reference datum and the coordinate system. The reference datum is a model of zero elevation, which is used to calculate longitude and latitude. The coordinate system essentially is a set of coordinates that transforms latitude and longitude on a globe into XYs on a flat map.

In a sense, these two parts of a map projection (the reference datum and the coordinate system) constitute two separate steps. First, the reference datum is used to calculate LatLons for a location on a globe. Second, the coordinate system converts this LatLon data into XYs for plotting on a flat map.
Changing the reference datum of a project means that the old LatLon points need to be reprojected in order to spot correctly on a map. Since the LatLon data changes, Petra will apply the coordinate system to calculate new XY points.

**Advanced Tab**

Practically, changing a project's reference datum is done in two parts. First, recalculate the LatLon and XY of every well location, and then Petra will recalculate the LatLon and XY of all “auxiliary files” including overlays, grids, XYZ files, and LatLonZ files. The example will show changing a project from Oklahoma North (NAD27) to Oklahoma North (NAD83).

**Reprojecting Well Data and Overlays**

The first step to changing a project’s reference datum is to select “Datum Shift Entire Project…” (highlighted in red).

Here, select the new project reference datum. In the example below, the project is currently using the NAD27 reference datum, while the new or “Destination” datum is NAD83. As a reminder, the list of reference datums here is limited by the “Project Area” dropdown on the Datum Tab. Select the new reference datum form the dropdown menu and select “Continue” to set the new datum.

After selecting the new datum, Petra compares the current map projection on the right to the new projection on the left. Notice that the window on the right is empty, as no coordinate system is set. Next, select “Set New Projection…” (highlighted in red)
This opens up the coordinate system window. This screen has two major lists: the Coordinate System Types, and the individual Coordinate System Names. The Coordinate System Type list (highlighted in blue) shows all coordinate systems available for the currently selected reference data. In the example below, this list only shows coordinate systems that use the NAD83 reference datum. Here, select the type of coordinate system for the project. In the example below, “US State Plane 1983” is selected.

Selecting the coordinate system type populates the Coordinate System Name list with specific coordinate systems (highlighted in green). In the example below, the Oklahoma North state plane coordinate system is selected.

This brings up the comparison window again. This time, the window to the right is filled in with both the current and new map projections. Select “Convert Project” to continue (highlighted in red). Petra opens one final screen to confirm the changes. Select OK.
Reprojecting Overlay files, Grids, LatLonZ, and XYZ files

After converting the well locations, Petra automatically prompts you to apply the same datum shift to overlay files, grids, XYZ files, and LatLonZ files. Since the well locations have changed, it’s important to reproject the other data to match. Though the example below has all auxiliary data checked, you only need to select data appropriate for your project.

Reprojecting Overlay Layers

The next step is to select which overlay layers to reproject into the new map projection. Clicking “Select Files” opens up the project’s OVERLAY folder in an external Microsoft Explorer window. Drag and drop files from the Explorer window into the “Input Overlay Files” window (highlighted in red). Petra also automatically creates a backup of all overlay files when a datum shift is applied. The backup filename simply appends a timestamp (YYYYMMDD_HHmmss) between the overlay name and file extension. You can also add a prefix to the backup file name. In the
example below, the prefix of “BACKUP” is added. Select “Convert Overlay(s)” to reproject the selected overlay files.

Reprojecting Grids

Next, select the Grids Tab. The Grids Tab shows a list of the grids to be reprojected. By default, Petra looks in the project’s GRIDS directory. It’s worth noting that the datum shift tool can only reproject one folder of grids. If your project has multiple grid folders, you can either move them all into one folder or perform the “Datum Shift Aux Files” function for each folder.

The Options Tab for the Grid Tab controls a few more options about datum shifting grids. Petra automatically creates a backup of all grid files when a datum shift is applied. The backup filename simply appends a timestamp (YYMMDD_HHMMSS) between the grid name and file extension. It’s also possible to add a prefix to the backup file name. In the example below, the prefix of “BACKUP” has been added. This tab also controls how Petra resamples the existing grids to fit the new projection. The grids can be output as rectangular or triangular grids.
Reprojecting XYZ Files

External XYZ control points need to be reprojected in order to plot correctly on the map. Under the XYZ Files Tab, select which XYZ files to reproject into the new map projection. Clicking “Select Files” opens up the project’s root directory folder in an external Microsoft Explorer window. Drag and drop files from the Explorer window into the “Input XYZ Files” window (highlighted in red). Petra also automatically creates a backup of all XYZ files when a datum shift is applied. The backup filename simply appends a timestamp (YYYYMMDD_HHmmSS) between the XYZ file name and file extension. You can also add a prefix to the backup file name. In the example below, the prefix of “BACKUP” is added. Select “Convert Files…” to reproject the selected XYZ files.

Reprojecting LatLonZ Files

External LatLonZ control points need to be reprojected in order to plot correctly on the map. Under the LatLonZ Files Tab, select which LatLonZ files to reproject into the
new map projection. Clicking “Select Files” opens up the project’s root directory folder in an external Microsoft Explorer window. Drag and drop files from the Explorer window into the “Input LatLonZ Files” window (highlighted in red). Petra also automatically creates a backup of all LatLonZ files when a datum shift is applied. The backup filename simply appends a timestamp (YYYYMMDD_HHMMSS) between the LatLonZ file name and file extension. You can also add a prefix to the backup file name. In the example below, the prefix of “BACKUP” is added. Select “Convert Files...” to reproject the selected LatLonZ files.

4.4.2.11 File Tab

The File Tab saves specific map projections and establishes a default map projection for all new projects.

Background

In a large multi-user environment, these administrative options are useful for leveraging the geodetic expertise of a few and applying it to several projects or to the company as a whole. Saving a map template can be useful for making a backup or for propagating a specific map projection from one Petra project to another. Similarly, setting a default system map projection can be useful when all Petra users are working in a similar geographic environment.

Using the File Tab

Using Map Projection Template

Map Projection Templates simply store the settings of the currently saved map projection in an external *.MPT file. Especially when using a non-standard custom projection, template files are useful for making backups of Petra map projections as well as quickly copying the map projection from one project to another. To save a map projection template file, select the save button. To load an preexisting template, select the load button.
Setting a Default Map Projection

The best time to set a project’s map projection is at the very beginning. A default projection ensures all new projects system-wide will automatically use one predefined map projection.

To set a system-wide default projection, select the “Save System Map Projection…” button under the File Tab of the Map Projection Settings window. This creates a new file in the system-wide PARMS directory called DEFPROJECTION1.BIN. This file contains the project’s current map projection. Setting a default projection can be useful for companies or field offices that are focused on a specific basin where one map projection is always applicable.
When new projects are created, Petra will ask the user if they want to use the default map projection.

4.4.3 Map Projection HowTo Guides

- How to Reproject a Project to use a Different Reference Datum
- How to Reproject a Project to use a Different Coordinate System (With the Same Datum)
- How to Import New LatLon Data
- How to Import New XY data
- How to Use Map Projection Administrative Options

4.4.3.1 Reproject an Entire Project to a Different Coordinate System (With Same Datum)

Reprojecting a project to use a new coordinate system is not a trivial task. Make sure to have a backup of the entire project before attempting this.
As stated above, Petra uses the project’s coordinate system to calculate XYs from LatLons. Changing this coordinate system means it’s necessary to recalculate the XYs. This example will show a project changed from Oklahoma North (NAD27) to Oklahoma South (NAD27). In this case, both map projections use the NAD27 reference datum, but the coordinate system is different (Oklahoma North vs. Oklahoma South).

Reprojecting Well Data and Overlays

The first step to changing a project’s coordinate system is to open the Map Projection Settings box. In the example below, the project is an older project with a “custom” Oklahoma North (NAD27) projection.

The next step is to set the new coordinate system. The easiest way to do so is to use one of the standard coordinate systems, so select the “Standard” coordinate system radio button at the top of the screen and go to the Standard Tab (both highlighted in red in the example below). This screen has two major lists: the Coordinate System Types, and the individual Coordinate System Names. The Coordinate System Type list (highlighted in blue) shows all the different kinds of coordinate systems available for the currently selected reference datum. In the example below, “US State Plane 1927” type is selected. Selecting the coordinate system type populates the Coordinate System Name list with all the available coordinate systems (highlighted in green). In the example below, the Oklahoma South state plane coordinate system is selected.
Setting a standard coordinate system

Select “Save” to enact the changes and convert the project. Since the coordinate system has changed, the XYs will need to change as well. Make sure to select “Yes” when Petra asks to recomputed XY well locations using the new map projection.

Confirming the new map projection

Reprojecting Grids

Reopen the map module, and verify that the well locations and overlay files line up correctly. It might be necessary to reset the data limits to reflect the new locations of the well and overlay data. To do so, select Display>Auto Scale Mode & Map Extents From Wells.

The wells and overlay should now be lined up using the new coordinate system. The final step here is to reproject the grids. Select Contours>Grids>Convert Grid Map Projections.

The Grids Tab shows the grids contained inside the project’s GRIDS folder. To change this directory, select the Dir Tab. Next, select the grids to reproject. The MapProjection Tab shows the map projection of the grids on the left in green and the new grid map projection on the right in blue. Notice that in this example, the grid was Oklahoma North (NAD27) and will be reprojected to Oklahoma South (NAD27).
Selecting grids to reproject (Left), examining the old and new grid projections (Right)

The Options Tab gives a little finer control on how the grids will be reprojected. Petra automatically stores backup copies of all reprojected grids. By default, Petra adds “NEW” as a suffix to new grids. It’s possible to change it by entering new text, but there needs to be some text here. This tab also controls how Petra resamples the existing grids to fit the new projection. You can output the newly reprojected grids as rectangular or triangular grids.

The Dir Tab changes the directory of reprojected grids. This tool will only reproject grids within this folder. If your grids are stored in multiple folders, it’s probably best to perform this operation several times to get all different folders. To reproject the grids, select OK. Petra will review the selected grids and generate a report.

Setting the reprojected settings (Left), the directory of the grids to reproject (Right)
Reproject an Entire Project to a Different Reference Datum

Reprojecting a project to use a new reference datum is not a trivial task. Make sure to have a backup of the entire project before attempting this.

Since this process changes the reference datum on which all LatLon data relies, Petra will recalculate the LatLons based on the new reference datum. Since the LatLon data changes, Petra will apply a new coordinate system to calculate new XY points. The example will show changing a project from Oklahoma North (NAD27) to Oklahoma North (NAD83). While both these coordinate systems are named the same (“Oklahoma North”), they are based on two separate datums so they calculate XYs differently.

Practically, changing a project’s reference datum is done in two parts. First, recalculate the LatLon and XY of every well location, and then recalculate the LatLon and XY of all “auxiliary files” including overlays, grids, XYZ files, and LatLonZ files.

Reprojecting Well Data and Overlays

The first step to changing a project’s reference datum is to open the Map Projection Settings box. In the example below, the project has a “Standard” Oklahoma North (NAD27) projection.

A project with a Oklahoma North (NAD27) projection

The next step is to use the Datum Shift Utility to reproject well data to use the new
reference datum. Go to the advanced tab, and select “Datum Shift Entire Project…” (highlighted in red).

Here, select the new project reference datum. In the example below, the project is currently using NAD27, while the new or “Destination” datum is NAD83. Select the new reference datum form the dropdown menu and select “Continue” to set the new datum.

After selecting the new datum, Petra compares the current map projection on the right to the new projection on the left. Notice that the window on the right is empty, as no coordinate system is set. Next, select “Set New Projection…” (highlighted in red)

This opens up the coordinate system window. This screen has two major lists: the Coordinate System Types, and the individual Coordinate System Names. The Coordinate System Type list (highlighted in blue) shows all coordinate systems available for the currently selected reference datum. In the example below, this list
only shows coordinate systems that use the NAD83 reference datum. Here, select the type of coordinate system for the project. In the example below, “US State Plane 1983” is selected.

Selecting the coordinate system type populates the Coordinate System Name list with specific coordinate systems (highlighted in green). In the example below, the Oklahoma North state plane coordinate system is selected.

Selecting a standard coordinate system

This brings up the comparison window again. This time, the window to the right is filled in with both the current and new map projections. Select “Convert Project” to continue (highlighted in red). Petra opens one final screen to confirm the changes. Select OK.

Reprojecting Overlay files, Grids, LatLonZ, and XYZ files

After converting the well locations, Petra automatically prompts you to apply the same datum shift to overlay files, grids, XYZ files, and LatLonZ files. Since the well locations have changed, it’s important to reproject the other data to match. Though the example below has all auxiliary data checked, you only need to select data appropriate for your project.
Reprojecting Overlay Layers

The next step is to select which overlay layers to reproject into the new map projection. Clicking “Select Files” opens up the project’s OVERLAY folder in an external Microsoft Explorer window. Drag and drop files from the Explorer window into the “Input Overlay Files” window (highlighted in red). Petra also automatically creates a backup of all overlay files when a datum shift is applied. The backup filename simply appends a timestamp (YYYYMMDD_HHMMSS) between the overlay name and file extension. You can also add a prefix to the backup file name. In the example below, the prefix of “BACKUP” is added. Select “Convert Overlay(s)” to reproject the selected overlay files.

Reprojecting Grids

Next, select the Grids Tab. The Grids Tab shows a list of the grids to be reprojected. By default, Petra looks in the project’s GRIDS directory. It’s worth
noting that the datum shift tool can only reproject one folder of grids. If your project has multiple grid folders, you can either move them all into one folder or perform the “Datum Shift Aux Files” function for each folder.

The Options Tab for the Grid Tab controls a few more options about datum shifting grids. Petra automatically creates a backup of all grid files when a datum shift is applied. The backup filename simply appends a timestamp (YYYYMMDD_HHMMSS) between the grid name and file extension. It’s also possible to add a prefix to the backup file name. In the example below, the prefix of “BACKUP” has been added. This tab also controls how Petra resamples the existing grids to fit the new projection. The grids can be output as rectangular or triangular grids.

Selecting a grid to reproject (Left), setting the location of the reprojected grid (Right)

**Reprojecting XYZ Files**

External XYZ control points need to be reprojected in order to plot correctly on the map. Under the XYZ Files Tab, select which XYZ files to reproject into the new map projection. Clicking “Select Files” opens up the project’s root directory folder in an external Microsoft Explorer window. Drag and drop files from the Explorer window into the “Input XYZ Files” window (highlighted in red). Petra also automatically creates a backup of all XYZ files when a datum shift is applied. The backup filename simply appends a timestamp (YYYYMMDD_HHMMSS) between the XYZ file name and file extension. You can also add a prefix to the backup file name. In the example below, the prefix of “BACKUP” is added. Select “Convert Files…” to reproject the selected XYZ files.
Reprojecting LatLonZ Files

External LatLonZ control points need to be reprojected in order to plot correctly on the map. Under the LatLonZ Files Tab, select which LatLonZ files to reproject into the new map projection. Clicking “Select Files” opens up the project’s root directory folder in an external Microsoft Explorer window. Drag and drop files from the Explorer window into the “Input LatLonZ Files” window (highlighted in red). Petra also automatically creates a backup of all LatLonZ files when a datum shift is applied. The backup filename simply appends a timestamp (YYYYMMDD_HHMMSS) between the LatLonZ file name and file extension. You can also add a prefix to the backup file name. In the example below, the prefix of “BACKUP” is added. Select “Convert Files…” to reproject the selected LatLonZ files.

*This example essentially changes the map projection from the NAD 27 Oklahoma North state plane to the NAD 83 Oklahoma North state plane. While both these coordinate systems are named the same (“Oklahoma North”) and they share the same north and southern latitudes, they are based on two separate ellipsoids so
they calculate XYs differently.

4.4.3.3 Use Map Projection Administrative Options

While importing new data with a different projection into a project is fairly common, changing an entire project’s map projection is usually rare. As such, the risks of bad map projections will usually outweigh the rewards of all users being able to easily work with the project’s map projections. Limiting access to changing map projections is a good way to prevent accidents and ensure project stability.

Setting a Default Projection

The best time to set a project’s map projection is at the very beginning. A default projection ensures all new projects system-wide will automatically use one predefined map projection.

To set a system-wide default projection, select the “Save System Map Projection…” button under the File Tab of the Map Projection Settings window. This creates a new file in the system-wide PARMS directory called DEFPROJECTION1.BIN. This file contains the project’s current map projection. Setting a default projection can be useful for companies or field offices that are focused on a specific basin where one map projection is always applicable.
Locking the Map Projection

One the map projection is set, locking the project’s map projection is an easy and quick way to prevent accidents. On the Lock Tab of the Map Projection Settings window, select “Lock Map Projection…” Locking a project’s map projection disables changing the project’s datum, coordinate system, or XY units (feet or meters). It’s worth noting that any user can still change the import datum. Unlocking a project is fairly easy and can be performed by all users in the project. Simply select “Unlock Map Projection…” on the Unlock Tab.

Adding a password adds significantly more security as only users with the password can change the map projection. On the same Lock Tab, select “Password Protect Lock” option before locking the map projection. This saves the current map projection, and prompts the user to set and confirm a new password. Again, this disables changing the project’s datum, coordinate system, or XY units (feet or meters). Any user can still change the import datum, however.

Setting Map Projection Administrative Privileges with Petra. INI

Another way to limit the users able to modify map projections is with an administrative list stored in a Petra.INI file. With this method, there are no passwords to remember and the administrative list can be applied to either one Petra project or to all Petra projects on a server.

Petra.INI is just a plain text file with an *.INI extension. This file isn’t created automatically, so it’s necessary to either create it from scratch or copy the sample Petra.INI located in the PetraSRV\PARMS folder. To limit access on a single project, save Petra.INI inside the project’s root directory (e.g. H:\Projects\SMITH FIELD). To limit access on every project on a server, save Petra.INI to the folder where the Petra executables are located (by default, this is in the PetraSRV directory).

Once the file is placed in the proper spot, edit it using Microsoft Notepad or
WordPad. The example below prevents normal users from saving default map projections or changing a project’s existing map projection. To turn off each individual limitation set the item to YES. As an example, `SAVEDEFAULTPROJECTION=YES` allows all users to save default map projections. The ADMINLIST sets up a specified list of users as admins. In the example below, JHK and KHM are on the administrator list, so they can change map projections or save default projections.

```
[GENERAL]
SAVEDEFAULTPROJECTION=NO
; This option prevents users saving default projections
ALLOWUSERPROJECTION=NO
; This option prevents users from creating "User Defined" coordinate systems under the ; stand

[USERSOURCE]
ENABLED=1
ADMINLIST=JMK, KHM
; This sets the administrator list. Users JMK and KHM are administrators.
```

Map projection settings as viewed by a normal user. Note the lack of a “Save” button.

An admin list relies on a set of user names. To change user names while inside a project, select Project>Settings>Set User Source Code… and enter the appropriate user name.

Changing the user name

For more information on using Petra.INI see “Petra Usage in Large Multiuser Environments” available at: https://petraftp.ihsenergy.com/petramultienv.pdf
4.4.4 Convergence Angle Correction

Convergence Angle Background

In the figure below, the 90° W, 100° W and 110°W longitude lines are highlighted in red on top of a map of the US. The central meridian at 100° W is straight up and down, while 90° W and 110°W are slightly curved towards the north pole. Importantly, all three lines of longitude are perfectly north and south, but are curved and distorted by being on a flat surface. “True north” is at the top of the page, but away from the central meridian the local direction of north known as “grid north” will be a little different. To better illustrate the difference, there are two sets of arrows on the figure – one to the west in Utah and one to the east in Missouri. The longer arrows on the figure show true north at the top of the map, while the shorter arrows following the curved longitude lines reflect the local grid north. The difference between these two directions is called the “convergence angle”, and is shown on the figure to the right. Odds are good you’ve actually already run into this before – angled section lines (common in west Texas and New Mexico) follow grid north rather than true north.

Directional wells need to be projected to your map’s grid north rather than true north in order to plot on the map correctly. To better illustrate the point, a directional well going due north should be parallel to the north-south section lines.

The problem is that there’s no consistent standard for reported directional survey convergence angle correction. While most companies report survey data relative to a projection-dependant grid north, many directional companies report survey data relative to true north. Failing to add a convergence angle to true north-based data or adding a convergence angle correction to grid north-based data will both result in a wellpath that’s plotted in the wrong place.

Every well stores a “flag” that tells Petra if the survey data stored in the database is set to true north (and thus needs a convergence correction) or to grid north (which does not need a convergence correction). By default, Petra assumes that the directional survey is relative to true North. In other words, it automatically assumes...
that all survey data needs a convergence correction. If a well is already set to grid north, it’s necessary to disable this correction.

There are two options for changing convergence angle corrections. One option is to simply turn off all convergence angle correction, or it’s possible to change the well convergence angle settings (or “flag”) for each well.

**Turning off all Convergence Correction**

The simplest way to turn off all convergence correction is to select the “Survey Convergence Angle” button on the second toolbar on the Map Module. To open and close this toolbar, select the “<<” button on the far right side of the regular toolbar.

Turning off all convergence angle correction (currently active)

Turning on all convergence angle button (currently inactive)

This is a relatively quick way of turning off all convergence angle correction without changing individual well flags.

**Setting the Convergence Correction “Flag” for a Single Well**

Odds are good, however, that the directional wells in any given project will be a mix of grid and true north-based surveys. In order to correctly draw every well, Petra stores a “flag” for each well. To change this convergence correction flag for a single well, first select the correct well in the Main Module. Next, open the Directional Survey Data tool by going to the Location Tab and select the Dir. Survey button. Finally, navigate to the Advanced Tab on the Directional Survey Data box and select XY Grid North (Never Rotate for Map Projection) under the Survey data Orientation section.

Setting the convergence correction for a single well
Select Survey Orientation Function

This tool can recommend whether an individual well should or should not have a convergence correction, as well as set the flags for all directional wells in a project to either use grid or true north. The "analyze" tool calculates a BH location for the survey data both with and without a convergence correction, and compares these locations to the actual header-supplied BH location.

To open this tool select Compute>From Locations>Set Dev. Survey Grid Orientation from the Main Module.

Reviewing convergence correction for all directional wells

Analyze Survey and Report Only - This tool will compare the actual BH location to BH locations calculated from directional survey data, but will only generate a report called "DEVFLAG" in the project directory. This report will include the well's WSN and UWI, as well as the convergence angle at the well's location (calculated from the map projection). This will also include the calculated XY locations for the BHL without a convergence correction (true north), XY location for the BHL with a convergence correction (grid north), and the actual BH location in the project.

In the example below, most wells' true north-calculated BH locations are close to the actual BH locations, and the convergence correction is set correctly. The highlighted well, however, shows that the current convergence correction is set to grid north, while the true north BHL is closer to the actual BH location.
A survey orientation report

**Analyze Survey and Set based on BH Location** - This tool will compare the actual BH location to BH locations calculated from directional survey data, and change the convergence angle correction flags in the project based on the recommendations.

**Set All Flags to "GRID NORTH" (Never Rotate)** - This option changes all directional survey convergence angle flags in the project to "grid north." This effectively says that all wells in the project already have the convergence correction applied to the directional survey data.

**Set All Flags to "TRUE NORTH" (Rotate)** - This option changes all directional survey convergence angle flags in the project to "true north." This will apply the convergence correction to all wells in the project.

### 4.5 Main Module Toolbars

The Main Module’s toolbar has links to most modules as well as links to opening and closing projects.

Petra can also use custom, user-created toolbars with direct links to most functions in Petra. For more information on custom toolbars, see here.
- This button creates a new project.
- This button opens an existing project.
- This button closes the current project.
- This button opens the Select Wells by Data Criteria tool.
- This button opens the View/Edit Zone Data tool.
- This button opens the Map Module.
- This button opens the Cross-Section Module.
- This button opens the Spreadsheet Module.
- This button opens the Log Cross Plot Module.
- This button opens the Z Cross Plot Module.
- This button opens the Histogram Module.
- This button opens the Decline Curve Analysis Module.
- This button opens the Production Group Plots and Normalization Tool.
- This button opens the Seismic Module.
- This button opens PetraSeis. Note that this button will be grayed out if PetraSeis isn't installed.
- This button opens the Thematic Mapping Module.
- This button opens the 3D Visualization Module.
- This button opens the Slip Logs Module.
- This button opens the Log Correlation Module.
- This button opens the Directional Well Module.

4.5.1 Custom Toolbars

In addition to the main Petra toolbar, Petra can use up to three custom toolbars at the top or left side of the Main Module. Each of these custom toolbars can contain a
number of buttons which correspond to over 200 available menu options.

Enabling Custom Toolbars

To add a custom toolbar, select View>Custom Toolbar 1>Enabled.

For Toolbar 2 or 3, select the relevant toolbar menu on the dropdown (View>Custom Toolbar 2>Enabled enables toolbar 2, for example).

Next, select the location for the desired toolbar. Custom toolbars can either be at the top of the Main Module (immediately below the main toolbar), or on the left side of the Main Module.

View>Custom Toolbar 1>Dock Top or View>Custom Toolbar 1>Dock Left
To remove custom toolbars, either select the relevant "enabled" command, or select View>Reset to Default View to remove all custom toolbars.

Opening the Custom Toolbar's Options

Once a custom toolbar is added to the Main Module, the next step is to add commands. Select the button on the empty custom toolbar, and select Options>Customize Custom Toolbar #1.

Selecting the Customize Custom Toolbar button

This opens the customizer dialog for that particular custom toolbar.

Adding Commands to Custom Toolbars

The "Command Groups" drop shows the same structure as the Menu's at the top of the main module. Selecting a menu populates the "Commands" list box with all commands available for that menu. You can then select the desired command along with a different icon (all default to the same) and add it to the "ToolBar Items".

Once a command is added to the "ToolBar Items" you can then change the Caption and/or Hint. Selecting the "Show Caption" option will include the "Item Caption" on the toolbar with the icon. Doing this for all desired commands results in a completely
customized toolbar!

The Customizer modifies the command buttons on custom toolbars.

- This button moves the selected command to the top of the list. Commands at the top of the list will be at the far left of toolbars docked at the top of the Main Module.

- This button moves the selected command up the list. Commands at the top of the list will be at the far left of toolbars docked at the top of the Main Module.

- This button moves the selected command down the list. Commands at the bottom of the list will be at the far right of toolbars docked at the top of the Main Module.

- This button moves the selected command to the bottom of the list. Commands at the top of the list will be at the far left of toolbars docked at the top of the Main Module.

- This button adds the selected command to the ToolBar Items list.

- This button adds a separator to the ToolBar Items list.

- This button removes the selected command from the ToolBar Items list.
- This button clears all commands from the ToolBar Items list.

If All Else Fails

All custom toolbar settings are stored in the Client Parms folder in a file named "tbSettingsMain.def". This file can be copied to other clients/computers if so desired. Deleting this file will also return Petra to it's default state with no custom toolbars or commands configured.

4.6 Main Module Tabs

The Main Module has several tabs that display data about the various kinds of data loaded into the database. Each tab will display data relevant to the selected well on the well list on the left side of the screen.

Project Tab
Well Tab
Location Tab
Formation Tops Tab
Zone Tab
Logs Tab
IP Tests Tab
FM Tests Tab
Cores Tab
Perfs Tab
Shows Tab
Production Tab
Prod Cums Tab
Rasters Tab
Other Tab
Scout Tab
View Tab
4.6.1 Project Tab

The Project Tab displays and controls some of the basics of an entire Petra project, including the description, parameters and project data directories, the total well count, and the map projection.

Project Description

The Project Description is used as a label on graphic displays. To modify the project description, type over the description data that is displayed in the Project Description field.

Parameters and Project Data Directories

Parameters Dir - This entry displays the location of the Private Parameters directory for the currently selected user.

Project Data Dir - This entry displays the location of the Project Data Directory for the project.

Well Count
Total Number of Wells In Project - This entry displays the total number of wells in the project.

Number of Currently Selected Wells - This entry displays the number of currently selected wells in the project.

Map Projection
This box displays some of the details on the Petra project’s map projection, including reference datum, coordinate system, and units of measurement. To change the map projection select the button.

4.6.2 Well Tab

The Well Tab displays and modifies information about the selected well on the well list. Typing a value in the appropriate entry field will change that field.

The Well Tab displays header and symbol information about the selected well.

- These buttons change between the currently selected wells in the project. Alternatively, select the left mouse button on the well list displayed on the left side of the main screen.
- This button saves any changes made to the database. Note that Petra also prompts to save changes before selecting another well if any fields have changed.

- This option undoes the last changes made to the well if the button is displayed.

Header Information

The Well Tab displays a few well header basics, including UWI, well number, name, operator, lease, and field.

Well Symbol and Description

This dropdown selects the map symbol displayed on the Map and Cross Section Modules.

Active Datum

The active datum is the depth reference for the well. This is commonly used to converted MD depths to SS depths. The dropdown selects the active datum for the well.

KB = Kelly Bushing, DF = Drill Floor, GR = Ground, SEIS = SEISmic

Remarks

This field contains remarks about the well.

4.6.2.1 Build Well Labels

The Build Labels function can build a "label" string and store in either the Well Label or Sort Key field using parts from other well header fields. This can be very useful in project areas such as the Mid Continent where many wells have the same well name or number in different locations. Building a label using section-township-range fields makes well identification much easier. Well Labels may contain up to 32 characters.

To build new well labels, select Wells>Build Well Label from the menu bar at the top of the Main Module.
The objective in building the well labels is to define each of the Well Label Components. Each component is selected from the Select Component section along with its length and starting position.

Well labels will be built for either "All Wells" or only the "Currently Selected Wells" depending on the option selected.

Add - This button adds the selected component on the dropdown to the Well Label
Components list.

**Replace** - This button replaces the highlighted component on the Well Label Components list with the component on the dropdown menu.

**Drop** - This button removes the highlighted component on the Well Label Components list.

**Start Column** - This entry sets the starting position in the component field. For example, if you wanted the API series number, set the start column to 6 and the length field to 5.

**Length** - This entry sets the the number of characters extracted from the component field.

**Use Defaults** - This option will create labels using the UWI for each well.

**Build** - This option builds the labels and writes the results to the database.

**Template**

You can save and load your well label component definition to a .BWL file using the Template Save and Load functions. The template file contains the settings to rebuild the labels using the same scheme as previously defined.

**Custom Labels File**

You can save a file containing the actual well label values using the Save and Load functions under the Custom Labels File section.

**Options Tab**

**Trim Leading Zeros From TRS Data** - This option will trim leading zeros from township, range and section values. For example, a value of 03 to be written as 3.

**Drop Unnecessary Special Characters** - If you use special characters as a component, such as, ",", "/", "#", it is possible because of other components being blank, that you are left if leading, trailing or nothing but special characters. This option will remove those characters.

**Store Computed Label In** - This option determines whether the computed label is stored in the Well Label field or the Sort Key field in the database.

**Presets** - This section contains predefined component lists for your usage. These are kept as .BWL files in the "parms" folder under the Petra program directory (typically petrasrv\parms or geoplus1\parms). After selecting a Preset, click the "Load Preset" button to load and see the component list.
4.6.3 Location Tab

The Location Tab displays and controls individual well locations and directional surveys, as well as the project-wide map projection.

The Location Tab displays location information about the selected well.

- This button saves any changes made to the database. Note that Petra also prompts to save changes before selecting another well if any fields have changed.

- This option undoes the last changes made to the well if the button is displayed.

Surface Location
These entries show the LatLons and XYs for the selected well’s surface location.

Bottom Hole Location
These entries show the LatLons and XYs for the selected well’s bottom hole location. Note that these entries will all be 0’s where there is no specific bottom hole location.

Make Bottom Hole Equal To Surface Location - This option overwrites the bottom hole location with the location stored in the surface hole location.

Display Lat-Lon As
This entry sets how Petra displays LatLons. LatLons can display either as degrees, minutes, seconds or as decimal degrees.

- This button locks the currently selected well's location. A locked well location won't change either my manual changes to the database or through data imports. Note that project-wide location locking is enabled or disabled from the Program Options tool's Locks Tab.

- For directional wells, this button uses survey data to calculate the bottom hole location.

- This button opens the wells location in bing maps. This can be useful for quickly checking conditions for future well locations, such as spotting a well in the middle of a golf course or elementary school.

- This button opens the wells' directional survey data window. Deviated wells are displayed in map form as a small triangle spotted at the surface location and the well symbol spotted using the directional survey data and a user-specified depth at which the well symbol is positioned along the projected borehole path or worm track.

- This button opens the Congressional Location Information window.

- This button opens the Offshore Location Information window.

- This button opens the Texas Location Information window.

- This button opens the NorthEast Location Details window.

- This option opens the Map Projection Settings window.

4.6.3.1 Directional Survey Data

Petra uses directional survey data to compute the positions of deviated and horizontal wells for mapping, cross-sections, and calculations. Survey data from a directional drilling company usually consists of some combination of measured depth (MD), inclination (INC), azimuth (AZI) true vertical depth (TVD), North-South offset footage (NS) and East-West offset footage (EW). To access a well's survey data, select the “Dir Survey” button on the Location Tab in the Main Module.

Data Conventions

The convention for inclination is 0 degrees for vertical and 90 degrees for flat. Inclinations above 90 degrees are inclined up. As an example, an 86 degree inclination is going down through section at 4 degrees below horizontal, and a 94
degree inclination is going up through TVD at 4 degrees above horizontal.

Azimuth data is commonly measured in positive degrees measured clockwise from north, where 0 degrees is north, 90 is east, 180 is south, and 270 is west. This convention is sometimes called “unformatted.” Less commonly, azimuth data consists of a numeric compass heading in degrees preceded by either the letter N or S and followed by the letter E or W. As an example, N30E means 30 degrees east of north. S60W means 60 degrees west of south. This convention is sometimes called “formatted.” Petra can import and display azimuth data in either convention.

The convention for NS offsets is north offsets are positive and south offsets are negative. Similarly, east offsets are positive, and west offsets are negative.

General Tab
Data Tab
Preview Tab
Import/Export Tab
Calc TVD Tab
Method Tab
Advanced Tab
Maintenance Tab

Working with Multiple Directional Surveys
Petra can store any number of survey data sets (both real and planned) for any well. Multiple surveys are really intended only for proposed and actual surveys. It’s best to keep each actual completion (even those from the same surface location) separate and in different wells in Petra. Keeping multiple drilled laterals in the same well greatly limits your ability to display in cross-section, map, and grid as well as store any useful header info or petrophysical data. The multiple survey toolbar is available on the bottom of every tab on the Directional Survey Data window.

4.6.3.1.1 Grid & True North / Convergence Correction

Background
In the right figure below, there’s a flat, 2-D picture of the spherical, 3-D Earth. This figure is, in effect, a crude map projection. The center of the image on the right is on
the equator and 100° W. The lines of longitude at 90° W, 100° W and 110° W are outlined.

On the right side of the figure, we’ve stripped out the picture of the globe to leave the three longitude lines where one is straight, and two are curved. Since each one of these lines represents a line of longitude, all three of these lines are straight north and south. The curvature is the consequence of projecting the curved surface of the earth onto a flat surface. The straight line in the center is the “central meridian.” The central meridian defines the center of the projection and consequently has the least distortion. Away from the central meridian, however, the distortion increases and longitude lines start to curve - especially at higher latitudes.

A globe (modified from Google Earth, 2008) highlighting 110, 100, and 90 degrees longitude (Left), the same longitude lines without the globe (Right). Modified from Dana (1999)

“True north” is at the top of the map, but away from the central meridian the local direction of north known as “grid north” will be just a little different. To better illustrate the difference, there are two sets of arrows on the figure – one to the west in Utah and one to the east in Missouri. The longer arrows on the figure show true north at the top of the map, while the shorter arrows following the curved longitude lines reflect the local grid north. The difference between these two directions is called the “convergence angle”, and is shown on the figure to the right. Odds are good you've actually already run into this before – angled section lines (common in west Texas and New Mexico) follow grid north rather than true north.

Looking closely at the Carter-Knox map shows that these section lines are angled slightly as well. The difference between true north and grid north for this area with the UTM Zone 14 projection is around 0.8 degrees.
Directional data need to be projected to your map’s grid north rather than true north in order to plot on the map correctly. To better illustrate the point, a directional well going due north should be parallel to the north-south section lines – even if the section lines are angled like in the Carter Knox project.

The problem is that there’s no consistent standard for reported directional survey convergence angle correction. While most companies report survey data relative to a projection-dependant grid north, many directional companies report survey data relative to true north. Failing to add a convergence angle to true north-based data or adding a convergence angle correction to grid north-based data will both result in a wellpath that’s plotted in the wrong place.

Turning off all Convergence Correction

The simplest way to turn off all convergence correction is to select the “Survey Convergence Angle” button on the second toolbar on the Map Module. To open and close this toolbar, select the “<<” button on the far right side of the regular toolbar.

Turning off all convergence angle correction (currently active)

Turning on all convergence angle button (currently inactive)

This is a relatively quick way of turning off all convergence angle correction without changing individual well flags.

Setting the Convergence Correction “Flag” for a Single Well
Odds are good, however, that the directional wells in any given project will be a mix of grid and true north-based surveys. In order to correctly draw every well, Petra stores a “flag” for each well. To change this convergence correction flag for a single well, first select the correct well in the Main Module. Next, open the Directional Survey Data by going to the Location Tab and select the Dir. Survey button. Finally, navigate to the Advanced Tab on the Directional Survey Data box and select “XY Grid North (Never Rotate for Map Projection)” under the Survey data Orientation section.

Setting the convergence correction for a single well

Setting the Convergence Correction “Flags” for All Directional Wells

To change the convergence correction flags for all wells, select Compute > from Locations > Set Dev. Survey Grid Orientation from the Main Module. Here, you can select to disable or enable the convergence correction for all wells with the bottom two options: Set All Flags to “GRID NORTH” or Set All Flags to “TRUE NORTH.”

Petra’s “Analyze Survey” tool can shed light on whether a convergence angle should or should not be applied to a particular well. Essentially, Petra calculates a BH location for the survey data both with and without a convergence correction. These
two BH locations can then be compared with the actual header-supplied BH location. Based on this comparison, Petra can recommend whether an individual well should or should not have a convergence correction. The example below shows a report generated from the first option, “Analyze Survey and Report Only.”

The results of a Petra review of BHL locations and convergence corrections

In the example above, most surveys show that the true north BH is closer to the actual BH, so the convergence correction is set correctly. The highlighted well, however, shows that the current convergence correction is set to grid north, while the true north setting is closer. Petra can either make just a report or change the convergence flags for each well automatically.

4.6.3.1.2 Multiple Directional Surveys

Petra can store any number of survey data sets (both real and planned) for any well. Multiple surveys are really intended only for proposed and actual surveys. **It’s best to keep each actual completion (even those from the same surface location) separate and in different wells in Petra.** Keeping multiple drilled laterals in the same well greatly limits your ability to display in cross-section, map, and grid as well as store any useful header info or petrophysical data. The multiple survey toolbar is available on the bottom of every tab on the Directional Survey Data window.

**Current View Dropdown**

This dropdown sets the currently displayed survey definition. By default, Petra creates two entries: “Actual” and “Proposed.” A “~” next to the definition signifies
that the survey definition contains data.

Survey Def Maintenance - This button opens the Survey Def Maintenance tool, which changes how Petra labels different sets of surveys.

4.6.3.1.2.1 Survey Definition Maintenance

Edit Survey Definitions Tab
By default, Petra creates two survey definitions for “Actual” and “Proposed” survey data sets. Note that neither of these default entries can be deleted. This window also modifies each survey definition’s default color, which can be displayed in the Cross-Section Module.

The Edit Survey Definitions Tab allows for any number of different survey data sets to be created, which is usually used for different proposed survey plans. To add a new survey definition, select “Add Definition” and enter in the new survey definition’s name and description. To delete a new survey definition, select the desired survey row and select “Delete Definition.” Note that all survey information contained in the deleted survey definition for all wells will be deleted.

The “Get well count for each definition” button counts the total number of all wells in the project containing survey information in each survey definition.

Other Survey Options Tab

Import Options Tab
By default, Petra loads new survey information into the “Actual” survey definition. The Import Options tab sets which survey definition Petra stores new surveys by default. Note that importers elsewhere in Petra have the option to change the destination of new surveys.

Set Default Definitions Tab
This tab sets the “Active” and “Secondary” definitions for all selected wells (selected in Main Module). “Active” surveys will be the set displayed in the various modules, as well as the survey used in all calculations requiring survey data. “Secondary” surveys can be displayed alongside the “Active” survey in the Cross-Section Module and the 3d-Viz Module.
Copy Survey(s) Tab

This tab copies survey data from one definition to another for the current well, Main Module selected wells, or for all wells in the project. This option overwrites all survey data in the destination definition. In the example below, “Actual” surveys will overwrite all survey data in the “Proposed” definition.

4.6.3.1.3 Directional General Tab

The General Tab shows the units for both depths and XY offsets. Remarks can be stored in the large “remarks” text box in the middle of the screen.
Compute

This section quickly converts MD to TVD or vice versa. Note that while every MD has only a single TVD, a single TVD can have multiple valid MD values; Petra will select the first MD value with the desired TVD.

Delete Survey... - This button is used to delete all survey data from memory. You must then choose the OK button to permanently delete the survey from the database.
Lock Survey - This button saves all changes to the database and prevents further changes to the survey data. A well with a locked survey shows a red outline around the well information on the top of the screen, on all survey information on the Data Tab, and on the “Dir Survey…” button on the main Module’s Location Tab. To unlock the survey, select the “Unlock Survey” button in the same location.

Disable Use of Survey For This Well - This option disables directional surveys for the well. Petra will simply use the surface and bottom hole location on the Main Module’s Location Tab.

Horizontal well - This option flags the selected well as a "horizontal well." Petra can use this flag in data searches and other operations.

4.6.3.1.4 Directional Data Tab

The Data Tab shows the actual survey points stored in Petra’s database in a spreadsheet format. It will be blank for wells with no survey data. New data points can be manually added or old values can be changed. While it’s possible to enter in an entire wellbore’s survey points manually on the Data Tab, it’s almost always faster to use the import utility on the Import/Export Tab.

The Directional Survey Data’s Data tab showing the well’s individual survey points.

XY Offsets Mode and Inc / Azimuth Mode
Data values can either be viewed and edited by MD, TVD, INC, and AZI in "XY Offsets Mode" or by MD, INC, EW, NS in "Inc/Azimuth Mode." Petra will compute EW and NS offsets from entered inclination and azimuth data but will not compute the inclination and azimuth from offset data. From a user’s perspective, changing the offset data deactivates inclination and azimuth data. Modifying each point’s MD, INC, and AZI gives a little more flexibility later.

Note that Petra can display or import azimuth data in either the formatted or unformatted convention (e.g. “N25E” or “25”). By default, Petra displays the “formatted” convention. Selecting the “Dec Deg Azimuth” button instead shows azimuth in the “unformatted” convention.

**XY and Depth Units**

Set the "XY Units" and "Depth Units" combo boxes to indicate the units of the survey data. Note that this option does not convert the data at all – it just tells Petra whether the numbers used are in feet or meters.

**Adding and Modifying Data in the Data Window**

Moving around in the data spreadsheet is similar to other spreadsheet programs. The arrow keys, clicking in different cells, and the tab key all navigate through the data spreadsheet. To add a new row, select the down arrow on the last row or press tab or enter keys in the last cell of the last row. To insert a row above the currently selected row, press the Alt and Insert keys simultaneously or right-click the mouse and select "Insert New Row." To delete the currently selected row, press the Alt and Delete keys simultaneously or right-click the mouse and select "Delete Current Row." After making changes, select the "Keep Changes" button to update the database.

**Dec Deg Azimuth** - This option instead displays azimuth directions in decimal degrees rather than compass directions.

**Print** - This button sends the spreadsheet to the printer.

**4.6.3.1.5 Directional Preview Tab**

The Preview Tab displays projections of the wellbore’s path in three different planes: EW vs. depth, NS vs. depth, and a map view. This tab also opens a 3D visualization box with the outline of the wellbore.
The Directional Survey Data’s Preview Tab displaying two cross sections and a map view of a directional well

**Data Range**

The options in this box set maximum range for EW and NS offsets and vertical depth for the plots. Select the “ReDraw” button after changing the data range.

**3D View** - This button opens a small visualization tool that displays the wellbore in a 3-dimensional box. This box can be rotated around to illustrate the wellbore’s path or easily spot bad survey points. The “Draw Axes” button in the lower right corner adds scales for each axis of the box.

**Smooth** - This button smoothes the survey offsets slightly. Repeat the smooth process for higher degrees of smoothing. Note that this option changes the survey data.

**Print** - This button sends the display to the printer. The display should be printed in landscape format for best results.

**Redraw** - This button redraws the plots with the selected data range.

4.6.3.1.6 Directional Import/Export Tab

The Import/Export Tab moves survey data into and out of Petra’s database. To import survey data into a specific survey definition (such as “proposed” or “actual”),
select the relevant definition from the “Current View” dropdown at the bottom of the screen.

The Directional Survey Data’s Import/Export Tab

ASCII Survey Files

Petra’s import and export is limited to ASCII survey files, such as TXT or LAS. Given that directional companies provide survey data in a wide variety of formats and file types, it’s often useful to first open the given file in a spreadsheet program, remove extraneous header information and any extra formatting in between survey data points, and export as a simple text file.

Survey Format

The drop-downs in this box set the format of the survey file both when importing and when exporting. Along with a few special formats (like MMI, LAS, and DTI), most survey files can be divided into two categories: keyword or columnar.

Keyword survey files have a line above the first survey point that tells Petra which column is which survey element.

*WELL 0926421110000100
*XYUNITS F
*DEPUNITS F
*COLUMNS *MD    *TVD    *EW    *NS
Columnar survey files on the other hand simply have a delimited columnar or tabular listing and can only contain a single well per file. When importing non-keyword formatted files, set the units to indicate the units of the file. Petra has no way of determining the units on non-keyword files.

When exporting data, set the XY units and Depth units to whatever units you want the exported file to contain regardless of the actual units of the survey. Petra will make the appropriate conversions.

**Extend Directional Survey to TD During Import** - This button projects the survey data out to TD using the dip and azimuth of the last survey point.

**Calculate Bottom-Hole Location During Import** - This button recalculates the BHL based on directional survey data.

4.6.3.1.7 Directional Calc TVD Tab

A good percentage of survey data generated from directional companies starts at a “kick off point” well below 0’MD. MD, INC, and AZI data by itself simply tells where each successive survey is in relation to the previous survey - not in relation to the surface location. The Calc TVD Tab computes the wellbore’s path from a user-specified “kick-off” point.
Put another way, when loading only MD, INC, and AZI with no offset data from a kickoff point, Petra needs to know where this data starts in order to calculate an accurate model of the wellbore’s position. To use this utility, enter in the MD, TVD, XOFFSET (E+W-), YOFFSET (N+S-), INC, and AZI of the kick off. Select the “Compute TVD From MD” button to compute XOFF and YOFF data.

4.6.3.1.8 Directional Method Tab

The method screen defines which algorithm is used when converting inclination-azimuth data to x-y offsets during import. The difference between these algorithms is minimal with closely spaced survey points.
The advanced screen sets a couple of options for correcting for the convergence angle and for reducing the number of survey data points.
Survey Data Orientation

This section of the Advanced Tab sets the convergence angle correction for the selected well. Projecting the curved surface of the earth onto a flat computer screen inherently produces some distortion for all maps. Particularly in areas far from the central meridian of the selected map projection, the lines of longitude running north-south become angled – a common illustration is angled north-south section lines. While “True North” is at the top of the map (or screen), “Grid North” is at a slight angle due to this distortion. The angle between true and grid north is called the "convergence angle."

It’s important to plot directional wells relative to grid north, rather than true north; the BHL of a directional well plotted relative to true north can be hundreds of feet away from its true location. When the survey is oriented toward True North (lat-lon), then the survey path displayed on the map must be rotated to align with other features on the map that have been converted from lat-lon to xy using a map projection. There is no standard for directional surveys; azimuth survey data is reported both relative to true north and to a grid north.

When there’s doubt about a convergence angle settings, the Main Module’s “Analyze Survey” tool (Compute>from Locations>Set Dev. Survey Grid Orientation) can shed light on whether a convergence angle should or should not be applied. Essentially,
Petra calculates a BH location for the survey data both with and without a convergence correction. These two BH locations can then be compared with the actual header-supplied BH location. Based on this comparison, Petra can recommend whether an individual well should or should not have a convergence correction. Petra can either simply make a report, or can change the wells in the project automatically.

The “Set Dev. Survey Grid Orientation” Tool on the Main Module

Decimate Data

This option erases survey data points by a user selected factor. More specifically, this option keeps every Nth data points and erases the rest. As an example, the default 2 will keep only every other data point.

4.6.3.1.10 Directional Maintenance Tab

This tab changes directional well flags for all wells selected in the Main Module.
Reset all Wells to "Enabled" Survey Data - This option removes the Disable Use of Survey For This Well" option on the Directional Survey Data's General Tab for the currently selected survey definition (on the “Current View” dropdown) for all wells selected in the Main Module.

Reset all Wells to "Disabled" Survey Data - This option checks the “Disable Use of Survey For This Well” option on the Directional Survey Data’s General Tab for the currently selected survey definition (on the “Current View” dropdown) for all wells selected in the Main Module.

Reset all wells to “INC Present” Indicator - Petra keeps track of which wells have inclination and azimuth data. This information is available on the Misc Location Information window on the lower right corner of the Location Tab on the Main Module, and can also be used in well searches by data criteria. This option resets this information for all selected wells.

4.6.3.2 Congressional Location Information

The Congressional Location Information window modifies and displays location information based on the township and range system.
The Congressional Location Information screen establishes a well's surface and bottom hole location with the Township and Range System.

4.6.3.3 Offshore Location Information

The Offshore Location Information window modifies and displays location information.
based on the well's offshore area and block.

The Offshore Location Information screen establishes a well's surface and bottom hole location.

4.6.3.4 Texas Location Information

The Texas Location Information window modifies and displays Texas abstract and survey information.
The Texas Location Information screen establishes a well's surface and bottom hole location.

4.6.3.5 NorthEast Location Details

The NorthEast Location Details window modifies and displays a well's footage calls.
The NorthEast Location Details screen establishes a well's surface and bottom hole location using footage calls.

### 4.6.4 Formation Tops Tab

The FmTops Tab displays and modifies the selected well's formation tops.

- ![Maintenance](image) - This button opens the **Zone Maintenance Tool**.

- ![Print](image) - This button prints a hard copy of the tops and associated values for the currently selected well.

- ![New Top](image) - This button opens the **Add New Formation Top** tool.

- ![Aliases](image) - This button opens the **Formation Top Aliases** tool, which establishes a list of "equivalent" substitute tops.

- ![ReOrder](image) - This button opens the **Display Order for Tops** tool, which changes the order that Petra displays tops. This can be useful for filtering out only the most immediately relevant tops.

- ![Source](image) - This button opens the **Show Tops By Source** tool, which only displays tops with a certain set of source codes.

- ![Fault](image) - This button opens the **Fault Cut Details** tool, and is used for entering the depths to faults and the footage of any missing section.

**Tops Tab**
The FmTops Tab displays tops in a spreadsheet

Active Datum - This dropdown sets the active datum for the well.

Active Only - This option displays only the formation tops with active entries. Especially in large multi-user projects with lots of tops, this can be useful for trimming down the list of tops in the project.

Read Only - With this option set, the formation tops cannot be changed. This includes manually typing in new values, picking tops in other modules, or being overwritten during import.

Maintenance - This option opens the Zone Maintenance Tool, which also creates and modifies formation tops.

Print - This option prints the currently selected well's formation tops.

New TopAliases - This option opens the Define Formation Top Aliases Tool. This sets how Petra will replace missing tops with other "equivalent" tops in the database.

Reorder - This option opens the Order Z Data Items Tool. This sets the desired order that tops will appear on the Fm Tops tab and in other dropdowns in Petra's modules.

Source - This option opens the Show Tops by Source Tool. Formation limits Formation Tops to only the source or sources selected. This can be useful for only displaying or modifying your tops in a large multi user environment.

Fault Cuts - This option opens the Fault Cuts Tool. Petra can store fault cuts and throw to help in reconstructing the stratigraphic positioning of the lithology.
4.6.4.1 Fm Tops Source Restriction

Petra can store a source code for every top. This source code is typically a user’s initials, but can also reflect the origin of the top (such as GRID in the example below for formation tops sampled from a grid rather than correlated by hand.) Each source code can be up to 32 characters long. By default, all users can modify tops of any source code.

To restrict formation tops based on source code, select the button on the bottom of the Main Module’s FmTops Tab.

The Show Tops By Source Tool limits how tops are displayed. Only the tops with the selected source codes display anywhere in Petra.

Show all Sources - This option shows all tops for all sources in the project.

Show Tops For Selected Sources Below - This option only shows tops with the selected source code or codes. Tops without these selected source codes WILL NOT appear elsewhere in Petra, including the Map and Cross Section Modules.

FmTops Source Code Administrative Options

By default, all users with write access to the database server can modify all tops in the database, regardless of source. By modifying the "Petra.INI" file, administrators can set the project to only allow users to modify tops with their source code. When this feature is active, users are prompted for their source code when they start up Petra. It is kept in the registry, so they only need to enter it once. To implement the top source restriction mechanism, modify Petra.INI with the following lines:

```ini
[USERSOURCE]
ENABLED=1
BLANKS=1
ADMINLIST=<comma separated list of user's source codes>
```
**ENABLED=** - This line enables (ENABLED=1) or disables (ENABLED=0) source code restriction.

**BLANKS=** - This line controls whether users can modify tops with a blank source code. When this option is BLANKS=0, all users can modify a top with a blank source code. When this option is instead BLANKS=1, only administrators can modify a top with a blank source code.

**ADMINLIST=** - This line sets up a comma-delimited list of user source codes who have "administrator" rights.

### 4.6.4.2 Formation Top Aliases

Top aliasing assigns an ordered list of top names to the original, or aliased top. These tops serve as a list of "equivalent" tops that fill in if the original top is absent. Alias tops can function like the original top in many places in Petra, including gridding, calculations, and on display in the Cross Section Module.

Choose the "Aliases" button at the bottom of the FmTops tab on the main screen. Select the top to be aliased from the drop-down list at the top of the screen. Tops that already have an alias definition assigned are highlighted in light blue. Aliases should be specified in order of preference from highest priority at the top of the list to lowest priority at the bottom of the list.

![Define Formation Top Aliases](image)
An aliased top. Petra will look for the "2nd_Wall_Creel" top first, followed by "603WLCK2" and finally "2WC" Set Aliases For Top - This dropdown selects the top that will store the aliases. This should be the first choice, or top priority top. To add a alias, select the desired top from the "Available Tops" list and use the "->" button to add it to the "Top Aliases" list. The "->" button adds all tops on the "Available Tops" list to the "Tops Aliases" list. 

**Be sure to include the top name of the top being aliased.** To drop a specific top from the alias, select the desired top on the "Top Aliases" list, and use the "<" button to remove it. The "<<" button removes all tops from the the "Tops Aliases" list. 

Save - This option saves the alias list to the database.

Remove Alias... - This option removes the alias definition for the top selected in the "Set Aliases For Top" dropdown.

Done - This option returns to the Main Module.

FmNam Alias File

This option applies formation top aliases to PdCums, and the ProdFM and the FMatTD well entries.

Use Default Alias File - This option uses the aliases currently active in the Petra project.

Use File - This option uses an external file to set the aliases for the PdCum names, and ProdFM and FMatTD entries. The file itself is a simple text file with two types of entries: a formation name with a "1" prefix, and alias names for the formation with a "2" prefix. In the example below, formations 404HFNR+, 404MRRS, 404PCKS, and 404TSSYB are alias names for 404HFNR. And, formations 603DKTD, 603DKTDU and 603DKTDL are alias names for D_SAND.

```
1404HFNR
2404HFNR+
2404MRRS
2404PCKS
2404TSSYB
1D_SAND
2603DKTD
2603DKTDU
2603DKTDL
```

FmName Alias File Update

Do not Over Write This File - This option keeps a pre-existing external alias file as-is. Select this option to use the external file.

Create FmName Alias File From Top Aliases - This option creates a new formation alias file, or overwrites the file selected in the entry box.

**Note:** For information on copying Alias Tops, [see here](#).
4.6.4.3 Repeat Tops

Horizontal wells can cross a single formation top multiple times. In the example below, the horizontal well crosses Top A multiple times at different MD depths. To capture this information, previous versions of Petra required the creation of additional formation tops like A_1, A_2, and A_3 as shown in the example below on the left. With Version 3.2.3.0 and above, these multiple tops can now be stored as repeats for Top A as shown on the example below on the right. This makes viewing, picking, analyzing, and gridding horizontal and deviated wells much simpler and faster.

![Old Versions vs Version 3.2.3.0 Example](image)

Repeat Tops are also useful for storing estimated tops in horizontal wellbores. In addition to the above situation, repeat top values can also be located directly above or below the bore-path. Say a top does not cross a horizontal well, but rather it just dips close to it; you can now pick that top in space at a vertical offset above or below the actual bore-path. This will be better explained/visualized below when discussing the Cross-Section Module.

![Petra Main UI](image)

**Active Datum** - This dropdown sets the active datum for the well.
**Active Only** - This option displays only the formation tops with active entries. Especially in large multi-user projects with lots of tops, this can be useful for trimming down the list of tops in the project.

**Read Only** - With this option set, the formation tops cannot be changed. This includes manually typing in new values, picking tops in other modules, or being overwritten during import.

**Current Top** - This tool sets the active repeat top. The left and right buttons scroll through the tops list.

- **MD** - This entry stores the MD value of the top.
- **SS** - This entry stores the SS value of the top.
- **TVD** - This entry stores the TVD value of the top.

**MD/TVD Linked** - This option allows repeat tops above or below the bore-path. This can be used to estimate a top that's a known distance above or below a feature intersected by the horizontal wellbore. These estimated tops can be useful for Since the XY aerial location of the top is known, these "unlinked" tops can be useful for adding additional control points for mapping and gridding.

**Quality** - This option stores a quality code for the specific top. This can be useful for recording the confidence in the top or the method used to create the top.

**Time (MS)** - When the well has a velocity function, this entry stores the time of the top.

**Hole Angle** - When the well has a directional survey stored, this entry stores the inclination of the wellbore at the top's MD.

**Change Date** - This entry records the change date of the top.

**Remark** - This entry stores any additional remarks about the well.

**New Repeat Top** - This option adds a blank row to the repeats tab.

**Delete Selected** - This option deletes the currently selected row.

**Maintenance** - This button opens the Repeat Top Maintenance Tool.

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**Using Repeat Tops in the Map Module**

**Using Repeat tops in the Cross-Section Module**

**Using Repeat Tops in the Raster Log Calibration**

**Using Repeat Tops in the Slip Logs Module**
This dialog merges selected formation tops into a single top as repeats.

Storing multiple repeated formation tops in previous versions of Petra required the creation of additional formation tops. In the example below, a horizontal well passing through the same stratigraphic surface three times needed three distinct tops (A_1, A_2, and A_3) as shown in the example below on the left. This dialog allows you copy those repeated values them into Top A as repeats, as shown on the example below on the right.

To open the Repeat Tops Maintenance Tool, select the button on the bottom of the Main Module FmTops Tab Repeats Tops Tab.

Source Tops - This list sets the multiple tops that all reflect the same actual lithologic boundary.
**Target Top** - This dropdown sets the single repeat top that will store the multiple source tops.

**Keep Source Tops When Done** - After Petra collapses the multiple tops into a single repeat top, this option will keep the original entries in the source formation tops.

**Delete Source Tops When Done** - After Petra collapses the multiple tops into a single repeat top, this option will remove the entries in the source formation tops.

### 4.6.4.4 Add New Formation Top

This tool adds a new formation top to the database. To open this tool, select the button on the Main Module's FmTops Tab.

![Add New Formation Top Marker](image)

**Name** - This option sets the formation top's name.

**Source** - This option sets the formation top's source. This is most commonly the interpreter's initials, but can really be anything that reflects the origin of the tops. Petra has several tools that filter formation tops down by source, so it's usually worth spending the time to use this entry.

**Description** - This sets the description of the formation top, and can be more descriptive than the formation top's name. This can be particularly useful for documenting your work in a project, so that when you return to it 6 months later you don't have to reinvent the wheel.

**Decimals** - This option sets the desired decimal place precision for the top. A 0 decimal precision will store to the nearest whole integer depth unit (depending on the settings on the Map Projection Settings Units Tab). Given the inherent uncertainty in wireline logs, there's not much benefit in anything above 1 or 2 decimal place precision.

**Remarks** - This stores an unlimited box of text for the formation top. This can be used to document the top's origins, technique, history, or anything else relevant to the formation top.
4.6.4.5 Fault Cuts

Petra stores well fault cuts in the database. Fault cuts can be useful for restoring missing section on stratigraphic cross-sections.

To modify an existing fault cut, highlight the old fault cut, change the information, and select the button.

To add a new fault cut, enter the desired information and select the "+" button.
To drop an existing fault cut, highlight the desired fault cut and select the "-" button.

- **Name** - This entry sets the fault cut’s name.
- **Source** - This entry sets the fault cut's source. Generally this will be the user's initials.
- **Depth of Fault Cut** - This entry sets the depth of the fault cut. Note that this depth can be in MD or TVD.
- **Amount of Section Missing** - This entry sets the amount of section missing.
- **Color** - This sets the color of the fault cut. To change the fault cut's color, select the colored box.
- **All** - This option applies the currently selected color to all fault cuts in the well.
- **Name or Comment** - This entry stores remarks or comments about the fault.
4.6.5 Zone Tab

Petra defines a “Zone” as a specific interval in a well that can be defined by a top and a base. Inside each zone, Petra stores “Data Items” that relate to that zone. The Zones Tab displays and modifies zone information for the selected well and for the project as a whole.

The Zones Tab displays both “zones” and “data items”.

- This button opens the Zone Maintenance Tool.
- This button opens the View/Edit Zone Data Tool.
- This button creates a new data item in the selected zone with the New Data Item Tool.
- This button opens the Pay Interval Data Tool.
- This button prints a list of the data items and values for the currently selected well.
Printing a list of the zone data items for the currently selected well.

- This button opens the Assign Zone Item Aliases Tool

4.6.5.1 Zone Maintenance

The Zone Maintenance tool adds, changes, or deletes zone and zone data items. This tool has three tabs: Zones Data Items, and Interval Definition. The zone selected on the Zones Tab controls the data displayed in the other tabs. For example, to view the interval definition of zone "A", first click the cursor on the row containing the "A" name and description, then click the Interval Definition tab to see the depth interval data.

Zones Tab

This tab displays a list of the zones in the project. Typing over the existing text can modify the zone name and description.
The Zone Maintenance Zones Tab

- This button opens the New Zone Definition window.
- This button opens the Modify Zone Definition window.
- This button deletes the currently selected zone, along with all the data items inside that zone. This is irreversible.
- This button opens the Reorder Zone Names tool.
- This option sets a highlight color for the selected zone. This color will only appear on the individual user’s copy of Petra, and not to all users in a project.
- This option removes a highlight color for the selected zone.
- This box displays the selected zone’s highlight color

Data Items Tab

The Data Items tab adds, modifies, reorders and deletes the data items for a selected zone.
The Zone Maintenance Data Items Tab

- **New Item...** - This button opens the New Data Item window
- **Modify Item...** - This button opens the Modify Data Item window
- **ReOrder...** - This button opens the Select Display Order for Data Items & Tops window
- **Clear Data...** - This button removes all data from the selected data item. Note that the empty data item will remain in the database.
- **Clear Remarks...** - This button removes all remarks from the selected data item. Note that the empty data item will remain in the database.
- **Delete...** - This button erases the selected data item and the data contained inside the data item.
- **Decimals...** - This button sets the number of decimals displayed for the data item. The default is zero.
- **Save CSV File...** - This button saves a comma separated values (*.CSV) spreadsheet with columns for data item name, source, and description.
- **Save Template...** - The "Save" button saves the current zone's data items to a template (*.USR) file. The "Load" button loads a template file as a system template. Petra can sue a system tamplate to populate newly created zones.
- **Print...** - The print button prints a list of the data items in the currently selected zone.
- This button adds a user-selected color highlight to the selected data item.

- This button removes a user-selected color highlight.

- This option locks or unlocks the selected data item. Once an item is locked, users cannot change the values, either through importing new data or manually typing entries into the database.

- This option deletes data items based on well count. Petra will delete data items that have a well count equal-to or less than a specified number of wells. As an example, setting this value to 5 will eliminate data items with active values in 5 or fewer wells. This can be useful for pruning out low-value, low-well count items.

- This button performs a Find/Replace operation on data item source codes.

## Interval Definition

The Interval Definition Tab defines the upper and lower depth limits of a zone, either by a specific MD/TVD depth or with FmTops. Many of Petra’s tools are based around the concept of zones, so taking a moment to establish the interval definitions of zones is a good investment of time.

The upper and lower depth can each be defined using a fixed measured depth or TVD subsea depth. More typically, the upper and lower depth can also be defined using formation tops with optional footage offset. The formation tops method defines a true geologic zone with depths varying from well to well.
4.6.5.1.1 New/Modify Zone Definition

The New Zone Definition window creates new zones for the project. Generally, zones are defined by a stratigraphic interval between two tops.

The New Zone Definition Window

Zone Name - The Zone Name is a 1 to 30 character name of the zone of interest. The system automatically will convert the name to upper case and any intermediate blanks to underscores.

Description - Enter a short zone description such as the formation top names used for depth interval definition.

Remarks - Enter any pertinent remarks up to 4096 characters.

Templates

By default, the new zone will be created but will not contain any item names. However, you can create the new zone and copy the item definitions from a "template" zone.

Create Without Items - This default option creates the new zone without any data items.

Create Items From Zone Below - This option copies data item definitions from a user-selected zone (on the dropdown immediately below the "Create Items from Zone Below") into the newly created zone. Note that no data will be copied - only the empty data items and definitions.

Create Items from System Template - This option creates the new zone with the data items loaded into Petra's system template. To set up a system template, see the "Save Template"/"Load Template" buttons on the Zone Maintenance Data Items Tab.

4.6.5.1.2 Reorder Zone Names

The Reorder Zone Names Tool reorders the zones in a project. This tool can also filter out irrelevant zones.
The Reorder Zone Names Tool

**Current Display Order** - This list shows every data item in the zone.

**New Display Order** - This list shows the reordered zone names. Use the < and > keys to add and subtract group names to the New Display Order list, and the up and down arrow keys to change the order of a selected zone.

- This button adds the selected zone from the Current Order list to the New Order list.

- This button adds all zones from the Current Order list to the New Order list.

- This button removes the selected zone from the New Order list.

- This button removes all zones from the Current Order list.

- These buttons change the order of the selected zone on the Reordered New Order list. Selecting the up arrow moves the selected zone higher, while the down arrow moves the selected zone lower on the list.

- This option resorts the zones on the Current Order list in ascending alphabetical order (A to Z).

**Show Listed Items Only** - By default, Petra will show the zones items on the New Order list first, followed by all other zones. This option instead restricts Petra to show ONLY the zones on the New Order list. **With this option selected, zones not on the New Order list will never show up elsewhere in Petra.**
4.6.5.1.3 New/Modify Data Item

Item Name - This entry sets the name of the new data item.

Source - This entry sets a source code for the new data item. Generally, source codes designate the user creating the data item or the method used to create the data item.

Units - This dropdown sets the units for the new data item.

Decimals - This entry sets the number of decimals for the data item. It's sometimes useful to trim trailing digits for easier display.

Data Type - This section sets the general type of the data item. Numeric items store numbers with a set of digits, Text items store a string of text, and Date items store a specific date that can be used in minimum and maximum date search.

Description - This entry sets the description for the data item.

Remarks - This entry sets the remarks for the data item.

4.6.5.1.4 Display Order for Data Items & Tops

Formation Tops and Zone data items can be displayed in a preferred order rather than the default order in which the data fields were defined.

To reorder Zone Data Items, select the ReOrder button on the Zone Maintenance Tool’s Data Items Tab.

To reorder Formation Tops, select the ReOrder button on the bottom of the Main Module’s FmTops Tab.
Order Tab

Current Order - This list shows every data item in the zone.

New Order - This list shows the reordered raster group names. Use the < and >
keys to add and subtract group names to the New Order list, and the up and down arrow keys to change the order of a selected raster group.

- This button adds the selected data item from the Current Order list to the New Order list.

- This button adds the all group names from the Current Order list to the New Order list.

- This button removes the selected group name from the New Order list.

- This button removes all group names from the Current Order list.

- These buttons change the order of the selected data item on the Reordered New Order list. Selecting the up arrow moves the selected data item higher, while the down arrow moves the selected group name lower on the list.

- This option resorts the data items on the Current Order list in ascending alphabetical order (A to Z).

- This option resorts the data items on the Current Order list in descending alphabetical order (Z to A).

- This option resorts the data items on the Current Order list by the data items source code.

- This button sorts the data items by the number of wells containing the data item. This option is particularly useful for sorting through low well-count formation tops. With a large project and lots of data items, this can take a long time.

- By default, Petra will show the data items on the New Order list first, followed by all other data items in the zone. This option instead restricts the data items in Petra to ONLY the items on the New Order list. Items not on the New Order list will never show up elsewhere in Petra.

Import/Export Tab
Reorder Using Petra Order List
This option saves and loads data items to a Zone Order List file or *.ZOL.

Order Using External File (STRAT TABLE)
This option saves and loads data items to a Strat Table (*.DAT).

4.6.5.2 View/Edit Zone Data

The View/Edit Zone Data displays and modifies zone data items in a project.

To open this tool, select View/Edit All... button at the bottom of the Main Module’s Zones Tab, or select Zones>View/Edit on the menu bar at the top of the Main Module. Additionally, there are a few links to this dialog in other tools.

The left side of the screen contains a nested list of the zones and data items. Use the "+" button to the left of the desired zone to expand the tree, and then select the desired data item.

The right side of the screen displays a list of all the wells in the project along with a column for the selected data item’s values. Note that entries here can be edited as well.
4.6.5.3 Assign Zone Item Aliases

Zone Data Item aliasing assigns an ordered list of data items to the original, or aliased item. These items serve as a list of "equivalent" items that fill in if the original item is absent. Alias items can function like the original zone data item in many places in Petra, including gridding, calculations, and on display in the Cross Section Module.

To set up zone data item aliasing, select Zones>Zone Item Aliases... on the menu bar at the top of the Main Module.
Assign Zone Item Aliases

This tool simply selects the desired data item. Select the zone and zone data item to store the alias definition, and select the "Assign Zone Aliases..." button to set the equivalent alias data items. Note that data items that already have an alias definition assigned are highlighted in light blue on the Zone Items list.

Select Zone Item List

This tool sets the aliases for the selected data item. Aliases should be specified in order of preference from highest priority at the top of the list to lowest priority at the bottom of the list.

Zone - This list shows the available zones in the project. If a zone isn't showing up, make sure the "Show Listed Only" option on the Reorder Zone tool is off.

Zone Item List - This list shows every data item in the zone. If a data item isn't showing up, make sure the "Show Listed Only" option on the Display Order for Data Items tool is off.

Selected Zone Items List - This list shows the aliased data items. Use the < and > keys to add and subtract group names to the Selected Zone Items list, and the up and down arrow keys to change the order of an individual data item.

- This button adds the selected zone from the Zone Item list to the Selected Zone Items list.

- This button adds all zones from the Zone Item list to the Selected Zone Items list.
- This button removes the selected zone from the Selected Zone Items list.

- This button removes all zones from the Selected Zone Items list.

- These buttons change the order of the selected data item on the Selected Zone Items list. Aliases should be specified in order of preference from highest priority at the top of the list to lowest priority at the bottom of the list.

4.6.5.4 Zone Item Hyperlinks

A hyperlink is any text string that represents a full filename or URL web address. When the hyperlink is activated, the application that Windows associates with the extension is launched. For example, if a hyperlink has an .XLS extension, Excel is launched to view the hyperlink data file.

Hyperlink text can be entered as the text item or remark portion of a zone item on the zones tab. The hyperlink is activated when you right-click on the zone item name and select the "Jump to Hyperlink" from the pop up menu.

Hyperlinks can also be activated from the map module. First, right-click on a well (on the map) and select your "user favorites" to include a text zone item containing a hyperlink. Anytime you right-click on a well, and select the menu item containing the hyperlink text on the zones tab, the hyperlink will be activated.

A special "@folder:" notation can be used to allow hyperlinks to be stored within the project. For example, you could create a folder under your project’s root folder called "LINKS". Then, you would enter a hyperlink text as @LINKS: MyWellDrillingReport.xls. Petra would look for the file called MyWellDrillingReport.xls under the "links" folder and activate the hyperlink process.

4.6.6 Logs Tab

The Logs Tab displays and modifies the digital log curves for the selected well.
The Logs Tab displays project-wide information.

The log tab screen provides options pertaining to the well logs for the current well. All available logs for the well are listed and can be selected. The selected logs can then be viewed graphically by clicking the Preview button. Additionally, the log values (digits) can be edited by choosing the log name from the drop down list box. The Depths option can be used to restrict the logs for previewing or editing.
Delete - This option deletes the currently selected log or logs. By default, this only erases the log from the selected well. By selecting "All", Petra will delete the displayed log curve from all wells in the project.

Rename - This option renames the selected curve to use another name already in the database.
4.6.6.1 Log Maintenance

The Log Maintenance Tool creates, deletes, and renames log definitions. This tool can also change the default log scales and lock/unlock a curve for the entire database.
Delete... - This option deletes the log definition and all associated data for all wells in the database.

Rename... - This option changes the name and descriptive text for a log definition.

Scale... - This option sets the default scale for the log.

New... - This option creates a new log definition. Note that the new definition will have no log data (0 wells) associated with the new log definition. Generally, this option is best for renaming a log trace to a new name. After creating the new log definition, use the Logs Tab's "Rename..." option to change the log to the new name.

Wells... - This option displays the "Select Wells" screen with the wells containing the highlighted log.

Lock/Unlock - This option globally locks or unlocks the selected log definition.

Print - This option prints the curve information on this screen.

Close - This option closes the Log Maintenance Tool and returns to the Main Module's Log Tab.

Display Filter

Set Display Filter... - This option opens the Filter Log Curve Names tool. When the curves are in the "Filtered Curve List" on the right side of the screen, only those selected curves will display in Petra.

To move a curve to the Filtered Curves List, select the "->" button to bring over a single selected curve, or the ">>" to bring over all curves on the Available Curve List. To drop a curve from the Filtered Curves List, select the "<-" button to remove a single selected curve, or the "<<" to drop all curves on the Filtered Curve List.
Different naming conventions between wireline companies and tools mean that one type of digital log curve can have a variety of different names. As an example, within the same project a gamma ray curve can be named GR, GRD, GRN, GRR, GRS, GAMMA, and so on.

Generally, we want Petra to treat all these curves as the same. Rearranging a dozen log curve names for display on a cross section can be tedious, and performing a calculation with multiple logs with different names can be almost impossible. Digital log aliasing is a great way to get around these naming problems by establishing a list of curve names that are equivalent. In other words, if the curve name isn't present, Petra will look down the list to find another curve name as a substitute.

The alias list is a list of log curves to be searched only if the original log curve (aliased curve) is missing for a well. If the original log is present, it will be used.

To Define log aliases, select Logs>Define Aliases on the menu bar at the top of the
Main Module, or select the "Aliases..." button on the Main Module's Logs Tab.

Aliases Tab

First, use the “Chose Log to be Aliased” dropdown to select the digital log curve name that will store the aliasing. In the example below, the GR log will store the alias list for all gamma ray curves. Since Petra will always start at this curve name, the selected name should be your top choice for the curve in question.

Next, select other curves to add to the list, and use the “>” arrow to add them to the Log Aliases list. You can reorder the list by using the up and down arrow keys. Since Petra goes down this list from top to bottom, the order here should reflect the relative priority or quality of the logs with the best logs at the top.

When you've completed the aliasing, click the “Store Aliases” button to save the changes to the database. Click “Done” to leave the aliasing screen and return to the Main Module.

Choose Log to be Aliased - This dropdown selects the digital log curve name that will store the aliasing.

Store Aliases - This button saves the existing alias list for the log name selected on the "Chose Log To Be Aliased" dropdown.

Help - This option opens the help file.
Done - This option closes the Define Log Curve Aliases Tool. If you Select “Done” before storing the aliases, Petra will not save your alias list.

Delete - This option deletes the currently selected alias list on the "Chose Log to Be Aliased" dropdown

File Tab

Petra can store log alias lists to an external file. The format of this file is listed at the bottom of the File Tab. This can be useful for transferring log aliases between projects, or for trying out different log alias schemes.

Assign Aliases Using an Alias Definition File - This option loads an alias file from an external definition file. Use the "Browse" button to navigate to the desired file. Use the "Edit" button to open a text editor to modify the file.

Replace Method

Replace Only Aliases Listed in Def File (keep all others) - This option replaces only the aliases specifically listed in the external alias file.

Delete All Current Aliases and Replace With New Ones From Def File - This option first deletes all aliasing in the project, effectively replacing the aliasing in the project with the aliases from the file.

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Add New and Merge With Existing Aliases - This option adds new log aliases. Where log definitions in the project and in the external file overlap, Petra will attempt to merge the two.

Create Log Alias file from Current Log Aliases - This option creates a new alias file based on the log aliases currently stored in the project.

Report Tab

The Report Tab creates a text file that shows which wells will be affected by the currently selected log alias.

Report - This button runs the alias through the currently selected wells and generates a text file with each well and the substituted curve. With large projects, this can take considerable time.
4.6.6.3 Log Preview

The log preview function provides an interactive display containing selected logs displayed side-by-side. Logs can be quickly evaluated for quality control. Irrelevant logs can be deleted and multiple log runs can be merged to form one complete log trace. The log preview function displays and correlates formation tops.

The log preview screen operates in either Log Mode or Tops Mode. When logs are active, you can edit logs. When tops are active you can correlate tops. The top mode is active whenever tops are displayed.
Setting The Log Scale

By default, log data is automatically scaled to either linear or logarithmic (log10). Logs displayed on a logarithmic scale are indicated with an asterisk following the log name. To manually set the scale, select Logs>Set Track and Scale to open the Set Log Track Scale and Data Correction Tool.

Setting The Depth Range (Zooming) -

The default depth range is that range set on the "Logs" tab screen. The depth range can be modified using two methods: The "Depths-Set Depth Range" menu is used to manually set the range to defined by depths or formation tops. The depth range can also be "zoomed" graphically using the mouse. To start the depth selection process, either click the small depth tool button or hold down the Shift key then click and hold the left mouse button at the minimum depth. Drag the mouse over the desired depth interval and release the button at the maximum depth. Once in zoom mode, you can scroll the screen up or down by 1/3 of the screen height. A pop up menu displayed with a right mouse button click provides additional zoom and scrolling options.

Log Mode
Note: The log database is not actually modified (with one exception) until you exit the log preview screen. Then you are prompted whether or not to update the log database. The one exception is if you delete a log, in which case the log is deleted immediately after verification. Once deleted, a log cannot be recovered. Use the "Drop" function to remove unwanted logs from the display without deleting them.

Mouse Controls

Many options are provided via a "pop up" menu displayed by clicking the right mouse button.

Curve Color - This option changes the color of the curve on the Log Curve Previewer. This does not change the logs’ display color for the cross-section or anywhere else in the project.

Previous Zoom - This option returns to the last zoomed view.

Zoom In By 2X - This option zooms in on the upper part of the log curves.

Zoom Out By 2X - This option zooms out.

Scroll Up - This option scrolls up through the logs.

Scroll Down - This option scrolls down through the logs.

Default Depth Range - This option resets the depth range to the defaults set on the Main Module’s Logs Tab.

Show Curve Header Info - This option displays some log information, including the depths, the step interval, total number of data points, depth units, and some statistical measurements.

The Curve Header Info box

Set Log Curve Scale - This option opens the Set Log Track Scale and Data Correction Tool.

Corrections and Rescale - This option opens the Set Log Track Scale and Data
Correction Tool

Stats Histogram - This option displays a frequency histogram of the selected log showing data range, mean, standard deviation, mode, and sample counts.

Query Depths - This option displays a small window with the start and stop depth, step increment, and the total number of points in the well.

![Using the Depth Query option](image)

Delete Log Curve - This option deletes the selected log from the project database.

Merge Log Curves - This option merges the data from a "Source" log into a "Target" log. Follow the prompts at the bottom of the screen to first click the left mouse button on the "source" and then the "target" log. To cancel the merge operation, click the right mouse button.

Copy Curve - This option creates a copy of the curve with a different name.

![The Copy Curve option](image)

Draw Curve - This option draws in a log curve. After selecting this option, the cursor turns to a pen icon. Click once to start drawing, and again to add successive points. Right click to stop drawing points.

Draw Curve Shift - This option graphically moves the selected log curve.

Interpolate Nulls - Linear - This option interpolates between null values by simply drawing a straight line between the adjacent data points.

Interpolate Nulls - Cubic - This option interpolates between null values by fitting a curve to the nearest adjacent data points.

Null Curve Section - This option sets log digit values to a null over a given depth interval. The depth interval is defined using the depth range selection technique described earlier.
Shift Curve Starting Depth - This option can be used to shift the starting depth of a log up or down by a given amount. A positive shift amount shifts the log deeper while a negative value shifts the log shallower.

Shift Using Depth Pairs - This option shifts the log curve’s depths with a set of drawn depth pairs. Note that Petra will stretch and squeeze the log in order to accommodate multiple depth pairs.

Establishing a set of Depth Pairs

Smooth Log Curve - This option smoothes or filters the selected log digits with a triangular smoothing filter. The number of filter coefficients can be set from 3 to 25 by selecting Logs>Set Smoothing Strength on the menubar at the top of the screen.

De-Spike Curve - This function clips anomalous data outside a rectangular region drawn on a curve. The user draws a rectangle over the curve section that defines the depth range and low and high amplitude values allowed. Curve values falling outside the rectangle (either to the left or right side) are first set to null then new values are interpolated for each of the null values using the remaining good data samples.

Change Depth Units - This option changes the depth units of the selected well. Note that this will affect all curves with the logs definition.

Alter Sample Rate - This option changes the sample rate of the selected curve.

Cutoff Line - This option simply draws a straight line at the specified value. This can be useful for evaluating curves or for finding anomalous values. To remove the line, enter a cutoff of "0."

Drop Curve From Display - This option removes the selected log from the screen. This option does not delete the curve from the database.

Move Curve Left 1 Track - This option moves the curve one track to the left.
Move Curve Right 1 Track - This option moves the curve one track to the right.

Restore Original Curve - This option restores the original log digits from the log database. Any changes made to the log are not saved.

Formation Top Mode

In Formation Top Mode, the Log Curve Previewer can correlate the formation tops that are in the project. To enter Formation Top Mode, select the "Show Formation Tops" option at the top of the screen. Alternatively select Tops>Show Tops/Hide Tops from the menu bar at the top of the screen.

Selecting The Formation Tops To Display

To select the tops that appear on the Formation tops dropdown menu, select Tops>Select Tops on the menu bar at the top of the screen. Here, add tops to the "Selected Zone Items" list by selecting the "">" button to add a selected top, or the ">>" button to add all tops. To drop a top from the "Selected Zone Items" list, select the desired top and select the "<" button. To drop all tops from the "Selected Zone Items" list, select the "<<" button.

Changing Formation Top Values

Moving an existing top
Tops already in the database are displayed as a single line drawn across the depth track. As the cursor is moved over the top’s line, the line turns white to indicate it is active. While a top is active (white), it can be dragged up or down on the depth axis by clicking and holding down the left mouse button. The top is redrawn at its new depth value when the right mouse button is released.

**Correlating a new top**

To correlate a new top, select the desired top in the tops dropdown box at the top of the screen. Next, select the button or Tops>Correlate on the menu bar at the top of the screen. The cursor will jump to the center of the screen with the correlation line. Position the cursor at the appropriate depth and click the left mouse button. The screen will redraw with the new top value. The correlation can be canceled by clicking the right mouse button instead of the left button.

**Top values are not stored back to the database until (1) you reselect tops, or (2) you exit the log preview screen. In either case, you are prompted before the database is updated.**

**Round Tops Values** - When checked, this Tops-Menu option causes top values to be rounded to the nearest whole foot or meter. This option only affects values that are changed using the cursor procedure described above.

4.6.6.3.1 Log Preview Scales

The Set Log Track Scale and Data Correction Tool sets the log scale in the Log Curve Previewer Tool and performs some simple corrections to log curves.
Log Track Display Scale

**Automatic** - This option automatically attempts to set a reasonable track minimum and maximum based on the data.

**Linear** - This option sets the track to use a linear track scale.

**Log** - This option sets the track to use a logarithmic track scale.

**Log Curve Defaults** - This option scales the track to the log curve's default scale.

**Track Min/Max** - These entries set the left and right boundaries for the track when the "Use Track Min-Max Values" option is selected.

**Use Track Min-Max Values** - This option sets the track minimum and maximum from the "Track Min" and "Track Max" entry boxes.

**Use Log Data Range for Track Range** - This option uses the minimum and maximum values from the log curve for the track minimum and maximum.

**Plot as Discrete Points** - By default, Petra attempts to connect log curve data points. This option instead plots the data as individual, unconnected data points.
Log Data Correction

Set the scale mode to automatic, linear or log10 and the minimum and maximum scale range.

The log scale option also provides the means to "correct" the log digits using simple math functions. The digits of the selected log can be added, subtracted, multiplied, or divided by a specified constant value.

This section applies a simple mathematical function to the log such as adding, subtracting, multiplying by or dividing by a constant. To apply a correction, change the correction type from "No Correction" to the appropriate math function. Next enter the constant value to be applied.

Add/Subtract/Multiply By/Divide By Constant - These options perform a simple mathematical operation using the value in the "Correction Constant" entry box.

Re-Scale using Min-Max Range - This option rescales the selected log to the minimum and maximum set on the "Track Min" and "Track Max" entry boxes. This can be useful for rescaling a log to a 0-100 scale.

Add/Subtract/Multiply By/Divide By Correction Curve - In contrast to using a single correction constant, this option instead performs a simple function using an additional log curve selected by the "Correction Curve" dropdown. Note that the value of the curve will be set to null where the correction curve is also null.

Apply Correction to All Log Depths - This option will perform the log data correction to all log depths.

Apply Correction To Only Those Depths Currently Displayed - This option will perform the log data correction only to the depths currently displayed on the Log Curve Previewer.

4.6.6.3.2 Set Depth Range

The Set Depth Range screen defines the upper and lower depth range based on a formation top, measured depth, or true vertical depth, or zone definition.
Formation Top and Offset - This option sets the depth interval to vary from well to well based on the values of the formation tops. Select the formation top reference from the drop down list and optionally set a numeric offset value. The offset provides for such intervals as 100 feet above and below a given top.

Measured Depth - If the entire well interval is desired, set the upper depth to -100000.0 and the lower depth to +100000.0.

TVD SS - This option can be used to set the depths to a vertical interval for deviated wells that contain survey offset data.

Set Upper and Lower Depths From Zone - This option sets the upper and lower limits based on a zone's interval definition.

4.6.7 IP Tests Tab

The IP Tests Tab displays and modifies information about the selected well on the well list. To change an entry, double click the relevant test. To enter a new test, select the “Details” button.
The Well Tab displays header and symbol information about the selected well.

**Show combined Well Completions** - This option forces Petra to display test data for all well completions, even when projects store separate completions as separate wells.

**Production Test Details Window**

The details button opens the Production Test Details window. This displays more specific information about the tests. To add a new test, enter the relevant data for the test and select the "+ Add" button. To modify an existing test, select the "Update" button.

**PD Test Tab**

This tab displays and modifies production test data for the selected well. The upper dropdown menu displays different tests.
Modifying Tests

**Update** - This option applies any changes made to the entries and saves them to the database. These changes overwrite the currently selected test.

**Add**  - This option applies any changes made to the entries and creates a new test to the database.

**Delete** - This option deletes the currently selected production test.

- The arrow buttons cycle through the selected wells’ tests.

**Add to Perfs** - This option adds the currently selected tests top and base to the well's perfs.

**Clear Fields** - This option clears the test's fields.

Treatments Tab

This tab displays and modifies treatment data for the selected well. The upper dropdown menu displays different tests.
The Production Test Details Treatments Tab

**Update** - This option applies any changes made to the entries and saves them to the database. These changes overwrite the currently selected test.

**Add** - This option applies any changes made to the entries and creates a new test to the database.

**Delete** - This option deletes the currently selected production test.

- The arrow buttons cycle through the selected wells' tests.

**Clear Fields** - This option clears the test's fields.

**Maintenance Tab**

The maintenance tab deletes tests for the currently selected well or all wells, and changes the units flags.
The Production Test Details Maintenance Tab

Delete All Tests for this Well... - This option deletes all IP tests for this well.

Delete All Tests for All Wells In DB - This option deletes all IP tests for all wells in the project.

Set All PD Test UNITS Flags to Current Project Units - This option resets all production tests to use the current project units of measurement.

Options Tab

The options Tab just changes how the Production Test Details window displays choke.
Display Choke in 64ths of Inch - This option forces Petra to display choke in 64ths of an inch.

4.6.8 FM Tests Tab

The Fm Tests Tab displays and modifies formation test information about the selected well on the well list. Typing a value in the appropriate entry field will change that field.
The Main Module's Fm Tests Tab

Production Test Details Window

The details button opens the Production Test Details window. This displays more specific information about the tests.

Fm Test Tab

This tab displays and modifies production test data for the selected well. The upper dropdown menu displays different tests. To add a new test, enter the relevant data for the test and select the "+ Add" button. To modify an existing test, select the "Update" button.

The Production Test Details PD Test Tab

Modifying Tests

**Update** - This option applies any changes made to the entries and saves them to the database. These changes overwrite the currently selected test.

**Add** - This option applies any changes made to the entries and creates a new test to the database.

**Delete** - This option deletes the currently selected production test.

* - The arrow buttons cycle through the selected wells’ tests.

**Add to Perfs** - This option adds the currently selected tests top and base to the well's perfs.
Clear Fields - This option clears the test's fields.

Recoveries Tab

This tab displays and modifies recovery data for the selected well. The upper dropdown menu displays different tests.

The Production Test Details Treatments Tab

Update - This option applies any changes made to the entries and saves them to the database. These changes overwrite the currently selected test.

Add - This option applies any changes made to the entries and creates a new test to the database.

Delete - This option deletes the currently selected production test

- The arrow buttons cycle through the selected wells' tests.

Maintenance Tab

The maintenance tab deletes tests for the currently selected well or all wells, and changes the units flags.
Delete All Tests for this Well... - This option deletes all IP tests for this well.

Delete All Tests for All Wells In DB- This option deletes all IP tests for all wells in the project.

Set All PD Test UNITS Flags to Current Project Units - This option resets all production tests to use the current project units of measurement.

Options Tab

The options Tab just changes how the Formation Test Details window displays choke.

Display Choke in 64th of Inch - This option forces Petra to display choke in 64ths of
an inch.

Maintenance Tab

The maintenance tab deletes tests for the currently selected well or all wells, and changes the units flags.

![The Formation Test Details Maintenance Tab]

- **Delete All Tests for this Well...** - This option deletes all IP tests for this well.
- **Delete All Tests for All Wells In DB** - This option deletes all IP tests for all wells in the project.
- **Set All FmTest UNITS Flags to Current Project Units** - This option resets all formation tests to use the current project units of measurement.

4.6.9 Cores Tab

The Well Tab displays and modifies information about the selected well on the well list. Typing a value in the appropriate entry field will change that field.
The Well Tab displays header and symbol information about the selected well.

Cored Interval Details

This tab displays and modifies core data for the selected well. The list on the left side of the screen displays different tests. To add a new core interval, enter the relevant data for the core and select the "+ Add" button. To modify an existing core, select the "Update" button.
Type - This entry displays the general type of core. "CONV" and "SDWL" are common abbreviations for conventional and sidewall cores.

Date - This entry displays the date of the core.

Side Wall Core - This option toggles the flag for a side wall core.

Top - This entry sets the top of the cored interval.

Base - This entry sets the base of the cored interval.

Recovered (Ft or Mts) - This entry sets the total recovered footage.

Quality or Show - This entry sets the quality of the core, or reports the show of the core.

Lithology Desc - This entry describes the lithology of the core.

Formation - This entry reports the formation of the core.

Remarks - This entry stores any additional remarks about the core.

4.6.10 Perfs Tab

The Perfs Tab displays and modifies perf information about the selected well on the well list. Double clicking a specific perf entry or the empty perf field will open the Perfed Intervals Tool.
Perfed Intervals Tool

The Perfed Intervals Tool displays more specific information about each perf. The list on the left side of the screen displays different perfs. To add a new test, enter the relevant data for the test and select the "+ Add" button. To modify an existing test, select the "Update" button. Once you've made all the desired changes, select the "Save Changes and Exit."
**Source** - This entry sets the source of the imported perfs.

**Date** - This entry sets the date of the original perf.

**End Date** - This entry sets the end date of the perf.

**Perf Type** - This dropdown sets the general type of perf. Note that this also includes bridge pugs, squeezed intervals, and junk.

**Top Depth** - This entry sets the top of the perfed interval.

**Base Depth** - This entry sets the base of the perfed interval.

**Nbr of Slots** - This entry sets the number of slits for the perfed interval.

**Diameter** - This entry sets the diameter of the interval.

**Method** - This entry sets the method used for the interva.

**Completion Type** - This entry sets the completion type of the interval.

**Remarks** - This field stores any additional remarks or comments about the interval.

### 4.6.10.1 "Problem" Perfs

Petra projects often contain duplicate or redundant perf intervals. These “problem” perfs can be divided into two major sets: gross interval perfs, or duplicate perfs. Petra automatically recognizes these perf intervals and color-codes them. Gross interval perfs are coded as red, while duplicate perfs are classified as blue.

**Gross Interval Perfs (RED)**
Commercial data vendors originally copied perf information from reported IP tests. Additionally, Petra also has an option to import IP tests as gross perfs. When one IP test covers multiple perfs, this method records one large “perf” that covers the entire gross interval. These gross intervals obscure the actual perfs in a well and invalidate most perf footage calculations.

**Duplicate Perfs (BLUE)**

Duplicate perfs occur when the same perf interval is repeated in the database. Just like gross intervals, this can come from commercial data sources, or from reimporting data into a Petra project.

In the example below, you can see that there are only four actual perfed intervals: 1150-1158, 1164-1169, 1229-1236, and 1240-1245. The remaining perfs are either gross intervals or duplicates. Notice that Petra color codes these intervals both on the list and the graphical diagram of the perfs.

Petra had a few tools for dealing with these duplicate and erroneous perf intervals that are more efficient than erasing them manually. For more detailed information, see "How to fix Problem Perfs."

**4.6.11 Shows Tab**

The Shows Tab displays and modifies show information about the selected well on the
well list. Double clicking a specific show entry or the empty show field will open the Shows Details Tool.

![Image ofShows Details Tool]

The Perfs Tab displays perf and bridge plug about the selected well.

**Shows Details**

The Shows Details Tool displays more specific information about each show in the well. The list on the left side of the screen displays different shows. To add a new test, enter the relevant data for the test and select the "+ Add" button. To modify an existing test, select the "Update" button.
The Shows Details tool displays and modifies detailed information on the shows stored in the project.

**Top** - This entry sets the top of the show interval.

**Base** - This entry sets the base of the show interval.

**Show Type** - This field stores the type and other general remarks for the show.

**Shows** - This entry stores the general type of show. Options include oil, gas, water, and other.

### 4.6.12 Monthly Production Tab

The Monthly Production Tab displays monthly production streams from the selected well on the well list.

For information about importing ASCII Monthly Production data, see here.

For information about importing PI Monthly Production data into a project, see here.

For related information about computing monthly production variables from other production data using equation transform, see here.
The Production Tab displays the selected well's monthly production data.

**Options...** - This button selects the displayed streams, production variables, and the axes on the chart.

**Print** - This button prints the production plot shown on the Main Module.

**Data** - This button opens a spreadsheet to display and modify the monthly production data.

**Maintenance** - This option opens the Monthly Production Maintenance tool, which controls the names of the production streams and establishes naming aliases. This tool also deletes production streams.

**Live...** - This option displays a small window outlining the production streams for the selected well.

**Quick Set** - This option adds a set of three dropdowns to the bottom of the Production Tab: OIL, GAS, and WTR. These dropdowns select production streams displayed in green, red, and blue, respectively. The Quick Set is a quicker way of switching between different production streams than using the Options menu.

**Locked** - This option locks the selected well's monthly production data. Locked production data cannot be changed, or overwritten.
Show Daily Rates - This option converts monthly production rates into daily rates by dividing by 30.

4.6.12.1 Monthly Production Chart Options

The Prod 1 and Prod 2 Tabs set the production data shown on the production chart.

Data 1/Data 2 Tab
Years Tab
Options Tab
Z-Data Tab
4.6.12.1.1 Monthly Production Chart Prod1/2 Tab

The Prod 1 and Prod 2 Tabs set the production data shown on the production chart.

**Production Stream** - This dropdown selects the individual production stream. By default, the OIL, GAS, and WATER and water streams are set in green, red, and blue. Select "None" to disable the graph.

**Cumulative Values** - This option displays cumulative values for the selected stream at the bottom of the plot.

**Auto Scale** - This option automatically scales the selected production stream to use the desired logarithmic decades set on the Options Tab.

**Linear** - By default, Petra plots production values on a logarithmic scale. This option forces Petra to instead use a linear scale.

**Manual Y-Max** - This entry specifies a maximum for the selected production stream. Values above this plot will be off the top of the chart. Note that the minimum will be determined by the number of log cycles.

**Color Box** - This bar sets the color of the stream on the plot. To change the color, select the color box, and select a new color on the
Changing the production stream color

**Suppress Y Axis** - This option suppresses the labels on the Y axis.

4.6.12.1.2 Monthly Production Chart Years Tab

The Years Tab sets the extents of the X axis

**Automatic** - This option sets automatic scaling for the X axis of the production chart to the first and last month of production.

**Manual** - These entries set limits on the duration of production data. By default, Petra displays data from 1900 through 2100, which will be much too big a range for most applications.

**Include Historical Production in Manual Years Mode** - Some states record historical production in a single historical year labeled "0." This option includes this historical year 0 in when years are set manually.
4.6.12.1.3 Monthly Production Chart Options Tab

The Options Tab sets some of the details and scaling for the monthly production charts.

**Number of Log Cycles on the Y-Axis** - This entry sets the number of logarithmic decades.

**Use Common Scale On All Graphs** - This option forces all 3 graphs to use the maximum computed scale.

**Use Aliases** - This option uses monthly production name aliases.

**Draw Through Null Values** - This option will draw a line to connect all values. By default, months with no production have gaps in the graph line.

**Position Relative to Well Symbol** - This option sets the location of the monthly production plot around the well symbol.

**Load Template** - This button loads previously saved production options settings from a *PDO file.

**Save Template** - This button saves the production options settings to a *PDO file.
4.6.12.1.4 Monthly Production Chart Z Data Tab

The Options Tab sets some of the details and scaling for the monthly production charts.

**Post Z Data Zone Items on Chart** - This option allows zone data items to be plotted on the production chart.

**Select Zone Items** - This button selects the desired zone data items for display on the production chart. Here, select the desired zone and data item on the first two lists, and select the "->" button to bring the data item over to the "Selected Zone Items" list.

4.6.12.2 Modifying Monthly Production Data

The Modify Monthly Production Data" edits the selected wells production streams with a spreadsheet.

Every-time this dialog is closed, the view settings (including displayed streams) are saved as private parameters. You can also choose to save a default view (press
"Save Default View"). When a default view is saved, you can now change the view to "Use Default View" for any well in that project.

### Single Stream View

The production variable is selected from a drop down list of all defined variables. Each year of production is displayed as a row of values. Columns are labeled JAN through DEC. If the well does not contain any data, you are prompted for the first and last year of production to define the rows of the spreadsheet.

### "Column" or Multi-Stream View

Check the "Column View" check box to view more than one production stream as columns in the table. You can select the desired streams from the list on the right that appears in the "Column View." The far most left column displays the date in the format Month/Year. Inserting and Deleting years works the same as in the normal view, except it is done one year at a time (you cannot insert or delete individual months within a year).
$0 = \text{Null}$ - This option treats zero values as nulls.

**Active Only** - This option displays only months with values

**Column View** - This option changes the single stream view to column or multi-stream view

**Locked** - This option locks the selected well's production data. While locked, it cannot be overwritten or changed.

**Read Only** - This option sets the production data to read only. While in read only mode, data cannot be overwritten or changed.

**Show Prior Cum** - Older wells have production prior to data recording, which is typically stored in the monthly production in a special year "0" entry. This option displays these historical records, which can be important for calculating production cums.

**View**

**Use Last View** - This option uses the last view selected on the Modify Monthly Production Data tool.

**Use Default View** - This option uses the default view saved by the user.

**Save Default View** - This option saves the current settings on the Modify Monthly Production Data tool. Selecting the Use Default View option will always display these settings.

**Years Displayed**

**Start Year** - This entry sets the starting year of the displayed data.
**End Year** - This entry sets the ending year of the displayed data.

**Display Data Range** - Selecting this option shows all data for the selected well, regardless of the Start and End Year entry boxes.

**Display Custom Range** - This option limits the data only to the Start and End Year entry boxes

**Modifying Data**

The Modify Monthly Production Data tool works much like any other spreadsheet. To modify entries, select the desired field and overwrite the existing data.

Use the pop up menu (right mouse click) to invoke many functions.

**Copy & Paste** - Copy and Paste are now available on the pop-up menu (right click) as well as accessible through the keyboard shortcuts (Copy-CTRL+C, Paste-CTRL+V). Pasting is only allowed if the "Read Only" checkbox is unchecked. This feature is intended to be used for getting data into or out of an Excel spreadsheet.

**Adding New Rows (Years)** - Rows are added to the top or bottom of the spreadsheet if you hold down the Shift Key and use the Up or Down Arrow key to move beyond the first or last year of production.

**Deleting A Row (Year)** - Delete a row by pressing the Alt-Delete key combination or from the pop up menu. Year 0 cannot be deleted.

**Inserting A Row (Year)** - Insert a new row above the current row by pressing the Alt-Insert key combination or from the pop up menu. The year of the inserted row is 1 less than the current row.

**Show Graph** - A simplified production chart can be displayed by activating this option.

**Save and Load Templates** - Templates store the current view settings to/from an external file with a *.MPD extension.

4.6.12.3 **Monthly Production Maintenance**

The monthly production maintenance screen is used to add, modify, and delete monthly production database variables.

**Production Database Items** -

Select one of the existing production variables to modify the name, units or description or delete production.

**Definition**
Name - A 1 to 10 character string to identify the production variable. Examples are OIL, GAS or CO2.

Units - An optional 1 to 8 character code to identify the units of the production data. Examples are BBL (barrels) or MCF (thousand cubic feet).

Description - A 1 to 40 character string to describe the production variable in more detail.

Add - Adds a new production definition to the production database.

Modify - Changes the name, units or description of an existing production variable.

Delete - Deletes the production definition and all associated data from the production database.

4.6.13 Prod Cums Tab

The Prod Cums Tab displays and modifies cumulative production values for the selected well on the well list. To modify an entry, select the "Details" button.

Prod Cum data by itself isn't easily mappable or used in calculations. It's often useful to use the Extract PdCum Data To Zone tool to copy some of these variables to a zone data item.
The PdCum Details Tool changes the data in an individual well and column names for the entire project. This tool also deletes all production cums from the project.

**Data Tab**

The Data Tab changes individual data for a specific well. This includes changing the formation name, top and base, dates, and production cums.

![Data Tab screenshot](image)

The Data Tab modifies the selected well's PdCum data

**Fixed Column Labels**

The Fixed Column Tab changes the names of the columns as they appear on the Prod Cums Tab. Most users will want to leave these alone.
The Fixed Column Labels Tab modifies the columns that appear on the Man Module’s Prod Cums Tab.

User Column Names

The User Column Names Tab sets the column definitions for the user column names. Here, select the desired column and change the name and type. Note that numerical fields can have a set number of decimal places.
The user Column Names modifies additional column name in the project database.

Options

The Options Tab sets a couple of additional options for name substitution and date format.

![Options Tab](image)

The Options Tab controls how Petra replaces missing ALTNAME entries and displays dates

**Substitute FMNAME when ALTNAME is BLANK** - This option replaces missing entries for altnames with the formation name.

**Date Format** - This dropdown selects how Petra displays dates. By default, Petra uses mm/dd/YYYY

Advanced Tab

The Advanced Tab performs a couple of additional maintenance tasks, including global PdCum deletion and locking wells.
The Advanced Tab deletes PdCums with a specific formation name, locks PdCum data, and modifies PdCums with "0" tops and bases.

**Global Deletion** - This option deletes all PdCum entries with a set FmName. Note that the name must match exactly.

**Locks** - This option locks and unlocks the PdCum entries for the selected wells.

**Set ZERO Top and Base Values to NULL** - This dropdown replaces PdCum tops and bases with "0" values to a null. This can be useful for eliminating erroneous calculations involving depths.

**Report Tab**

The Report Tab creates CSV file of PdCum data.

To add a data column to the report, simply double-click the desired data field in the "Available Columns" list.

To remove a column, double-click the desired data field in the "Report Columns" list.

To rearrange the list in the Report Columns list, select the desired field, and use the up and down arrows to move the individual data field up or down. Entries on the top of the list will appear first (and to the left) on the CSV.
To create the file, select the "Create Report..." button. This opens an entry to select the desired name and location of the file. As a CSV file, the report can be opened in most spreadsheet programs.

An example CSV PdCum report

4.6.14 Rasters Tab

The Rasters Tab displays and modifies the calibrations for scanned wireline paper
logs, known as "raster logs."

The Rasters Tab

- This option displays a small window on the selected raster's group and file locations.

- This button opens the Pay Interval Data Tool.

- This option opens the Raster Image Calibration Tool. This tool depth-registers the image and sets its group name. This tool also has a few image processing tools and can straighten and despeckle the image files. This tool can pick tops, pay, and digitize the log images.

- This button opens the Group Maintenance tool.

- This tool opens the Neuralog Scanner Interface tool. The "Group Name Indicating Log Type" sets the raster group name for the scanned log. The "Store Scanned Image and 'LIC' File in Following Folder" option sets the location for the scanned image file and LIC created by the neuralog scanner.
The Neuralog Scanner Interface window

- The button opens the Raster Log Correlation tool.

- This button removes the raster log group name from the project database. This option does not erase the image file or the LIC file.

- This button merges two or more selected log groups.

- This option creates a brief text file containing a summary of the selected raster group names.

A Raster List File

4.6.14.1 Raster Image Calibration

The Raster Image Calibration tool adds depth calibrations to raster logs, straightens images, adds pay intervals, and creates digital logs.

To open the Raster Image Calibration tool, select the Assign/Calibrate button on the Rasters Tab. This opens the “Calibrate Log Image” screen. Notice that the well’s UWI and name appear on the screen.
An Introduction to Image Groups

The Cross Section and Log Correlation Modules display log images for a given well by referencing group names. For example, you might display images from the "GR" group in track 1 and images from the "Default" group in track 2.

Petra predefines one group called the "Default" group. You can create as many groups as you have different images for a well. Groups names should normally have something to do with either the log curves they contain or the sample rate of the log, i.e., "5-inch logs".

Each well can have only one image in a group. However, there is no limit on the number of different groups you can define. Therefore, if you have 5 different log images for a well, you must have 5 different image groups defined. The well will have 1 image in each of the 5 groups.

The Petra database has a table containing a reference to log image calibrations. Each record in the table contains a well sequence number (WSN), image group number (IGN) and a path to the calibration file. This scheme allows an unlimited number of images to be referenced for any given well.

Assign A Group Name

Select the appropriate image group from the "Image Group Name" drop-down list or add a new group using the "Group>Add or Delete Groups..." menu.

Assign A Well

If a well has not been assigned, choose the "Well>Assign Image To Well" menu to
select the well from a list. The image and calibration file will be associated with this well.

**Open an Image File**

Use the "File>Open Image" menu item and select the log image file. It will be loaded into memory and displayed on the screen.

**Raster Image Calibration Toolbar**

- The "Save Calibration As" overwrites the calibration file (*.LIC) for the current raster image. This will save the depth calibration points, headers and footers, and scale markers set on the raster image to a specific "group name."

- The "Save Image As" saves the changes made to the image file (such as image editing or image straightening). Like any other file, you can permanently overwrite the existing image file or create a brand new copy. Note that overwriting the existing file may make pre-existing depth calibration points and groups inaccurate.

- The "Cut Out Section" tool removes a portion of the image file and splices the image back together. This can be useful for removing extraneous portions of the log. For more information, see log image editing.

- The "Crop At Depths" tool removes the image file beyond the uppermost and lowermost depth calibration points, header, footer, or scale markers. For more information, see log image editing.

- The "Crop At Edges" tool removes the image file beyond the left and right most track edge. For more information, see log image editing.

- The "Add Straight Edge" button adds a straight edge for raster image straightening. Users adjust this line to reflect

- This "Straighten Image" tool uses the straight edge to straighten the log image.

- This tool rotates the entire image. For more information, see log image editing.

- The "Show Image Details" tool displays more detailed image about the image file, including bits/pixel and image size.

- This button opens the Raster Test Indicators tool. This can plot perfs, formation and IP tests, and other test data on the Raster Image Calibration tool.
Getting Started

Adding Depth Calibration Points, Edges, Header/Footer/Scales
Straightening Log Images
Plotting Test Indicators
Displaying and Picking Tops
Log Image Editing

Advanced Tools

Digitizing Raster Log Curves

4.6.14.1.1 Depth, Header, and Scale Calibration

Raster logs are scanned copies of paper logs saved as image files. In order to plot the correct part of the picture at the right depth on a cross section, Petra requires computer-recognizable depths to be assigned to depths printed on the original log. This tool can set headers, footers, and scales, as well as left and right edges. Petra saves these calibration points to a associated (*.LIC) text file for every group name.

Depth Calibration Toolbar

The depth calibration toolbar is probably the easiest way to rapidly work with depth and other calibration points.

To display this toolbar, select View>Depth Calibration Toolbar.
Scroll to Top and Base

These buttons simply jump to the shallowest or deepest depth calibration point.
To jump to the top calibration point, select either the “T” or up arrow button.

Adding, Changing, and Dropping Depth Calibrations

Depth calibration points translate depth marks on the image into depths that Petra can use. The portion of the image that can be displayed on the cross-section is only the section within the range of the calibration depths. Portions above the shallowest depth and below the deepest depth will not be displayed.

To add a depth point, select the "Add" button on the toolbar, or Depths>Add Depth Point on the menu bar at the top of the Calibration Tool Bar. Note that Petra will draw a horizontal cursor over the image. Position the horizontal cursor over the desired image exactly at the depth you wish to pick, then click the left mouse button. Finally, enter the depth value. After entering the depth value, the screen will redraw showing the new calibration depth point. Repeat the process for each depth reference point.

To change the location of the depth, click and drag the depth marker using the left mouse button.
To edit the value of an existing depth, click on the depth line with the right mouse button and enter a new value.

To delete an existing depth calibration point, select Depths>Delete Depth” option menu or the Delete button located at the top of the Calibration Tool Bar. After invoking the delete function, click the left mouse button on the depth marker to be deleted. The screen will redraw once the marker is deleted.

You can also delete all depth references using the Depths>Delete All Depths...

Automatically Interpolating Depths

This tool automatically creates depth points by a given interpolation increment between the uppermost and lowermost calibrated depths. Since Petra already scales between registered depths, automatically adding a lot of new points does not aid in the overall calibration of the raster log. Creating a bunch of extraneous depth calibration points is often more trouble than it's worth - it's generally better to look for the small black interpolated depth lines, and add new depth points where necessary. Most rasters only need a few depth calibration points, and even extremely distorted ones usually won't need more than a dozen.

To automatically create depth points, select the "Interp" button on the toolbar or select Edit>Interpolate Depths. Here, select the depth increment - Petra will interpolate between depth calibration points using the set footage.

Before (left) and after (right) depth point interpolation. Note the automatically interpolated depths in thin black lines remain unchanged.
Decimating Depth Calibrations

This tool decimates depth calibration points in between the upper- and lowermost points. This can be useful for removing unnecessary calibration points created by the interpolation tool or an overzealous interpreter.

To decimate depth points, select the "Interp" button on the toolbar or select Edit>Interpolate Depths. Here, select the depth increment - Petra will interpolate between depth calibration points using the set footage.

![Before (left) and after (right) decimating every third depth point](image)

Left & Right Edges

The left and right edges set the useful boundaries of the group image. These boundaries can be useful for trimming extra white space on the sides of the image.

To set the left and right edges, select the "Left" or "Right" button on the toolbar, or select Edit>Set Left-Most Edge or Edit>Set Right-Most Edge on the menu bar at the top of raster calibration tool.

Next, position the line at the relevant part of the image and left click. For the left side, for example, set the edge on the left side of the image. Note that the edges will have a blue triangle pointing inward. If the triangle is pointing out away from the center of the image, it's on the wrong side.

To change the location of either edge marker, click and drag the marker using the
left mouse button.

Blue left and right edges added to a raster log. Note the small triangles pointing inward.

Upper & Lower Scale

The scales help define what the curves on the raster log actually represent. Scales can be plotted in the raster image's track on both the Cross Section Module and Log Correlation Tool.

To set the scales, select the "Top" button on either the "UprScl" or "LwrScl" section of the the toolbar, or select Edit>Upper Scale Header>Set Upper Scale Top / Edit>Lower Scale Header>Set Lower Scale Top on the menu bar at the top of the raster calibration tool. Position the line at the upper part of the scale, and left click. Note that Petra will draw a green line on the image.

Next, select the "Bottom" button on either the "UprScl" or "LwrScl" section of the the toolbar, or select Edit>Upper Scale Header>Set Upper Scale Bottom / Edit>Lower Scale Header>Set Lower Scale Bottom on the menu bar at the top of the raster calibration tool. Position the line at the bottom part of the image, and left click. Petra will draw the section in between the two lines with a green overlay. Note that this overlay is just for positioning, and won't appear on cross sections.

To change the location of either edge marker, click and drag the marker using the left mouse button.
Headers

Headers designate the part of the image occupied by the image's header, which usually contains well information, dates, and other relevant wireline information.

To set the header, select the "Top" button on the "HDR" section of the toolbar, or select Edit>Log Header>Set Log Header Top on the menu bar at the top of the raster calibration tool. Position the line at the upper part of the scale left click. Note that Petra will draw a green line on the image.

Next, select the "Bottom" button on the "HDR" section of the toolbar, or select Edit>Log Header>Set Log Header Bottom on the menu bar at the top of the raster calibration tool. Position the line at the upper part of the header left click. Petra will draw the section in between the two lines with a pale blue overlay. Note that this overlay is just for positioning, and won't appear on cross sections.

To change the location of either header marker, click and drag the marker using the left mouse button.
Display Gaps

The portion of an image interval between 2 calibrated depths can be hidden during cross-section display if that interval is tagged as a "display gap". Gaps can result when calibration files are merged and there is a gap between the sections being merged. You can manually define a depth interval to be a gap by clicking the left mouse button between 2 calibration depths while holding down the control key. Each time you click, the gap is toggled on or off. Display Gaps are shown in the calibration screen as a "grayed out" portion of the image.

Saving the Calibration File

Choose the "File>Save Calibration As..." menu to save a file containing the calibration data, image name, depth references, etc. This will also update the Petra database with a reference to the calibration file which is now associated with the current well.

The "File>Save Calibration" will save the current calibration being modified.

Log Image Calibration files have a file extension of ".LIC"
Loading a Calibration File

You can load and modify a previously saved calibration file using two methods.

First, the "File>Load Calibration File" menu allows you to choose the specific calibration file to be loaded. The image name will be read from the calibration file and the image will be opened and displayed.

Secondly, the "File>Load Calibration For Group" menu will retrieve the name of the calibration file from the Petra database which is associated with the current well and image group name.

4.6.14.1.2 Log Image Calibration Net Pay - Cross Section

Scanned raster log images, displayed in the cross section module, can show one or more color-filled intervals representing zones of "pay." Also, the pay thickness for these intervals can be stored in the Zone database where they become available for posting or contouring.

The pay intervals are defined in the Log Image Calibration screen. The user picks the top and base depths of each pay interval. A vertical guide line can be added and used as a visual aid to show where the log curves cross over the desired "cutoff" value.

Each defined interval is associated with a "pay number" and color. Pay numbers range from 1 to 100. For example, a log image might have 5 intervals picked, with two intervals making up pay zone 1 and the other three belonging to pay zone 2. Petra will compute and display the thickness of each of the 5 intervals and will store the sum for all pay zone 1 intervals in the zone database. Likewise, the sum for all pay zone 2 intervals can be stored in the zone database. Optionally, the total thickness of all pay zones (pay 1 plus pay 2) can be stored in a total pay zone item.

Pay Toolbar

Select Pay Number

Click the left or right arrows to decrease or increase the pay number respectively. The pay number will appear in the "Pay and Color Indicator" (see below). All intervals with similar pay numbers will be summed together as a single pay value stored in the zone database.

Pay Number and Color Indicator

This rectangle indicates the current settings for the pay number and color. It can also be dragged and dropped onto an existing interval to set that interval's number.
and color.

Select Pay Interval Color

Click the Pay Color icon to display the system color dialog screen. Choose the color you want to use for shading the pay interval. The color will appear in the "Pay and Color Indicator" (see above). Ideally, all intervals with similar pay numbers should have the same color.

Pick Cutoff Guide Line

Use the cutoff guide line icon to add a vertical line to the log image marking the desired log curve cutoff. Position the vertical cursor at the appropriate cutoff value and click the LEFT mouse button. You may click on and drag the cutoff guide line to reposition it at any time.

Pick Pay Intervals

Use this icon to begin picking one or more intervals for the current pay number and color. First, position the horizontal cursor at the TOP of the interval, at the point where the log curve intersects the cutoff guide line. Click the LEFT mouse button to record the top of the pay. Next, position the horizontal cursor at the BASE of the interval, at the point where the log curve intersects the cutoff guide line. Again, click the LEFT mouse button to record the base of pay. You may repeat this process for other intervals within the pay zone, or click the RIGHT mouse button to end.

Delete Pay Interval

Use this icon to delete an interval. Click on the icon then click between the top and base of the interval to delete. Alternately, you can delete an interval using the "right-button" pop up menu. Click the RIGHT button over the interval to delete, then choose the "Delete Selected Pay Interval" menu option.

Clear All Pay Intervals

Use this icon to delete all pay intervals from memory.

Store Pay In Database

Use this icon to store pay thickness values in the Zone database. Totals for each numbered Pay zone will be stored separately as well as a single total pay thickness.

Steps to Pick Pay Intervals
Step 1 - Define the Cutoff Guide Line using the icon.

Step 2 - Set the Pay Number using the icon.

Step 3 - Set the Pay Color using the icon.

The Pay Number and Color indicator will show the settings.

Step 4 - Click the Pay Interval icon to start picking intervals. Pick the TOP of the interval, then the BASE of the interval. Next, either pick the top and base for another interval or click the RIGHT mouse button to end.

Adjusting Pay Interval Depths

The top and/or base of an interval can be moved using the LEFT mouse button. Click, hold and drag the LEFT mouse button on the top or base marker. Move it to the new position and release the mouse button.

Changing Pay Interval Number and Color

You can change the Pay Number and Color of any previously defined interval by dragging and dropping the Pay Number and Color rectangle onto the pay interval image. Alternatively, you can right-click on the pay interval (anywhere between the top and base depths) to display the pop up menu. Choose the menu entitled, "Apply Pay Number and Color To Current Interval".

Changing Color for All Similar Pay Numbers

For example, you need to change the color for all intervals making up Pay #2. Click the RIGHT mouse button over any interval of Pay #2, to display the pop up menu. Choose the menu entitled, "Apply Color to All of Same Pay Number".

4.6.14.1.3 Raster Test Indicators

The Raster Image Calibration tool can plot tests, shows, production and formation tests, casing, and cores.

To add test indicators, select View>Plot Test Indicator on the menu bar at the top of the Raster Image Calibration tool.

Options Tab
Display

This section sets which test indicators are plotted on the Raster Image Calibration. Checked entries will be plotted.

Symbol Position

These sliders sets the location of the test indicators relative to the raster image.

Symbol Width - This entry sets the size of all test symbols on the Raster Calibration Tool.

Size Scale Factor - This entry sets the size of the test indicators. 1 is the default size of the symbols, 0.5 is 1/2 the normal size of the symbol, and 5 is 5 times the size of the symbol.

Skip Items Flagged as "Do Not Plot" - Petra's database stores "do not plot" flags for all test indicators. This option will not plot any tests with these flags enabled.

Perfs/Shows/Pd Tests/Fm Tests/Casing Cores Tab

The Raster Test Indicators tool has several additional tabs that set the color and line width of the different test indicators.
4.6.14.1.4 Log Image Editing

The Log Calibration tool includes a few additional tools for editing the raw log image files. This process modifies your image file, so be sure not to save over the original image file and have a backup. To restore the filtered lines select File>Reload Original Image.

This can be useful for cleaning up images for digitizing raster logs. Since the tracing algorithm looks for adjacent dark pixels, it can easily get confused by vertical scale lines and horizontal depth lines. The Log Calibration tool can filter out straight horizontal and vertical lines that can confuse the auto-digitizing function. Log imaging editing isn't foolproof - using filters can reduce the clarity of the curves as well, especially where the curves intersect the filtered horizontal or vertical lines.

Rotate Image

Scanning can sometimes subtly rotate image logs. The easiest way to spot this is tilted depth/scale lines or by zooming out. Note that this can increase the margins to the left or right the actual image. It's often useful to use the "Crop at Edges" can remove extra white space created by rotating the image.
To use this tool, select the button on the toolbar. Alternatively, select Edit>Rotate Image on the menu bar at the top of the Raster Image Calibration tool. Positive numbers rotate the image clockwise, and negative numbers rotate the image counterclockwise.

The original image (left) and after using the "Rotate Image" tool (right)

**Flip Black and White**

This tool flips the colors of the loaded image. For monochrome images, this will simply flip the black and white. Note that this tool will also flip the colors of color images as well.

To use this tool, select Edit>Flip Black and White on the menu bar at the top of the Raster Image Calibration tool.
Crop at Edges

This tool removes the image file beyond the "Left-Most Edge" and "Right-Most Edge" in blue.

To use this tool, select the button on the toolbar. Alternatively, select Edit>Crop at Edges on the menu bar at the top of the Raster Image Calibration tool.
Crop at Depths

This tool removes the image file beyond the uppermost and lowermost depth calibration points, header, footer, or scale markers.

To use this tool, select the button on the toolbar. Alternatively, select Edit>Crop at Depths on the menu bar at the top of the Raster Image Calibration tool.

Cut Out Section

This tool removes a part of the image file between a user-selected top and bottom. Petra will automatically splice the image back together to form a continuous image.

To use this tool, select Edit>Cut Out Section on the menu bar at the top of the Raster Image Calibration tool. Next, set the top and bottom of the section to remove from the image. Note that Petra will add a blue box and outline over the selected area. Next, select "OK" to remove the section.
Auto Trim Edges

The Auto Trim Edges tool attempts to automatically remove blank space around the image. Manually using the "Crop at Depths" and "Crop at Edges" tool is often better, but slower.

To use this tool, select Edit>Auto Trim Edges on the menu bar at the top of the Raster Image Calibration tool.

Remove Vertical Lines

This tool attempts to filter out vertical lines from the images. This tool works best on straightened images where the vertical lines are perfectly straight. Even slightly curved vertical lines won't be recognized by this process. To use this tool, select Edit>Filter>Remove Vertical Lines on the menu bar at the top of the Raster Image Calibration tool.
Remove Horizontal Lines

This tool attempts to filter out vertical lines from the images. This tool works best on perfectly horizontal lines. To use this tool, select Edit>Filter>Remove Horizontal Lines on the menu bar at the top of the Raster Image Calibration tool.
De-Speckle Image

This tool attempts to remove isolated dark spots on the image. To use this tool, select Edit>Filter>De-Speckle Image on the menu bar at the top of the Raster Image Calibration tool. Enter the maximum dot size in pixels and select "OK." A smaller "Maximum Dot Size" setting will be more conservative, while a larger setting will remove more dots.

Color to Monochrome

Some raster images are saved as color files, even though they are scanned copies of black and white paper logs. This tool will convert color images to monochrome, which can decrease file size.
To use this tool, select Edit>Color To Monochrome on the menu bar at the top of the Raster Image Calibration tool.

**Convert Image Bits per Pixel**

"Color depth" indicates the number of bits that describe a single pixel's color in an image file. This is usually expressed in bits per pixel: 1 (monochrome), 8 (8-bit color), 16 (high color), or 24 (true color) bits per pixel. Higher color depths represent finer color gradation, but take up more file space. Generally, raster images don't need high color depth to represent lithology. Note that this tool will only work on images with color depths above 1.

To use this tool, select Edit>Convert Image Bits per Pixel on the menu bar at the top of the Raster Image Calibration tool.

Raster logs often have curved or distorted images from paper stretch or misalignment of the original paper log during the scanning process. Crooked images can create problems when displaying raster images on the Cross-Section or Log Correlation modules.

**Getting Started with Depth Calibration Points**

Petra uses depth calibration points as "nodes" that set the location of the straight edge. When you straighten an image, you generally want the header and scale information to be straightened as well. Since image straightening works at each depth calibration point, it's a good idea to add a “fake” depth point above the header and below the footer information before straightening. Once the image is straightened, you can always delete these fake depth calibration points. Depending on the image, you can use a couple of different strategies.

First, create a good set of depth calibration points - generally, most images will only need a few points to accurately capture the depths. Next, add a fake depth calibration point above the header and another fake point below the footer. This ensures that when we straighten the image, we also straighten the header and footer. For raster logs with multiple runs and scales, you'll need a set of depth points over the entire raster log.

**Adding a Straight Edge**
To straighten an image, select the button on the toolbar or select Edit>Add Track Straight Edge… on the menu bar at the top of the Raster Image Calibration tool.

The straightening process involves defining a "Track Straight Edge" along the leftmost track edge. This straight edge is a multi-segmented line connected to each calibration depth marker.

The Track Straight Edge is identified with a series of control points located at the intersection of each calibration depth. You can, and should, move these control points to align the boundary segments with the image tracks. The control points can be moved using the left mouse button. Now you see why we generated a small number of depths. We only need enough depth points to define the track straight edge segments. You can always add more depth points if the track straight edge can not be manipulated to align completely with the image.

Next, click to set a straight vertical line on top of one of the vertical lines printed in the raster image. Though this tool suggests the left side of the depth track, any consistent vertical line will work. Petra will generate a straight line with node points at every one of the depth calibration lines.

Next, drag each node point so that it accurately covers the crooked line on the log; if you find that you need more nodes, simply add another depth registration point.
Finally, click on the “Straighten Image” button on the toolbar at the top of the screen: or go to Edit>Straighten Image Edges... on the menu bar.

In the example below, notice how the image is crooked. The crooked interval is bracketed off with depth markers at 6188’ and 6190’, and a straight edge is added.

Next, the straight edge nodes are moved to fit the left track edge.
Finally, by clicking “Straighten image”, Petra moves parts of the image to bring the straight edge into alignment.

Saving your changes

Straightening the image makes changes to the image file. Depending on the situation, you can either overwrite the existing image file or create a new version. To save an image, select the button on the toolbar, or select File->Save Image As... on the menu bar.
To add the Track Straight Edge, choose the Edit->Add Track Straight Edge menu option. Align the vertical cursor with the left edge of the LEFTMOST log track and click the left mouse button.

The straightened image must be saved back to disk as a TIFF file. You should create a new file. Do not write over your original image.

At this point you may choose to clear the artificial depth calibrations and proceed with normal calibration. Refer to the Depth Calibration section for details. Or you can exit without saving your calibrations. Whatever you do, DO NOT save over a good calibration file with the artificial depths used for straightening.

4.6.14.1.6  Digitizing Raster Logs

The raster log image calibration screen can also be used to digitize log curves and store them in the digital log database. Digitizing a curve involves using the mouse to trace over the curve on the image. Points are picked along the curve which identify each deflection of the curve values. You may start and stop the process as many times as necessary to digitize the interval of interest. Each start-stop or continue-stop sequence will generate a "curve segment". Curve segments may overlap and can be edited or deleted independent of other curve segments. These curve segments can be saved to a file as your "work-in-progress" and loaded at a later time to continue. Once the entire curve section has been digitized and edited to your satisfaction, they are stored in the project log curve database under a specified curve name. Existing database curves can either be replaced or appended with the newly digitized section.

IMPORTANT - Only one curve trace can be digitized at once. If you have several curve traces to digitize, then you'll need to digitize and store the first curve, "clear", then begin digitizing the second curve trace.

Before You Start!

1. You must open an image or previous calibration file.
2. The image must be depth calibrated over the interval to be digitized. Refer to the Depth Calibration section for details.
3. Activate the "Curve Digitizing Tool bar" option located under the View menu.
4. Click the Set Curve button to enter the log curve name and scale.
5. Define the track boundaries of the track containing the curve to be digitized.
6. Adjust the track boundaries to remove skew.

Setting the Curve Name and Scale
Digitizing Tool after setting a "linear" scale of 0 to 100.

**Defining the Track Boundaries**

The Digitizing Tool bar contains a "Track" section with a Left and Right button. To add the Left track boundary, click the Left button. Align the vertical cursor with the left edge of the track and click the left mouse button. Repeat the process using the Track Right button to define the right side of the log track.

Logs can only be digitized within the calibrated depth range.

**Adjusting the Track Boundaries To Remove Skew**

Many times, the edges of the log tracks are curved due to paper stretch or slippage while being scanned. The left and right track boundaries are identified with a series of control points located at the intersection of each calibration depth. You can, and should, move these control points to align the boundary segments with the image tracks. The control points can be moved using the left mouse button. Aligning the segments will remove skewing and result in more accurate digital curve values. Entire images can be straightened using the **Straighten Image** function.

**Start Digitizing**
Start by identifying the curve you wish to digitize by clicking the "Set Curve" button at the top of the digitizing tool bar. Select an existing curve or enter a new curve name. You must also specify the curve values for the left and right sides of the track boundary.

The Digitize Tool bar contains a section called "Digitize". To begin digitizing a section, click either the "Start" or "Continue" button under the "digitize" tool, or click the "Manual" button under the "Auto" tool. If you click the "Start" button you will be prompted for the curve name and range information.

To digitize the curve section, position the cross-hair cursor at the uppermost depth on the curve trace to be digitized and click the left mouse button. Repeat by clicking at each significant deflection of the curve. IF YOU MAKE A MISTAKE, you can either STOP and edit the bad point(s), or continue and edit them later.

You can also use a continuous "stylus" mode option by activating the stylus mode in the curve definition screen. In the stylus mode, curve points are continuously recorded as you hold down the left mouse button and draw over the curve. You may temporarily activate the stylus mode by holding down the Alt key as you digitize.

Stop Digitizing

You can stop the digitizing process by clicking the right mouse button or by clicking on the "Stop" button on the Digitize Tool bar.

Auto Tracing

The section under "Auto" toolbar allows automatic digitizing of simple, bold, well-defined curves. You begin by clicking the "Start" button under the "Auto" section, then on the uppermost point on the curve to be digitized. The auto tracer will attempt to follow the densest portion of the log beginning at the selected point. You may press the ESC key or click the left mouse button to stop the auto tracer. The "Manual" button allows you to manually re-digitize over section not properly handled by the auto tracer. The "Set" button displays a screen for setting properties controlling the auto tracer.

Changing the Track Scales (Linear Curve Scale Wrapping)

Whenever the log image curve reaches a track edge, the scale will "wrap" and the curve will reappear on the opposite side of the track. At this point, you will need to STOP digitizing, change the scale, and then CONTINUE digitizing. The current left and right side track scale is displayed near the top of the Digitize Tool bar. Each curve scale range will be displayed in a different color beginning with red for the base scale. There are 6 colors defined above and below the base scale.

To increase the scale range, i.e., wrap the curve to the right, click on either the "->" button or on the right side scale value. To shift the scale to the left, click on either the "<-" button or on the left side scale value.
The auto tracer will attempt to detect the track edge. It will stop the auto trace and request if you want it to automatically adjust the curve scale to account for the wrap.

**Editing a Curve Segment**

**Selecting a Curve Segment** -

Any of the digitized curve segments can be edited by first clicking the "Select" toolbar button and clicking on a curve segment or by simply double-clicking the curve segment. Selection is detected by a mouse click close to one of the control points making up the segment. The "selected" segment will be identified by small rectangles drawn at each control point of the curve. A right mouse click will deselect the curve segment.

**Changing Curve Scale Range** -

If you digitize a curve segment with the wrong scale range, select the segment, set the scale range at the top of the digitizing toolbar, then click the "Scale" button in the "Edit" section.

**Moving Curve Segment Points** -

Any of the selected curve segment points can be repositioned using the left mouse button. A right mouse click will deselect the curve segment to show the edited curve.

**Deleting a Curve Segment** -

Click on the "Delete" toolbar button in the Edit section to delete the selected curve segment. You can also simply press the Delete Key to delete the selected curve segment.

**Breaking a Curve Segment** -

You may break a segment into two segments. First, select the segment. Then, hold down the CTRL-key and click on a segment control point. All points ABOVE the picked point will become unselected. They are now part of a different segment.

**Breaking and Deleting Part of a Segment** -

You may break a segment into two segments then delete the bottom portion. First, select the segment. Then, hold down the CTRL and ALT-keys together and click on a segment control point. All points BELOW the picked point will be deleted.

**Using the Delete Rectangle** -

You can use a Delete Rectangle to delete intermediate points of the selected curve segment. To begin, select a curve segment. Hold down the SHIFT-key and click-and-drag the left mouse button to form a rectangle. All points within the depth range of the rectangle will be deleted. The segment will be de-selected and two new segments will be formed.

**Deleting ALL Curve Segments** -
Click on the "Clear" tool bar button in the Edit section to delete all curve segments that have been digitized.

**Merging of Curve Segments -**

Normally, when a curve segment is digitized over the same depth interval as a previous curve segment, the new segment is automatically merged into the earlier segment. Merging prevents having multiple segments over the same depth interval. Segments will not be merged when the auto-trace function is used or when the "wrap" settings are different. You can manually merge segments by first selecting a curve segment then press the F5 function key.

**Saving Your Work-In-Progress**

You can save the digitized curve segments to a file. If you think you may need to modify the curve segments at a later time, you should save them BEFORE you store your curve in the database.

**Storing Your Curve In The Database**

Storing the curve in the database makes a digital curve available for other function in Petra. When a curve is stored, the curve segments are resampled to the specified sample rate and merged together. When segments overlap in depth, earlier segments are replaced by later ones, i.e., the last segment you digitize overwrites the first segment you digitized (assuming there is overlap).

You may also load a digital log curve from the database using the "Load" button under the "Curve" section.

**Starting Another Curve**

If you want to digitize more than one curve, you will need to use the "Edit>Clear" button on the toolbar. This will remove previously digitized segments from memory so they don't get stored as part of the new curve.

**Digitizing Non-Linear Scales**
Example of Non-Linear Scale Details

Setting the Non-Linear Scale Points and Values

The non-linear scale is defined as a series of value-pixel pairs (max=100).

To begin picking the scale points, click the "Start" button (shown above). You will be prompted to begin the process.

Click the left-most scale point of the scale bar and enter it's scale value.

(If your scale uses a value of "infinity", enter a scale value of 1E20 or some other large number less than 1E30)

Proceed by clicking and entering values for each of the other scale points, working your way from left to right.
Terminate the process by clicking the "End" button or simply right-click the mouse. Petra will display each of the digitized scale values.

Note how the non-linear scale is displayed on the image and the left and right-most values are denoted on the toolbar.

Proceed with curve digitizing as described above.

**Warning** - There is no scale "wrapping" with non-linear scales.

4.6.14.1.7 Formation Tops

**Selecting and Displaying Tops**

To display tops, select Tops->Select Tops from the menu bar at the top of the Raster Image Calibration tool.
**Edit Mode**

To edit formation tops, select the green "Start Top Editing" radio button on the Tops toolbar (highlighted in red).

4.6.14.1.7.1 Repeat Tops

**Repeat Tops** occur when the same lithologic interval is encountered multiple times in the same wellbore. This is most common in directional wells, though is also possible with structurally complex areas with overturned beds and folds.

To add repeat tops in the Raster Image Calibration tool, select Tops>Enable Repeat Tops.

When editing formation tops, you can now pick, move, or delete repeat values as well. First ensure that under the Tops menu, ‘Show Repeat Tops’ is checked. This should display any tops along with their repeat values if any exist in the visible range. When in editing mode, there is a new check box and button on the Edit Fm Tops dialog. If the ‘Pick Repeat Tops’ dialog is checked then holding down the CTRL key while clicking adds a repeat of the selected top at that depth. ALT clicking deletes a repeat top. You can also click and drag any top to adjust its position. The ‘Set Repeats’ button opens a grid showing you the value of all repeats for the given top. From here you can edit, add, or delete values.
The Raster Group Maintenance Tool controls image group names, establishes raster group aliases, and performs other raster group maintenance tasks.

To open the Raster Group Maintenance tool, select the button on the bottom of the Main Module’s Raster Tab.

Details Tab

The Details Tab displays and modifies group names and group description.

Image Group Name - This entry sets the selected image group name.
Image Group Description - This entry sets the image group description.

To add a new group name, enter the desired group name and description.

- This button adds a new group image using the entries in the group name
and description entry boxes.

- **Replace** - This button overwrites the currently selected image group’s name and description with the entries in the relevant boxes.

- **Delete** - This button erases the currently selected image group on the Log Image Groups list. Petra’s link to all the image and LIC files will be severed, but the actual files themselves will not be erased.

**Aliases Tab**

The Aliases Tab establishes raster log group names. In practice, this option will attempt to replace a missing group with one of the other “equivalent” raster group on the alias list.

The fundamental problem with log data is the proliferation of log names created by different commercial data vendors and individual users. The same general type of raster log (such as gamma ray and resistivity curves) can have hundreds, if not thousands, of different names in a single project.

**The Log Image Group Maintenance Alias Tab**

**Rename Tab**

This option renames all members of a selected group name to a new group name.
Misc & Tools Tab

The Misc & Tools Tab performs multiple maintenance tasks for the raster groups in the Petra Project.

Print Group List - This tool creates a simple list of all the raster group names in the project.
Misc Maintenance Tasks

Export Summary Report CSV File - This option creates a *.CSV file for every raster in the project. This includes fields for UWI, TD, group name, top (depth1), base (depth2), the directory containing the raster's LIC and TIF files, and a comment field. This can be particularly useful for dealing with directory changes due to moving a project or raster data. One great technique is opening the *.CSV file in a spreadsheet, and sorting by comment to isolate which directories no longer work.

Delete Groups With No Images - This option deletes groups with no associated images. This can be useful when cleaning up a project.

Delete All Groups - This option deletes all groups from the project. More specifically, this removes the references in the project database to the LIC and TIF files. The LIC and TIF files are not erased, and can be reimported into a Petra project.

Delete Selected Groups - This option deletes groups selected on the "Log Image Groups" list from the project. More specifically, this removes the references in the project database to the LIC and TIF files. The LIC and TIF files are not erased, and can be reimported into a Petra project.
Resolve Image Paths - This option uses the search criteria established by ImageSearch.TXT to permanently fix the project database. Note that this method will attempt to find every missing LIC and TIF file in a project; depending on the number of missing files and the specificity of the search criteria, this can take a very long time.

Clear MJ LogSleuth Flags - This option clears the MJ LogSleuth Flags in the project database.

Add Missing Well Records To LIC - This option adds missing well header information to LIC files.

Repair/Synchronize LIC File Groups -

Find/Replace LIC/TIF Path Prefixes - This tool performs a "find and replace" operation on the LIC and TIF pathways in Petra's database. This is useful for changing the first part of a path, or "prefix" when the folder containing the rasters has moved.

Delete Uncalibrated Rasters - This option removes group names without any depth calibration points.

Change Blanks to Underscores in LIC and Image Names - This option converts any blanks in the LIC and image filenames to underscores. As an example, "49025103990000 Resistivity.TIF" would be renamed to "49025103990000_Resistivity.TIF"

Resolve Duplicate LIC References -

Set MJ LogSleuth Flags - This option changes the MJ LogSleuth Flags in the project database.

Delete Association if LIC/TIF Files Can Not Be Found - This option removes group names from the project if the LIC and TIF files are missing.

Delete Pay Data From LIC Files - This option removes pay information from the final line of LIC files.
Export Image Counts CSV File - This option creates a *.CSV file that displays the well count versus group name for the project. This can be useful for eliminating group names with low well counts.

Convert File References to UNC Names - This option converts local file system references to use universal naming convention. As an example, this tool converts file names like H:\Images to reflect \Server\Images

Create Report Showing Groups That might Be Merged -

Replace LIC/TIF Paths - The biggest difference is that, instead of replacing the first part of the path or “prefix”, this tool replaces the only the specific path given. This tool leaves subfolders alone, making it a much more specific tool.

The Find/Replace LIC/TIF Path will replace ONLY the path “C:\geoplus1\Projects\SOONER DATA CLASS\IMAGES” with “N:\Rasters\Sooner”

Change LIC "HEADERTOP/BOT" References to "LOGHEADERTOP/BOT" - Old projects sometimes store the scale section of the raster image as the header rather than as a scale section. This option renames the section stored as the log header

Disassociate All MJ Rasters - This option removes all references to the MJ LogSleuth raster logs.

Set Image Source for Selected Groups and Wells -

Copy Tab

The Copy Tab copies the image files from their original location to a specified path.

Does this change which file Petra points to?
Reorder Tab

The Reorder Tab sets the order of the log image groups.
Available Raster Groups - This list shows every raster group in the project.

Reordered Raster Group - This list shows the reordered raster group names. Use the < and > keys to add and subtract group names to the Reordered Raster Group list, and the up and down arrow keys to change the order of a selected raster group.

- This button adds the selected group name from the Available Raster Groups list to the Reordered Raster Group list.

- This button adds all group names from the Available Raster Groups list to the Reordered Raster Group list.

- This button removes the selected group name from the Reordered Raster Group list.

- This button removes all group names from the Reordered Raster Group list.

- These buttons change the order of the selected group name on the Reordered Raster Group list. Selecting the up arrow moves the selected group name higher, while the down arrow moves the selected group name lower on the list.

- This option resorts the group names on the Available Raster Groups list in alphabetical order.
Translate Tab

The Log Image Group Maintenance Translate Tab

4.6.14.3 ImageSearch.TXT

ImageSearch.TXT is useful for resolving problems when images are spread over multiple locations. ImageSearch.TXT file establishes a set of criteria where Petra will automatically search additional paths if the images are not found in their original locations.

Importantly, this method is only temporary. This method doesn’t make any changes to the database, so it searches for the images and LIC files every redraw. Consequently, this method can draw significant network resources and computer time, and should only be used as a short-term fix. The Resolve Image Paths tool available on the Log Image Group Maintenance Misc & Tools Tab uses the search criteria set by IMAGESEARCH to permanently update the TIF and LIC pathways in the project database.

The ImageSearch file itself contains a list of folder or drive names where the images and/or calibration files are located. Note that Petra looks in the project’s IMAGES directory first, before using ImageSearch.TXT, so it’s not necessary to add that folder to the list. By default, Petra looks in every subfolder of the listed paths, but adding a “-“ forces Petra to only look in the designated folder.

When setting up the pathways, be as specific as possible. Searching an entire drive or server will search every subdirectory, which can take a very long time.
An example of IMAGESearch.TXT

To perform the search in every project, place ImageSearch.TXT in the Petra program folder.

Alternatively, to perform the search in a single project, place the file in the project's images folder.

4.6.14.4 Pay Interval Data

Petra stores "Pay" intervals in the database. These are usually graphically picked off raster logs. "Pay" intervals usually represent a productive interval, but can also be used to simply highlight lithology or other intervals of interest.

To open the Pay Interval Data tool, select the button on the Main Module's Rasters Tab. Alternatively, select Logs>Pay Data Maintenance... on the menu bar at the top of the Main Module.

Displaying Interval Data on the Cross Section Module

Using the Pay Data Toolbar to Pick Pay Intervals on a Cross Section

General Tab
Name - This entry sets the pay's name.

Source - This entry sets the source code of the pay name.

Description - This entry sets the pay name's description.

Pattern - Though it's off by default, Petra can draw patterns inside pay intervals. The left up/down button sets the pattern, while the slider bar to the right sets the density of the pattern. To turn on pay interval patterns, select the "Plot Pay PATTERN Symbols" option on the Pay Data Display Options tool's Options Tab.

Comments - This entry stores comments about the pay name. This is a good place to store cutoffs used in creating the pay.

Data Tab
Top/Base - These entries set the top and base of a pay interval.

Data Units - This option sets the data units for the pay interval.

Shift - This option shifts the top and base of a selected pay interval up or down by a specified footage.

View Data as - This option sets the

View Tab

The View Tab simply displays a graphical representation of the available pay intervals for the well selected on the Main Module. Note that Petra adds the MD extents of the view at the top and bottom of the rectangle.
Zone Tab

The Zone Tab saves the footage of the selected pay interval to a zone data item.

Store Pay Total In Zone Item

Zone - This dropdown sets the desired zone. Note that this dropdown controls the data items in the "Item" dropdown immediately below.
Item - This dropdown sets the data item that will contain the stored pay totals. Note that this will overwrite any stored data in the data item.

Source - This entry sets the source for the zone data item.

Apply TVD Correction - This option attempts to correct for the difference between MD and TVD based on directional survey data.

Export Tab

Export Pay Intervals to the Following File - This entry sets the location of the pay file.

Include Pay Source in Export File - This option includes the pay source in the exported file.

Maintenance Tab
Delete Single Pay For Selected Wells - This button deletes the selected pay intervals for the wells selected in the Main Module. This option keeps the pay names intact.

Delete ALL Pay For Selected Wells - This button deletes ALL pay intervals for the wells selected in the Main Module. This option keeps the pay names intact.

Delete Single Pay Name for ALL Wells In DB - This button deletes the selected pay name and all its intervals for ALL wells in the project database.

Delete All Pay Names For ALL Wells in DB - This button deletes ALL pay names for ALL wells in the project database.

ReOrder Tab

By default, pay intervals will appear in the list in the order they are created in Petra. This tab changes the order of pay to a user-selected order.
- This button adds the selected pay interval to the Selected Item list.

- This button adds all pay intervals to the Selected Items list.

- This button removes the pay highlighted on the Selected Items List.

- This button removes all pay on the Selected Items List.

- These buttons change the order of the highlighted pay interval on the Selected Zone Items list. Pay on the top of the list will appear first.

4.6.15 Other Tab

The Other Tab displays and modifies fault cuts, production symbols, well history, liner and cement details, velocity data, and pay data.
Fault Cuts - This button opens the Fault Cuts window.

Pd Sym - This button opens the Pd Sym tool.

Well History - This button opens the selected well's well history, which is a simple *.TXT file. If the well doesn't currently have a well history file, Petra will prompt the user to add one.

Liner Details - This button opens the Liner Details window.

Cement - This button opens the Cement Details window.

Velocity - This button opens the Depth-To-Time Functions window.

Pay Data - This button opens the Pay Interval Data window.

### 4.6.15.1 Production Symbols

Production Symbols are depth referenced well symbols stored in each well. These well symbols can be plotted on cross sections on the depth track it indicate various producing zones. Optionally, each well symbol can have a remark posted beside it on the cross section.

To change the size of the production symbols, select the System Color and Style Definitions tool with Display>Colors on the menu bar at the top of the Cross Section Module. Here, change the size of the "Xsect Prod Symbols" option.
To modify an existing production symbol, highlight the old production symbol, change the information, and select the button.

To add a new production symbol, enter the desired information and select the "+" button.

To drop an existing production symbol, highlight the desired production symbol and select the "-" button.

**Depth** - This entry sets the depth of the production symbol.

**Depth Symbol** - This dropdown sets the symbol that will appear on the well's depth track.

**Color** - This option sets the color for the symbol.

**Remark** - This entry stores any additional remarks for the production symbol.

**Posting Production Symbols On The Cross Section**

In the Map Module, select **Wells>Plot Test Indicators** on the menu bar at the top of the screen. Here, select the "Prod Symbols" option. The production symbols will be plotted in the center of the depth track.
4.6.15.2 Liner Details

To modify an existing liner entry, highlight the old entry, change the information, and
select the button.
To add a new liner entry, enter the desired information and select the "+" button.
To drop an existing liner entry, highlight the desired liner entry and select the "-" button.

**Top** - This entry sets the top of the liner.
**Base** - This entry sets base of the liner.
**Size** - This entry sets the size of the liner.
**Units** - This entry sets the units of measurement.
**Date** - This sets the date of the liner.
**Comment** - This entry stores remarks or comments about the liner.

### 4.6.15.3 Cement Details

To modify an existing cement entry, highlight the old entry, change the information, and select the button.
To add a new cement entry, enter the desired information and select the "+" button.
To drop an existing cement entry, highlight the desired cement entry and select the "-" button.
**Top** - This entry sets the top of the cement.

**Base** - This entry sets base of the cement.

**Date** - This sets the date of the cement.

**Comment** - This entry stores remarks or comments about the cement.

### 4.6.15.4 Depth-To-Time Functions

Petra stores depth-to-time functions internally in the project database. This tool adds, modifies, and deletes velocity functions in the project.

To open the Depth-To-Time Functions tool, select the "Velocity" button on the Main Module's Other Tab.

#### General Tab

![Depth-To-Time Functions](image)

#### Data Tab

The Data Tab shows the actual velocity function values for the selected function.
**Depth to Time Function** - This dropdown selects the desired depth to time function loaded into the project.

**Velocity Function Datum** -

**Replacement Velocity** -

**Set As Active**

**Export CSV** -

---

**Preview Tab**

The Preview tab displays a graph of the selected depth-to-time function.
**Depth to Time Function** - This dropdown selects the desired depth to time function loaded into the project.

**Show Time vs. Depth Plot** - by default, the graph shows interval velocity, RMS velocity, and average velocity. This option instead displays a single time vs. depth plot of the selected function.

**Show X-Axis As** - This option changes the horizontal axis to depth or time.

**Set As Active** - This button sets the currently selected velocity function as the "active" function for the well.

**Print** - This option prints the plot on the screen.

---

**Import Tab**

The Import Tab imports new time-to-depth functions and overwrites existing functions with revised data.
Depth To Time Function - This dropdown selects the location of the loaded time-to-depth function. Selecting an existing function will overwrite the function with the data from the file by default, but the "Append to Current Function" option will instead append new data to the end of the function in the project database. To add a new function name, select the "Create New Name..." button.

Format

The Format Section tells Petra how to load the file correctly.

Columns - This dropdown sets the format of the imported file. Options include "Depth, Time", "Time, Depth", "Velocity Databank LAS", and "PetraSeis 'ftn' file."

Depths - This option sets the depth units of the depths in the selected file.

Time - This option sets the time units of the times in the selected file. Petra can import any combination of seconds/milliseconds and one-way/two-way.

Datum - This option sets the datum for the imported file.

Replacement Velocity - This option sets the replacement velocity for the imported data.

Set as Active Depth to Time Function - This option sets the imported function as the active function for the selected well.

Append to Current Function - By default, importing a depth-to-time function into an existing function will overwrite the function with the data from the file. This option instead appends new data to the end of the function in the project database.

Extend Tab

The extend tab
Copy Tab

The Copy Tab copies a Depth-To-Time function.

Copy Depth to Time Function

This tool copies the active function to a set of wells. This can be significantly easier than manually importing the Depth-To-Time function for multiple wells.

Copy and Make It the Active Depth to Time Function - This option copies the function to the wells selected on the "Wells To Receive the Depth to Time Function", and makes it the active function.
Copy and Make It the Active Depth to Time Function IF No Active Function Is Set - This option copies the function to the wells selected on the "Wells To Receive the Depth to Time Function", and makes it the active function only if the well doesn't have an active function.

Copy Depth to Time Function - This option copies the function to the wells selected on the "Wells To Receive the Depth to Time Function", but does not change any of the settings regarding the active function. Wells with an existing active function will retain their active function. Wells without an active function will just have the copied function in the database; it won't be set to the active function.

Make Function Active (do not copy) - This option doesn't actually copy the function from one well to another. Instead, this function sets the selected function to be the active function in wells where it is present in the database.

Wells To Receive the Depth to Time Function

All Selected Wells - This option will copy the function to all wells currently selected in the Main Module.

Wells From WSN List Below - This option will only copy the function to the wells on a WSN list. Select the "Browse" button, navigate to the desired *.WSN file, and select OK.

Copy Function from Another Well to This Well

This tool just copies the function from another well. Simply enter the WSN of the well to receive the currently active depth-to-time function, and select the "Apply Function From Other Well."

Convert Tab

The Convert Tab just has a utility for converting depth and time using the currently active function.
To use this tool, simply enter the desired time or depth, and select the relevant "Time To Depth" or "Depth To Time" button.

**Seismic Datum** - This option sets the seismic datum for the calculations.

**Include Well Datum In Calculations** - This option includes the well's active datum (set on the Main Module's FmTops Tab) in the calculation. By default, this is on.

### 4.6.16 Scout Ticket Report

The Scout Tab displays and modifies information about the selected well on the well list. Typing a value in the appropriate entry field will change that field.
A scout ticket report is a well report showing selected data items for each well in the project. Several options are available to filter what data actually gets included in the report.

**Options Tab**

**Include The Following Optional Data Groups** - This section lists several check box items each of which enables or disables a particular data group. For example, to include formation tops in the report, click the "Formation Tops" check box so that it is "checked". Use the ALL button to quickly check all items.

**Choose Z Data...** - This button invokes a screen for selecting a list of Z data items. You may choose one or more zones and zone items to include in the scout ticket report.

**Suppress NULL Tops and Z Data Items** - When this option is checked, only tops and z data values which contain non-null values will be included in the report. If not checked, then all tops and selected z data values will be listed. A blank field in the report
indicates null values.

Print To File For Preview - Check this option to have the report written to a temporary file and displayed using the system text editor. When this option is not checked, the report will go directly to the printer.

Print With Small Font - Checking this option allows more lines per page.

Wells Tab

Wells To Report On - The report can be generated for all wells in the project or only those wells which are currently selected in the main screen well list. Choose "All Wells" or "Currently Selected Wells".

Sort Wells By - This option determines the sort order of the reported wells. Wells can be listed by "UWI (API No.)", "Well Label", or "WSN".

Start Each Well On A New Page - This option applies when the report is sent directly to the printer. Each well can start at the top of a new page. This option has no effect when the report is printed to a file for previewing.

4.6.17 View Tab

The Well Tab displays and modifies information about the selected well on the well list. Typing a value in the appropriate entry field will change that field.
The Well Tab displays header and symbol information about the selected well.

4.6.18 Intervals Tab

Interval data stores data to a specific depth interval that doesn’t fit well with the traditional zone concept, such as data that is too fine (such as core descriptions) or too coarse (such as mud weights or biostratigraphic information) to fit inside two formation tops.

Petra stores interval data in tables and fields similar to a spreadsheet. The “table” stores related interval data in a spreadsheet, where each interval is stored as a separated row. In the example below, the project has the default tables LITH, CORE, and PALEO.

Inside the table, each interval is stored as its own row, and information about that interval is stored in “fields”, or columns in that row. All tables come with a few fields, TOP, BASE, DATE1, DATE2, QUALITY, and FMNAME, but you can add user-defined fields containing numbers, dates, or text. In addition to the standard fields, the LITH table in the example below contains the field “Desc” which stores lithologic descriptions.
Creating, Modifying and Deleting Tables

Creating, Modifying and Deleting Fields

Reordering Tables & Fields

Adding Interval Data

Changing Interval Attributes, Markers, and Patterns

Find/Change Data...

Using Interval Filters

Storing Interval Thickness to an Interval

Gaps, Overlapping Interval Data, and Bulk Shifts

Calculations with Interval Data

Graphing Interval Data

Setting Default Tables and Fields

4.6.18.1 Creating, Modifying, and Deleting Tables

An interval data "table" stores interval data in a spreadsheet, where each interval is stored as a separated row. Since every interval row in the table shares the same fields (as columns), it’s a good idea to keep different types of data in different tables. To create, modify, or delete tables in a Petra project, select the “Maintenance” button on the bottom of the Interval Tab on the Main Module.
- This option adds a new interval data table. Selecting this option brings up a dialogue box to add the new table’s name and description. A newly created table contains no new fields.

- This option edits just the name and description of an existing interval data table. To edit the fields inside the interval, select the “Data Fields” option on the Maintenance screen.

- This option deletes the entire interval data table, along with all the fields and data contained within the table.

### 4.6.18.2 Creating, Modifying, and Deleting Fields

In an interval table, each interval is stored as its own row, and information about that interval is stored in “fields”, or columns, in that row. To create, modify, or delete fields in a Petra project, select the “Maintenance” button on the bottom of the Interval Tab on the Main Module.
This option adds a new interval field to the selected interval data table. Selecting this option brings up a dialogue box to add the new field’s name, description, and attributes. The Kind dropdown box sets the kind of data the interval field stores: a Real Field, Date Field, or String Field. Real Fields simply store numbers, such as porosity or permeability. Dates store calendar days as MM/DD/YYYY. String values store text like core descriptions. For Real fields, the Units box sets the displayed units of measurement, while the Decimal Places for Display option sets the displayed trailing decimals.

- This option modifies the name, description and attributes of the selected field.
- This option deletes the selected field.

4.6.18.3 Reordering Tables & Fields

By default, interval tables show up in the order they’re created. Especially in large multi-discipline, multi-user projects with many different kinds of data, it’s often useful
for a user to reorder and filter the interval tables to only show relevant data. To reorder the Interval tables, select the “Order...” button on the Interval Tab on the Main Module. This brings up the “Filter Interval Data Table Names” box. Here, use the “>” button to bring a single selected table from the Available Internal Table List on the left to the Filtered Interval Table List on the right. The “>>” button brings over all available tables. Once on the Filtered Interval Table List, use the up and down arrows to change the order of the shown tables. Tables at the top of the list will be shown before tables on the bottom of the list. To drop a selected table from the Filtered list, select the “<” button, and to drop all tables from the filtered list, select the “<<” button. If there are any tables on the Filtered Interval Table List, only those tables will be shown.

Reordering and Hiding Fields

By default, interval fields show up in the order they are created. To reorder the Interval fields, select the desired table and select the “Columns...” button on the Interval Tab on the Main Module (highlighted on the left figure below). This brings up the “Interval Data Column Display Properties” window. This screen shows the list of the table’s available fields on the left, the displayed fields on the upper right, and the selected field’s properties are shown in the lower right. This window changes the order of the displayed fields, hide and show specific fields, and changes field properties.
Reorder the specific fields

To reorder a field, select the column at the top of the screen and drag it to the desired position. In the example below, the “TOP” column has been dragged to be before the “QUALITY” column.

![Reorder Fields Example](image)

Hide and show specific fields

To drop a specific field, select the column at the top of the screen and select the “-” button. To add a specific field, select the field name from the list on the left side of the window and select the “+” button.

Change the field properties

The “Column Properties” on the lower right shows name, justification, shown decimals, the label style (Name or Name and Units), and the data property (Value or Quality). Changing these settings changes how the selected field will be shown.

![Field Properties Example](image)

4.6.18.4 Adding Interval Data

New interval data can be brought into Petra either manually or by a tabular data import.

**Adding New Data Manually**

To add new intervals manually, first select the correct well in the Main Module. On the Interval Tab, select the right interval table. In the example below, the “LITH” table is selected. Finally, select the “Edit details” button in the upper right on the Interval Tab. This brings up the Edit Interval Data window for the selected interval table. Continuing with the example, the Edit Interval Data window below shows the fields for only the LITH table.

![Interval Data Example](image)
To add a new interval, enter in the Top and Base. Next, select the button to add the interval.

With the interval now added, enter in the remaining interval details and select button to save the changes to the interval. In the example below, the Quality, Formation, and LITH Table specific fields are filled in.

To save the changes to the database, select OK. Here, Petra gives the option to save or discard ALL changes made to the selected well’s interval table. All the edits to all intervals will be ignored if you select CANCEL.

**Importing Tabular Interval Data**

Digital data where each row contains information about a discrete interval can be easily imported into Petra. Before attempting to import interval data, check to see if the data has a column dedicated to the UWI/API. Since Petra assigns interval data to specific wells by comparing UW/API numbers, interval data without an identifying API/
UWI column can’t be imported. The easiest way to remedy this is to simply open the interval data in a spreadsheet program, and add a new column for well UWI/API.

To import new digital interval data, select Project->Import>Import Tabular Interval Data… on the menu bar at the top of the Main Module. This opens the “Import Interval Data from Tabular File Format” box. Here, select the “Open File” button and navigate to the interval data’s location.

Once the file containing the interval data is opened, Petra switches to the Data Format Tab. This tab essentially links the entries in the file to specific kinds of data.

The first step is to select the interval data file’s formatting under File Format. Files can be imported into Petra in one of three formats: “Columnar”, “Comma Delimited”, or “~ Delimited.” Columnar data organizes data into fixed columns, where Petra imports data based purely on the number of characters from the left. The left screenshot, on the other hand, shows the API number as defined by columns 1 through 14.

Comma and ~ delimited data, on the other hand have no fixed column size and are instead separated by a comma or a tilde. With delimited data, Petra imports data based on the “Field” defined by the delimiter. The example below shows the same UWI/API field defined in two different ways. The right screenshot shows the API number defined as “Field (1)”, i.e. it is separated by the first comma.
Be careful when importing text as a comma delimited file. If the text has a comma in it, Petra will read that as the end of the field. The interval data stored as UWI, Top, Base, Description such as:

05123187700000, 6295, 6998, Calcareous, micaceous, clay-rich siltstone

Would only be imported as:

API: 05123187700000
Top: 6295
Base: 6998
Description: Calcareous

In other words, all the description past the first comma is cut off. This can also cause bad imports when data is beyond the comma-filled text.

The next step is to establish field definitions. Essentially this step defines which part of the file is which kind of interval data. The easiest way is to select and highlight the specific data field in the “Data Record” part of the screen, then select the type of interval data on the left. Petra can import fields for any interval table. In order to put interval data with the correct well, the UWI or API # field must be defined.

When loading the TOP and BASE of the interval, Petra assumes that the depths are in MD. To import other depths, such as SS or TVD, select the appropriate depth on the “Field is not a Depth or is MD” dropdown when establishing a field definition.

For user-defined fields (Not the TOP, BASE, DATE1, DATE2, QUALITY, FM NAME, UNITS fields), Petra can store a quality code. To import the quality code, select the “Store Field Value” dropdown menu and set it to “Store Field Quality Code.”

To add the field definition, select the “+” button. The “-“ button drops the selected field definition. To modify an existing field, make the appropriate changes and select the button.

The example below shows field definitions for the data file, which include the well API, interval top, interval base, formation name, and description.
To save the field definitions and options, select the “Save” button. This option saves a *.FMI file. Selecting the “Load” button restores all the saved settings.

Most data files have some header or comments at the top. The “Records to Skip Before 1st Well” option tells Petra to skip a set number of lines before importing any well data. Click the "Set Skip" button to set the number of skipped records based on the record currently in the data record window.

### 4.6.18.5 Changing Interval Attributes, Markers, and Patterns

Every interval stores a set of colors, markers, and patterns that can be displayed on the cross-section module. It’s possible to change these settings for every interval individually, or with multiple intervals at a time.

#### Setting a Single Interval’s Attributes, Markers, and Patterns

First, select the desired interval by clicking on the graphical representation of the interval on the right side of the screen. The selected interval will be marked with a black triangle on the right side of the interval (highlighted in the example below). Next, select the Attributes Tab. Here, select the interval’s line and fill color. In the example below, the first interval (a calcareous siltstone interbedded with sandstone) will be drawn with a light blue fill. Notice that the selected color appears on the list of intervals on the far left as well as on the graphical representation of the intervals on the far right.
Next, select the Markers Tab. Select the marker from the list of available markers, set the style and color, and select the Add button to post the marker symbol. In the example below, the “X” signifies a lack of porosity from the core description.

Single - A single symbol is plotted
Tiled - Multiple symbols are plotted like wallpaper.
Column - Multiple symbols are stacked vertically in a column
Row - Multiple symbols are aligned horizontally in a row
Stretch X - A single symbol is plotted with its width stretched to fit the interval width
Stretch Y - A single symbol is plotted with its height stretched to fit the interval height
Stretch XY - A single symbol is plotted with its width and height stretched to fit the interval rectangle
Finally, select the Patterns Tab. This sets a wide variety of lithologic patterns. Select one of the available patterns and a size from the list and select the button. Note that the “size” of the pattern governs the density of the pattern's display. The example below shows the interbedded sands and shales from the core description.

Setting Multiple Intervals’ Attributes, Markers, and Patterns in a Single Well

First set a single interval to the desired attributes, markers, and patterns. Next, select the button on the “Defaults” section on the Attributes Tab (highlighted below). This stores the current scheme of colors and patterns as a “default” attribute so it can be used later on different intervals.

The next step is to select the multiple intervals that will have this default attribute scheme. To select multiple intervals, select the “Set Tabs” button: or hold down the CTRL key. Next, select the desired intervals on the graphical representation of
the intervals on the right side of the screen. Note that the selected or “tagged” intervals have a small black triangle on the far right (highlighted in the example below). In the example below, all the very fine grained sandstones have been tagged.

To tag all intervals in the well, select the button. To drop all tags, select the button.

Finally, select the button on the Defaults section of the Attribute Tab. This applies the current “Default” scheme of colors, markers, and patterns to all tagged intervals.

The button only applies the default scheme to the currently selected interval, while the button applies the default scheme to all intervals in the well.

To add another “default” scheme, simply set a single interval to the desired colors, markers, and patterns and select the button on the “Defaults” section on the
Attributes Tab. In the example below, there are three default schemes based on lithology: the blue interbedded siltstone/sandstone, the pale yellow very fine grained sandstone, and the bright yellow fine grained sandstone.

Even after adding default schemes, it’s easy to go back and modify individual intervals to display different information. In the previous example, three different default schemes reflected lithology and grainsize from core descriptions. To carry this example one step further, markers can also be added to signify porosity. Recall that for the sandstone/siltstone, an X marked low porosity. To add markers for an individual interval, select the interval and go to the Markers Tab. Select the marker and the marker’s color, and select the \(\text{Add}^{+}\) button. In the example below, red stars have been added for all intervals with porosity above 10%, and a black X for all intervals with porosity below 10%.

To save the changes to the database, select OK. Here, Petra gives the option to save or discard ALL changes made to the selected well’s interval table. All the edits to all intervals will be ignored if you select CANCEL.

Setting Multiple Intervals’ Attributes, Markers, and Patterns in
Multiple Wells

The previous methods change the display of intervals for one well at a time. This can work well for a small number of intervals in a few wells. Even a modest Petra project can contain a large amount of intervals spread out over many wells; changing intervals one well at a time would be very tedious and time-consuming.

Petra’s Find and Replace Interval Data can apply one of the “Default” attribute color and pattern schemes to all intervals in the selected wells that meet a set of search criteria. For more information see the Find/Change Data section.

4.6.18.6 Find/Change Data...

The Find and Change Data function searches intervals by data criteria and either changes the intervals’ color and pattern fills, or changes field data entries.

To perform a search on interval data, select the “Maintenance” button on the bottom of the Interval Tab on the Main Module. Next, under the Data tab (highlighted in blue) select the “Find/Change Data…”

Setting Basic Interval Search Criteria

Select the interval data table to search under the TABLE dropdown. Next, select the interval field that will be searched under the FIND DATA IN dropdown menu. On the WHERE dropdown, select the style of the search. Petra can search inside data fields in a few different ways; select the condition (such as Data is Equal to value) and the appropriate value, range, or text string to find. The example below shows a search
for intervals containing the phrase “very fine grain.”

Limiting the Interval Search to a Zone

This search can be further limited by zones on the Options Tab. Since a zone can be defined by a set of formation tops or depths, this can be a powerful way of limiting the search to intervals that have footage inside a specific stratigraphic interval. In the example below, only intervals intersecting the DSAND zone will be used.

Using a Filter in the Interval Search
With a Find and Replace operation, filters provide a finer control over which intervals are changed. Intervals that do not meet the filter criteria are not changed. To create or modify a set of filters, select the “SetFilters…” button on the Options tab.

Filter criteria are shared between different functions, making it easier to use the same subset of interval data for different applications. Deselecting this box in any part of Petra does not erase the filter criteria; it simply inactivates the filters. For more information on filters see the “Using Filters” section of this document.

Setting the Color and Patterns for the Interval Search

Using the Find and Replace Data method to change color and patterns applies a “default” attribute scheme to intervals meeting search criteria. This method’s key advantage is that it can be applied to multiple wells in a project. As a reminder, a “default” attribute is created in the Edit Interval Data window. For more information on creating a default attribute scheme, see the above section on “Setting Multiple Intervals’ Attributes, Markers, and Patterns in a Single Well.”

Once the search criteria are set, select “Set Interval Attributes.” This tells Petra to change the color and pattern attributes of the intervals that meet the search. On the CHANGE INTERVAL ATTRIBUTES TO dropdown menu, select the appropriate default attribute scheme. The example below shows that the lithologic description field “Desc” in the LITH table will be searched. Recall that in earlier examples, very fine grained sandstones were given a pale yellow color fill with a sandstone lithologic pattern. In the search shown below, intervals containing the phrase “very fine grain” in the lithologic description will be given this same color and fill pattern.

Setting the Data Change for the Interval Search
Using the Find and Change Data function changes field data entries in intervals meeting search criteria. This method changes a selected field value for every interval meeting search criteria. This method’s key advantage is that it can be applied to multiple wells a project.

Once the search criteria is set, select “Change Data Values.” This tells Petra to change a specific field on the intervals that meet the search. On the CHANGE DATA IN dropdown menu, select the appropriate field and data value. The example below shows that the lithologic description field “Desc” in the LITH table will be searched. In the search shown below, intervals containing the phrase “very fine grain” will have their Qual field changed to “B.”

4.6.18.7 Using Interval Filters

Filters limit the intervals used in a particular process. Filters give more control over which intervals are displayed on map and cross sections, which intervals are used in calculations to create zone and log curves, and which intervals are used in Find/Replace operations.

In all these cases, filters add an additional set of search criteria. Intervals that do not meet the filter criteria are not used for that particular task. For example, intervals that don’t pass the filter criteria in the Map Module are not plotted on the map. Filter criteria are shared between different functions, making it easier to use the same subset of interval data for different applications. Unchecking this box in any part of Petra does not erase the filter criteria; it simply inactivates the filters. To create a new set of filters, select the “Set Filters…” button. The examples below show the “Set Filters…” for displaying intervals in the Map Module and for calculations in the Main Module.
The Interval Data Selection filters can be divided into two parts. The upper half of the screen builds and modifies filters, while the lower half shows the active filters and the “pass” relationship between different filters.

To create a new filter, select the table and field for the filter from appropriate dropdown menus. The example below filters intervals in the LITH table by data in the DESC data field.

Next, select the filter’s “Search Type.” With one exception (“Interval Thickness In Range”) the search type tells Petra what the filter should look for inside a field:

- Not Equal to Value
- Equal to NULL
- Not Equal to NULL
- Value in Range
- Field Contains String

“Interval Thickness in Range” eliminates intervals that are thicker or thinner than a given range. Finally, select the “Add” button to add the filter to the “Current Filters” list at the bottom of the box. In the example below, the filter is set to include only intervals that contain the words, “very fine grain”
Up to 10 filters can be active at once. There are two options for how to combine multiple filters: “Pass Filter when ANY conditions are met” and “Pass Filter when ALL conditions are met.” The choice of these two options can have a significant influence on which intervals are plotted on the cross-section. For more on combining multiple filters, see Appendix 2.

Pass Filter when ANY conditions are met – this will pass any interval where at least one of the conditions is met. This is the more permissive option, since only one of the filter criteria needs to be met to pass.

Pass Filter when ALL conditions are met – this will pass any interval only when all conditions are met. This is the more restrictive option, since all filter criteria need to be met to pass.

### 4.6.18.8 Storing Interval Thickness to an Interval Field

This operation stores each interval’s thickness to a specified field in that interval.

Select the “Maintenance” button on the bottom of the Interval Tab on the Main Module. On the Table tab, select the interval field that will store the interval thickness. In the example below on the left, the “Recov” field on the CORE table is selected. Next, under the Data tab (highlighted in blue on the example to the right) select “Store Interval Thickness” (highlighted in red).
The example below shows that the sidewall core thicknesses (in this case given a thicker interval) all store thicknesses of 2 feet in the “Recov” field.

4.6.18.9 Gaps, Overlapping Interval Data, and Bulk Shifts

Interval data is often at the wrong depths, or contains overlapping intervals or gaps. Though interval data is designed precisely to handle this incomplete and contradictory data, it’s often useful to convert interval data into one continuous chain for display or calculations. Interval data can also become out of sync with other well data; moving interval data up or down with a bulk shift easily remedies the discrepancy.

To perform these operations on a single well, select the “Edit Details” button on the upper right corner of the Interval Tab on the Main Module. Next, Edit dropdown on the menu bar at the top of the window, select “Make Intervals Continuous” button or “Resolve Internal Overlaps”, or “Bulk Shift.”
Make Intervals Continuous
This option eliminates overlaps where two different intervals cover the same footage. With this option, Petra moves the base of the upper interval to match the top of the lower interval, as shown in the example below.

Resolve Internal Overlaps
This option eliminates gaps between intervals. With this option, Petra moves the base of the upper interval to match the top of the lower interval to cover the gap, as shown in the example below.

Bulk Shift
This option adds or subtracts a specific number to all interval depths. A negative number moves all intervals up, while a positive number moves all intervals down.
4.6.18.10 Calculations with Interval Data

Petra can perform basic calculations on interval data columns, zone data items, or constants. This operation is performed on all intervals in selected interval table in either the current well or for all wells selected in the Main Module. To calculate a new interval data column from another, select the appropriate interval table on the appropriate well, then select the “Calculate Column…” on the Interval Tab.

First, establish where the output will be stored. Petra can store data to a new or preexisting column in the selected data table. To store data to a new column, select “Create New Column” and enter in the new column’s name. To use a column that’s already in the data table, select “Use Existing Column”, and select the column from the underlying dropdown menu. Be careful when using an existing column, as this operation can overwrite any data already entered.

Next, enter an equation using variables and mathematical operators. For a list of available operators and sample equations, see appendix 3. The variable on the left side of the equal sign is the result variable. Note that the variables here are just text and will be assigned later, so they can be either specific (“porosity”) or general (“A”). Note that equations can be saved and loaded again at a later date with the “Save” and “Load” buttons on the right side of the screen. In the example below, porosity data is being used to calculate a permeability value.

Now that the equation is entered, select “Assign Vars.” This populates the Variable List in the bottom left corner of the window with the variables written in the equation. Select a variable from the Variable List, and select a column, zone data item, or constant from the relevant dropdown menus on the right. Select the “Assign” button. This will change the entry in the Variable List box to reflect the correct variable.

The Options Tab has a few more controls over the calculation. The calculation can be performed on only the currently selected well in the Main Module, or on all wells selected in the main module. Petra stores a null value whenever there’s a missing variable in the calculation, but the “Save ZERO value to Database” can overwrite this null value with a zero. By default, Petra overwrites all interval data fields during the
calculation. Deselecting the “Overwrite Existing Database Values with Calculation Result” forces Petra to leave existing database numbers alone, limiting the calculation to only filling in null values. To perform the calculation, select the OK button.

4.6.18.11 Graphing Interval Data

Petra can plot any numerical interval “real value” versus depth or another real value. This can be particularly useful for quickly seeing how a quantity such as mud weight changes with depth, or understanding the relationship between two different kinds of data like porosity and permeability.

To view an interval graph, first select the correct well in the Main Module. On the Interval Tab, select the right interval table. In the example below, the “CORE” table is selected. Finally, select the “Edit details” button in the upper right on the Interval Tab.

On the Graph Tab, select “Depth vs Z” or “X vs Z” on the first dropdown menu. “Depth vs Z” shows the selected values for the interval fields selected on the Z1, Z2, and Z3 dropdown menus on the vertical axis relative to depth on the horizontal axis.
The example below shows how porosity varies with depth.

```
4.6.18.12 Setting Default Tables and Fields
```

Changing these default interval tables can be useful from an administrative perspective. Changing these tables ensures that all new projects will be created with the same interval tables and fields, though these can always be changed inside Petra.

When creating a new project, Petra looks at a file called INTDATA.DEF located in the program's Parms directory. On most standalone installations, this will be located in C:\geoplus1\Parms. This file contains the default tables and fields that will be created in a new project.

It's important to not edit the default interval table file (INTDATA.DEF). Instead, copy the INTDATA.DEF file to a new file called INTDATA.USR. Make all new changes to the new file called INTDATA.USR. Petra first looks for INTDATA.USR before it looks
for INTDATA.DEF.

The default version of this file contains three tables: LITH, CORE, and PALEO.

**Table: LITH - Lithology**
- **Field**: Desc - Description

**Table: CORE - Core Interval Data**
- **Field**: Poros - Core Porosity
- **Field**: Perm - Core Permeability
- **Field**: Recov - Amt of Core Recovered

**Table: PALEO - Paleo Data**
- **Field**: FmName - Formation Name
- **Field**: Bug - Fossil Name
- **Field**: Age - Age of Zone
Petra reads the INTDATA file and builds interval data based on comma-delimitated values.

TABLE, TABLE NAME, “Table Description”
FIELD, KIND, NAME, SRC, “Field Description”, UNITS, DECIMALS

TABLE – This signifies that the entry is for a new table.
Table Name – This is the name of the table. It’s a good idea to separate tables based on genetically related data, such as mudlogs, core descriptions. Remember that tables, unlike zones, are completely independent of stratigraphy, so it is probably easier to lump all related data together rather than break out intervals based on specific formations.

“Table Description” - This sets a brief description of the Table. In the example, the “LITH” field’s description is “Lithology Data.” Remember to put quotation marks around the description.

FIELD – This just signifies that the entry is for a new field. Make sure all new field entries are prefaced by “FIELD.”
Kind – Fields can store three kinds of data: Real Values, Date Values, or String Values. The letter here tells Petra what kind of data this field will store – “R” for Real values, “D” for Date values, and “S” for String values. Real values simply store numbers, such as porosity or permeability. Dates store calendar days as MM/DD/YYYY. String values store text, like core descriptions.
Name – This is the name of the field.
SRC – This sets the user source for the specific field. User sources are useful for distinguishing between different user’s interval data in a multiuser environment.

“Field Description” – This sets a brief description of the field. In the example, the “Recov” field’s description is “amt of core recovered.” Remember to put quotation marks around the description.

UNITS – This sets the units of the field.
DECIMALS – This sets the number of decimals shown for real value (numerical) data. Though it’s a good idea to set this value to 0 for string and date fields, it’s not necessary.

4.7 Selecting Wells

It’s often useful to trim the wells selected in a project module only to a relevant subset of wells. To change the wells in any given module, select Wells>Select on
the menu bar at the top of the module.

Prospect Mode might be useful if you're regularly working with a smaller subset of wells in a larger project.

All Wells - (CTRL + A) This option selects all wells in the project. While Petra is in Prospect Mode, selecting "all wells" will only select all the wells in the prospect rather than all wells in the entire project.

Current Well Only - (CTRL + W) This option selects only the currently highlighted well in the project.

By Data Criteria - This option opens the Select Wells By Data Criteria tool. This is an incredibly useful tool for nested and complicated searches based on well attributes or database information.

Wells From a WSN List - This option selects wells based on a pre-existing WSN list. For more information on creating WSN lists, see here.

From a List of Well names - This option opens the Well List Selection tool. This tool selects wells from a sortable well spreadsheet of wells' UWI, WSN, Label, and names.

Primary Completions Only - This option selects only wells with "0000" at the end of the UWI.

Map Selected Wells - This option selects the wells currently selected on the Map Module.

Cross Section Wells - This option selects the wells currently selected on the Cross Section Module.

Log Cross Plot Well - This option selects the wells currently selected on the Log Cross Plot Module.

PetraSeis Wells - This option selects the wells currently selected in PetraSeis.

Synchronize Modules to Main - This option forces all open Modules (except the Cross Section Module) to use the wells selected on the Main Module.
4.7.1 Prospects

Prospects are a subset of wells from a larger project database. When working in the prospect mode only wells inside the prospect are visible; Petra ignores all other wells in the original project. **Selecting "all wells" in prospect mode will only select the wells that are in the prospect.**

Prospect mode only acts as a filter on the visible wells - there still is only one copy of the well data. Any changes made to a prospect will be reflected in the original project and any other prospect containing the modified wells. Adding or deleting a well to the database while in the prospect mode will also add/delete the well in the prospect. Likewise, be careful about changing the map projection while in prospect mode. Map projections are global to the original project database. Changing the projection could interfere with other people’s prospects made from the same project.

Petra’s prospect files (*.PRO) are simple text files that contain the prospect description, aerial extent, update timestamp, and a list of the wells in the prospect. Note that prospects keep track of wells with well serial numbers (WSN), which just reflects the order a well was loaded into the project. Since a well’s WSN is specific to a project, it won’t necessarily reflect the same well in two different projects. If you wish to give someone a list of wells in a prospect, save a UWI list instead.

When a prospect mode is active, Petra will display the prospect description on the Petra window header.

![A *.PRO prospect file with the prospect’s description, extents (in the SW and NE corner), update timestamp, and WSNs](image)

**Main Module**

All the Main Module's prospect tools are available on **Project>Prospect>...** on the menu bar at the top of the screen.
Save Prospect Well List... - This option saves the wells currently selected wells listed in the Main Module. Next, select file name and location and then a prospect file description. Note that saving a prospect can directly put Petra into Prospect mode.

Load Prospect Well List... - This option enables prospect mode with the wells contained within a selected *.PRO file.

Exit Prospect Mode and Use Project Mode... - This option exits prospect mode, and return to the default project mode where all wells are available. Note that this will either select all wells in the project, or continue to use the wells selected in the prospect.

Map Module

All the Map Module’s prospect tools are available on **Wells** on the menu bar at the top of the screen.

Create New Prospect>From Current Limits - This option saves the wells inside the current map **data limits**. Petra will draw a red rectangle to show the exact extent of the data limits. Next, select file name and location and then a prospect file description. Note that saving a prospect can directly put Petra into Prospect mode.

Create New Prospect>Prospect from User-Drawn Rectangular Area - This option selects wells based on a user-drawn rectangle.

Open Prospect - This option enables prospect mode with the wells contained within a selected *.PRO file.

Close Prospect Mode - This option exits prospect mode and uses the previously selected wells.

Close Prospect Mode - This option exits prospect mode and uses all wells in the project.
**Prospect AOI> Show Prospect AOI Limits** - This option displays the prospect extents as a red rectangle on the Map Module. Selecting this option toggles this rectangle on and off.

**Prospect AOI> Search for Wells in Prospect AOI** - This option searches the prospect's aerial extents. This option can be useful for

**Search Entire Project for Wells in AOI** - This option finds all wells in the project inside the prospect's aerial extents. Since this method will search all wells in the entire project, this tool can be useful for updating a prospect after importing wells, drilling new wells, or otherwise changing the data in the project.

**Search Current Prospect Wells for Wells in AOI** - This option searches for wells inside the prospect's aerial extents. This search will only include wells that are currently included in the prospect.

**Do Not Change Prospect Well List** - This option only performs the search.

**Prospect AOI> Modify Prospect AOI** - This option changes the extents of the prospect's AOI, and gives the user a chance to update the prospect with the wells inside the new borders.

**Search Entire Project for Wells in AOI** - This option finds all wells in the project inside the prospect's aerial extents. Since this method will search all wells in the entire project, this tool can be useful for updating a prospect after importing wells, drilling new wells, or otherwise changing the data in the project.

**Search Current Prospect Wells for Wells in AOI** - This option searches for wells inside the prospect's aerial extents. This search will only include wells that are currently included in the prospect. This can be useful for shrinking a prospect,

**Do Not Change Prospect Well List** - This option only performs the search.
4.7.2 Select Wells By Data Criteria

The Select Wells By Data Criteria tool is a powerful way to concentrate on a group of wells based on a variety of selection criteria.

To search for wells meeting a specific data criteria, select the item from the list box and click the Search... button or simply double-click the listed item. Depending on the search criteria, you may be presented with another dialog box to specify the detailed search criteria.

Search - This option checks the well list against the selected search criteria.

Accept - This option selects the well list for the relevant application. As an example, the accept button can deliver the selected wells to the Map Module.

Cancel - This option cancels the well search and returns to the relevant application.

Help - This option opens the Help Menu.

Selecting wells based on data criteria

Combining Multiple Criteria

The "Combine Using" option combines multiple search criteria to create more sophisticated search lists.

AND - This option requires all criteria to be satisfied in order to pass.

OR - This option requires only one criteria to be satisfied in order to pass.

NOT - This option requires that the well pass the first criteria, but fail any additional criteria.
To better illustrate nesting multiple searches, we'll apply the criteria “Object is yellow” and “Object is smaller than a breadbox” to three objects: a banana, an apple, and a schoolbus.

"Object is yellow” AND “Object is smaller than a breadbox” - Only the banana is both yellow and small, so it fulfills the criteria.

"Object is yellow” OR “Object is smaller than a breadbox” - All three objects fit the criteria. The schoolbus is yellow, the apple is small, and the banana is both yellow and small.

"Object is yellow” NOT “Object is smaller than a breadbox” - Only the schoolbus fits the criteria. Both the banana and the schoolbus are yellow, but the NOT excludes the small banana.

Search Criteria

Global

All Wells In Database - This option merely reverts the selected wells back to all wells in the project.

Original Well List - This option reverts the selected wells back to the list of wells which were selected when the Search option was initiated.

WSN List File - This option selects wells inside a previously saved WSN (*.WSN) file.

UWI List File - This option selects wells inside a previously saved UWI (*.UWI) file.

Well List - This option brings up a list of the currently selected wells. This list can be sorted by UWI, WSN, Well Label, or Well Short Name.

WSN Range - This option selects wells based on a range of WSN numbers. Since Petra assigns WSN numbers based on import order, this can be useful for selecting wells imported at a specific time.

Locked Data Fields - This option selects wells based on locked data fields in one or more parts of the data base.

Pseudo Wells - This option selects wells marked as "Pseudo" wells

Invert Selection List - This option changes the well selection list by selecting all wells which are not selected. For example, if 10 out of 100 wells meet particular selection criteria, then inverting the list would select the other 90 wells that did not meet the criteria.

Well Header

Well Identifiers - This option searches one or more well header fields, such as, UWI,
Well Name, Operator, etc. The search can look for fields containing a string, and exact match, or mask specifier. For much more detail on this tool see "Select Wells By Well Identifiers."

**Multiple Completions** - This option works with multiple completions, which are usually stored in Petra’s database as additional wells with an appended number on the 13-14th digit of the API number. The "All completions for the Current Well Set" adds well completions for the currently active set of wells. The "Only Wells Containing Multiple Completions" selects only wells with multiple completions - single well completions are ignored.

**Operator** - This option selects wells based on a list of unique operator names.

**Well Name** - This option selects wells based on a list of unique well names.

**Lease Name** - This option selects wells based on a list of unique lease names.

**Field Name** - This option selects wells based on a list of unique field names.

**Symbol Code** - This option selects wells with one or more well symbol codes.

**Date Data Was Changed** - This option finds wells that had data changed within a range of dates. This can include well header data, locations, formation tops, zone data, or digital log data. This tool can be useful for isolating wells with a particular vintage of data, or for repairing bad imports.

**Datum**

**By Active Datum** - This option finds wells with the active datum (either KB, GR, DF, or SEIS) between a minimum and maximum depth.

**With No Active Datum** - This option finds wells with no active datum. Since the active datum is used in calculating SS and SSTVD depths, this can be very useful for troubleshooting data in a project.

**TD** - This option searches wells with a total depth within a given range.

**FM at TD** - This option selects wells based on a list of formations in the "Fm at TD" entry. Note that this entry is set on the Main Module’s Well Tab.

**Well History Present** - This option selects wells that have a well history loaded into the database. Note that a well’s history is set on the Main Module’s Other Tab.

**Geology**

**Any Tops** - This option selects wells that have any loaded formation tops.

**Tops Data** - This option finds wells by the presence or absence of formation tops.
and quality codes. For more detail on this tool, see Select Wells by Tops.

By Top Source - This option finds wells with formation tops with a specific source code.

Any Fault Cuts - This option selects all wells containing any fault cut records.

Any Raster Pay - This option selects all wells containing any pay intervals.

Formation penetrated at TD - This option selects wells based on the "FM at TD" field on the Well Tab.

Velocity Data - This option selects wells by the presence or absence of an assigned velocity function.

Unassigned Tops/Correlations - This option selects wells with unassigned tops or unassigned correlations.

Interval Data - This option searches wells that have interval data inside a zone. Note that the zone's Interval Definition must be set.

Zones

Zone or Tops Data - This option selects wells by tops or data items criteria. For more information on this tool, see Select Wells By Zone or Tops Data.

Zone Text Item - This option selects with specific text string in a data item's remark field or quality code. For more information on this tool, see Select Wells By Zone Text Item.

Any Tests in a Zone - This option searches wells that have test data inside a zone. Note that the zone's Interval Definition must be set. For more information on this tool, see Select Wells With Tests In A Zone.

Interval Data - This option searches wells that have interval data inside a zone. Note that the zone's Interval Definition must be set.

Production

Any Monthly Production - This option selects wells that contain any monthly production data.

NO Monthly Production - This option selects wells that contain NO monthly production data.

Producing Fm Name - This option selects wells based on a list of unique formations. Wells with with the selected formation in the "Prod. FM" field on the Well Tab will be selected.

Production Stream Names - This option selects wells that contain one or more production streams.
**Pd Cum Data** - This option selects wells that contain one or more production cumulative data based on formation name, or with values inside a zone's interval definition.

**Any Perfs** - This option selects wells containing any perfs.

**Any Shows Data** - This option selects wells containing any show records.

### Tests

**Any Perfs** - This option selects wells containing any perforation records.

**Any Production Tests (IP)** - This option selects wells with an IP or other production test.

**Any Formation Tests (DST)** - This option selects wells with any formation tests.

**Any Tests in a Zone** - This option selects wells with IP test, DSTs, perfs, cores, etc. in a selected zone. Note that the zone’s Interval Definition must be set.

**Prod Tests by Fm Name** - This option selects wells based on the loaded production test formation names. These names are set on the "FmName" field on the Main Module’s Fm Tests Tab.

**Fm Tests by Fm Name** - This option selects wells based on the loaded IP test formation names. These names are set on the "FmName" field on the Main Module’s IP Tests tab.

### Mechanical

**Any Perfs** - This option selects wells containing any perforation records.

**Any Casing Data** - This option selects wells with any casing records.

**Any Cored Intervals** - This option selects wells containing any cored interval records.

**Any Shows Data** - This option selects wells containing any shows.

**Casing, Liner and Cement** - This option selects wells based on size, depth, and dates of casing, cement, and liner data.

### Locations

**Lat-Lon or XY Limits** - This option selects wells inside a Lat-Lon or XY box.

**Sec-Twn-Rge Limits** - This option selects wells inside a box set by sections.

**Wells with Directional Survey** - This option selects wells containing directional surveys.

**Any Horizontal Wells** - This option selects wells with the "Horizontal Well" switched on the Directional Survey Data window’s General Tab.
Distance Btwn Surface and BH Loc - This option selects wells based on the distance between the surface and bottom hole location established on the Main Module's Location Tab. This tool selects wells with a distance greater than or equal to a user-selected value.

Wells within a Radius - This option selects wells within a user-selected radius from the currently selected wells.

Wells with BH Spot Location Data - This option selects wells with a bottom hole location set on the Main Module's Location Tab.

Wells in Offshore Block (Surface) - This option selects wells with a surface location set inside a specific area/block. This information is set in the Offshore Location Information window available from the Main Module's Location Tab.

Wells in Offshore Block (Btm Hole) - This option selects wells with a bottom hole location set inside a specific area/block. This information is set in the Offshore Location Information window available from the Main Module's Location Tab.

Logs

Digital Logs

Log Curves - This option searches for wells containing one or more selected log curves. For more information on this tool, see Select Wells By Logs.

Raster Logs

Calibrated Rasters - This option selects wells based on the calibrated raster logs in the database. For more information on this tool, see Select Wells with Raster Log Images

Any Raster Pay - This option selects wells with any raster log group names.

Interval Data

Intervals in a Zone - This option searches for wells that have intervals inside top and base set by the selected zone's interval definition. Note that the zone's Interval Definition must be set.

4.7.2.1 Select Wells By Well Identifiers

This well selection criteria searches the well header data fields for matches on one or more text strings. Matches may be based on an exact match of the well data and the search string or on a partial match with the well data. Also, the search string can represent a mask containing the wild card characters "*" and "?" similar to the way DOS uses masks.
Data Tab

This section defines the well data fields to search, each corresponding search string, and search condition. Enter the search string for each well data item to be searched and select the appropriate corresponding search condition.

![The Search By Well Identifier Data Tab]

Data Field List

Place a check beside each well data field to search on. The following fields may be searched:

- UWI (API#)
- Well Name
- Well Number
- Well Label
- Operator
- Historical Operator
- Lease Name
- Lease Number
- Field Name
- Prod Fm
- Remarks
- County
State

Well Date

Text String To Search For

Enter the string, substring or mask to search for next to each data field to be searched.

The following are examples of mask wild cards:

<table>
<thead>
<tr>
<th>Mask</th>
<th>Matching Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
<td>All text</td>
</tr>
<tr>
<td>A*</td>
<td>All text beginning with the letter A</td>
</tr>
<tr>
<td>*-1</td>
<td>All text ending with -1, e.g., A-1, C-1</td>
</tr>
<tr>
<td><em>ABC</em></td>
<td>All text containing the letters ABC</td>
</tr>
<tr>
<td>A??</td>
<td>All 3 letter text beginning with A</td>
</tr>
<tr>
<td>ABC??XYZ</td>
<td>Text fields such as, ABCDEXYZ, ABC88XYZ</td>
</tr>
</tbody>
</table>

Search Conditions

Is Equal To - Well is selected when the well data field must match the search string exactly.

Is Not Equal To - Well is selected when the well data field must not match the search string exactly.

Contains - Well is selected when the well data field contains the search "substring".

Does Not Contains - Well is selected when the well data field does not contain the search "substring".

Matches Mask - Well is selected when the well data field matches the mask wild card pattern.

Does Not Match Mask - Well is selected when the well data field does not match the mask wild card pattern.

String Length - Well is selected when the well data field item length is equal to (=), greater than (>), or less than (<) a particular value. The length is specified in the "Text String to Search For" field. The length can be preceded by a condition code (=, >, <) to indicate length condition to match. For example, to find all wells with API number less than 14 characters, enter "<14" in the search text field. (do not type the
quotes). If no condition code precedes the length, then "equal to" is assumed.

Options Tab

The Options Tab sets how Petra handles multiple well identifier criteria in the search. Note that the "combine conditions" option here only applies to the well identifier search, and not to the broader "Select Wells By Data Criteria" search.

The Search By Well Identifier Options Tab

**AND** - This option requires all criteria to be satisfied in order to pass.

**OR** - This option requires only one criteria to be satisfied in order to pass.

To better illustrate nesting multiple searches, we'll apply the criteria "Object is yellow" and "Object is smaller than a breadbox" to three objects: a banana, an apple, and a schoolbus.

"Object is yellow" AND "Object is smaller than a breadbox" - Only the banana is both yellow and small, so it fulfills the criteria.

"Object is yellow" OR "Object is smaller than a breadbox" - All three objects fit the criteria. The schoolbus is yellow, the apple is small, and the banana is both yellow and small.
4.7.2.2 Select Wells By Formation Penetration

This function looks at the Formation at TD “well header” data field (FM@TD) and compares it with an ordered list of formation names. Formation names can come from the FMTOPS table or from an external "strat table" file.

Selection is performed by finding a match of each well's FM@TD value with the formation list. If the FM@TD is in the list and it is equal to or follows after the specified formation name in the ordered list, then the well is considered to "penetrate" the specified formation.

Select Wells Which Penetrate the ... - Select the formation name for which a well must penetrate to be selected. The formation drop down list is loaded with names based on the "Stratigraphy Is Defined By" option (see below).

Stratigraphy Is Defined By

This option determines the ordered list of formation names and therefore the stratigraphic sequence or formations.

The Project's Formation Tops - This option uses the the formation list from the formation tops display order. The order is set with the Select Display Order for Data Items tool.

"STRAT" Table Data File - This option uses an external file of formation names. The file or "strat table" must contain the formation names as one name per record and organized from shallowest to deepest, i.e., the first record is the shallowest formation. Use the "Browse" button to select the strat table file. The file can be viewed or modified using the "Modify Strat Table" button. Use the "Reload" button to reload the table after any modifications. To create a strat table file from a Petra
project, see the "Order Using External File (STRAT TABLE)" section of the Select Display Order for Data Items help document.

4.7.2.3 Select Wells By Zone or Tops Data

This function selects wells by data item criteria. As an example, this tool can search for wells with TD greater than 8000, cumulative gas 100,000 mcf or greater, and a completion date in the range of 1/1/90 to 12/31/99.

Z Data Tab

![Z Data Tab](image)

Selection Mode

Select Wells when ANY Criteria Is Found - This option returns wells with at least one of the zone data items tests falls within the minimum and maximum. This is a more lax criteria, and will return more wells.

Select Wells When ALL Criteria Is Found - This option returns wells only when ALL of the wells' selected data item values fall within the minimum and maximum. This is a more stringent test criteria, and will return fewer wells.

Zone Data Selection Criteria

This section specifies up to 6 conditions for selecting wells.

Use? - This option enables the specified condition. Note that deselecting this checkbox does not erase the zone, item, or min/max.

Zone - This dropdown selects the desired zone for the condition.
Item - This dropdown selects the desired data criteria for the condition. This dropdown will only contain data items from the zone selected immediately to the left.

Minimum/Maximum - This entry sets the minimum and maximum for the selected item. These fields can use scientific notation (such as 1E30, -1E30, 1E-30) very large or very small values. For dates, enter the minimum and maximum values as month/day/year, such as 9/23/65 or 01/01/1999.

Select When Null - Instead of using the minimum and maximum values, this option overrides the condition to only look for wells with a NULL in the data item.

Use SSTVD Tops - By default, Petra looks for MD values on formation tops. This option instead specifies the minimum and maximum top as SSTVD tops.

Use Top Aliases - This option enables top aliasing.

Use Zone Aliases - This option enables zone aliasing. When the original data item is blank, Petra will attempt to look down the list of equivalent zone data items.

Dates Tab
The Dates Tab limits the text search to only text items changed within a specific date range.

Include Date Range Search - The "From" and "Through" entries set the calendar date range. Only items changed within the selected timeframe will be selected.

Quality Tab
The Quality Tab adds an additional quality code search.
Include Quality Code Search - This option restricts the search to only the wells that have the selected quality code. This tool can use multiple quality codes - just separate the different codes with semicolons (;).

When working with multiple conditions and a quality code search, the ALL or ANY selection mode set on the Z Data Tab controls how Petra returns wells. With an ALL search, all of the conditions need to have one of the quality codes. With an ANY search, only one of the conditions needs one of the quality codes.

4.7.2.4 Select Wells By Zone Text Item

This well selection option searches a text-type zone data item or the remark field of a numeric zone data item for one or more values.

Data Tab

The Data Tab controls how Petra searches for text.
Select Zone and Item To Be Searched

Choose the desired zone and data item name for the search.

View/Edit - This button opens the View/Edit Zone Data tool.

Use Aliases - This button allows the search to use data item aliases.

Search Method

Search For Items Listed Below - This method selects wells from a list of the unique remarks in the selected data item. This option is best used for text fields with a relatively small number of unique values, such as a source code or flag. Text fields like comments, on the other hand, can have a totally unique entry for every well; the Keyword search is a much better option for text fields like this.

To use this method, select the "Get Data" button on the bottom of the tool. Here, Petra will load the list box with all unique values from the current wells. Select the desired text box and select "OK" to search all wells containing that exact entry.

Search For Wells Containing Keyword(s) - This option searches the text values or remarks for specific words or phrases. Separate keywords by a comma. Phrases containing blanks must be enclosed in double quotes. Click the OK button to begin the search.

Data Fields To Examine

This section sets the individual parts of the data item for the text search. Note that the search can include the "Text Item or Remark" field and/or the "Quality Code" field for the data idem.

Examine Text Item or Remarks - This option instructs the search to look inside the
"Text Item or Remark" field.

**Examine Quality Code** - This option instructs the search to look inside the "Qual" field.

<table>
<thead>
<tr>
<th>Item Name</th>
<th>Ref</th>
<th>Units</th>
<th>ZValue</th>
<th>Qual</th>
<th>Text Item or Remark</th>
<th>ChgDate</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LLPISRC</td>
<td></td>
<td></td>
<td></td>
<td>TOBIN SUPERBASE</td>
<td>06/18/2006</td>
<td>Lat-Lon PI Source</td>
<td></td>
</tr>
</tbody>
</table>

A "Text" Zone Data Item

**Choose One or More Data Values To Select Wells By**

This list is only used with the "Search For Items Listed Below" search option. Select the "Get Data" button to load all unique values for the selected zone data item using the currently selected wells. Highlight one or more data values and click OK to begin the search. With a large number of wells and a large number of unique text strings, this process can take a considerable amount of time. Avoid using this option for data items with large number of unique text strings, like well comments.

**Dates Tab**

The Dates Tab limits the text search to only text items changed within a specific date range.

Include Date Range Search - The "From" and "Through" entries set the calendar date range. Only items changed within the selected timeframe will be selected.

**4.7.2.5 Select Wells With Tests In A Zone**

This well selection option will examine a selected zone interval for the occurrence or one or more data criteria consisting of IP or production tests, formation tests (DST),
perfed intervals, cored intervals, and shows.

Zone to examine for tests - This option searches for wells that have tests inside the top and base set by the selected zone's interval definition.

Look for wells with the following test information

IP Tests
Other Prod Tests
Fm (DST) Tests
Perfs
Shows
Cores

Options

Select Wells when ANY Criteria Is Found - This option returns wells with at least one of the selected tests falls within the zone interval. This is a more lax criteria, and will return more wells.

Select Wells When ALL Criteria Is Found - This option returns wells only when a well as ALL selected tests within the zone interval. This is a more stringent test criteria, and will return fewer wells.

Options Tab
IP and Prod Tests Must Contain Treatments Containing the Following Text - This option adds an additional search criteria in the "Treatments" section of tests.

Restrict By Perf Source - This option restricts the search to only the wells that meet the Perf Source.

4.7.2.6 Select Wells By Tops

The Select Wells By Tops tool selects wells by the presence or absence of tops and quality codes. This tool can also isolate wells based on the formation top's modification date.

Options Tab

The Options Tab sets the tops and search criteria.

When Is A Well To Be Selected
Select Well if ALL of the Selected Tops Meet the Requirements - This option returns only wells with ALL the digital curves selected on the "Choose Logs for Well Selection" list.

Select Well if ANY of the Selected Tops Meet the Requirements - This option returns wells with at least one of the digital curves selected on the formation" list.

Select Well if NONE of the Selected Tops Meet the Requirements - This option returns wells that do not have any of the digital curves selected on the "Choose Logs for Well Selection" list.

Selection Requirements

If Top is Present in the Database - This option returns wells that have the selected top or tops.

If Top is NOT Present in the Database - This option returns wells that do not have the selected top or tops.

If Top Was Modified Within the Specified Date Range - This option returns wells that have been modified within the date range set by the Dates Tab.

Quality Tab

The Quality Tab adds an additional quality code search. When working with multiple conditions and a quality code search, the ALL, ANY, or NONE selection mode set on the Options Tab controls how Petra returns wells. With an ALL search, all of the tops need to have one of the quality codes. With an ANY search, only one of the tops needs one of the quality codes. With a NONE search, Petra will return only the wells that do not have a formation top with any specified quality codes.

Include Quality Code Search - This option restricts the search to only the wells that have formation tops with a specific quality code. This tool can use multiple quality codes - just separate the different codes with semicolons (;).
Dates Tab

The Dates Tab limits the text search to only text items changed within a specific date range.

Include Date Range Search - The "From" and "Through" entries set the calendar date range. Only items changed within the selected timeframe will be selected.

Repeats Tab

4.7.2.7 Select Wells With velocity Function

The Select Wells With Velocity Function tool finds wells with loaded, active, or missing velocity functions
Search method

**Find Wells With Selected Velocity Functions** - This option selects wells based on the velocity functions selected on the "Choose Velocity Functions For Well Selection" list. Note that this tool also uses the "Selection Mode" option, which can change how Petra searches for wells.

**Find Wells With ANY Velocity Functions** - This option selects wells that have a velocity function.

**Find Wells With ANY Velocity Functions** - This option selects wells that do not have a velocity function.

**Find Wells With Selected Velocity Functions as Active** - This option selects wells based on the ACTIVE velocity functions selected on the "Choose Velocity Functions For Well Selection" list. Note that this tool also uses the "Selection Mode" option, which can change how Petra searches for wells.

**Selection Mode ("Find Wells With Selected Velocity Functions" Search Method Only)**

**Select Well if ALL of the Selected Functions Are Present** - This option returns only wells with ALL the velocity functions selected on the "Choose Velocity Functions for Well Selection" list.

**Select Well if ANY of the Selected Functions Are Present** - This option returns wells with at least one of the velocity functions selected on the "Choose Velocity Functions for Well Selection" list.
Select Well if NONE of the Selected Functions Are Present - This option returns wells that do not have any of the velocity functions selected on the "Choose Velocity Functions for Well Selection" list.

4.7.2.8 Select Wells By Casing, Liner, or Cement

Casing Tab

Search By Casing Depth - This option returns wells with any casing inside the set depth range.

Search By Casing Size - This option returns wells with any casing sizes within the range.

Any Casing Data At All - This option returns wells with any loaded casing data, regardless of depth or size.

Liner Tab

Search By Liner Depth - This option returns wells with any liner inside the set depth range.

Search By Liner Size - This option returns wells with any liner sizes within the range.

Search By Liner Dates - This option returns wells with liner dates between the set
range.

Any Liner Data At All - This option returns wells with any loaded liner data, regardless of depth, size, or date.

Cement Tab

Search By Cement Depth - This option returns wells with any cement inside the set depth range.

Search By Cement Dates - This option returns wells with cement dates between the set range.

Any Liner Data At All - This option returns wells with any loaded liner data, regardless of depth, size, or date.

Options Tab

When ALL Conditions Are Met - This option returns wells only when ALL of the selected casing, liner, and cement values meet the selected conditions. This is a more stringent test criteria, and will return fewer wells.

When ANY Conditions Are Met - This option returns wells with at least one of the
selected casing, liner, and cement values meet the selected conditions. This is a more lax criteria, and will return more wells.

4.7.2.9 Select Wells By Logs

This tool selects wells based on digital log curves.

Logs Tab

Selection Mode

Any Curves At All - This option returns wells that have any digital curves within the depth ranges set on the Depths Tab.

Select Well if ALL of the Selected Logs Are Present - This option returns only wells with ALL the digital curves selected on the "Choose Logs for Well Selection" list.

Select Well if ANY of the Selected Logs Are Present - This option returns wells with at least one of the digital curves selected on the "Choose Logs for Well Selection" list.

Select Well if NONE of the Selected Logs Are Present - This option returns wells that do not have any of the digital curves selected on the "Choose Logs for Well Selection" list.

Choose Logs For Well Selection

This list shows all logs names and definitions stored in the project database. Click this list to highlight and thus select one or more logs you want the selected wells to contain.
Select All - Click this button to highlight and select all logs in the selection list.
Select None - Click this button to deselect all logs in the selection list.
Use Aliases - This option enables log aliasing.

Depths Tab

The Depths Tab sets up a depth range for the log curve search. With this option enabled, Petra will only return wells with at least a single log value inside this depth range. Note that the selection mode (any curve or ALL/ANY/NONE selected wells) will affect how the depth range works. As an example, the "Select Well if ALL of the Selected Logs Are Present" option, on the other hand, will only return wells with all of that have all of the curves on the well selection list inside the depth range.

Restrict By Logs Within a Depth Range - This option enables and disables the depth range search.
Select Well if ANY of the Selected Logs Are Present - This option returns wells with at least one of the digital curves selected on the "Choose Logs for Well Selection" list.
Select Well if NONE of the Selected Logs Are Present - This option returns wells that do not have any of the digital curves selected on the "Choose Logs for Well Selection" list.

Set Depths - This button opens the "Set Depth Range" tool. Note that the desired interval can be set to a formation top, MD, or TVD. For MD and TVD, select the relevant button and enter the adjacent depth in the entry field. For tops, select the
desired top from the “Fm Top Name” dropdown box. Notice that an offset can also be added or subtracted to the fm top; this offset will include data points above or below the actual fm top depth.

Logs Must Cover Entire Depth Range - By default, Petra will return wells with at least one log curve-depth value in the depth range. This option restricts the search to only logs that completely cover the interval.

Find Only Curves with Depth Units Equal To: - This option restricts the search to wells with log curves set in the desired depth unit (feet or meters).

Find Only Curves with Sample Rate - This option restricts the search to wells with a specified sample rate.

Other Tab
Log must have an LAS Header Associated with it - This option only returns wells with a loaded LAS header stored in the database.

4.7.2.10 Select Wells with Raster Log Images

Raster Logs Tab

![Raster Logs Tab Image]

Search Method

Find Wells With Selected Rasters - This option returns wells that have the raster group names selected on the Choose Logs for Well Selection list. Note that the "Raster Selection Mode" section further controls how the search handles multiple group names.

Find Wells with ANY Rasters - This option returns wells with at least one raster log group.

Find Wells With NO Rasters - This option returns wells with at no raster log groups.

Find Wells with MJ Associated Rasters - This option returns wells that have the MJ Associated group names selected on the Choose Logs for Well Selection list. Note that the "Raster Selection Mode" section further controls how the search handles multiple group names.

Find Wells with IHS (Direct Connect) Rasters - This option returns wells that have the IHS Direct Connect group names selected on the Choose Logs for Well Selection list. Note that the "Raster Selection Mode" section further controls how the search
handles multiple group names.

Raster Selection Mode

Select Well if ALL of the Selected Logs Are Present - This option returns only wells with ALL the digital curves selected on the "Choose Logs for Well Selection" list.

Select Well if ANY of the Selected Logs Are Present - This option returns wells with at least one of the digital curves selected on the "Choose Logs for Well Selection" list.

Select Well if NONE of the Selected Logs Are Present - This option returns wells that do not have any of the digital curves selected on the "Choose Logs for Well Selection" list.

Options Tab

Use Aliases - This option uses the list of "equivalent" raster group names or aliases established on the Raster Log Maintenance's Aliases Tab.

Search For Uncalibrated Rasters Only - This option ignores raster logs with depth calibration points, and only selects wells with uncalibrated raster groups. This can be useful for troubleshooting a project, or for finding wells that need more work.

Select When Source Contains - This option limits the search only to raster group names with a source code. This tool can use multiple quality codes - just separate the different codes with semicolons (;).

When working with multiple conditions and a quality code search, the ALL or ANY
selection mode set on the Raster Logs Tab controls how Petra returns wells. With an ALL search, all of the group names need to have one of the quality codes. With an ANY search, only one of the group names needs one of the quality codes.

**Depths Tab**

The Depths Tab sets up a depth range for the log curve search. With this option enabled, Petra will only return wells with at least a single raster calibrated depth inside this depth range. Note that the selection mode (any curve or ALL/ANY/NONE selected wells) will affect how the depth range works. As an example, the “Select Well if ALL of the Selected Logs Are Present” option, on the other hand, will only return wells with all of that have all of the groups on the well selection list inside the depth range.

Restrict By Logs Within a Depth Range - This option enables and disables the depth range search.

Set Depths - This button opens the "Set Depth Range" tool. Note that the desired interval can be set to a formation top, MD, or TVD. For MD and TVD, select the relevant button and enter the adjacent depth in the entry field. For tops, select the desired top from the “Fm Top Name” dropdown box. Notice that an offset can also be added or subtracted to the fm top; this offset will include data points above or below the actual fm top depth.
Run Bulk Query

This "Select Wells By Data Criteria" feature provides a method to re-run several "query history files" and save each resultant well list as a WSN file.

This screen provides a series of buttons to fill a 2-column grid defining the query history file on the left and the associated wsn list file on the right.

Run Bulk Query From File

Select a file name to load or save the query/wsnfile criteria

Load - Load a previously saved bulk query file (BWQ file extension)

Save - Save a bulk query file (BWQ file extension)

Run Bulk Query - Run each query history and save resultant wsn lists. A report is created showing the results of each file.
Add Row - Click this button to add a row to the grid
Delete Row - Deletes the row pointed to by the grid row cursor
Delete All Rows - Deletes all grid rows with an "are you sure" prompt.
Set Query File - Displays a file dialog for choosing the query history file to be placed in the left side of the grid at the current grid row cursor.
Set WSN File - Displays a file dialog for choosing the WSN list file to be placed in the right side of the grid at the current grid row cursor.

4.7.3 Well List Selection

This tool selects wells from a simple list of wells in the project.
To open this tool, select Wells>Select>Wells from a List
Wells can be selected for display or various processing from a list containing the .
Select wells by clicking and highlighting the well entry in the list box. Two modes of selection are provided. The "Extended Selection Mode" allows selection by dragging the mouse cursor over the items similar to using Windows Explorer. You must hold the control key down to select individual wells. Disable the extended mode selection by clicking on each well while holding down the Ctrl. key.

Sort Wells By
This dropdown determines how Petra sorts and displays the well list. Petra can display wells by UWI, WSN, Label, and Well Short Name. Selecting the UWI entry,

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for example, will sort the well list in an ascending UWI numbers and will displays will
display the fields with the UWI value first.

Choose From

This section defines which well list is displayed.

Selected Wells - This option limits the available well list to only the wells currently
selected in the Main Module.

All Wells - In project mode, this option will display all wells in the project. In
prospect mode, this option will only display the wells selected in the active prospect.

Well List

This list contains the wells available for selection. This list will behave a little
differently depending on whether the "Extended Selection Mode" option on the
bottom of the screen is selected. Note that toggling the "Extended Selection
Mode" option will deselect all wells on the well list.

"Extended Selection Mode" OFF

This option is best for selecting a small set of wells. Clicking on a well highlights and
selects it. Clicking on a well again deselects it.

"Extended Selection Mode" ON

When the "Extended Selection Mode" option is selected, you can click and drag to
select multiple adjacent wells. To select additional wells, hold down CTRL and drag
over the additional well names.

Load - This option will highlight the list of wells from a UWI list.
Save - This option will save the currently highlighted wells to a UWI list.
Save WSN - This option will save the currently highlighted wells to a WSN list.

Invert List - The "Invert List" option changes the status of each selected well to
nonselected and each nonselected well to selected well.

Select All - This button will highlight all wells on the available well list.
Select None - This button will deselect all wells on the available well list.

4.8 Compute Functions

Petra contains many compute functions, largely divided up by the general type of data
analyzed.

To open any of Petra's compute tools, select *Compute>* from the menu bar at the top of the Main Module.

**Using Log Curves**

**Using Zones or Tops**

**From Production Data**

**Using Locations**

**Using Test Data**

**Using Interval Data**

4.8.1 **Using Log Curves**

To open any of Petra's log compute tools, select *Compute>*From Logs* from the menu bar at the top of the Main Module.

**Footages (Reservoir Properties)**

**Statistics**

**Equation Expression**

**Substitution**

**Pay Flag Curve**

**Normalization**

**Pay Continuity**

**Advanced Transforms**

**Pay Report**

**Sum Raster Pay Within Zone**

**Extract Log Stats to Int Data**

4.8.1.1 **Log Footage Summation**

The Log Footage Summation function calculates log footage and reservoir parameters using digital logs. Essentially, the Footage Summation function analyzes digital logs and sums up the footage that meets a set of user-defined criteria. This footage is stored as a zone data item.
These summed footages and reservoir parameters can be computed for one or more zones simultaneously. The calculation can be done for all selected wells in the main module or on only the currently selected well in the main module.

As an example, Petra can calculate net pay in the D sand by computing how much section has GR below 60 API, porosity above 10%, and resistivity above 10 ohms between the top and bottom of the D sand. As shown in the following log, only the interval from 6346' to 6353' fits all three criteria, and will calculate as "Net."

Calculating a Gross footage, a Net footage, and a Net/Gross ratio will generate a set of data items that look like this:

```
<table>
<thead>
<tr>
<th>Item</th>
<th>Src</th>
<th>Units</th>
<th>Value</th>
<th>Qual</th>
<th>Test Item or Pemark</th>
<th>LogDate</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROSS</td>
<td>43</td>
<td>000</td>
<td>0.0</td>
<td></td>
<td></td>
<td>03/27/2009 Gross</td>
<td></td>
</tr>
<tr>
<td>NET</td>
<td>6</td>
<td>000</td>
<td>0.00</td>
<td></td>
<td></td>
<td>03/27/2009 Net</td>
<td></td>
</tr>
<tr>
<td>NGR</td>
<td>0.14</td>
<td></td>
<td>0.14</td>
<td></td>
<td></td>
<td>03/27/2009 NetGross</td>
<td></td>
</tr>
</tbody>
</table>
```

To open the Log Footage Summation tool, select Compute>From Logs> Footage (Reservoir Properties)... from the menu bar at the top of the Main Module.

**Data Tab**

All the curve drop down boxes on the lower half of this tab have two names. The "Porosity" drop down box is also "Condition 1."

The first through fourth Log Curve drop down boxes, "Porosity", "Water Sat", "Permeability", and "Gamma Ray" only need to be filled with the named log (a density porosity log in the "Porosity" slot, for example) if you are calculating the reservoir statistical measurements Poros Ft, Perm Ft, Hydrocar Ft, Avg Porosity,
Avg Perm, or Avg SW. The first three footage types, Gross, Net, and Net/Gr, completely ignore these named definitions.

The Gross calculation sums footage in the Gamma Ray/(Condition 4)'s drop down box. You can easily put an SP or resistivity curve as your "Condition 4" and calculate Gross feet on that. Similarly, the Net calculation sums footage that satisfies conditions on all checked drop down boxes regardless of curve drop down box name. In the screenshot above, a Net calculation will sum log footage that has density porosity (DPHI) between 0.10 and 1, gamma ray (GR) between 0 and 100 API, and a deep induction (LLD) between 10 and 9999. In the example above, putting the LLD curve into the Permeability/(Condition 3) drop down box will still have the same result.

Compute Footages For (Enter Zone Field Name)

First, select the type of footages to calculate by checking the small box beside each reservoir parameter. Each of these footage parameters will be stored as a data item in the zone selected in the Depth Zones Tab. Default names for the data items are provided for each parameter, but these names can be changed by simply typing over the name. As an example, you can change "GROSS" to "D_SAND_GROSS."

Gross - Gross footage is computed using one of two methods selected in the Options Tab. It is either the isopach thickness based on the zone's upper and lower depth or it is summed using the Gamma Ray/(Condition 4) log curve cutoff condition.

Net – Net footage is the summation of the total number of feet where the Porosity/(Condition 1) curve passes its cutoff criteria. All checked log curve drop down boxes cutoffs are used as cutoff criteria.

Net/Gr (NGR) - Ratio of the Net divided by Gross. You must compute Net and Gross
in order to compute Net/Gr.

**Poros Ft (PHIH)** - Summation of each sample interval multiplied by each *Porosity/(Condition 1)* curve value passing all cutoff criteria. You must also select Net with this option.

**Perm Ft (KH)** - Summation of each sample interval multiplied by each *Permeability/(Condition 3)* curve value passing all cutoff criteria. You must also select Net with this option.

**Hydrocar Ft (SOPHIH)** - Hydrocarbon Feet is the summation of each sample interval multiplied by each *Porosity/(Condition 1)* times 1.0 - *Water Sat/(Condition 2)* passing all cutoff criteria. Requires porosity and water saturation curves.

**Avg Poros (PHIA)** - Arithmetic mean value of all *Porosity/(Condition 1)* curves values passing all cutoff criteria.

**Avg Perm (KA)** - Arithmetic, geometric, or harmonic mean value of all *Permeability/(Condition 3)* curve values passing all cutoff criteria. Select the method of averaging in the Options Tab.

**Avg SW (SWA)** - Arithmetic mean value of all *Water Sat/(Condition 2)* curve values passing all cutoff criteria.

**User Ft** - Summation of the total number of feet where all cutoff criteria are meet.

### Log Curves and Conditions

This section is used to select the log curves and their cutoff criteria for the summation. Check the small box to the left of each curve drop down box list to indicate selection. Unselected boxes are not used as cutoff criteria.

**Porosity Log** - This log is used for all Net calculations as well as for PHIH, HPV, and PHIA calculations. You may select any type of log here to be used in a generic Net calculation.

**Water Saturation** - When used for HPV calculations, this log must specify a water saturation curve. For generic Net calculations, specify any log type.

**Permeability** - When used for KH and KA calculations, this log must specify a permeability log. For generic Net calculations, specify any log type.

**Gamma Ray** - When used for "Gross Sand" calculations, this log should specify a gamma ray, vshale, or other sand indicating log curve. Otherwise, you may specify any conditional curve for net calculations.

**User Log** - Any additional log curve and condition you want to use.

### Cutoff Criteria

For each log selected for use, enter the cutoff limits as the minimum and maximum
allowed values. The curve "passes" the conditional test whenever its value falls within the minimum and maximum range. Be careful of values expressed as a percentage, like porosity. 5% porosity can be expressed as "5" or as "0.05." Make sure to check your logs for consistency.

View Zone Fields... - This button brings up the "View/Edit Zone Data" dialog where you can check computed results.

Depth Zones Tab

Compute Footages Over Zones

Petra reads the top and bottom depths defined on the selected zone's interval definition, and will calculate footages over that interval. In this example, the D_Sand zone is defined by the D_SAND fm top as the top, and BASE_D_SND fm top as the base. This interval can be further constrained with the Filter Tab. Since the limits of the calculation come from each zone definition, you can select one or more zones for the reservoir footages calculation.

If your zone intervals are defined by the default -99999.0 to +99999.0 MD - You will need to either define the zone, or specify a top and bottom with the Filter Tab. Otherwise, Petra will calculate log footage from -99999 to 99999 MD. Since any limits will come from the Filter Tab, you can only select one zone to calculate reservoir footages.

After the summation, each selected zone will contain new data items for each reservoir summation checked and named in the Data Tab.

Source Code for Output Zone Items – This adds a source code to newly created
reservoir data items. Changing the Source Code when repeating a log footage summation will create an entirely new set of data items with the new source code.

Options Tab

Correct Footages For TVD - Check this option if you wish to use True Vertical Depths instead of Measured Depths. This will have an effect only on wells with survey data.

Use Log Curve Aliases - This option causes log aliases to be used. When a specified curve is missing, an alias log will be used. This is very useful for large projects. Log curve names are aliased under the Log Tab in the main module.

Store Errors in Remarks Field - Use this option to store a remark in the zone item containing the reason a well could not be computed.

Substitute WELL TD When Missing Base of Zone Interval - Use this option to use the TD value as the base of the zone interval whenever the interval top is present but the interval base is missing (null). The TD value must be stored in the WELL zone and TD zone item. The quality code field of the computed value will contain a code of "TD" to indicate that the TD was substituted for the base. This can generate anomalously high results if there is more log section below the interval of interest, or anomalously low results if the well does not completely penetrate the interval.

Write Warnings to Report File – this generates a report file called "FOOTSUM.TXT" in the project's PARMS directory. This will report errors due to missing tops or incomplete log sections.

Correct for Fractional Depths - This option determines whether a full or fractional amount of the sample rate is accumulated for the first and last depth sample. For
example, if a zone started at fm top 4100.5 ft and the curve sample rate was 1.0, with values at 4100.0 and 4101.0, then checking this option would sum only 0.5 ft for the first sample, instead of 1.0 because only half of the data falls within the zone. When this option is unchecked, any sample that passes the conditions gets a full sample rate accumulated.

Flag Quality with "+" If Any Nulls Found in Zone – This generates a "+" sign in the quality field if any null values are found in any curve used for a log footage calculation. This is a sign that part of the curve was not used, so the footage reported is a minimum.

GROSS Calculation Method
This section determines how "GROSS" is computed for each zone.

Gross Interval Thickness Only - This option subtracts the upper interval depth from the lower interval depth. Interval depths are defined by the zone reference depths. If the log curves define a smaller interval, i.e., the log data does not extend over the entire zone, then the Gross value will reflect the smaller interval thickness.

"Gross Sand" Thickness (Passes GR/(Condition 4) Condition Only) - This option must have a Gamma Ray/(Condition 4) curve specified and the resulting Gross value is the number of feet where the curve passes its cutoff condition. Any log, such as an SP or resistivity log, can be placed in the Gamma Ray/(Condition 4) drop down box for this calculation.

Average PERM (KA) Calculation Mode
This selects the method of computing average permeability.

Compute For
This simply chooses whether a footage summation is for calculated for all selected wells in the main module, or only for the currently selected well in the main module.

If Depths or Any Logs Are Missing
This tells Petra how to deal with missing log curves or depths.

Do Not Overwrite DB – This option will not write anything to the database. Use this if you have already done work in these exact zone data item fields.

Store Zero – This option will overwrite the data item with a zero. A missing GR curve does not mean that there is no pay, so use caution with this option.

Store Null – This will overwrite a value in the data item with a null.

If Cutoff Conditions Are Not Met
This tells Petra how to handle logs that do not meet the petrophysical cutoff
conditions outlined in the Data Tab.

Do Not Overwrite DB – This option will not write anything to the database. Use this if you have already done work in these data item fields.

Store Zero – This will overwrite the database with a zero. A full suite of logs that does not meet the cutoff conditions probably does mean that there is zero net pay. However, odd log scaling or percentages stored as integers (5% as "5") can result in curves not meeting cutoffs when they should.

Store Null – This will overwrite the data item with a null.

Capture Tab

The Capture Tab allows you to collect other data about the footage operation.

"Pay" Counts - This section allows you to capture the number of "pay" intervals that passed the cutoff criteria within each computed zone. The number of "pay" intervals will be stored in the specified Zone Item name. There will be a count for each zone interval selected for calculation. Higher pay counts can reflect multiple pay intervals within a zone, or more variable reservoir quality.

Percent Interval Covered – This section allows you to capture the percentage of the zone covered by logs. Petra reads the upper depth of the shallowest log curve and the lower depth of the deepest log curve, and compares these to the zone definition to calculate a percentage. If your zone is defined by the default -99999 to 99999 MD, this will be a meaningless number.

Pay Flag Curve – This section generates an additional log curve that reflects the Net log footage summation. Pay and Non-Pay can be defined as any number or null values. Usually, Pay is defined as 1 and Non-Pay as 0 or Null.
In the D sand example, the pay zone at 6350’ defined by GR, LLD, and DPHI is clearly shown by the PAY curve at the far right. In addition to simply showing pay intervals, these curves can be useful in log calculations. For example, to selectively erase a curve everywhere but over a pay zone you can multiply porosity by a pay curve where pay is 1, and non-pay is null.

**Filter Tab**

The filter tab sets controls on what log interval inside the zone definition is considered during the footage summation.

**Depth Bounds**

Setting Depth Bounds allows you to set upper and lower limits on the interval inside a
zone used for a log footage calculation. These limits can be from a discrete MD or TVD depth, or from fm tops. How this works will depend on how you have defined your zone.

**If your zone intervals are defined by tops and are selected in the Zones Tab** – Setting a limit in the Filter Tab can only limit the interval inside zone-defined top and bottom as limits. This can be useful if your selected zone is defined as a large interval, and you want to calculate footages over a relatively smaller interval inside that zone.

**If your zone intervals are defined by the default -99999.0 to +99999.0 MD** - Specify a top and bottom with the Filter Tab. Otherwise, Petra will calculate log footage from -99999 to 99999 MD.

**Use Top Aliases** – This tells Petra to use top aliases in setting limits. Top aliases are set in the Main module under the FmTops Tab.

**Use TD if Missing Lower Top** - Use this option to use the TD value as the base of the zone interval whenever the interval top is present but the interval base is missing (null). The TD value must be stored in the WELL zone and TD zone item. The quality code field of the computed value will contain a code of "TD" to indicate that the TD was substituted for the base. This can generate anomalously high results if there is more log section below the interval of interest, or anomalously low results if the well does not completely penetrate the interval.

**Use Depth Bounds even if Zone Depths Are Missing** – This tells Petra to use the depth limits set in the Filter Tab if the tops that define the Zone are absent (see above). If your zone intervals are set to the default -99999 to 99999 MD, this button has no effect.

**Thickness Restriction**

This sets a minimum and maximum pay thickness that will be added to the summation. Without this restriction, an interval with 15 two foot thick uneconomic stringer sands will add up to 30' of pay.

**File Tab**

The File Tab allows you to save log footage settings and recall them later. This is useful if you are working with multiple pay zones or with running multiple petrophysical cutoffs. Saving templates is also useful for running batch footage summations with the Batch Tab.
Load Template - This button loads an external log footage template file.

Save Template - This button saves the current settings to an external log footage template file.

Export Tab

The Export tab allows you to export a comma delimited spreadsheet file (*.CSV) that contains the top and base of each log interval meeting the log criteria. This can be very useful for developing an inventory of uphole pay zones behind pipe.
This CSV exports UWI, Name, Number, Label, Top in MD, Base in MD, Top in SSTVD, and Base in SSTVD.

For the D Sand example above, a Net footage export looks like this:

"UWI", "NAME", "NBR", "LABEL", "TOPRD", "BASERD", "TOPSSTVD", "BASESSTVD"
"GS1251950500", "FEDERAL HOOKER", "4-21", "4-21", 6340.0000, 6350.0000, -1612.0000, -1627.0000

Of the types of footages, only the Net and Gross intervals have a top and a bottom; the rest, like Net/Gr, are statistical measurements of reservoir quality. When a Gross interval alone is calculated, this export will be gross interval. When a Net interval alone is calculated, this export will be the net interval. If Gross and Net are simultaneously calculated, the export will be the net interval.

Store Top-Base Intervals to Pay Database

This option allows you to save the intervals to the raster pay database.

Batch Tab

The Batch Tab allows you to run multiple log footage summation templates (see FILE TAB above) as a batch. This is particularly useful for areas with multiple pay zones, or for running summations on the same zone in different ways with different curve conditions. You change the queue either by using "Select Files" or by using the add ",--", drop ",--", or clear all items ">>" buttons.

Select Files - This button adds multiple template files from the same location. Click "Select Files" and navigate to the location of your template files. Next, highlight the template files by left clicking and dragging the mouse or by using SHIFT+Left click or...
CTRL + Left click. It is important that template files are all in the same place. **Using "Select Files" again will replace any already selected template files.**

Using the Add and Subtract buttons is faster for adding multiple files in different locations. Click the add button "<", and navigate to the location of your template file. You can only add one template at a time this way. The subtract button ">" will drop a selected template file. The drop all templates button ">>" will clear the list.

### 4.8.1.2 Log Statistics Calculation

The Log Statistics function computes simple statistics on a selected log for one or more zones. The results are stored in the zone items database. The calculation will be done for all currently selected wells on the Main Module.

To open the Compute Log Statistics tool, select Compute>From Logs>Statistics from the menu bar at the top of the Main Module.

**Data Tab**

The Data tab selects the digital log curve and the statistics to derive from the log.
Select Log Data From
This section sets the log for the statistical calculation. The dropdown menu contains a list of every digital log curve in the project.

Use Alias Logs - This option uses log curve aliases when the selected curve is absent. Disabling this option will force Petra to only use the exact curve name.

Compute Items
The Compute Items section selects the desired statistical calculations, controls a couple of options on the statistics, and sets the data item that will store the result in each well. By default, Petra names each data item by the statistic and the curve name. Calculating the Sum on the ABHV curve (as in the screenshot above) creates a default data item Sum_ABHV. These names are defaults only; to change the name, simply overwrite the existing.

Sum - This option simply adds all the curve values together. Note that this calculation can be affected by the curve's sample rate, the "Compute 'Sum' Using" option on the Options Tab helps to normalize sums by sample rate.

Minimum - This option simply finds the minimum.

Maximum - This option finds the maximum value for the curve.

Mean - This option finds the mean or average for the curve. The "Mean Calculation" option below sets whether the mean is Arithmetic, Geometric, or Harmonic.

Std Dev - This option finds the standard deviation for the curve.

Percentile N = - This option finds the value of the curve at the selected percentile. By default, Petra looks for the 10th and 90th percentiles. To change the percentile, simply type in the desired number between 0 and 100.

Depth - This option calculates the depth at which the Minimum or Maximum log value occurs in the zone.

View Zone Data... - This button opens the View/Edit Zone Data tool. This can be useful for checking computed results without closing the Log Statistics Calculation Tool.

Compute For Zones
This list selects the zones used in the calculation. Petra uses Zones to both set the data item's location and the depth interval over which the log statistics are computed.
As an example, selecting the "D_Sand" zone will put the calculated data items into the D Sand Zone, and use the zone's interval definition to limit the calculation to only the log curve inside the D Sand zone.

This tool requires the Zone's interval definitions to be set - the default -99999 to 

Source Code For Results

This option adds a source code to the statistics data items.

Options Tab

Compute "Sum" Using - A curve with a sample rate of 0.5' has twice as many values as a curve with a 1' sample rate. Even with identical curve profiles, the 0.5' sample rate curve will have a sum twice as high as the 1' sample rate curve. This option multiplies the computed curve sum values by the curve sample rate.

Zone Item Discriminator – This option uses a numerical zone data item to filter the calculated statistics. When this option is selected, Petra will check every curve value against this number and ignore values that meet the criteria. As an example, this tool can set an upper limit on porosity values, so wash-out induced porosity spikes are ignored.
Log Curve Discriminator – This option uses a discriminator curve to filter the statistical data. At depths where the discriminator curve contains a 0 or null value, the corresponding depth will be skipped in the statistical calculation. If this box is checked and the log is absent, the statistics will not be calculated.

4.8.1.3 Log Equation Transform

This function allows you to compute a log curve from one or more logs by specifying a generalized equation transform. After the equation is written, you assign equation variables to database variables. Equation variables may be logs, zone data items (including fm tops), numeric constants, or curve depths.

To open the Log Equation Transform tool, select Compute>From Logs>Equation Expression... from the menu bar at the top of the Main Module.

Equation Tab

In the Equation Tab, you can enter an equation using variables and mathematical operators. The variable on the left side of the equal sign is the result variable.

Variables

Variables are just text, which can either be very specific (“GAMMARAY” or “FORMATION_TEMPERATURE”) or general (“A” or “B”).

Mathematical Operators

Petra recognizes a wide variety of mathematical operators:

+ Addition
- Subtraction
* Multiplication
/ Division
** Exponent

ABS(x)       - Absolute value of x
ACOS(x)       - Arccosine of x (in radians)
ASIN(x)      - Arcsine of x (in radians)
ATAN(x)       - Arctangent of x (in radians)
COS(x)      - Cosine of x in radians
COSH(x) - Hyperbolic cosine of x (radians)
EXP(x)      - e to power of x
INT(x)            - Truncated value of x
LOG(x),LN(x)      - Natural Log of x
LOG10(x)      - Log based 10 of x
MAX(x,y)      - Maximum of x and y
MIN(x,y)      - Minimum of x and y
ROUND(x)      - Rounded value of x
SIN(x)            - Sine of x in radians
SQRT(x)      - Square root of x
SQR(x)      - x squared
SINH(x)      - Hyperbolic sine of x (radians)
TAN(x)      - Tangent of x in radians
TANH(x)      - Hyperbolic tangent of x (radians)

Operator Order
1 Exponent
2 Multiplication and division
3 Addition and subtraction

Use of parentheses can change the order of precedence.
Example Equations

GRN = GR - MEAN_GR + MEAN
LOGNRM = LONORM + (LOG - PICKLO) * (HINORM - LONORM) / (PICKHI - PICKLO)
LOGNRM = LOG + LOGPICK - GOODPICK
SW = (RW / (RT * (PHI**M)))**(1/N)
R = ((A + B * (C - 1.0)) / 100
R = X*SIN(A) + Y*COS(B)
R = LOG10(X)
R = X*X or R = SQR(X)
R = X**Y (x raised to the y power)

Load and Save Buttons

You can save equations in the system equation file and load them at a later date. A number of useful equations come packaged with Petra.

Options Tab

The Options Tab limits the calculation to a set depth or to a subset of wells in the
4.8.1.3.1  Log Equation Assignments

After creating the log equation, the next step is to assign specific logs, zones, constants, or log depths to the variables.

Assignments Tab
Now that the equation is parsed, you can assign your output log and variables.

**Output Log** - Petra will create a log curve that uses the same variable name to the right of the equation if that curve does not exist. In the example above, Petra will create a new curve named “DPHI.” Alternatively, click the drop down box and assign the output curve to an existing curve name.

**Equation Variable Assignments** - This is where you tell Petra what logs, constants, or zone data items you want included in the equation. Click on a variable in the “Equation Variable Assignments” box. Next, click on a Log, Zone, Constant, or Log Curve Depth button in the “Assign Variable To” section. Click on the associated drop down box and find the specific log or data item or enter a constant. Finally, click on assign. This will change the Equation Variable Assignments box to reflect the correct variable. Using the exact curve names in the equation tab will cause Petra to “guess” at the variable assignments, which can save time.

**Options Tab**

Remember that fm tops are data items in the FMTOPS zone. Under the Options Tab, you also have the option of using MD, TVD, or SSTVD depths in the equation.
4.8.1.4 Log Curve Substitute

This log function performs a conditional data substitution using "if-then-else" type logic. You specify the source log to be evaluated along with the logical condition to test the source log against. In addition, you specify what output results you want when the test evaluates to true and what output results you want when it is false.

An example of this logical test might be; "If GR is equal to NULL then set GR to GR_NRM, else set GR to GR". This operation would substitute the GR_NRM curve for any NULL values found in the GR and replace GR curve in the database.

To open the Log Curve Substitute tool, select Compute>From Logs>Substitute from the menu bar at the top of the Main Module.

This function can be used to fill in NULL sample values from another log, or set specific values to NULL or some other value.

The substitute function will be applied to all currently selected wells, i.e., those wells showing in the main window list.

Select the desired options then click the OK button to perform the substitute function.
Log To Evaluate (source)

This dropdown sets the log curve to evaluate.

Condition

This section contains the logical condition to test the source log against. Available conditions are:

- EQUAL TO
- LESS THAN
- LESS THAN OR EQUAL TO
- GREATER THAN
- GREATER THAN OR EQUAL TO
- NOT EQUAL TO

Compare To

This list box contains all available logs in the project. Select the data to compare the source log to. You may select another log curve, test against a constant value, or test the source curve for a NULL or missing value.

When True, Result Is

This list box contains all available logs in the project. Select the data you want the results to contain when the condition evaluates to TRUE. You may select another log curve, test against a constant value, or test the source curve for a NULL or missing value.
When False, Result Is

This list box contains all available logs in the project. Select the data you want the results to contain when the condition evaluates to FALSE. You may select another log curve, test against a constant value, or test the source curve for a NULL or missing value.

Store Output Log In (results)

This list box contains all available logs in the project. Specify the name of the log curve you want the output results to be stored in. You may select an existing log or type in a new log name for which you will be prompted for the new log description.

Delete If Missing Any Logs - Check this option if the output log should be deleted if any of the logs used in the comparison are missing for the well.

Restrict Depth Range... - The log substitute function can be applied to the entire log depth range or restricted to a specific depth interval. The depths can be set using a constant range or variable range based on the formation tops.

4.8.1.5 Compute Pay Flag Curve

The Compute Pay Flag Curve function generates a binary log curve that shows where log curves meet a set of user-defined criteria. In other words, Petra creates a log that distinguishes between pay and non-pay based on log parameters. In the curve, pay and non-pay can be defined as any number or null values. Usually, pay is defined as 1 and non-Pay as 0 or Null.

As an example, Petra can distinguish pay in the D sand by GR below 60 API, porosity above 10%, and resistivity above 10 ohmm between the top and bottom of the D sand. As shown in the following log, only the interval from 6346’ to 6353’ fits all three criteria. The pay curve on the right demonstrates this interval.
In addition to simply showing pay intervals, these curves can be useful in log calculations or to show contacts. For example, to selectively erase a curve everywhere but over a pay zone you can multiply porosity by a pay curve where pay is 1, and non-pay is null.

To open Compute Pay Flag Curve Tool, select Compute>From Logs>Pay Flag Curve from the menu bar at the top of the Main Module.

Input Curves Tab

Curves and Cutoffs  This section is used to select the log curves and their cutoff criteria for the curve calculation. Select the curve name and establish the condition and cutoff value.

Available conditions are:

EQUAL TO

LESS THAN
LESSTHAN OR EQUAL TO
GREATER THAN
GREATER THAN OR EQUAL TO
NOT EQUAL TO

For each log selected for use, enter the cutoff limits as the minimum, maximum, or exact value. Log curves can also be selected as a variable cutoff. As an example, a “gas effect” cutoff can be established so pay is only where neutron porosity is less than density porosity. Unselected boxes are not used as cutoff criteria.

Use Log Curve Aliases - This option causes log aliases to be used. When a specified curve is missing, an alias log will be used. This is very useful for large projects. Log curve names are aliased under the Log Tab in the main module.

All/Any Condition Met - In the example above, the pay curve criteria is GR below 60, LLD above 10, and DPHI above 10%. An interval that has fits all these criteria will be flagged as pay. You also have the option to select whether any conditions are met. This would flag any interval where any of these criteria pass as pay.

Output Curve Tab

The Output Curve sets the name and specific values of a pay curve.

Output PAY Flag as Curve - By default, Petra will create a log curve called PAY. Alternatively, enter a new curve name.

Curve Value when PAY - This entry sets the curves value when the criteria on the Input Curves Tab is satisfied. By default, pay is 1.

Curve Value When NON-Pay - This entry sets the curves value when the criteria on the Input Curves Tab is not satisfied. By default, non-pay is zero.

Set to NULL - This entry box will assign null values to non-pay.
Update/Replace Existing Pay Curve – When the pay curve named above already exists and you are replacing it inside a certain depth range (see below in the DEPTH TAB), you have the option of updating the curve or replacing the curve. Updating the curve will merge the new pay curve into the existing one, leaving the pay curve outside of the depth limits untouched. Replacing the curve, on the other hand, will null the rest of the pay curve outside of the depth limits.

Depths Tab

The Depths Tab allows you to set limits on the extents of the pay curve calculation.

Set Depths... - This button opens the to set limits based on discrete MD or TVDSS depths, fm tops, or from zone definitions. In the Set Depth Range box, select the relevant top, MD, or TVD button. For MD and TVD, select the relevant button and enter the adjacent depth in the entry field. For tops, select the desired top from the “Fm Top Name” dropdown box. Notice that an offset can also be added or subtracted to the fm top; this offset will include data points above or below the actual fm top depth.

In the example above, the pay curve will only be calculated from the top of the D sand to the base of the D sand.

Filter Tab

This sets a minimum thickness filter both for pay and non-pay.
Apply Minimum Bed Thickness Filter - This option enables and disables the minimum bed thickness filter.

In the example above, any interval that calculates as pay that is below 1' thick will be set to non-pay. Likewise, any non-pay intervals thinner than 1' will be set to pay. This is useful for “chattering” logs and washouts.

Pay Data Tab

This option allows you to save the pay curve-calculated intervals to the raster pay database.

Wells Tab

The calculation can be done for all selected wells in the main module or on only the currently selected well in the main module.
4.8.1.6 Cross Over Flag Curve

A Cross Over Flag Curve is a binary curve that shows where one log crosses over another. One of the most useful applications of this function is to calculate a “gas effect” curve from neutron and density porosity curves. This curve is useful for petrophysical calculations like log footages.

To open the Cross Over Flag Curve tool, select Compute>From Logs>Cross Over Flag Curve from the menu bar at the top of the Main Module.

Data Tab

The Data Tab is used to select log curves and their scales. Petra scales the curves to these values and calculates where one curve crosses another. In other words, cross over is calculated as if the curves were actually plotted. In the example below, cross over is established when neutron porosity (NPHI) is to the right of density porosity (DPHI) even though NPHI is on a 0-30 scale and DPHI is on a 0-0.3 scale.
Store Output Flag Curve As - The Output Curve sets the name and specific values of a pay curve. By default, Petra will pick the first alphabetized curve name in the database. Click the drop down box and assign the output curve a new curve or type in a name. In this example, the output curve will be named “Crossover.”

Use Log Curve Aliases - This option causes log aliases to be used. When a specified curve is missing, an alias log will be used. This is very useful for large projects. Log curve names are aliased under the Log Tab in the main module.

Options Tab

The Output Curve Values section sets the specific values of a cross over curve.

When Cross Over Condition - This entry sets the curves value when the criteria on the Input Curves Tab is satisfied. By default, pay is 1.

When Not Cross Over Condition - This entry sets the curves value when the criteria on the Input Curves Tab is not satisfied. By default, non-pay is zero.
Make NULL - This entry box will assign null values to non-pay.

Output Curve Update Mode – When the cross over curve named above already exists, you have the option of updating the curve or replacing the curve. Updating the curve will merge the new pay curve into the existing one, leaving the pay curve outside of the depth limits untouched. Replacing the curve, on the other hand, will null the rest of the pay curve outside of the depth limits.

4.8.1.7 Log Curve Normalization

The process of log normalization calibrates curves for several wells to a common scale. Typically, curves are calibrated using one of two methods; base line shift or scale range adjustment sometimes called sensitivity calibration. A base line shift adjusts the curves to a common scale by subtracting out the curve's current baseline and adding back in the desired base line value. Scale range adjustment attempts to calibrate the curves to have a common minimum and maximum value over the over the normalization depth interval.

For a longer discussion of log normalization, see the Log Normalization Overview.

Data Tab

The data tab section contains the input and output log curve selections and the normalization depth Zone.
Curve To Normalize - This dropdown selects the curve to normalize. This original curve will remain unchanged, and the normalized version of the curve will be copied to the "output curve selected below.

Use Log Aliases - This option uses log curve aliases for the input log curve to normalize. In practice, this option will attempt to replace the missing log curve name with one of the other "equivalent" logs on the alias list.

Normalized (Output) Curve - Select or enter a new curve name which will contain the results of the normalization.

Normalization Depth Zone - This option sets the upper and lower limit of the normalization based on a zone's interval definition. Ideally, this zone should restrict the normalization to a lithologic package in which the log curves have a common reading from well to well. Large depth intervals can skew results.

Method Tab

The method section determines which type of calibration is done. The Options Tab section sets more details for each method.

Base Line Shift - This method adjusts each curve by adding or subtracting a constant to the curve's values. In other words, this option simply shifts the curve left or right in order to fit each curve to a specified baseline. This baseline can either be a computed average or a user-set value. This method only changes the magnitude of the curve values, the shape of the curve remains the same.

In the example below, well A's original curve (blue) is very close to the overall baseline (in the middle of the track) while well B's original curve reads high and to the right relative to the baseline set in the middle of the track. Well A's normalized curve (red) doesn't shift too much, while well B's normalized curve shifts to the left.
A Base Line Shift applied to two curves in two wells (A and B). The original curves are in blue, and the normalized curves are in red.

**Scale Range (High-Low)** - This method adjusts each curve to have a common minimum and maximum value. This option effectively stretches and squeezes the curves to use a new range, which can change both the magnitude and shape of the curve. This method is best used to normalize old, less sensitive logs with newer, more sensitive logs. This method can adjust the curves to the computed average minimum and maximum values of all curves or to a user-defined range. This method can produce a "blocky" curve that often benefits from the Advanced Transform Module's Smooth Logs tool.

In the example below, well A's original curve (blue) covers most of the range set by the left and right edges of the track, while well B's original curve covers a smaller range. Well A's normalized curve (red) expands a little so that the maximum and minimum reach the edges of the track, while well B's normalized curve expands and shifts a lot more.

**Percentile Range** - This method adjusts each curve such that two given percentiles have a common minimum and maximum value. By using a percentile rather than the absolute maximum or minimum, this method is least prone to anomalous effects caused by washouts or other data spikes. This option effectively stretches and...
squeezes the curves to use a new range, which can change both the magnitude and shape of the curve. This method is best used to normalize old, less sensitive logs with newer, more sensitive logs. This method can adjust the curves to the computed average minimum and maximum values of all curves or to a user-defined range.

In the example below, well A's original curve (blue) covers most of the range set by the left and right edges of the track, while well B's original curve covers a smaller range. Well A's normalized curve (red) expands a little so that the P5 and P95 reach the edges of the track, while well B's normalized curve expands and shifts a lot more. Notice that the minimum and maximum extend beyond the set ranges.

Options Tab (Base Line Shift Method)

The Base Line Shift method provides two choices for normalization.

Normalize Mean Values to Average Of All Means - This option shifts curves to the computed average value for all wells.
Normalize Mean Values To - This option shifts curves to a user-defined value.

Store Computed Means In Zone Variable Name - This option stores the computed mean values for the original curve in a data item in the zone selected on the Data Tab. This can be useful for mapping or troubleshooting later. By default, Petra will store the mean in a data item called "MEAN_GR." To change this data item, enter a new data item name.

Options Tab (Scale Range Method)

Normalize Scale Range to the Average Computed High and Low Values - This option stretches the curves so that the maximum and minimum of each curve matches the average maximum and minimum curves of all curves.

Normalize Scale Range to the Low and High Values Below - This option stretches the curves so that the maximum and minimum of each curve are the "Scale Low Value" and "Scale High Value" entries.

Store Data Low and High values In Zone DB As - This option stores the computed high and low values for the original curve in two data items in the zone selected on the Data Tab. This can be useful for mapping or troubleshooting later. By default, Petra will store the high and low values in data items called "LOW_NORM" and "HIGH_NORM." To change this data item, enter new data item names.

Depths Tab

This tab controls how Petra limits the normalization process to a specific depth.
interval, and how Petra overwrites existing log curves.

Restrict Depths

This option opens the "Set Depth Range" tool, which controls the upper and lower limits of the normalization process. The depth interval can be specified in measured depth, TVD, or relative to formation tops.

In the Set Depth Range box, select the relevant top, MD, or TVD button. For MD and TVD, select the relevant button and enter the adjacent depth in the entry field. For tops, select the desired top from the “Fm Top Name” dropdown box. Notice that an offset can also be added or subtracted to the fm top; this offset will include data points above or below the actual fm top depth.

To set depths by a zone’s interval definitions, select the desired zone on the “Set Upper and Lower Depths From Zone” dropdown menu. Note that the WELL zone by default covers -1M MD to +1M MD, so it should cover the entire footage of all wells.

Output Curve Update Mode
This option controls how Petra overwrites curves already in the database. This can be important for normalizing the same curve over two or more different intervals.

**Replace Curve** - This option completely replaces the curve in the database with the latest normalized curve.

**Append to Curve Currently In Database** - This option simply adds the newly normalized curve to the existing curve. Where the new curve overlaps the existing curve, the new curve will overwrite older curve data.

**Wells Tab**

The Wells Tab specifies which wells will have their curves normalized.

[Image: Log Curve Normalization window with options: All Selected Wells, Current Well Only]

**All Selected Wells** - This option will normalize the curves for all wells currently selected in the Main Module.

**Current Well Only** - This option will normalize the curves only on the single well highlighted in the Main Module.

4.8.1.7.1 Log Normalization Overview

**Introduction**

Well logs provide the largest source of information available about the variation in lithology and fluid content within the subsurface. As the computational power available to the geological community has increased in recent years, the ability to process and map various rock properties based on digital log data has become easier. Mapping of these rock properties, either for a reservoir model or a regional
exploration play, can identify areas where the data does not make any sense in view of the other subsurface information. Further study may reveal that some rock types, such as anhydrite, that should have identical properties in all wells, actually has differing readings in some of the wells. This does not mean that this data should be eliminated from the study, but only that a higher degree of accuracy is needed for mapping. The process of log normalization adjusts the log data, in all of the wells, to have the identical response in an identical lithology; thus making the log data compatible with each other.

There are numerous reasons why the logging tools do not always provide identical readings in similar lithologies. These may include, but are not limited to: differing vintages of logs, differing logging companies, tool design, borehole environment, on-site tool miscalibration, tool malfunction, and improper scaling.

Goals and Philosophy

Prior to any log normalization, one should always keep in mind the final goal of the project, and ask the question 'how critical is the data to the final interpretation?' For example, if you are mapping a regional porosity trend which is truncated by erosion, with no seismic data to support the truncation edge, is it necessary to have the porosity data to within 1 porosity unit, probably not. If on the other hand, you are asked to provide the pore volume of a reservoir for an economic analysis for a potential CO2 flood, then the time would be well spent.

The objective of well log normalization is to improve the dataset, not create it. The final results using the normalized data are only as valid as the variation (locally and regionally) in the interval used to normalize the data. If the interval used to normalize the data turns out to be less consistent than what you originally thought it to be, then you may end up warping the data to make it consistent with a lithology in one area, which in reality is erratic in nature across the area. In other words, if you are not sure that normalization will improve the quality of the data in a particular well, then leave it alone.

Situations arise which make the normalization process more of an art form than science. Regional shales that are frequently the only available high gamma ray and high neutron calibration lithology may have wide variations due to hole enlargement, or a shaly sand section may not have any suitable low response 'clean' lithology. It is best that one takes some time in deciding how much variation is in deed present across the study area, by laying out some logs scattered across the area. How consistent are the lithologies? Of the consistent lithologies available, do they represent both the high and low curve readings seen on the logs? Do the high and low log readings occur near to each other, or are they widely separated in the wellbore? Do these lithologies extend across the study area? Is it necessary to correlate only certain zones for data display or is it sufficient just to display the entire digital dataset? You might consider computing the average gamma ray value over
the normalization interval using the Compute - From Logs - Statistics menu contouring the results.

It is best to keep good records, documenting your process of log normalization. One of the best places to do this is in the project - remarks file. This way, others can follow your steps in the future, or you can review your methods, when something doesn't go well. Always create new log curves, leave the original log curve intact. Sometimes one has to rethink the process and start over. In general, it is best to let well enough alone and use the results from your best attempt. If the process is unsuccessful, define your next try in terms of changing the original raw data, not another attempt on the already manipulated data.

If there are reasonably good normalization lithologies present in the wellbore, then you should be able to remove approximately 85% of the errors and other 'noise' in the data (Sheir, 1991). The remaining 15% of the 'noise' could be due to local changes in lithology, tool inaccuracies, or errors in normalization assumptions.

**Which Logs?**

Logging tool responses vary, some are consistently more accurate than others. Dan Shier (1991), indicated in a general terms the percentage of well log types, which needed to be normalized. The table is reproduced below:

<table>
<thead>
<tr>
<th>Log Curve</th>
<th>% Needing Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP</td>
<td>100%</td>
</tr>
<tr>
<td>Gamma Ray</td>
<td>90%</td>
</tr>
<tr>
<td>Sonic (Compensated)</td>
<td>3%</td>
</tr>
<tr>
<td>Density</td>
<td>25%</td>
</tr>
<tr>
<td>Compensated/Sidewall Neutron</td>
<td>20%</td>
</tr>
<tr>
<td>Old Neutron</td>
<td>100%</td>
</tr>
<tr>
<td>Induction</td>
<td>&lt;2%</td>
</tr>
</tbody>
</table>

It can be seen that with the SP, gamma ray, and old neutron logs it is best to normalize all of the logs. For curves like the sonic and induction it is best just to go through the dataset and select only those wells which are anomalous and set them aside for later study.

For the intermediate group of logs, including the density and the compensated/
sidewall neutron logs, the first task is to identify the wells in the study which appear to be consistent and to be correct. These are the 'type' wells. The other, more questionable wells are then compared to the nearest 'type' well and accepted as-is or set aside for normalization.

Method Overview

The objective of normalization work is to adjust all log curves so that they give an identical reading in an identical lithology. Because we will be re-scaling and shifting the curve response during normalization it is imperative that the curve be edited for any cycle skips, spikes or any other digitization errors before anything else is done.

Usually two different 'normalization lithologies' are used, one that has relatively high amplitude readings, and the other that has relatively low amplitude readings on the curve to be normalized. These two lithologies need not be found in a single contiguous zone. The zone(s) containing these 'normalization' lithologies, may or may not be separate from the 'objective' zone in which maps will be eventually be made.

The 'normalization intervals' should be correlated through all of the logs and the 'normalization zones' defined (if the entire curve is not be used as the normalization interval). If there are a number of curves to be normalized, it is better to define a normalization zone in the database, where all of the separate log 'picks' can be placed, keeping the general well zone from getting cluttered with data items.

Once these zone(s) have been defined in each well, a value representing the high and low log reading must be obtained. There are several methods were these values can easily be obtained:

Method 1:

Display a histogram of the curve to be normalized over the depth range of the normalization interval. (Histogram-Logs- Set Axes and Scales) The histogram shows the character of the log and is an excellent tool for picking the mode, mean, and the edges of the data accurately. Set axes and scales for the appropriate curve. Define the 'pick' by creating a high and low data item for the curve (example: highgr, lowgr, highsp, lowsp, etc.). Make the curve part of the data item name, especially if more than one curve is to be normalized.

Display the log curve to the right of the histogram, this will help when the 'pick' is made, to eliminate picking any data 'glitches'. Start picking the values in the histogram by hitting the start button located on the tool bar. With the curve displayed, pick from the histogram the 'high pick' in the high amplitude interval and the 'low pick' from the low amplitude interval, by toggling in the drop down menu between the various data items. Right click on the mouse to have the pop-up screen to either redraw the screen or to go on to the next well. It is best to do all of the
wells first, and then come back and review your picks, making any changes as needed. To reduce the time required to perform this task, you may want to proceed through all wells doing all of the 'high picks', followed by doing all of the 'low picks'.

After all of the picks have been made, display a frequency plot of each pick (main panel - zone - view/edit - norm. zone - high (low) - display stats). With the statistics displayed, record the mean high and the mean low curve values. These two numbers are the regional high and low normalization values used to normalize the individual well log in the study.

In the general case, log normalization requires that the log curve be shifted and scale adjusted at the same time. This is accomplished by applying a linear equation to each data point on the curve. The basic equation to normalize any curve is:

\[
CRVNRM = LONRM + (CURVE - PICKLO) \times \frac{HINRM - LONRM}{PICKHI - PICKLO}
\]

- **CRVNRM** = Normalized value
- **CURVE** = Raw value
- **HINRM** = Regional high normalization value (mean of all individual well's high values)
- **LONRM** = Regional low normalization value (mean of all individual well's low values)
- **PICKHI** = Well's high normalization value (i.e. zone.highgr, or zone.highsp)
- **PICKLO** = Well's low normalization value (i.e. zone.lowghgr, or zone.lowsp)

Compute the normalized log curve (compute-logs-equation expression either loading the normalization equation from the saved equations or enter the expression). Assign values to the equation with the regional high and low values entered as a constant and assign the well's high and low values from the appropriate zone. Create a new curve name for the curve that is being normalized, i.e. grnorm, or spnorm.

**Method 2:**

This method is very similar to the previous method. A PICKHI and a PICKLO are computed for each individual well instead of being picked from a histogram. Over the defined normalization interval, the statistical mean of the curve at the 90th
percentile (high) and 10th percentile (low) are computed. (Compute-log-statistics, check the nth percentile and n = 10 or 90 and compute the arithmetic mean over the normalization interval)

Using the 10th and 90th percentile also eliminates any spurious data due to data spikes or cycle skips which were not originally edited out of the data. The mean of the histogram of these values become our regional low normalization value (mean of 10th percentile) and high normalization value (mean of 90th percentile). These high and low picks can be displayed and modified using the histogram module as the starting point for method 1 described above. Compute the normalized curve in the same manor using MEAN90 and MEAN10 for the individual well’s normalization values.

**Method 3:**

In this method, the normalization interval should include both the high and low curve readings. Compute the mean and standard deviation of the curve over the interval. Histogram the mean and the standard deviation computed from all of the wells. Record the mean of each (i.e. mean of the mean, MEANT, and mean of the standard deviations, SDT). These 'means' become our regional or type value. The equation for normalization using the mean and standard deviation is:

\[
\text{CRVNORM} = (\text{MEANT} - 2\times\text{SDT}) + (\text{SDT}/\text{SDI})\times(\text{CURVE}-\text{MEANI}+2\times\text{SDI})
\]

- **CRVNRM** = Normalized value
- **CURVE** = Raw value
- **MEANT** = Regional mean normalization value
- **SDT** = Regional standard deviation normalization value
- **MEANI** = Well’s mean value (i.e. zone.meangr, or zone.meansp)
- **SDI** = Well’s standard deviation value (i.e. zone.sdgr or zone.sdsp)

**Checking the Results:**

It is a good practice to review the newly normalized curve. Histogram the new curve, over any interval, and step through the wells, displaying the curve distribution. Note any well that doesn't fit the general histogram pattern for the interval, and inspect
them for any obvious problems. These problem wells may have to be re-normalized.

Special Problems

Cased and Open Boreholes

Wells with log runs over both cased and open hole intervals have to be considered separately. This is especially true with the old neutron logs. In these cases the well has to be separated into cased and open hole sections and the log normalized over each portion separately.

Compaction related changes

Differences in compaction history can affect log response. This is not much of a problem in passive subsidence, but in areas of complex history, this could present to be a problem. Few sedimentary rocks change little with increasing burial depths, most notably low porosity carbonates and anhydrite. If these rock types can be used as normalization lithologies, generally effects of compaction can be ignored.

In sand/shale sequences most rocks display a systematic change with depth. Both sands and shales become more resistive, higher in density, lower in apparent neutron porosity and lower in travel time. In these cases, it is best to work with the shale and the shaly siltstones if at all possible.

Density compaction gradients are in the order of one porosity unit per 2000 feet of burial. If the structural relief is 2000 feet or less within the area, compaction changes between wells are not a significant concern. In areas of uniform dip, a linear trend surface generally provides the best regional pattern to which each well can be adjusted. If however, the residuals from that surface are non-random, further investigation is needed.

Comments on Various Log Types

SP Log

The best procedure with dealing with the SP log is to rescale it in units of percent deflection, where a 0% deflection represents the maximum right hand deflection (maximum shale) and a 100% deflection represents the maximum left hand deflection (clean sand). The first step is to establish a shale base line for each SP log. This is easily picked interactively from the cross section module (logs - pick baseline cut-offs). When this data item is subtracted from the digitized curve, the resulting curve should ideally have no drift. If the salinity of the formation water does not change over the digital interval, a histogram of the newly formed driftless curve should
provide the needed clean (low) and high (shale) picks. This assumes that a clean sandstone is present within the interval. In cases where only shaly sandstones are represented, then it is best to set their maximum left hand deflection (clean) at 70% or some other arbitrary value (i.e. thick submarine fan sections).

Gamma Ray Logs

As a rule regional shale sections are chosen as high-pick gamma ray normalization zones. Highly radioactive uranium-bearing shales such as the Barnett Shale does not make a good normalization interval. These shales usually have values, which lie outside the range of some of the older gamma ray detectors for which they were designed for (Shier, 1991).

Old gamma ray logs should be converted into API units per the listed chart, prior to normalization.

Old gamma Ray Log Conversion Units (Hilchie, 1979)

<table>
<thead>
<tr>
<th>Service Company</th>
<th>Conversion Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>API Units</td>
<td></td>
</tr>
<tr>
<td>Schlumberger</td>
<td>1 ug Ra equiv./ton</td>
</tr>
<tr>
<td>16.5</td>
<td></td>
</tr>
<tr>
<td>Lane Wells</td>
<td></td>
</tr>
<tr>
<td>Series 400 (scintillation)</td>
<td>1 radiation unit</td>
</tr>
<tr>
<td>2.16</td>
<td></td>
</tr>
<tr>
<td>Series 300 (geiger counter)</td>
<td>20.2 counts/minute</td>
</tr>
<tr>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Series 200 (ionization ch.)</td>
<td>1 standard unit</td>
</tr>
<tr>
<td>216.0</td>
<td></td>
</tr>
<tr>
<td>PGAC</td>
<td></td>
</tr>
<tr>
<td>Type F (geiger counter)</td>
<td>1 microroentgen/hr.</td>
</tr>
<tr>
<td>14.0</td>
<td></td>
</tr>
<tr>
<td>Type T (scintillation)</td>
<td>1 microroentgen/hr.</td>
</tr>
<tr>
<td>15.0</td>
<td></td>
</tr>
</tbody>
</table>
| McCulloough                          | 1 microroentgen/
Sonic Logs
Sonic logs are not subject to sensitivity problems, where only curve shifting is required for normalization. The best lithology is to choose a non-porous (limestones or anhydrites), low travel time interval (lithology) for the normalization lithology.

Neutron Logs
All neutron logs are based on the relationship that porosity is inversely proportional to the log of the counts/second. A relatively small error in calibration at the wellsite corresponding to the high porosity lithology leads to large errors in the apparent porosity of reservoir rocks. A relatively large error the counts/second in tight lithology produces a small inaccuracy in porosity. In many cases, the zero porosity is correct, but the high porosity end is off and a scaling factor must be applied.

Old Neutron Logs
Old neutron curves require one additional step, which is not needed for any other curves (Shier, 1991). This step converts a linear scale of counts/second (but logarithmic with respect to porosity) to one that is linear with respect to porosity. Shier (1991) describes the method as picking the PICKHI and PICKLO first from modern compensated neutron logs. These same high and low values are recognized on the old neutron logs and recorded. These four data items are entered into the following equation:

CVNORM = The antilog of:

\[
\text{CVNORM} = \frac{\text{CURVE} \times (\log Rhp - \log Rlp) + (Whc \times \log Rlp) - (Wlc \times \log Rhp)}{(Whc - Wlc)}
\]

CVNORM = Normalized neutron porosity in percent porosity
CURVE = Raw neutron porosity in counts/second, etc.
Rlp = Regional value of low porosity lithology in percent porosity
Rhp = Regional value of high porosity lithology in percent porosity
Wlc = Low porosity lithology for the well in counts/second
Whc = High porosity lithology of the well in counts/second

Note, if only a few old neutron logs are in the study it is probably best to simply ignore them for mapping purposes.

Density Logs

Nearly all of the non-porous rocks encountered in the petroleum industry have densities in the 2.6 to 2.9 gm/cc range. Coal and anhydrite are the exceptions. Within this density range it's usually possible to establish one good normalization lithology. Establishing a second reliable normalization lithology at a lower density level usually proves to be impossible, due to the fact that these lower densities are affected by hole enlargement and are also frequently blurred by overlapping lithologic variations. Log normalization is done strictly by curve shifting. This lack of establishing a reliable low-density lithology does not introduce the inaccuracies that might be expected because the reservoir beds are not very different in density than the normalization lithology that was used (Shier, 1991).

Resistivity Logs

It is generally best not to normalize any of the resistivity curves. Use them as-is in standard log analysis, correcting for mud resistivity, etc. as needed.

References


4.8.1.8 Pay Continuity

This function can be used to compute the percentage of pay that is "continuous" between a well and its neighbors.

Pay in each well is represented by a selected "pay flag" (0 or 1) digital log curve over one or more Zone intervals. Depth matching in wells is determined by Zone tops and bases. Pay is considered "continuous" between two neighboring wells when both zones contain a non-zero pay flag value. The continuity calculation computes the percentage of total shared pay footage to total pay footage, with adjustments made for differences in thickness between wells.

Petra compares the amount of continuous pay between a “node” well and its “neighbor” wells. For each well, pay continuity is computed between the well and its nearest neighbors. The value stored in each well zone item is the distance-weighted average of the continuity values computed for each neighboring well.

The utility of a continuity calculation is only as good as the constraining zone definitions. This calculation works best on a zone with fairly tight depth limits and with few washouts. A thick zone definition containing multiple pay streaks will generate worthless numbers.

To open the Log Curve Substitute tool, select Compute>From Logs>Substitute from the menu bar at the top of the Main Module

Compute Tab

Check the boxes and set the names of the zone items you want to compute.
Pay Continuity (%) - Zone Item Name for storing pay continuity percentages. Continuity values range between 0.0 and 1.0.

Avg Continuous Pay - Zone Item Name for storing average number of feet (or meters) of continuous pay in the "node" well.

Neighborhood Count - Zone Item Name for storing the count of the number of neighbors used in the calculation for the "node" well.

Total Pay - Zone Item Name for storing total number of feet (or meters) of pay in the "node" well.

Method of Continuity - Select method 1 or 2 as described above. Method 1 calculates continuity as a percent of the sum of the pays in both wells, while Method 2 calculates continuity as a percent of the total pay in the node well.

Source Code for Computed Items - Enter the source code for storing any zone items.

Method 1

This method computes continuity as a percent of the sum of the pays in both “node” well and “neighbor” well.

CONTINUITY = (AC+BC)/(AT+BT)

Where

AC = #ft continuous pay in "node" well A
BC = #ft continuous pay in “neighbor” well B
AT = total #ft of pay in "node" well A
BT = total #ft of pay in “neighbor” well B

In the above example, Zone I is 100% continuous between wells A and B. Zone II is discontinuous, i.e., 0% continuous. Zone III would be (10'/15') or 66% continuous. For well A, total continuity, for zones I, II and III, would be 66%.

Where, AC=10, BC=10, AT=20, BT=10 CONT=(10+10)/(20+10)=20/30=0.66666

Method 2

This Method computes continuity as a percent of the pay in the “node” well only.

CONTINUITY = (AC)/(AT)

Where

AC = #ft continuous pay in "node" well A
AT = total #ft of pay in "node" well A

In the above example, Zone I is 100% continuous between wells A and B. Zone II is discontinuous, i.e., 0% continuous. Zone III would be (5'/10') or 50% continuous. For well A, total continuity, for zones I, II and III, would be 50%.

Where, AC=10, AT=20 CONT=10/20=0.50

Zone Tab
Select one or more zones for which you want pay continuity computed. Petra uses zone *interval definitions* to limit the interval calculated. If your zone intervals are defined by the default -99999.0 to +99999.0 MD, you will need to define the zone in the Main Module.

**Options Tab**

*Distance Search (Radius) for Neighboring Wells* - This section allows to limit the minimum and maximum distance between a "node" well and its neighbors. This limit is in XY map units.

*Maximum Number of Nearest Neighbors Used* - set the upper limit on the number of neighboring wells used to compute values at each node well. For example, if 8 is specified the 8 nearest wells to the node well are used. The neighbors must also meet the min-max radius condition. In other words, if a well is too far or too close than the minimum or maximum distances, it will be ignored.
Store NULL If Compute ZERO Value - Check this option when you want null values stored in place of zero pay values. Normally, if a well's pay flag curve accurately reflects the logs and has no pay, the computed values should be ZERO.

Report Info – Petra can generate a report of the continuity calculation called CONTINUITY.TXT in the projects “Reports” folder. This controls the level of report information generated and can be set to minimum, detailed, or no report.

Pay Curve Tab

Choose the pay flag curve used to represent pay in each well. A pay flag curve should have values of 0 for non-pay and 1 for pay. Only wells containing this curve will be used.

Export Tab

This section allows for the export "control point" files for Pay Continuity, Avg Continuous Pay, and Total Pay. There will be one set of files for each zone selected. Each file contains Wsn, Lat, Lon, Z values for the computed data. Points are computed at the mid-point between a node well and each neighboring well.

These files can be loaded into the map module for posting and contouring using the "external control point“ option.
Folder To Store LatLonZ File - Click the "Browse" button to select the folder where the control point files will be saved.

Prefix - You may enter a text string that is used to prefix each of the file names.

Files names are generated using the following format: Prefix_ZoneName_ItemName.


To calculate Pay Continuity, in the main module go to Compute>From Logs>Pay Continuity…

4.8.1.9 Advanced Transforms

The Log Transformations Module performs a variety of calculations on digital log data. These calculations range from relatively simple spike clipping and curve splicing to generating brand new curves and complex petrophysical modeling. Though many of these tools exist in an abbreviated form in the Log Curve previewer, the tools in the Log Transformations Module can operate on multiple wells at once and with easier control over depth ranges.
To open the Advanced Transform module, select Compute>From Logs>Advanced Log Transformations from the menu bar at the top of the Main Module.

Available Calculations

- Amplitude Clipping
- Depth Clipping
- Copy Curve
- Depth Log
- Resample Logs
- Smooth Logs
- TVD Logs
- User Model
- Facies Log
- Cumulative Log Curve
- Merge Log Curves
- Convert Directional Survey to Curves
- Generate Curve from Scratch

Selecting Wells

It’s often useful to only work with a small subset of wells in a project. The dropdown menu at the top of the module displays the currently selected wells. The Log Transformations Module can select wells in a few different ways available from Wells menu bar at the top of the screen.

“Current Well From Main” selects the single well currently selected in the Main Module. “All Wells” selects all wells available in the project. “By Data Criteria” selects wells based on a set of nested criteria including well header information, logs, or zone data. “Wells from Main” selects all wells currently selected in the Main Module.
Setting Depths

It’s often useful to limit a log transformation to a specific interval of interest. Calculations can be constrained by zone definition, tops, or by a specified depth (MD or TVD). On the menu bar at the top of the screen, select Depths> Depths Range from the menu bar at the top of the screen. This opens the Depths Tab on the Histogram Data Definition screen.

To set depths by a zone’s interval definitions, select the desired zone on the “Select Zone(s)” list. Note that the WELL zone by default covers -1M MD to +1M MD, so it should cover the entire footage of all wells.

To set depths by tops or by a specific depth range, select the “Set Depth From Range” button. Next, select the “Set Range” button. In the Set Depth Range box, select the relevant top, MD, or TVD button. For MD and TVD, select the relevant button and enter the adjacent depth in the entry field. For tops, select the desired top from the “Fm Top Name” dropdown box. Notice that an offset can also be added or subtracted to the fm top; this offset will include data points above or below the actual fm top depth.

The example above is limited only to the area defined by two tops – 20’ above the 2ND_WALL_CREEK and 20’ below the 2ND_WALL_CREEK_BASE.

4.8.1.9.1 Amplitude Clipping - Log Transform

This transformation clips spikes in the data outside a given minimum and maximum value. This transformation can also replace a specific data value with a null, which can be useful when curves contain non-standard null values (such as “-9999” or “0” instead of the more common “-999.25”). This log transformation is available on the
**Advanced Transforms** tool.

![Amplitude Clipping Transform](image)

- **Log To Clip** – This dropdown selects the name of the log curve to be clipped. This option permanently changes the selected log curves, so it’s usually best to retain a backup set of curves and perform this operation only on a set of copied logs. In the example above, the GR curve is selected.

- **Minimum Amplitude Allowed** – This option sets the lower limit for clipping. Curve values below this value will be set to a null value. The default value of -1E30 is so low that Petra will not perform a minimum clipping. In the example above, GR values below 0 will be set to a null value.

- **Maximum Amplitude Allowed** – This option sets the upper limit for clipping. Curve values above this value will be set to a null value. The default value of -1E30 is so high that Petra will not perform a maximum clipping. In the example above, GR values above 200 will be set to a null value.

- **Set to NULL if log is equal to** – This option replaces a single value with a null value. Put another way, all log values equal to the entered data value will be converted to nulls. This option is most commonly used to correct data that was imported with non-standard null values like “-9999” or “0.” This function can be used independently of amplitude clipping.

In the example below, the original curve is on the left and the clipped curve on the right. Note that the gamma ray values in the clipped curve above 200 API and below 0 have been replaced with null values.
4.8.1.9.2 Depth Clipping - Log Transform

This transformation erases all log data beyond a specified depth range. The depth interval can be specified in measured depth, TVD, or relative to formation tops. This function is useful to reducing log data to just the interval of interest. This log transformation is available on the Advanced Transforms tool.
Select Logs To Depth Clip - This dialogue box shows the names of the logs in the database. Select one or more logs to depth clip. The “All” button selects all logs in the project, while the “None” button deselects all logs. Remember that this option permanently changes the selected log curves, so it’s usually best to retain a backup set of curves and perform this operation only on a set of copied logs. In the example above, the GR curve is selected.

Set Depths... – This button opens the “Set Depth Range” box. The settings here are already populated from the Log Transformation module, but can be changed here as well.

In the example below, the original curve is on the left and the depth clipped curve is on the right. The GR curve outside these depths 2ND_WALL_CREEK and 2ND_WALL_CREEK_BASE fm tops have been erased.

This log data transformation creates a copy of a log. It is useful in creating a backup
copy of a log before doing other transforms. This log transformation is available on the Advanced Transforms tool.

![Copy Log Window](image)

**Log To Copy** – This dropdown selects the source log curve that will be copied. In the example above, the GR curve is selected.

**Copy Log To** – This dropdown/entry field selects the name of the copied log, which can be either an existing log or a new log name. In the example above, the GR curve will be stored to GRD.

**Apply Depth Shift To Log Copy** – This option shifts the copied log up or down by a specified footage. Select the check box, and enter a positive shift value to shift the copied log deeper or a negative amount to shift it shallower.

In the example below, the copied log is displayed next to the original gamma curve.
This log data transformation is used to create a depth log matching the depths of a selected source log. Depth logs have the same depths as the source log in either measured depth or true vertical depth. Depth logs can be useful for cross plotting or for working with horizontal wells. This log transformation is available on the Advanced Transforms tool.

**Source Log** – This dropdown list selects the source log curve for the depth curve.
In the example above, the GR curve is selected.

**Computed Depth Log** – This dropdown/entry field selects the name of the copied log, which can be either an existing log or a new log name. Note that selecting a pre-existing log will overwrite the curve. In the example above, the depth log will be written to DEPTH. The example below shows a depth curve’s values (on the right) relative to the original MD (on the right).

In the example below, the source log’s depths are copied exactly to the depth curve.

<table>
<thead>
<tr>
<th>Depth</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>450.00</td>
<td>450.000000</td>
</tr>
<tr>
<td>450.50</td>
<td>450.500000</td>
</tr>
<tr>
<td>451.00</td>
<td>451.000000</td>
</tr>
<tr>
<td>451.50</td>
<td>451.500000</td>
</tr>
<tr>
<td>452.00</td>
<td>452.000000</td>
</tr>
<tr>
<td>452.50</td>
<td>452.500000</td>
</tr>
<tr>
<td>453.00</td>
<td>453.000000</td>
</tr>
<tr>
<td>453.50</td>
<td>453.500000</td>
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<tr>
<td>454.00</td>
<td>454.000000</td>
</tr>
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<td>454.50</td>
<td>454.500000</td>
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<td>455.50</td>
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<td>459.00</td>
<td>459.000000</td>
</tr>
<tr>
<td>459.50</td>
<td>459.500000</td>
</tr>
</tbody>
</table>

4.8.1.9.5  Resample Logs - Log Transform

This transform resamples one or more log curves to use a specified sample rate. This is most commonly used to ensure all logs have the same sample size during log calculations or models. This function can also convert logs from feet to meters or vice versa. The Resample Logs tool has two tabs: the Curves Tab and the Options Tab. This log transformation is available on the Advanced Transforms tool.
Curves Tab

Function to Perform – This dropdown selects the actual calculation for the selected log(s). There are five total options. In the example above, the “Resample Logs to New Sample Rate (Rate is Samples Per Foot or Mtr)” is selected.

Resample Logs to New Sample Rate (Rate is Feet or Mtrs per Sample) – This option resamples logs based on the number of feet/meters per sample. As an example, 5 feet per sample results in one sample every 5 feet.

Resample Logs to New Sample Rate (Rate is Samples Per Foot or Mtr) - This option resamples logs based on the number of feet/meters per sample. As an example, 5 samples per foot results in a sample every 0.2 feet.

Convert Units Only (Do Not Resample) – This option does not change the sample rate, but instead converts the MD values to use a different depth unit.

Set Units Flag (No Conversion, No Resample) – This option does not change MD values or resample, but instead changes the log curve’s units flag.

Interpolate Nulls Only (Do Not Change Sample Rate) – This option interpolates over gaps in the data, but does not resample the curve.

Select Logs To Resample – This dropdown menu selects one or more log curves that will be resampled. The “All” button selects all logs in the project, while the “None” button deselects all logs. In the example above, the GR curve is selected.

Options Tab

New Sample Rate – This option selects the new sample rate, which can be 0.1, 0.2, 0.25, 0.5, 1.0, or 2.0. Note that what this number actually represents is controlled by
the “Function to Perform” dropdown on the Curves Tab. In the example above, the sample rate is set to “5”, reflecting “5 feet per sample” as set on the Curves Tab. The example below shows how a decreased sample rate reduces the number of points on the gamma curve.

Depth Units – These two dropdowns select the current depth unit of the log and the desired depth unit of the log.

Curve Start Depth - The “Adjust to Multiple of Rate” option adjusts the first depth of the curve to ensure that it is a multiple of the new sample rate. To leave the first depth alone, select “Do Not Adjust.”

Curve Bottom Depth – The “Adjust to Multiple of Rate” option adjusts the last depth of the curve to ensure that it is a multiple of the new sample rate. To leave the last depth alone, select “Do Not Adjust.”

Method - This dropdown determines the specific algorithm used to resample the logs.

Spline Interpolation – This method fits a curve to the data points and extrapolates the newly resampled data points from this curved line.

Linear Interpolation - This method fits a straight line between every two data points and extrapolates the newly resampled data points from this straight line.

Linear/No Interpolation - This method simply copies the last data point over the newly resampled data points, and does not actually reinterpolate through missing samples. This option works best on discrete data where there are single values separated by nulls such as core data.

The example below shows the original curve on the left, and a greatly resampled curve on the right. Note that the resampled curve only has one sample every 5 feet, greatly degrading the information in the original curve.
4.8.1.9.6 Smooth Logs - Log Transform

This transformation applies a few different filters to a selected log curve, including a smoothing filter, a square wave (or box) filter, and a derivative filter. This tool can apply any combination of the three filters. When multiple filters are selected, Petra will apply them in the order they are listed from top to bottom. This log transformation is available on the Advanced Transforms tool.
Input Log Curve – This dropdown menu selects the desired input log. In the example above, the GR curve is selected.

Output Log Curve – This dropdown/entry field selects the name of the copied log, which can be either an existing log or a new log name. It’s usually a good idea to either make a backup of the original curve or to filter only a copy of the original data. Note that selecting a pre-existing log will overwrite the curve. In the example above, the output log will be written to GR_SMOOTH.

Smoothing Filter

The smoothing filter is a rolling average that tends to decrease small scale jitters in the curve. The filter itself is a rolling average, meaning that for every data point in the curve Petra examines a number of points above and below. A five-point rolling average, for example averages the 2 points before the data point, the actual data point, and the two points after the data point. Petra can apply anywhere from a 3 point rolling average to a 999 point rolling average.

Apply Smoothing Filter - This check box actually applies the smoothing filter to the logs. Note that the smoothing filter can be applied in combination with the other filters.

Smoothing Filter Strength - This section controls the details of the smoothing filter. The “Smoothing Filter Strength” slider bar establishes the number of points used in the smoothing process: the minimum of 3 points translates to a relatively small smoothing effect, while the maximum of 999 points greatly smoothes the data – probably unrecognizably so for most data sets.

Petra makes a distinction between “Triangular” and “Block Average” smoothing. A triangular filter is a weighted average, where points in the rolling average closer to the actual data point have more weight than points more distant from the data point. A “Block Average” filter, on the other hand, gives all data points all equal weight in the average regardless of its distance from the data point.

The example below shows a smoothing filter with a strength of 35 on the right relative to the original curve on the left.
Square Wave (Box) Filter

The square wave filter looks for parts of the curve with rapid changes from high to low values, and replaces these with flat, boxy interfaces.

Apply Square Wave (Box) Filter – This checkbox actually applies the square wave filter to the data. Note that the square wave filter can be applied in combination with the other filters.

The example below shows the box filtered gamma curve next to the original curve on the left.
Derivative Curve

A derivative curve highlights the rate of change for a curve to highlight inflection points in the data; similarly, the second derivative calculates the rate of change of the derivative to further highlight the differences between inflection points.

Derivative Curve – This checkbox actually applies the derivative filter to the data. Note that the derivative filter can be applied in combination with the other filters.

Derivative - This section controls the details of the derivative curve filter.

1st and 2nd - The “1st” button calculates a 1st derivative of the input log, and the “2nd” button calculates a 2nd derivative of the input log.

Window - This entry box sets the width of the derivative calculation; by default, Petra analyzes a 1 foot/meter window around any specific data point. Larger windows increase the effect of larger multi-foot transitions and decrease the influence of small scale changes in the curve.

Abs Value – This button sets the derivative curve to only use positive values. By default, the derivative curve calculates positive values for positive changes in the 1st or 2nd derivative, and negative values for negative changes in the 1st or 2nd derivative.
The examples below show a 1st derivative curve relative to the original log on the left, and a 2nd derivative curve relative to the original log on the right.

4.8.1.9.7 Convert TVD Log - Log Transform

This transformation function converts Measured Depth (MD) logs to True Stratigraphic Depth (TVD) logs, and vice versa. This tool also calculates True Stratigraphic Depth (TSD) logs from MD logs. This log transformation is available on the Advanced Transforms tool.
Log To Convert – This dropdown selects the log that will be converted. In the example above, the GR log is selected.

Convert From – This option selects the specific calculation. Options include MD to TVD, TVD to MD, SSTVD to MD, and MD to TSD

New Log - This dropdown list selects the source log curve for the depth curve. In the example above, the GR curve is selected.

MD to TVD
This option converts a MD log into a TVD log based on the directional survey data loaded in Petra’s database. Wells without directional surveys will not have a TVD log calculated.

TVD to MD / SSTVD to MD
This option converts a TVD or SSTVD log into a MD log based on the directional survey data loaded in Petra’s database. Wells without directional surveys will not have a log calculated.

Convert MD to TSD Log
This option converts a measured depth log to a TSD (true stratigraphic depth) log. A TSD generates an estimate of true bed thickness log by accounting for the effect of a well passing through dipping stratigraphy. The resulting TSD log will have a starting depth equal to the TVD of the first log sample. Note that selecting this calculation creates the Structure and Depths Tab.

Structure Tab
The MD to TSD calculation requires an estimation of bed dip and azimuth. The values can either be zone items, constants, or logs. Dip is measured in degrees from horizontal where positive numbers are dipping downward; a flat dip is 0, a slight downward dip is 1, and a slight upward dip is -1. Azimuth is measured in degrees measured clockwise from north where North=0, East=90, South=180, and West=270 degrees.

To use zone data, select the appropriate zone and the specific data items containing dip and azimuth. The advantage of using zone data is that each well’s dip and azimuth can be individually tailored.

To use a constant dip and azimuth, enter the relevant numbers into the “Dip” and “Azimuth” fields. Practically, using a constant dip and azimuth suggests a rigid monoclinal dip over all wells in the calculation. In the example below, the dip is 15 downward with an azimuth of 67 degrees.

To use log data, select the well names for the dip and azimuth curves. This method is probably the most precise, though it is limited only to wells with dipmeter logs.

Values are Apparent Dip and Azimuth – This option sets the bed dip equal to the borehole dip.

Depths Tab

Set Depths... – This button opens the “Set Depth Range” box. The settings here are already populated from the Log Transformation module, but can be changed here as well. In the example below, the interval between the 2ND_WALL_CREEK and 2ND_WALL_CREEK_BASE fm tops are selected – Petra will not calculate a TSD curve outside these depths.
User models can perform log analysis functions such as computing clay volume, water saturation, effective porosity or any other calculation involving one or more log curves. The model is executed one time through for each depth or sample increment in the selected depth interval. Users should be familiar with programming languages such as FORTRAN before attempting to create or modify a user model file. All models must end in a .TXT extension.

This log transformation is available on the Advanced Transforms tool.

User Model File – This dropdown lists the existing user models in Petra’s USERMOD subdirectories. For standalone licenses, both the “Shared” and “Private” directories are C:\geoplus1\USERMOD by default. The network location of the USERMOD folder will depend on the installation. Commonly, for network licenses, the “Shared”
directory will be in the PetraSERV\USERMOD directory, and the “Private” directory will usually be in the client geoplus1\USERMOD directory.

**Compile Model** – This button loads the model into Petra’s memory and populates the Input and Output Tabs with variables.

**Execute Model** – Once the model is compiled and all input and output variables are assigned, this button actually runs the user model.

---

**Model Tab**

**View Model** – This option opens a read-only text editor with the currently selected model. Changes made here cannot be saved.

**Modify Model** – This option opens a text editor with the currently selected User Model. Changes made to the model can be saved.

**New Model** – This option attempts to open C:\geoplus1\USERMOD\Untitled.TXT with the computer’s default text editor.

**Refresh List** – This option refreshes the User Model File dropdown list at the top of the User Model Transform tool.

**Delete** – This option deletes the currently selected User Model.

**Copy As...** - This option copies the currently selected User Model with a user-selected name.

**Copy to Private Dir** – This option saves the user model to the private directory. Once in the private directory, the specific user model can be accessed by the user in any project.
Copy to Public Dir – This option saves the user model to the public directory. Once in the public directory, the specific user model can be accessed by any user in any project.

Input Variables Tab

User Models can use log curves, constant values, zone data items, 'NULL' values, 'DEPTH' or 'STEP' values as input variables. Each input variable should be assigned to the appropriate database entity.

To assign a model variable, select the variable name listed in the “Input Variable Assignments” list. Next, select the relevant log, zone item, constant, or "Other" item (including nulls, depth values, sample rates, TVD or SSTVDs). Select the “Apply” button to set the assignment and add it to the "Input Variable Assignments" list.

Load Assignments – This option loads a saved set of input variable assignments.

Save Assignments - This option saves the existing set of input variable assignments.
Output Variables Tab

The model stores one or more output log curves stored in the log database. These logs can be either be existing logs or new log names.

To assign an output model variable, select the variable name listed on the "Output Variable Assignments" list and select the desired output log. To create a new log name, type the log name in the "Log" drop down list. Click the Apply button and the log definition dialog screen will prompt you for the log units and description. Output logs computed in the model but not stored back in the database can be specified as "UNASSIGNED".
Options Tab

The Options Tab sets how Petra handles missing curves and establishes a depth range for the calculation.

If well is missing an input log – This dropdown establishes how Petra handles missing values. Petra can either skip wells missing any input values, or can simply assign missing values a NULL value.

Set Depths... – This button opens the “Set Depth Range” box. The settings here are already populated from the Log Transformation module, but can be changed here as well. Deselecting the “Restrict Model to Depth Limits” will run the user model over the entire depth range of the well.

Messages Tab

The Messages Tab provides the results of the user model, including which wells failed to go through the model due to missing data.
Creating User Models

User models are text files that contain the programming logic to perform complicated, multi-line equation and conditional operations on logs. The User Model Transform sets the input and output variables, establishes how Petra handles missing or incomplete data, and runs the models.

Statements

Each statement in the model consists of variables, operators, and keywords. Each statement in the model is terminated with a semicolon (;). Statements may be continued over more than one line. An operator or delimiter, such as a space or parenthesis separates constants, variables, and numbers. Statements which control the flow of the program logic contain keywords "GOTO", "IF...THEN...ELSE", or "BEGIN...END". Branching is done using statement LABELS placed on a line prior to the point of continued processing. Each label consists of a character string terminated by a colon (:). Examples of labels are LABEL1:, L999: and DONE:.

Variables

Variables can be named up to a maximum of 40 characters.

Log Definitions

LOGDEF statements precede all other declaration statements, and define the log's name, units, and descriptions. Log definitions use the syntax:

LOGDEF NAME(logname) UNITS(units) DESC(description);
Example:

```plaintext
LOGDEF NAME(GRTEMP) UNITS(API) DESC(GAMMA RAY);
```

Comments

An exclamation mark (!) or double forward slash (//) defines the beginning of a comment. A ! or // in column one will comment an entire line, while a ! or // comment text following the semicolon (;) will create an in-line comment.

Examples:

```plaintext
! this is a commented line.
A= B + C; ! this is an in-line comment.
// this is a comment as well
X = Y/Z; // and so is this
```

Symbols and Keywords

- `;` End of statement terminator
- `!` Comment indicator (start comment)
- `:` Label terminator
- Space Delimiter
- IF Test control word
- THEN Continuation of test
- THEN BEGIN Starts "TRUE" condition of test
- ELSE BEGIN Starts "FALSE" condition of test
- GOTO Branch to a label
- CONSTANT Declare constant
- LOG Declare curve
- LOGDEF Defines new curve in database
- IN Declare LOG curve as input only
- OUT Declare LOG curve as output only
- UPDATE Declare LOG curve as input but may be modified and stored back in the DB
**DO**  
Do loop  

**END**  
End THEN BEGIN or ELSE BEGIN section  

**ENDDO**  
End Do Loop  

**ENDDO**  
Terminates the model  

### Functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Keyword</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add</td>
<td>+</td>
<td>A+B</td>
</tr>
<tr>
<td>Subtract</td>
<td>-</td>
<td>A-B</td>
</tr>
<tr>
<td>Multiply</td>
<td>*</td>
<td>A*B</td>
</tr>
<tr>
<td>Divide</td>
<td>/</td>
<td>A/B</td>
</tr>
<tr>
<td>Exponential</td>
<td>** or ^</td>
<td>A**2 or A^2 (A squared)</td>
</tr>
<tr>
<td>Assign</td>
<td>=</td>
<td>A = 1.0</td>
</tr>
<tr>
<td>Compare equal</td>
<td>= or .EQ.</td>
<td>IF(A=B) THEN... or IF(A.EQ.B) THEN...</td>
</tr>
<tr>
<td>Compare not equal</td>
<td>.NE.</td>
<td>IF(A.NE.B) THEN</td>
</tr>
<tr>
<td>Logical AND</td>
<td>.AND.</td>
<td>IF( A=B) .AND. (C=D))...</td>
</tr>
<tr>
<td>Logical OR</td>
<td>.OR.</td>
<td>IF((A=B).OR.(C=D))...</td>
</tr>
<tr>
<td>Greater than</td>
<td>&gt; or .GT.</td>
<td>IF(A.GT.B)...</td>
</tr>
<tr>
<td>Less than</td>
<td>&lt; or .LT.</td>
<td>IF(A&lt;)= or .GE.</td>
</tr>
<tr>
<td>Greater or equal</td>
<td>&gt;= or .GE.</td>
<td>IF(A.LE.B)...</td>
</tr>
<tr>
<td>E to power of X</td>
<td>EXP(x)</td>
<td></td>
</tr>
<tr>
<td>Log (natural)</td>
<td>LN(x)</td>
<td></td>
</tr>
<tr>
<td>Log (base 10)</td>
<td>LOG10(x)</td>
<td></td>
</tr>
<tr>
<td>Absolute value</td>
<td>ABS(x)</td>
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<tr>
<td>Square of X</td>
<td>SQR(x)</td>
<td></td>
</tr>
<tr>
<td>Square root of X</td>
<td>SQRT(x)</td>
<td></td>
</tr>
<tr>
<td>Negative (-x)</td>
<td>NEG(x)</td>
<td></td>
</tr>
<tr>
<td>Truncate to integer</td>
<td>TRUNC(x)</td>
<td></td>
</tr>
</tbody>
</table>
SIGN of number times 1
BEGIN;
Round to 2 dec places ROUND(x)
Maximum of x and y MAX(x,y)
Minimum of x and y MIN(x,y)
Remainder of x / y MOD(x,y)
Sine of x SIN(x) x is in degrees
Cosine of x COS(x) x is in degrees
Tangent of x TAN(x) x is in degrees
Arcsine of x ASIN(x) angle returned is in degrees
( -1 >= x <=1 )
Arccosine of x ACOS(x) angle returned is in degrees
( -1 >= x <=1 )
Arctangent of x ATAN(x) angle returned is in degrees
( -1 >= x <=1 )
Ternary Interpolation Functions
A = ATERN(Ax,Ay,Bx,By,Cx,Cy,x,y);
B = BTERN(Ax,Ay,Bx,By,Cx,Cy,x,y);
C = CTERN(Ax,Ay,Bx,By,Cx,Cy,x,y);
SW = INTERN(Ax,Ay,Bx,By,Cx,Cy,x,y);
or
SW = TERNIN(Ax,Ay,Bx,By,Cx,Cy,x,y);

Ternary interpolation functions can be used to solve a triangular phase diagram defined by the vertices, AxAy, BxBy, and CxCy. Given the point x,y:

ATERN computes the percentage of A from 0-100,
BTERN computes the percentage of B from 0-100, and
CTERN computes the percentage of C from 0-100.
INTERN or TERNIN returns 1 if xy is inside the ternary triangle and 0 if outside.
Parenthesis

Binary operators are defined as an expression enclosed within parentheses, such as, (x+y) or (x*y). Statements require parentheses only when more than one binary operation is used or when you wish to force the evaluation precedence. The normal operator precedence from lowest to highest is:

+ and -
* and /
**

unary - (minus sign)

The expression A+B*C**D/E-F is equivalent to (A+((B*(C**D))/E))-F and would be evaluated in the following steps. Intermediate expressions are shown in braces.

K = C**D  [A+B*K/E-F]
L = B*K  [A+L/E-F]
M = L/E  [A+M-F]
N = A+M  [N-F]
O = N-F

Parenthesis force the sub-expression enclosed to be evaluated first, as illustrated below.

(A+B)*C**D/(E-F)

K = A+B  [K*C**D/(E-F)]
L = C**D  [K*L/(E-F)]
M = K*L  [M/(E-F)]
N = E-F  [M/N]
O = M/N

Declaration Statement

The declaration section is the first part of a model program in which the input and output logs and constants are defined. Each declaration statement consists of a
"type" keyword, a variable name, and a "use" keyword. It is not necessary to
declare temporary variables; temporary variables are defined for the first time with an
assignment statement.

Examples:

LOG SW IN;
LOG RHOB OUT;
CONSTANT SAND 2.5; ! value is optional
CONSTANT NULL; ! assumed to represent NULL log value

Executable Statement

An executable statement is any statement in which an equation type calculation is
performed or an assignment is made. The general form is:

ASSIGNMENT_VARIABLE = executable_statement;

Examples:

x = a * b;

x = (a*(b+c))/(x-y);

Note that each line is terminated with a semicolon (;) and the equal sign (=) is
required. Variables appearing on the right side of the equation must either be
declared as constants, logs, or be temporary variables defined as the result of an
earlier assignment statement.

GOTO and Label Statement

The "GOTO" keyword and following label is used to branch to another part of the
program.

Example:

IF ( x > 0.0 ) THEN GOTO DIVIDE;
y = 0.0;
GOTO MORE;
DIVIDE:
y = y / x;
MORE:
statement;
statement;

etc.

IF-THEN Statement
The IF-THEN statement conditionally executes a single assignment statement, GOTO, or BEGIN-END group based on the results of a logical comparison.

Example:
IF( GR = NULL ) THEN GOTO DONE;
IF( B .NE. 0.0 ) THEN C = A / B;
IF( SW > 0.75 ) THEN BEGIN;
SW3 = (1-SW)**3;
SW  = 1-(16/3)*SW3*(5-128*SW3);
END;

IF-THEN-ELSE Statement
The IF-THEN-ELSE compound statement provides conditional processing in a clear and efficient manner without the use of a GOTO.

Example:
IF ( logical expression ) THEN BEGIN;
statement;
statement;
etc.
END;
ELSE BEGIN;
statement;
statement;
etc.
END;
DO-LOOP Statement

The DO loop statement is used to repeat a section of the model a set number of times. The general format of the DO loop is:

```
DO counter = first TO last;
    statement;
    statement;
    etc.
ENDDO;
```

Example:
The following example sums values from 1 to 10. "A" is summed when K is even and "B" is summed when K is odd.

```
SUM = 0.0;
N = 10;
DO K = 1 TO N;
IF( MOD(K,2)=0) THEN BEGIN;
    SUM = SUM + A;
END;
ELSE BEGIN;
    SUM = SUM + B;
END;
ENDDO;
```

4.8.1.9.9  Facies Log - Log Transform

This transform uses log crossplot polygons to create new logs based on
petrophysical criteria. The Log Crossplot Module plots log curve values from the same depth together on a XY scatter plot or a ternary diagram. Regions on this crossplot, when outlined by polygons, represent specific combinations of two or more logs. Petra refers to these polygons as “facies.” This transform creates a new log based on the crossplot facies; when the log data fits inside a polygon, the polygon’s facies value is stored to the log. Facies logs can represent anything from pay flags to complete lithology descriptions.

As an example, the crossplot below shows gamma and resistivity curves. The polygon drawn on the log data represents the productive interval where gamma is lower than lower than about 90 API units and resistivity is above 10 ohmm. The polygon outlining the region has a facies value of 1. A facies curve transform applies this polygon to other wells. The depths were the gamma and resistivity curves fall inside this polygon are assigned the polygon’s facies value of 1, and the parts of the well where the gamma and resistivity curves fall outside this polygon remain a null value.

This log transformation is available on the Advanced Transforms tool.

This transform requires a set of polygons. These files are created in the cross plot module and have a *.XPP file extension. When opening the Facies Transformation tool, Petra by default opens the current project’s PARMS directory. Select the desired polygon file. In the example below, the GR PAY.XPP file is selected.
Petra then opens the Facies Log from Cross Plot Polygons tool. This tool is divided into several different tabs.

**File Tab**

The File Tab displays the selected polygon file, as well as the polygon file's comments. To change the selected polygon file, select the “Browse” button. By default, facies polygon files are stored in the project parms directory.

**Logs Tab**

The Logs tab sets the logs used in the facies curve calculation.

*X-, Y-, and Z-Axis* – These dropdown menus change the logs used in the crossplot.
calculation. By default, Petra will load the logs from the facies polygon. Changing the logs will keep the polygon cutoff values the same. In the example below, the GR and ILD curves are loaded in the X and Y axis.

**Use Log Aliases** – The transformation is picky about the exact curve name; if any of the X, Y, or Z logs are missing for a well, no output log is computed. This option tells Petra to use log aliases during the transformation.

**Output Facies Log** – This option his window also changes the name of the output facies curve; by default this is set to “FACIES” as in the example below. To change the name, just enter in a new curve name.

---

**Facies Tab**

The Facies Tab sets the actual values used in the facies curve.

**Default Facies Value** – This option sets the value assigned to the output log when the cross-plotted point does not fall in any of the polygons. Set a numeric value or enter the word NULL the use a null value for the default. In the example below, it’s set to 0.

**Log Values For Each Facies Polygon** – This window lists each of the polygon names along with their respective facies values. By default, Petra uses each polygon’s “facies value” created in the Log Crossplot Module. To change a polygon, select the polygon name on the list, and change the value on the “Edit Value” box. Select the “Change Value” button to accept the changes. In the example below, depths where the gamma ray and deep resistivity fall into the “PAY” polygon will be coded as 1 on the facies curve, while all other depths will be set to zero.
The Discriminators tab filters data points by log criteria. To set a discriminator curve, select up to 5 curves and set the scale using the minimum and maximum entry boxes. Data points that fall outside of these data criteria are not included in the facies curve and will be given the default facies value entered on the Facies Tab.

To use a discriminator, first select a log curve, enter the min and max values. Be sure to click the "Use" box beside the log name. The particular discriminator will not be used unless this option is checked.

The example below shows the original log on the left and the output facies curve on the right. The facies curve is plotted on a 0-2 scale, with everything above 0 filled in with red. The depths where the gamma and resistivity curves fall within the polygon are set to 1 and plotted as red, while the depths where the gamma and resistivity curves fall outside the polygon are set to zero and don't show on the log.
This transformation generates a curve in which each curve sample is the summation of all previous curve samples. This log transformation is available on the Advanced Transforms tool.

**Standard Summed Curve**

The “Standard Summed Curve” simply adds all preceding curve samples. This summation can start at the top and go down, or start at the bottom and go up.

**Cumulative Probability Curve**

The “Cumulative Probability Curve” calculates the probability for every value on the curve that another point has a higher value. An as example, a depth with a
cumulative probability of 0.10 means that the corresponding curve has a 10% chance that points will be greater than or equal to that value. In the examples below, the original depth vs. gamma ray curves is on the left, and the depth vs. cumulative probability curve is on the right.

In more detail, Petra calculates the cumulative probability curve in three steps:

1. Sort the curve from low to high value. Assign a sort number to each value starting from 1.

2. Divide each point’s sort number by the total number of sort values \( n \) plus 1. In the example below

3. Re-sort the data by depth, storing the probability to the output curve

Cumulative Curve Type – This option chooses between the “Standard Summed Curve” or the “Cumulative Probability Curve.”

Summation Direction - This option selects whether the summation will add values from top to bottom, or from bottom to top.

Apply Sample Rate to summed Values – This option corrects for different sample rates in the logs. A well with a 0.5’ sample rate will have twice as many values and twice the total summation as a well with a 1’ sample rate. Put another way, this option multiplies the curve values by the curve sample rate during summation.

Log Curve To Convert – This option selects the input log. Note that, unless the log is selected as the “New Cumulative Curve”, this log does not change in any way. In the example above, the GR curve is selected.

New Cumulative Curve – This option selects the name of the newly created cumulative log.

The example below on the left shows the original log next to the cumulative curve on
the right. The scale for the cumulative curve ranges from -110 to 5630, reflecting the high sum of all gamma ray values. The example below on the right shows the original log next to the output cumulative probability curve. Note that the gamma curve is on a 0-200 scale, while the probability curve is on a 0-1 scale.

4.8.1.9.11 Merge Log Curves Transform

This transformation splices together several log curves into a single log. This can be particularly useful for combining several different log runs into a single curve in Petra. This log transformation is available on the Advanced Transforms tool.

Source Curves to Merge – This option selects the curves to splice together.

Target Curve (Merge Into) – This option selects the destination curve.
This tool obeys a couple of rules when two or more logs have overlapping non-NULL values. Petra always preserves the target curve’s values, and won’t write overwrite values from any of the source curves. In the example above, Petra won’t overwrite any values already in the “Combined” target curve. Additionally, when two or more source curves overlap, Petra will use the first source curve listed. In the example above, Petra will use RUN1’s values over RUN2, and RUN2’s values over RUN3.

To reorder the Source Curves to Merge list, go to the Logs Tab on the Main Module. Here, select the Maintenance button to open the Log Maintenance window. Select “Set Display Filter.” Here, reorder the log curve names as desired.

This transformation generates new curves relative to MD based on directional survey.
data. Petra generates an X and Y curve automatically. This log transformation is available on the Advanced Transforms tool.

**X-Offset Log Curve** – This option sets the name of the X Offset Curve. By convention, offsets to the north are positive and offsets to the south are negative. By default, Petra will name this curve “XOFFSET”; to change the filename enter a new name or select a different curve from the dropdown box. There is no option to turn off this curve.

**Y-Offset Log Curve** - This option sets the name of the X Offset Curve. By convention, offsets to the east are positive and offsets to the west are negative. By default, Petra will name this curve “YOFFSET”; to change the filename enter a new name or select a different curve from the dropdown box. There is no option to turn off this curve.

**TVD Curve** – This option creates a True Vertical Depth (TVD) curve relative to MD. By default, Petra will name this curve “TVD”; to change the filename enter a new name or select a different curve from the dropdown box. The option box to the left toggles this curve’s creation on and off.

**MD Curve** - This option creates a Measured Depth (MD) curve relative to MD. By default, Petra will name this curve “MD”; to change the filename enter a new name or select a different curve from the dropdown box. The option box to the left toggles this curve’s creation on and off.

**DIP Curve** - This option creates a wellbore dip/inclination curve relative to MD. By default, Petra will name this curve “DIP”; to change the filename enter a new name or select a different curve from the dropdown box. The option box to the left toggles this curve’s creation on and off.

**AZM Curve** - This option creates a wellbore azimuth curve relative to MD. By default, Petra will name this curve “DEVI”; to change the filename enter a new name or select a different curve from the dropdown box. The option box to the left toggles this
4.8.1.9.13 Generate Curve From Scratch

This transformation generates a new log with a single selected value over a set depth range. This log transformation is available on the Advanced Transforms tool.

Output Curve – This option sets the name of the newly created log. This option can select an existing curve in the database, or create a new name. Setting the name to an existing curve name will completely overwrite the old curve. In the example below, the tool will create a new curve called “TEST.”

Depth Range – The “Set Depth” option establishes the upper and lower range of the new curve. These depths can be set by FmTops, MD, or TVD. In the example below, the new curve will start at 300’ MD and go to 500’ MD.

Sample Rate – This option sets the spacing between data points, or sample rate, of the data in samples per foot/meter. In the example below, the sample rate is set to 1, so the curve will have a data point at every foot.

Curve Value – This option sets the value actually saved versus MD. In the example below, the curve will read as a solid string of 1s all the way from top to bottom.
The Pay Report generates a listing from digital log curve data over one or more selected user zone intervals. The report shows a foot-by-foot listing of the curve values as report columns. The user may define a "summary type" for each column, such as, average value, total, cumulative, etc.

To open the Pay Report tool, select Compute>From Logs>Pay Report from the menu bar at the top of the Main Module

Zones Tab
Select Zones To Report Pay - Choose one or more zone intervals for which you want the pay report.

Report Wells - The report can list all selected wells or just for the current well.

Depth Increment for Report - This option controls the sample rate for the foot-by-foot listing. You can either use the sample rate for the log curves or specify a different sample rate. For example, if you have curves sampled at 0.25 feet, you might create a report and list only every 1 foot. The sample rate is given in feet/sample (or meter/sample).

Log Curves Tab

![Log Curves Tab Image]

Report Column Definitions - This section displays the report columns. Each column is associated with a log curve and shows the curve name, the column title for the report, the column width in characters, the number of digits to the right of the decimal point, and summary type.

Use Aliases - This option allows Petra to use log curve aliases.

Sum Type

Summary type can be changed by clicking the left mouse button on the "sum type" cell for a specific column. Available types are:

None - Column will have no summary values.

Total - The column summary will show the total sum of the curve values.

Total (weighted by rate) - The total sum will be multiplied by the sample rate. For example, if the curve in the column was a "pay flag" and the sample rate was 0.5, the total "pay" would be the 1/2 of the total count which would reflect the actual
number of feet of pay.

**Average** - The average curve value is displayed.

**Average (non-zeros only)** - Zero-valued curve samples are excluded from the average calculation.

**Cumulative** - The running total is displayed for each sample.

**Minimum** - The minimum curve value is listed at the bottom of the column.

**Maximum** - The maximum curve value is listed at the bottom of the column.

**Discriminator Curve**

This option uses a discriminator curve to filter the statistical data. At depths where the discriminator curve contains a 0 or null value, the corresponding depth will be skipped in the pay report. If this box is checked and the discriminator log is absent, the pay report will not be calculated.

**Available Curves List**

**To Add a Curve as a Report Column** - Select the curve in the "available curves" drop-down list. Click the "Add Curve" button. Set the "sum-type".

**To Replace a Curve** - Select the curve in the "available curves" drop-down list. Click in the curve title cell for the column to replace. Then click the "Replace Curve" button.

**To Drop a Curve Column** - Click in the curve title cell for the column to replace. Then click the "Drop Curve" button.

**File Tab**
Load Template - This button loads an external Pay Report template (*.PRP) file.

Save Template - This button saves the current color scheme to an external Pay Report template (*.PRP) file

EXAMPLE REPORT

=================================================================================================
Well: 42201077700000 A-1 1 1  [1]

Zone Summaries

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<thead>
<tr>
<th>DEPTH</th>
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<th>GR</th>
<th>GR</th>
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Zone : AB "A" 6671.0000 to "B" 6743.0000

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Zone: BC "B" 6743.0000 to "C" 6765.8167
4.8.1.11 Sum Raster Pay Within Zone

The Sum Raster Pay Within Zone tool adds pay intervals within a zone together, and stores the value in a zone data item. This can be useful for net pay mapping.

To open the Sum Raster Pay Within Zone tool, select Compute>From Logs>Sum Raster Pay Within Zone from the menu bar at the top of the Main Module

Zones Tab
Select Zones For Depth Interval

This list displays all the zones in the project. Selecting a zone will set the location of the data items calculated (the computed value and the pay count) as well as set the upper and lower limits of the calculation. By default, this tool searches for pay intervals within the top and base set by the selected zone's interval definition. To ignore the zone's interval definition, make sure to select the "Use Bounds Depths Even if Zone Depths are Undefined" option on the Depths Tab.

Select Type of Pay Value To Compute

Total Pay Thickness - This calculation returns the summation of all pay intervals in the zone.

Average Pay Thickness of Each Pay Interval - This calculation returns the average thickness of all pay intervals in the zone.

Maximum Thickness of Any Pay Interval - This calculation returns the thickness of the thickest pay interval in the zone.

Minimum Thickness of Any Pay Interval - This calculation returns the thickness of the thinnest pay interval in the zone.

Zone Item To Store Computed - This entry sets the data item that will store the computed value. Petra automatically attempts to create a data item name based on the type of pay value computed. Note that this data item will be located inside the zone selected on the "Select ZONES For Depth Interval" list.

Zone Item To Store Pay Count - This tool can also calculate the number of pay intervals in the zone for each well. This entry sets the name of the data item that stores this count. Leaving this entry blank will disable the count.

Zone Item Source Code - This entry adds an additional source code to the calculation.

Substitute TD if Bottom of Zone Is Missing - Petra uses the selected zone's interval definition to establish the depth window for the raster pay calculation. By default, if the lower boundary is missing, Petra will return a null value. This option instead substitutes the TD of the well for wells missing the base of the zone.

Apply TVD Correction - This option attempts to correct for deviated and horizontal wells by converting raster pay intervals picked in MD into TVD footage.

Store NULL Instead of Zero When No Pay is Picked - By default, Petra stores a 0 when no raster pay exists within the interval. This option instead stores a null value.

Do Not Overwrite Zeros With Nulls - Generally, Petra overwrites the selected data item whenever this calculation is run. With this option selected, Petra will not overwrite wells with a 0 value in the data item with nulls.
Pay Tab

Select Pay Interval To Sum - This list displays all the raster pay names in the project. Here, select one or more pay names for the calculation.

Source - This dropdown limits the pay names to only those with a selected source code. This can be useful for filtering out extraneous or irrelevant pay names.

Filter Tab

Depth Bounds
Limit Depths within a Zone to the Interval Below - This option enables additional depth bounds for the raster pay summation.

Const Depths - The upper and lower entries set bounds on the summation by a simple MD or SS depth range.

Fm Tops - The upper and lower boundaries within the zone are set by two formation tops.

Use Tops Aliases - This option allows Petra to use log curve aliases.

Use Bounds Depths Even if Zone Depths are Undefined - This option ignores the selected zone’s interval definition, and only uses the depth bounds set on the Filter Tab.

4.8.1.12 Storing Log Curve Statistics to an Interval

It’s sometimes useful to extract numerical data from log curves to an interval. More specifically, this tool calculates statistics over a selected log curve between the top and base of each interval and stores the result as a interval data field. This statistical measurement is stored to a data field in a selected interval table. When stored as interval data, log curve statistics can be easily used in petrophysical calculations or compared with other interval data fields.

To open the Log Stats To Interval Data tool, select Compute>From Logs>Extract Log Stats to Int Data… from the menu bar at the top of the Main Module

Select Log Data From

First, select the desired log curve from the dropdown menu at the top of the screen. In the example below, the GR curve is selected. Note that this tool will calculate log statistics on aliased curves, as well.
Interval Data Tables

Next, select the desired interval table from the “Interval Data Table” on the lower left side of the screen. In the example below, the LITH table is selected, so the statistics measured will be stored in interval data fields in the LITH table.

Stats to Extract

Finally, select the desired statistics and the desired location. In the example below, a mean (or average) will be calculated for the GR log. The calculated average will be stored in an interval data field called “GammaStat.” Petra stores statistics out to 7 decimal places, even though the interval data field may only show fewer trailing decimals.

4.8.2 Using Zones

To open any of Petra's zone compute tools, select Compute>From Zones from the menu bar at the top of the Main Module.

Isopach
TST and TVT
Equation Expression
Substitute
Substitute TD for Missing Zone Base
Z Summation
Multiple Regression Analysis
Neighbor Statistics

4.8.2.1 Isopach Calculation

Isopach thickness can be computed for one or more defined zones simultaneously. To calculate an isopach from the zone definition, select Compute-From Zones-Isopach from the menu bar at the top of the Main Module.

Method Tab
Zone Definitions - This option calculates isopach thicknesses using zone interval definitions defined in the Main Module. By using interval definitions, Petra can calculate multiple isopach values at one time.

Formation Tops - This option calculates isopach thicknesses using two formation tops. This method can only calculate the thickness of a single interval at one time.

From Zones Tab (Calculating from Zone Definitions)
This tab appears when the "Zone Definitions" method is selected on the Method Tab.

Output Name for Computed Isopach Variables
These options set the details on the data items that contain the calculated isopach value. When multiple zones are selected, Petra will create data items in every zone
that have the same name, source, and description.

**Name** - This option sets the name of the data item that will contain the computed isopach values.

**Source** - This option sets the source code for the isopach zone data item.

**Description** - This option adds a description source code for the isopach zone data item.

### Select The Zones for Isopach Calculation

This section lists the names of all user-defined zones. Use the mouse to highlight those zones for which you want the isopach variable computed. The "All" button selects all user-created zones, while the "None" button deselects all zones.

### From Tops Tab (Calculating from Formation Tops)

This tab appears when the "Formation Tops" method is selected on the Method Tab.

![Screenshot of isopach calculation interface](image)

**Top of Isopach** - This dropdown selects the top of the desired interval.

**Base of Isopach** - This dropdown selects the base of the desired interval.

**Store Computed Isopach Values In** - This entry sets the data item that will contain the computed isopach values. The upper dropdown sets the desired zone, and the lower dropdown sets the desired data item.

**Use Top Aliases** - This option uses top aliases for the calculation. In practice, this option will attempt to replace the missing top with one of the other "equivalent" tops on the alias list.
Make Isopach Zero When Top Quality Code Is - This option sets the isopach to zero when the top's quality code matches the entry box.

Make Isopach Null When Top Quality Code Is - This option sets the isopach to a NULL when either formation top's quality code matches the entry box. This can be useful for reducing the effect of uncertain or marginal formation tops.

Options Tab

![Options Tab screenshot]

Apply TVD Correction to Isopach - By default, Petra calculates the isopach thickness from MD depths. This option instead uses the formation tops' true vertical depths. Make sure to use this tool when working with deviated or horizontal wells.

Apply Fault Gaps to Isopach - This option will incorporate "fault gaps" in the isopach thickness. The "missing" section of any fault gap falling within the isopach interval will be added to the thickness. The final isopach value will be the sum of the difference in the fm tops plus all included fault gaps. Fault gaps falling outside the interval defined by the upper and lower tops will not be used.

Set to NULL if Fault (Gaps) within Zone - This option sets the isopach thickness to a NULL when the desired interval contains a fault cut.

Treat Tops as "Missing" if Top Quality Code Contains - This option forces Petra to ignore tops with the user-specified quality code. Note that the entry box can handle multiple quality codes separated with a ";".

When Upper or Lower Fm Top Is Missing

Store a NULL Value - When either the upper or lower formation top is missing, this option stores a NULL value.
Store a Zero Value - When either the upper or lower formation top is missing, this option stores a zero value.

Do Not Replace Current Database Value - When either the upper or lower formation top is missing, Petra will leave the existing value in the database alone. For brand new data items, this option will leave null values for wells without tops.

Force Isopach Value to be Zero if ISOPACH Quality Contains - This option forces Petra to store a zero when the destination isopach data item has the entered quality code. Note that this is only relevant to pre-existing data items; brand new data items will not have any quality codes.

4.8.2.2 Compute TST & TVT

The TST and TVT calculation is used to compute actual thickness of a zone by taking into account the regional or local structural dip and azimuth and directional well surveys.

To open the Compute TST & TVT tool, select Compute>From Zones>TST and TVT from the menu bar at the top of the Main Module.

Variables To Compute

Zone - This dropdown selects the zone for the TST and TVD calculation. Petra will use the upper and lower extents selected on the zone's interval definition.

TST - This dropdown sets the desired zone data item that will contain each well's calculated true stratigraphic thickness. You can select an existing zone item or enter a new name.

TVD - This dropdown sets the desired zone data item that will contain each well's calculated true vertical thickness. You can select an existing zone item or enter a
new name.

**Structural Dip and Azimuth**

This section defines the structural dip and azimuth used in the TST and TVT calculation. The structural setting can either be constant or individually set for each well with zone data items.

**Zone Data** - This option uses zone data items for dip and azimuth for each well. Wells without dip or azimuth entries will not have a TST or TVT calculation.

**Constant** - This option instead uses a constant, regional dip and azimuth for all wells in the calculation.

**Values are Apparent Dip and Azimuth** - This option changes the calculation to use apparent dip and azimuth. Note this option will use borehole azimuth instead of the bed azimuth for deviated and horizontal wells.

### 4.8.2.3 Zone Data Equation Transform

This function allows you to compute one zone variable from one or more zone variables using a generalized equation transform. Equation variables can zone data items (including fm tops), numeric constants, or datum elevations.

To open the Z data Equation Transform tool, select **Compute>From Zones>Equation Expression...** from the menu bar at the top of the Main Module.

![Zone Data Equation Transform dialog box]

**Load and Save Buttons** - You may save equations in the system equation file and load them at a later date.

**Zone Containing Equation Variables** - While this equation can use data items from any zone, this dropdown selects the zone that will contain the computed zone data item.
Enter Transform Equation Below

This entry sets the equation used in the data item calculation. Equations are made of variables and mathematical operators.

**Variables**

Variables are just text, which can either be very specific (“POROSITY” or “FORMATION_TEMPERATURE”) or general (“A” or “B”).

**Mathematical Operators**

Petra recognizes a wide variety of mathematical operators:

+ Addition
- Subtraction
* Multiplication
/ Division
** Exponent
ABS(x) - Absolute value of x
ACOS(x) - Arccosine of x (in radians)
ASIN(x) - Arcsine of x (in radians)
ATAN(x) - Arctangent of x (in radians)
COS(x) - Cosine of x in radians
COSH(x) - Hyperbolic cosine of x (radians)
EXP(x) - e to power of x
INT(x) - Truncated value of x
LOG(x),LN(x) - Natural Log of x
LOG10(x) - Log based 10 of x
MAX(x,y) - Maximum of x and y
MIN(x,y) - Minimum of x and y
ROUND(x) - Rounded value of x
SIN(x) - Sine of x in radians
SQRT(x) - Square root of x
SQR(x) - x squared
SINH(x)   - Hyperbolic sine of x (radians)
TAN(x)    - Tangent of x in radians
TANH(x)   - Hyperbolic tangent of x (radians)

**Operator Order**

1 Exponent
2 Multiplication and division
3 Addition and subtraction

Use of parentheses can change the order of precedence.

**Example Equations**

\[ R = \frac{(A+B^*(C-1.0))}{100} \]
\[ R = X*SIN(A)+Y*COS(B) \]
\[ R = LOG10(X) \]
\[ R = X^X \quad \text{or} \quad R = SQR(X) \]
\[ R = X^{**Y} \quad (x \text{ raised to the } y \text{ power}) \]

4.8.2.3.1 Z Data Equation Assignments

This screen assigns equation variables to the equation written on the *Zone Data Equation Transform*. Petra will attempt to match equation variables to relevant zone data items, but it’s always a good idea to validate each variable. Variables without a match will simply be assigned a constant with a value of zero.
Now that the equation is parsed, you can assign your output data item and variables.

First, establish your output data item. Petra will create a data item in the that uses the same variable name to the right of the equation. In the example above, Petra will create a new data item named “NGR.” Alternatively, click the drop down box and assign the output data item to an existing zone and data item.

Next, assign your variables. In other words, this is where you tell Petra what zone data items, constants, and elevations you want included in the equation. Click on a variable in the “Equation Variable Assignments” box. Next, click on a Zone, Constant, or Log Curve Depth button in the “Assign Variable To” section. Click on the associated drop down box and find the specific data item or enter a constant. Finally, click on assign. This will change the Equation Variable Assignments box to reflect the correct variable.

4.8.2.4 Zone Data Substitute

This Z data function performs a conditional data substitution using "if-then-else" type logic. The substitute function will be applied to all currently selected wells in the Main Module. This tool compares a zone data item to another zone data item, constant, or null. When the criteria is TRUE, this tool will write a zone data item, constant, or null to selected data item. When the criteria is FALSE, this tool will write a different zone data item, constant, or null to selected data item.

In the example below: Evaluate the D_Sand ISOPACH data item when it’s equal to a NULL. When this is TRUE, store a 0. When this is FALSE, store the D_Sand ISOPACH value. Write these results to the D_Sand ISOPACH data item.

To open the Zone Data Substitute Tool, select select Compute>From Zones>Substitute from the menu bar at the top of the Main Module.
Evaluate

This section sets the data item that will be evaluated. In other words, this is the specific data item Petra will read and compare to the criteria set below. In the example above, Petra will examine the ISOPACH data item in the D_Sand zone.

Condition

This dropdown selects the logical condition for the criteria. In the example above, Petra will look for wells where the ISOPACH is equal to the "Compare To" section. Other options include:

- EQUAL TO
- LESS THAN
- LESS THAN OR EQUAL TO
- GREATER THAN
- GREATER THAN OR EQUAL TO
- NOT EQUAL TO

Compare To

This section sets the specific search criteria for the substitution. Petra can compare the data item selected in the "Evaluate" section to another data item in the project, a constant, or a null/missing value. In the example above, Petra will look for wells where the ISOPACH data item is equal to a null value.

When True, Result Is
This section sets what result will be written when the evaluated data item meets the search criteria. This tool can write the value of another data item in the project, a constant, or a null/missing value. In the example above, where the ISOPACH data item is equal to a null value, Petra will write a 0 value.

When False, Result Is

This section sets what result will be written when the evaluated data item DOES NOT meet the search criteria. This tool can write the value of another data item in the project, a constant, or a null/missing value. In the example above, where the ISOPACH data item is NOT equal to a null value, Petra will write the ISOPACH value.

Store Results In

This section sets the destination data item of the substitution. Selecting the same data item as the "Evaluate" section will permanently overwrite the entries in the database.

Treat NULLS As

This section controls how Petra handles null values in the database. As an example, imagine comparing an isopach value to a constant 100; the TRUE condition is greater than 100, and the FALSE condition is equal to or below 100.

Large Positive Values - When this option is selected, Petra will treat null values as a large positive number. In the example above, null values will be treated as above 100 and therefore TRUE.

Zero Values - When this option is selected, Petra will treat null values as zero values. In the example above, null values will be treated as below 100 and therefore TRUE.

Ignore Null Values - When this option is selected, Petra will ignore wells with null values and will not perform the substitution operation. In the example above, null values will be ignored, so no substitution will take place.

4.8.2.5 Substitute TD for Missing Zone Base

This tool copies a well’s TD into missing formation tops that define the base of a zone defined by the interval definition screen.

To open the Substitute TD for Missing Zone Base tool, select Compute>From Zones>Substitute TD for Missing Zone Base from the menu bar at the top of the Main Module.
To use this tool, select the desired zone and select "OK." Petra will overwrite null values in the formation top that defines the base of the zone with the well's TD. Note that this tool will also add a "TD Subst" in the quality code for all wells with a substituted TD.

4.8.2.6 Zone Summation

This tool sums multiple zone data items together. This tool can also give a count of the total number of data items summed.

To open the Substitute TD for Missing Zone Base tool, select Compute>From Zones>Summation from the menu bar at the top of the Main Module.
Z Items To Sum

Z Items To Sum - This button opens the "Select Zone Item List" tool. Items on the "Selected Zone Items" list on the far right of the screen will be summed together.

The ">" adds the highlighted item to the Selected Zone Item List.

The ">>>" button adds all items in the currently highlighted zone to the Selected Zone Item List.

The "<" button drops the highlighted item from the Selected Zone Item List.

The "<<" button drops all items from the Selected Zone Item List.
Store Results Into

This entry sets the destination zone and data item of the summation. You can select an preexisting data item, or enter a new one. Selecting a preexisting data item will overwrite any data already in the project.

Store Number of Items Summed Into

In addition to a straight summation, this tool can also store a count of the total number of items summed.

Store Count - This option enables or disables the count being stored to the database.

This entry sets the destination zone and data item of the summation. You can select an preexisting data item, or enter a new one. Selecting a preexisting data item will overwrite any data already in the project.

Store NULL for Zero Results - This option stores a null value when the summation is equal to zero.

Store NULL When All Data is NULL - By default, this tool stores a zero when attempts to sum a set of null values. This option instead stores a null value for a full set of null values.

Do Not Replace Current Value if Can't Compute a Well - When this tool cannot successfully sum a set of data items, it normally overwrites the existing entry with a 0 (or a null if the Store NULL When All Data is NULL" option is selected). This option instead leaves the preexisting value alone when it cannot compute a summation.

Treat Zero Values as NULLS - This option changes how
Include All Well Completions

Zone Summation with Zero and Null values

By default, this tool treats null values as a zero, so that summing a value with a null equals the value. Changing the options changes how Petra sums zeros and nulls, especially so with multiple options selected at once.

<table>
<thead>
<tr>
<th></th>
<th>No Options Selected</th>
<th>&quot;Store NULL for Zero Result&quot;</th>
<th>&quot;Store NULL when All Data is NULL&quot;</th>
<th>&quot;Treat Zero Values as NULLS&quot; Only</th>
<th>&quot;Treat Zero Values as NULLS&quot; and &quot;Store NULL for Zero Result&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 + Null</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>0 + 0</td>
<td>Null</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Null</td>
</tr>
<tr>
<td>0 + Null</td>
<td>Null</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Null</td>
</tr>
<tr>
<td>Null + Null</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>0</td>
<td>Null</td>
</tr>
</tbody>
</table>

4.8.2.7 Multiple Regression Analysis

This tool applies a multiple regression analysis for one or more zone items. This can be useful for attempting to better understand relationships between related data items, and for prediction.

To open the Multiple Regression Analysis tool, select Compute>From Zones>Multiple Regression Analysis from the menu bar at the top of the Main Module.

Data Tab
Select Dependent Variable - This section sets the "Y" of the equation. Select the desired zone and data item.

Select and Add Independent Variables (Xs) To List Below - This section adds the multiple variables used in the regression. Select the desired zone and data item, and "+" to add the data item to the "Selected Independent Variables" list. To remove a data item, highlight it, and select the "-" button.

Selecting the "OK" button runs the analysis.

Report Tab

The Report Tab provides the results of the regression analysis, including the coefficients, correlation coefficient, and the goodness of fit. The Report Tab also displays the difference between the actual dependent variable and the predicted dependent variable for the wells used in the calculation.
4.8.2.8 Neighbor Statistics

Z Data Tab

Zone Item To Analyze - These dropdowns set the zone and data item for the statistics.

Zone to Store Results In - This dropdown sets the destination zone for the calculated statistics. In the example above, Petra will store the computed KB average in the WELL zone.

Compute

Item name - This entry sets the name of the data item that will contain the calculation result.

Source - This entry sets an optional source for the data item.

Compute Statistics For - This dropdown sets the specific statistical calculation. Entries include:

- Average Value
- Sum
- Min Value
- Max Value
- Avg Distance To Wells
- Min Distance To Wells
- Max Distance To Wells
Difference From Average Value

Neighboring Well Count

Location Type

The Location Type determines whether Petra defines neighbors in terms of surface locations or bottom hole locations.

Surface - When this option is selected, Petra will use wells with surface locations within the search radius.

Bottom Home - When this option is selected, Petra will use wells with bottom hole locations within the search radius.

Neighbors Tab

Radius of Search for Neighboring Wells - This entry sets the radius of the search for the calculation. Note that the entry is in XY map units - if the project uses US feet, this search will be in feet.

Include "Selected" well as a Neighbor - This entry sets whether a well's own value is used in the statistical calculation. When this option is deselected, the neighbor calculation will exclude a well's own value from the statistics.

Time Tab
Present Day Apparent Spacing - This option uses all wells in the neighbor calculation, regardless of the time drilled.

Spacing at Time Drilled - This option attempts to ignore the effects of wells that didn't exist when the examined well was drilled.

4.8.3 From Production

To open any of Petra's production compute tools, select Compute>From Production from the menu bar at the top of the Main Module.

Cumulative and Average Production Rates
Equation Expression...
Average or Cumulative Production Stream...
Sum "Field" Production Stream...
Sum Production Streams...
Extract PdCum Data To Zone
Rename Production Stream...
Time-Normalize Production...

4.8.3.1 Compute Cumulative Production

The Compute Cumulative Production Rate Tool extracts production data to a zone data item. As a zone data item, these values can be used in other calculations or mapped. This tool can extract several different kinds of production data, including:
Cumulative Production
Average Production Rate
Number of Years Produced
Number of Days Produced
Date of First Production
Date of Last Production

To open the Compute Cumulative Production Stream tool, select Compute>From Production>Average or Cumulative Production Stream from the menu bar at the top of the Main Module.

Data Tab

The Data Tab just sets the production stream to be analyzed.

Compute Values Using Following Monthly Production Stream - This dropdown defines the monthly production stream used in the calculations.

Include Historical Cum (Year 0) - This option includes include production prior to recording monthly values. This production is stored in year zero (0).

Time Tab

It's often useful to examine a specific time frame of production data. The Time Tab
Date Range

Compute for Constant Date Range - This option computes the statistics over a specific timeframe, specified by the "From" and "Through" entries to the immediate right.

Compute for Zone Date Range - This option computes the statistics over the timeframe specified by a "From Zone Item" and a "Through Zone Item." Unlike the "Compute for Constant Date Range", this option can compute a different range for every well.

Compute for Months - This option computes the statistics over range in the life of the well, specified in number of months. As an example, setting this to 3 and 6 will calculate the statistics from the third to sixth months of production for each well. Since this option looks at the individual life of each well, rather than a specific date, this can be useful for comparing lifecycle production from well to well.

First/Last Production Range

Compute for First - This option computes the statistics over the first specified number of months of production data. Note that this option can be limited to producing months only, rather than including non-productive months that can bring down the average production.

Compute for Last - This option computes the statistics over the last specified number of months of production data. Note that this option can be limited to producing months only, rather than including non-productive months that can bring down the average production.

Time Period Range

Use Time Period When Prod is At Maximum Value - This option calculates production statistics for a set number of months around the highest production.
Use Time Period When production is At Minimum Value (non-zero) - This option calculates production statistics for a set number of months around the lowest non-zero individual production value.

Range for Min-Max Period in Months - This dropdown sets the range for the or the "Time Period" ranges. As an example, setting this option for 7 with a "Use Time Period When Prod is At Maximum Value" will calculate the statistics over the interval 3 months before and after the highest producing month.

Method to Determine Min-Max Prod

Cum Prod Within Range -

Max or Min Prod Within Range -

Cum Prod Tab

The Cum Prod Tab control how this tool saves cumulative production values to a zone data item.

Store Cumulative Production In

Compute Cumulative - This option enables or disables the cumulative production summation. When this option is enabled, Petra will store the cumulative production to the specified zone data item.

When Cum Result Is Zero

This section how this tool treats zero cumulative production values.

Store NULL Value - This option stores zero cumulative production values as null values.

Store Zero Value - This option stores zero cumulative production values as zeros.
Avg Prod Tab
The Avg Prod Tab control how this tool saves cumulative production values to a zone data item.

Store Average Production Rate In
Compute Average Rate - This option enables or disables the average rate computation. When this option is enabled, Petra will store the average rate to the specified zone data item.

When Avg Result is Zero
This section how this tool treats zero average values.
Store NULL Value - This option stores zero average values as null values.
Store Zero Value - This option stores zero average values as zeros.

Method To Compute Average Rate
Compute Single Monthly Average - This option computes a simple average monthly production rate with total production divided the total number of months.

Compute DAILY Average using Days per Month - This option computes a daily average monthly production rate by dividing the average monthly production by the number of days in a month.

Compute Daily Average Using "DAYS ON" Production - The Days On stream simply records the number of days of production in a month. This option computes the daily average by dividing the production stream by the number of days of recorded production. This option can be more accurate, given good records.
DAYS ON Production from - This option sets the "Days On" production stream for the "Compute Daily Average Using "DAYS ON" method.

When DaysOn Values Are Missing - This option controls how the tool handles missing "Days On" values. This tool can either skip the month (which can skew the statistics), or use the number of days in the month (which effectively assumes full production).

High-Low Tab

The High-Low Tab stores the highest and lowest production rates to a zone data item.

Show Highest Production Rate In

Compute Highest Production Rate - This option stores the highest production rate over the range specified on the Time Tab to the zone data item specified below.

Show Lowest (non-zero) Production Rate In

Compute Lowest Production Rate - This option stores the lowest production rate over the range specified on the Time Tab to the zone data item specified below.

First-Last Tab
Store Date of First Prod - This option stores the date of first production to the zone data item specified below.

Store Date of Last Prod - This option stores the date of last production to the zone data item specified below.

Store Cum at First Prod Date - This option stores the cum at the first production date to the zone data item specified below.

Store Cum at Last Prod Date - This option stores the cum at the last production date to the zone data item specified below.

Capture Tab
The Capture Tab stores total years and days of production.

Capture Total Years Produced In
This option stores the total number of years of production used to compute the cum value.

**Do Not Compute Total Years** - This option disables the year calculation.

**Total First To Last Month Produced** - This option Check this option to count all months beginning with the first month of production to the last month of production.

**Total Productive Months Only** - Check this option to count all months beginning with the first month of production to the last month of production but months of zero production will not be included.

**Total First To Last Produced** - Check this option to count whole years beginning with the first production value through the last year of production.

**Capture Date of First and Last Production In**

This section will capture and store the first and/or last dates when production occurred, i.e., of the production range specified on the Time Tab.

**Capture Number of Days of Production**

This section will capture and store the total number of days used to compute the daily average production rate.

### 4.8.3.2 Monthly Production Equation Transform

This function computes a monthly production stream from one or production variables using a generalized equation transform.

To open the Monthly Production Equation Transform tool, select Compute>From Production>Equation Expression... from the menu bar at the top of the Main Module.
In the Equation Tab, you can enter an equation using variables and mathematical operators. The variable on the left side of the equal sign is the result variable.

**Variables**

Variables are just text, which can either be very specific (“OIL” or “2_Wall_Creek_GAS”) or general (“A” or “B”).

**Mathematical Operators**

Petra recognizes a wide variety of mathematical operators:

+ Addition
- Subtraction
* Multiplication
/ Division
** Exponent
ABS(x) - Absolute value of x
ACOS(x) - Arccosine of x (in radians)
ASIN(x) - Arcsine of x (in radians)
ATAN(x) - Arctangent of x (in radians)
COS(x) - Cosine of x in radians
COSH(x) - Hyperbolic cosine of x (radians)
EXP(x) - e to power of x
INT(x) - Truncated value of x
LOG(x),LN(x) - Natural Log of x
LOG10(x) - Log based 10 of x
MAX(x,y) - Maximum of x and y
MIN(x,y) - Minimum of x and y
ROUND(x) - Rounded value of x
SIN(x) - Sine of x in radians
SQRT(x) - Square root of x
SQR(x) - x squared
SINH(x) - Hyperbolic sine of x (radians)
TAN(x) - Tangent of x in radians
TANH(x) - Hyperbolic tangent of x (radians)

Operator Order
1 Exponent
2 Multiplication and division
3 Addition and subtraction
Use of parentheses can change the order of precedence.

Load and Save Buttons
You can save equations in the system equation file and load them at a later date.
4.8.3.2.1 Monthly Production Equation Assignments

Now that the equation is parsed, you can assign your output log and variables.

**Output Production Data** - This dropdown sets the name of the calculated production stream. Click the drop down box and assign the output curve to an existing production stream.

**Equation Variable Assignments** - This is where you tell Petra what production streams, constants, or zone data items you want included in the equation. Click on a variable in the “Equation Variable Assignments” box. Next, click on a Prod, Zone, or Constant button in the “Assign Variable To” section. Click on the associated drop down box and find the specific stream or data item or enter a constant. Finally, click on assign. This will change the Equation Variable Assignments box to reflect the correct variable. Using the exact names in the equation tab will cause Petra to “guess” at the variable assignments, which can save time.

When all equation variables are correctly assigned, click the OK button to proceed with the calculations.

4.8.3.3 **Compute Average or Cumulative Production Stream**

This function computes an average or cumulative production stream from monthly production data.

To open the Compute Average or Cumulative Production Stream tool, select `Compute>From Production>Average or Cumulative Production Stream...` from the menu bar at the top of the Main Module.
Source Production Stream - This dropdown sets the production stream used in the average calculation.

Compute Average Production As - These two dropdowns set the output production curve and type of average. To create a new output curve, simply enter a new name into the dropdown box.

Annualized Daily Rate - This option computes a simple average production rate based on the total number of days in a year.

DAILY Rate using Days per Month - This option computes a daily average monthly production rate by dividing the average monthly production by the number of days in a month.

Daily Rate Using 'Days On' From - The Days On stream simply records the number of days of production in a month. This option computes the daily average by dividing the production stream by the number of days of recorded production. This option can be more accurate, given good records.

Monthly Averages - This option sets the "Days On" production stream for the "Compute Daily Average Using "DAYS ON" method.

Treat Months With No Production - This option controls how the tool handles months missing production. This tool can treat the missing production as zero production (which will bring the average down) or skip the month (which will ignore its effects on the average). Put another way, this is the decision to treat a missing value as a zero or null, and will be affected by your database.

4.8.3.4 Sum "Field" Production Streams

This function sums production streams from multiple wells into a single well's
production stream. This can be useful for comparing one group of wells' production (such as an individual field) to another group of wells.

To open the Sum Production Streams tool, select Compute>From Production>Sum "Field" Production Streams... from the menu bar at the top of the Main Module.

The Production Group Normalization Tool can be a great alternative to summing production to a single well. This module doesn't require pseudo wells, can work with dynamic data, and has more options.

Field Well - This dropdown selects the well that will contain the summed production. This will overwrite the named production stream in the selected well, so it's a good idea to use a "pseudo" or placeholder well rather than an actual well.

Select Production To Sum - This dropdown selects the production stream to sum.

Data Normalization - This option attempts to

Include Historic Production -

Generate Associated "Well Count" Stream -

4.8.3.5 Sum Production Streams

This function sums multiple production streams into a single production stream.

To open the Sum Production Streams tool, select Compute>From Production>Sum Production Streams... from the menu bar at the top of the Main Module.
Data Tab

Sum Production in New Stream - This dropdown selects the production stream that will contain the sum. Select an existing production stream or enter a new name. Note that selecting an existing production stream will overwrite the production stream in the database.

Select Streams to be Summed - This list selects the production streams to sum together. Use SHIFT to select multiple successive streams, or CTRL to select streams individually.

Options Tab

Scale Factor for Computed Stream - This option multiplies or divides the production stream by a constant. This can be useful for changing the production stream’s order of magnitude. The default "(none)" option does not change the data.

Cumulative Production Value - This option stores a cumulative production value to a selected zone data item.

Generate an Associated "Count" Stream - This option creates a count stream that stores the number of streams contributing to the summed production. Petra will store a stream that appends "_CNT" to the name of the new stream. In the example above, the count stream will be named "OIL_WC-NB_CNT"

Load/Save Settings - These buttons save and load the settings on the Sum Production Streams tool to an external *.SPS file. This can be useful for running the same calculation multiple times.
### 4.8.3.6 Extract PdCum Data To Zone

The Extract PdCum Data to Zone Tool extracts production cum data to a zone data item. As a zone data item, these values can be used in other calculations or mapped.

To open the Extract PdCum Item to Zone Tool, select Compute>From Production>Extract PdCum Data to Zone from the menu bar at the top of the Main Module.
Data Tab

Depth Selection Method

This section determines how the tool finds pd cums for the zone data item.

Extract Within Zone Depths - This option finds pd cums that are within the interval definition for the zone selected on the "Zone" dropdown.

Extract Matching Formation Name - This option finds pd cums that match the formation name or names selected on the "Formation Names(s)" list to the right.

Extract Within Zone Depths and Matching Fm Name - This option finds pd cums that both match the formation name or names selected on the "Formation Names(s)" list AND are within the interval definition for the zone selected on the "Zone" dropdown.

Formation Name(s)

When either the "Extract Matching Formation Name" or "Extract Within Zone Depths and Matching Fm Name" depth selection methods are used, this tool will use the prod cums that match the names selected on this list.

Zone

This dropdown sets the zone that will contain the data item extracted from the production cum. When either the "Extract Within Zone Depths" or "Extract Within Zone Depths and Matching Fm Name" depth selection methods are used, this tool will use the zone interval definition set on the Zone Maintenance Tool.

Select Variables to Extract

This list selects the variables to write to the selected zone.

Options Tab

This section determines how the tool handles multiple production cums that match the criteria set on the Data tab.

Choosing the First PdCum Record (not by date) - This option only uses the first pd cum in the database. This won't necessarily be the earliest record or even the best record - only the first in the database.

Summing CUMS from Multiple Matching Records - When this option is selected, Petra will sum the cumulative values together.

Storing Each matching Record in a Different Zone Item - This option will store multiple
PdCum records in multiple data items. Petra will automatically append ",_1", "_2", and on to the multiple zone data items.

Choosing PdCum With most Recent Date - This option will only store the data from the production cum with the most recent date.

Use FmName (AltName) for Zone Item Name -

Substitute TD if Missing Zone Base - This option forces Petra to use the total depth (TD) as a substitute for missing zone base values. This can have a significant effect on calculations that use zone boundaries, including isopach and log calculations.

4.8.3.7 Rename Production Stream

This function renames a monthly production stream for either a single well, or for all selected wells.

To open the Rename Production Stream tool, select Compute>From Production>Rename Production Stream... from the menu bar at the top of the Main Module.

4.8.3.8 Time-Normalize Production

This function normalizes a production stream by shifting its start date back to the year 1900. This can be useful for comparing different wells with different start dates.

To open the Monthly Production Equation Transform tool, select Compute>From Production>Equation Expression... from the menu bar at the top of the Main Module.

The Production Group Normalization Tool can be a great alternative to this tool. This module doesn't require maintaining additional production streams in the database, can work with dynamic data, and has more options.

Input Production Stream - This dropdown selects the production stream to be normalized.

Output Time-Normalized Production Stream - This dropdown selects the name of the new normalized production stream. You can either select an existing production
stream name, or enter a new one. **Selecting an existing production stream will overwrite the preexisting data.**

![Graph of oil stream](image)

A normalized oil stream that starts at the year 0

### 4.8.4 Using Test Data

To open any of Petra's test compute tools, select `Compute>From Tests` from the menu bar at the top of the Main Module.

- Extract PD Test Z Data
- Extract Fm Test Z Data
- Flag Zones with perfs, cores, DSTs or shows
- Flag Wells with Tests...
- Find Producing Zone
- Copy Prod Tests To Perfs
- Remove "Problem" Perfs

### 4.8.4.1 Extract Mappable Z From Production Test

Production test data items such as IP volumes are not directly mappable. However, this function can be used to select important tests and copy selected attributes into the zone database where they can be mapped. Data will be extracted for the currently selected wells on the Main Module.
To open the Extract Mappable Z from Production Test tool, select Compute>From Tests>Extract PD Test Z Data... from the menu bar at the top of the Main Module.

Data Tab

Depth Selection Method - Test records can be selected by zone depth interval or formation name.

Extract Tests Using Zone Depths - This option will look for tests within the interval definition of the zone selected on the "Select Zone For Results" list. This method depends on having a zone interval definition along with good coverage of formation tops. This method can be good for filtering out erroneously named tests in the database, or for tests only within a specific lithologic package.

Extract Tests Which match Formation Name - This option looks inside the tests' "FmName" entry for text set on the "Formation Name" entry. This method only uses the database entry, rather than formation tops.

Select Zone For Result

For the Zone Depths mode, this dropdown specifies the search interval and the zone that will contain the computed zone data items. For the Formation Name mode, this dropdown just specifies the location of the computed results.

Formation Name
For the Formation Name method, this entry sets the text string that Petra will look for inside the tests' FmName entries. The "Exact" option is more strict, and requires that the entry match the specified text exactly, while the "Contains" option only requires that the test contain the text somewhere inside the database entry.

Select Variables to Extract

This section selects the specific data within the test to extract to a zone data item. This includes various volumes, pressures, and other test information. Petra will extract the value and save it to a data item in the zone selected in the "Select Zone For Results." Petra will only extract highlighted entries; left-click an entry to highlight it. Hold down CTRL to select multiple items. Note that SHIFT-click will select all items in between two successive mouse clicks.

Select Test Matching Test Types

This section restricts the search to specific test types. Petra's database includes:

IPT, IPF, IPP, IPS, PDT, PDF, PDP, PDS

Depth Tolerance Beyond Zone

By default, the Zone Depths mode limits tests to only those with at least some footage inside the zone interval. This option adds an additional buffer at a set footage beyond the exact zone intervals. For tight zone definitions, this can increase the chances of catching a test inside the zone.

Accept Only IP Test - Check this option if you only want to examine IP test types. All other production test types will be ignored.

Must Have Oil - This option ignores production tests without an oil volume.

Must Have Gas - This option ignores production tests without an gas volume.

Options Tab
Store Zeros as NULL - By default, Petra will store zeros in the zone data item with the test entry is zero. This option replaces zeros with null values.

Combine Well Completions - By default, Petra treats multiple completions as separate wells. This option will store test information from recompletions in the primary well's zone data item.

Store Upper and Lower Test Interval As Fm Tops - This option enables the "Formation Tops To Store Test Interval" section.

Formation Tops To Store Test Interval

This tool stores the top and base of the test interval as a formation top. Selecting a preexisting top will overwrite the values already in Petra's database. To add a new top, select the "New Tops" button.

Upper Top - This dropdown sets the formation top that will store the top of the test interval.

Lower Top - This dropdown sets the formation top that will store the top of the test interval.

Ignore "Preferred Test" Flag - Petra's database can store a single test as a "preferred" test. This tool normally attempts to use "preferred" tests first, but this tool will ignore this flag and treat each test equally.
Resolve Multiple Matches By

Choosing Only Preferred of the First Pd Test Record - This option will first attempt to use the tests with the "preferred" flag set. If no flags are set, then Petra will use the first production test entry.

Storing Each Matching Record In a Different Zone Item - This option stores a result for each test by creating multiple zone data items. Different zones have a "_1", "_2", and so on appended to the end.

Also Create Multiple Tops/Bases for Each Match - When the "Store Upper and Lower Test Interval As Fm Tops" option is selected, this option stores a top for each top and base by creating multiple tops items. Different tops have a "_1", "_2", and so on appended to the end.

4.8.4.2 Extract Mappable Z From Formation Test

Formation test data items such as formation pressures are not directly mappable. However, this function can be used to select important tests and copy selected attributes into the zone database, where they can be mapped. Data will be extracted for the currently selected wells, i.e., those wells listed on the main screen well list.

To open the Extract Mappable Z from Formation Test tool, select Compute>From Tests>Extract Fd Test Z Data... from the menu bar at the top of the Main Module.

Test Data Tab
**Depth Selection Method** - Test records can be selected by zone depth interval or formation name.

*Extract Tests Using Zone Depths* - This option will look for tests within the interval definition of the zone selected on the "Select Zone For Results" list. This method depends on having a zone interval definition along with good coverage of formation tops. This method can be good for filtering out erroneously named tests in the database, or for tests only within a specific lithologic package.

*Extract Tests Which match Formation Name* - This option looks inside the tests' "FmName" entry for text set on the "Formation Name" entry. This method only uses the database entry, rather than formation tops.

**Select Zone For Result**

For the Zone Depths mode, this dropdown specifies the search interval and the zone that will contain the computed zone data items. For the Formation Name mode, this dropdown just specifies the location of the computed results.

**Formation Name**

For the Formation Name method, this entry sets the text string that Petra will look for inside the tests' FmName entries. The "Exact" option is more strict, and requires that the entry match the specified text exactly, while the "Contains String" option only requires that the test contain the text somewhere inside the database entry.

**Select Variables to Extract**

This section selects the specific data within the test to extract to a zone data item. This includes various volumes, pressures, and other test information. Petra will extract the value and save it to a data item in the zone selected in the "Select Zone For Results." Petra will only extract highlighted entries; left-click an entry to highlight it. Hold down CTRL to select multiple items. Note that SHIFT-click will select all items in between two successive mouse clicks.

**Recovery Description Text**

This section restricts the search to specific text inside the recovery entry. The "Exact" option is more strict, and requires that the entry match the specified text exactly, while the "Contains String" option only requires that the test contain the text somewhere inside the database entry.

*Append Desc To Item Name* - This option appends the recovery description text to the created zone item name.

**Depth Tolerance Beyond Zone**
By default, the Zone Depths mode limits tests to only those with at least some footage inside the zone interval. This option adds an additional buffer at a set footage beyond the exact zone intervals. For tight zone definitions, this can increase the chances of catching a test inside the zone.

**Options Tab**

**Also Store Recovery Text Field** - When extracting recovery amounts, you may also store a text-type z variable with the amount, units, and description. The name of the variable is FMT_RECOV_TXT. This variable can be used for data posting instead of the Z value.

**Store Zeros as NULL** - By default, Petra will store zeros in the zone data item with the test entry is zero. This option replaces zeros with null values.

**Combine Well Completions** - By default, Petra treats multiple completions as separate wells. This option will store test information from recompletions in the primary well's zone data item.

**Store Upper and Lower Test Interval As Fm Tops** - This option enables the "Formation Tops To Store Test Interval" section.

**Formation Tops To Store Test Interval**

This tool stores the top and base of the test interval as a formation top. Selecting a preexisting top will overwrite the values already in Petra's database. To add a new top, select the "New Tops" button.

**Upper Top** - This dropdown sets the formation top that will store the top of the test interval.
**Lower Top** - This dropdown sets the formation top that will store the top of the test interval.

**Resolve Multiple Matches By**

- **Choosing Only Preferred of the First Pd Test Record** - This option will first attempt to use the tests with the "preferred" flag set. If no flags are set, then Petra will use the first production test entry.

- **Storing Each Matching Record In a Different Zone Item** - This option stores a result for each test by creating multiple zone data items. Different zones have a "_1", "_2", and so on appended to the end.

- **Also Create Multiple Tops/Bases for Each Match** - When the "Store Upper and Lower Test Interval As Fm Tops" option is selected, this option stores a top for each top and base by creating multiple tops items. Different tops have a "_1", "_2", and so on appended to the end.

**Extract All Recovery Records** -

**Test Type Tab**

This section restricts the search to specific test types.

**4.8.4.3 Flag Zones Containing Perfs, Cores or Shows**

This tool stores information to zone data items based on the tests in a project. This tool samples test information including perfs, cores, shows, DSTs, IP, PdCums, and faults.
To open the Flag Zones Containing Perfs, Cores, or Shows, select Compute>From Tests>Flag Zones with perfs, cores, DSTs or shows... from the menu bar at the top of the Main Module.

Select Zones To Compute

This list displays the zones in the project. Selecting a zone sets both the interval to examine, and the location of the created data item. Petra will use the test information whenever the test's top or base overlaps the zone interval definition top or base.

Perfs Tab

Perf Items To Compute

Choose which items you want to compute by placing a check in the appropriate box. You can use the default item names or enter your own name. The item name will become the zone item variable in the zone database.

FLAG=1 If Perfed In Zone - This variable will contain a value of 1.0 if any perf depth range overlaps the zone depth range. Otherwise, the values will be 0.0. If no perf records are found for the well, the value will be NULL.

Total Ft(mtrs) Perfed In Zone - This item will store the sum of all perf data falling within the zone depth range. The perfed top and base depths are clipped at the zone depths before summing.

MIN Depth Perfed In Zone - This item will store the minimum measured depth of all
perfs falling within the zone depth range. This value will not be less than the zone upper depth.

**MAX Depth Perf'd In Zone** - This item will store the maximum measured depth of all perfs falling within the zone depth range. This value will not be greater than the zone lower depth.

**Select Only Perf Types**

This section allows inclusion or exclusion of individual perf types. Only those records with the selected types will be analyzed. Note that this option depends on updated records in the project database.

**Cores Tab**

Choose which items you want to compute by placing a check in the appropriate box. You can use the default item names or enter your own name. The Item name will become the zone item variable in the zone database.

**FLAG=1 If Zone is Cored** - This variable will contain a value of 1.0 if any cores depth range overlaps the zone depth range. Otherwise, the values will be 0.0. If no core records are found for the well, the value will be NULL.

**Total Ft(mtrs) of Cores** - This item will store the sum of all core data falling within the zone depth range. The top and base depths are clipped at the zone depths.
before summing.

**MIN Depth of Cores** - This item contains will store the minimum measured depth of all cored intervals falling within the zone depth range. This value will not be less than the zone upper depth.

**MAX Depth of Cores** - This item contains will store the maximum measured depth of all cored intervals falling within the zone depth range. This value will not be greater than the zone lower depth.

**Shows Tab**

![Shows Tab Image]

**Show Items To Compute**

Choose which items you want to compute by placing a check in the appropriate box. You can use the default item names or enter your own name. The Item name will become the zone item variable in the zone database.

**FLAG=1 If Zone has Shows** - This variable will contain a value of 1.0 if any show's depth range overlaps the zone depth range. Otherwise, the values will be 0.0. If no core records are found for the well, the value will be NULL.

**Total Ft(mtrs) of Shows** - This item will store the sum of all show data falling within the zone depth range. The top and base depths are clipped at the zone depths before summing.

**MIN Depth of Shows** - This item will store the minimum measured depth of all shows falling within the zone depth range. This value will not be less than the zone upper depth.
depth.

**MAX Depth of Shows** - This item will store the maximum measured depth of all shows falling within the zone depth range. This value will not be greater than the zone lower depth.

**Select Only Show Codes**

This section allows inclusion or exclusion of individual show codes. Choices are oil, gas, water, and other. Only those records with the selected codes will be analyzed.

**DSTs Tab**

![DSTs Tab](image)

**DST Items to Compute**

- **Flag=1 if Zone has DST** - This option writes a "1" to the data item when the zone contains a DST. The entry to the left sets the name of the data item.

- **Total Ft(mtrs) of DST** - This option writes the total footage or meterage of the DST inside the zone. The entry to the left sets the name of the data item.

- **MIN Depth of DST** - This option writes the shallowest depth of the DST to the data item. The entry to the left sets the name of the data item.

- **MAX Depth of DST** - This option writes the deepest depth of the DST to the data item. The entry to the left sets the name of the data item.
DST Flag Curve

This option creates a log curve that shows the presence or absence of a DST. Intervals in the well with a DST will have a 1, while intervals without a DST will be left null. Flag curves can be useful for limiting log calculations. The entry box sets the name of the flag curve item.

IP Tab

**IP Test Items To Compute**

Flag=1 if Zone has IP - This option writes a "1" to the data item when the zone contains a IP. The entry to the left sets the name of the data item.

Total Ft(mtrs) of IP - This option writes the total footage or meterage of the IP inside the zone. The entry to the left sets the name of the data item.

MIN Depth of IP - This option writes the shallowest depth of the IP to the data item. The entry to the left sets the name of the data item.

MAX Depth of IP - This option writes the deepest depth of the IP to the data item. The entry to the left sets the name of the data item.

**IP Flag Curve**

This option creates a log curve that shows the presence or absence of a IP. Intervals in the well with a IP test will have a 1, while intervals without a IP will be left null. Flag curves can be useful for limiting log calculations.
Search Options

Any and All PD Test Records - This option allows Petra to search through all IP and PD tests.

IP Tests Only - This option restricts the search to only IP tests.

Selected Types - This section restricts the search to specific test types. Petra's database includes: IPT, IPF, IPP, IPS, PDT, PDF, PDP, PDS.

PdCum

PdCum Items to Compute

Flag=1 if Top-Base within zone - This option writes a "1" to the data item when the zone contains a PdCum. The entry to the left sets the name of the data item.

Top Depth From PdCum - This option writes the top of the PdCum inside the zone to a data item. The entry to the left sets the name of the data item.

Base Depth From PdCum - This option writes the base of the PdCum inside the zone to a data item. The entry to the left sets the name of the data item.

Fm Name from PdCum - This option writes the deepest depth of the DST to the data item. The entry to the left sets the name of the data item.

DST Flag Curve
This option creates a log curve that shows the presence or absence of a DST. Intervals in the well with a DST will have a 1, while intervals without a DST will be left null. Flag curves can be useful for limiting log calculations. The entry box sets the name of the flag curve item.

Fault Cuts Tab

![Image of Fault Cuts Tab]

**Flag=1 if Flt Cut within Zone** - This option writes a "1" to the data item when the zone contains a fault cut. The entry to the left sets the name of the data item.

**Total Ft(mtrs) of FltCuts in Zone** - This option writes the total footage or meterage of the fault cut inside the zone. The entry to the left sets the name of the data item.

**Nbr Flt Cuts in Zone** - This option writes the total number of fault cuts inside the zone. The entry to the left sets the name of the data item.

Options Tab
Combine Well Completions - By default, Petra treats multiple completions as separate wells. This option instead will add data items and curves to the primary completion instead of to the recompletion well.

Substitute TD When Bottom of Zone is Missing - By default, Petra skips the flag calculation when it is missing the fm top that defines the bottom of the zone interval definition. This option instead forces Petra to substitute the well's TD for the missing base. This can be useful for wells that do not completely penetrate the zone of interest.

Overwrite Good Values When Unable to Determine Zone Depths - When this tool can't determine the zone interval from the zone interval definition, it will not overwrite good values with null values. This option instead tells Petra to overwrite good values.

Store Flag=Null Instead of Zero - This option changes what this tool stores for zones that don't meet the search criteria. Instead of writing a zero, this option forces Petra to write a null value instead. This can have big implications for calculations using these flags, as multiplying something by 0 is different than multiplying by a null.

Sample Rate for Flag Curves in Ft (mtr) Per Sample - This sets the sample rate for the flag curves. Generally, you will want this to match the sample rate of other wireline logs.

Replace Current Flag Curves With New Calculations - This option completely overwrites the existing flag curves.

Treat Top=Base As 1ft Thickness - When the top of the zone interval definition
equals the base, this option forces the tool to treat it as a 1 foot thick boundary. This tool will return positive flags and curves if the relevant perfs, cores, or shows are within that one foot thick interval around the top/base.

Source Code for Output Zone Items - This entry sets a source code for all calculated zone data items.

Restrict Log Curves to Following Depths
This option restricts the calculation to only a set of MD values, or a MD value and each well's TD. This can further restrict the calculation inside a zone interval definition.

4.8.4.4 Flag Wells with Tests
Enter topic text here.

4.8.4.5 Find Producing Zone
This tool uses a well's perf data to store the formation name of the "producing zone." This can be useful for quickly filtering out producing wells to a relevent formation based on user-created formation tops rather than relying on database entries.

To open the Find Producing Zone tool, select Compute>From Tests>Find Producing Zones... from the menu bar at the top of the Main Module.

Data Tab
The Data Tab sets the zones, search criteria, and output zone data items.
Select Producing Zones From the Following

This list contains all the zones in a project. Petra will look for perfs within the zone depth intervals, and store the zone in the selected output zone data item.

Zone Depth Criteria

This section defines how Petra selects perf intervals.

**Shallowest Producing Zone** - When this option is selected, Petra will store the zone containing the shallowest producing zone.

**Deepest Producing Zone** - When this option is selected, Petra will store the zone containing the deepest producing zone.

**Largest Perfed Interval** - When this option is selected, Petra will store the zone containing the deepest producing zone.

Output Producing Zone Name To

This section sets the zone and data item that will contain the producing zone name.

Perfs Tab

The Perfs Tab sets a few options to limit the calculation to perfs with specific types and source codes.
Use Following Perf Types

The "Use Following Perf Types" tool restricts the search to only a specific type (or types) of perfs in the database. The utility of this tool is dependant on an up-to-date database with appropriate settings. The available types include:

- Active
- Inactive
- Open Hole
- Bridge Plug
- Packer
- Proposed
- Squeezed
- Frac Plug
- Junk

**Limit Perfs By Source Code Below** - This option limits the search only to perfs with a specific user-set source code.

4.8.4.6 Copy Prod Tests To Perfs

Sometimes data sets only include production tests, but not perfed intervals. This tool copies the top and base of production tests into the project's perfs.

To open the Copy Prod Tests To Perfs tool, select **Compute> From Tests>Copy Prod Tests To Perfs...** on the menu bar at the top of the Main Module.
Copy All Production Tests - This option copies the top and base of all production tests into the project's perfs.

Copy IP Tests Only - This option copies the top and base of only the IP tests into the project's perfs.

4.8.4.7 Remove “Problem” Perfs

Petra projects often contain duplicate or redundant perf intervals. You can deal with “problem” perfs in two ways – permanently deleting them with the Remove Problem Perfs Tool, or by keeping them in the database and filtering them out of Cross-Section displays and calculations. Deleting “problem” perfs permanently changes the database. Be sure to have a backup and to check the perfs that will be deleted. Petra stores information like start and end date for each perf, so make sure this data is captured in the remaining perfs.

To open the Delete Problem Perfs tool, select Compute> From Tests> Remove “Problem” Perfs on the menu bar at the top of the Main Module.

Delete RED Perfs - This option removes only gross-interval perfs.
Delete BLUE Perfs - This option removes only duplicate perfs.
Delete RED and BLUE Perfs - This option removes both gross-interval and duplicate perfs.
Report RED and BLUE Perf Counts - DO NOT DELETE - This option creates a simple summary of the number of duplicate and gross perfs in the selected wells. This tool can create an optional set of WSN lists for wells containing duplicate or gross perfs, as well.
4.8.5 Using Formation Tops

To open any of Petra's formation tops compute tools, select Compute>From FmTops from the menu bar at the top of the Main Module.

Isopach
Copy Alias Tops
Deviation Hole Angle
FmName Alias File...
Round Top Values
Fm Substitution
Extract Fault Gaps to Fm Tops
Copy Tops From Another Source
Copy/Merge Tops...

4.8.5.1 Copy Alias Tops

The Copy Alias Tops tool can consolidate all tops associated with a particular top alias. This tool will copy the first found top off the alias list into the aliased top’s value.

This function can be used to create a new formation top containing the "best" picks for a given top. For example, you could define an alias that has your picks as the first choice, and PI picks for the second choice. Copying the alias tops would result in your picks being copied if present, with PI tops chosen only if you hadn't picked the top.

To open the Copy Alias Tops Tool, select Compute>From FmTops>Copy Alias Tops... from the menu bar at the top of the Main Module.
Top Alias - Select the top alias you want to copy to.

4.8.5.2 Deviation Hole Angle...

The Deviation Hole Angle tool samples the hole angle at a specific point in a deviated well (usually a picked formation top) to a zone data item. This tool requires directional survey data to work.

To open the Deviation Hole Angle tool, select Compute>From FmTops>Deviation Hole Angle... from the menu bar at the top of the Main Module.

Compute at Depth
This section sets the location of the deviation angle calculation.

Top - This entry sets a specific depth at a formation top.

Well TD - This entry selects the well's TD

Show Hole Angle In
This section sets the zone and data item that will contain the calculated deviation angle.

Angle to Compute
This section sets the specific type of calculation. Petra can calculate the inclination or the azimuth.

Inclination of Borehole From Vertical - This option calculates the borehole's
inclination.

Azimuth Direction of Borehole - This option calculates the compass azimuth of the borehole.

Compute Angle From Depth Point to Surface - This option calculates the overall angle from the depth point set on the "Compute at Depth" option to the surface point.

Compute Local Angle at Depth Pt - This option only calculates the angle at the desired depth point set on the "Compute at Depth" option.

4.8.5.3 FmName Alias File...

This tool copies the formation top aliases in the project to an external text file, FMALIAS.TXT. This can be useful for taking formation top aliases created in one project into another project.

To open the Save FmName Alias File tool, select Compute>From FmTops>Copy Alias Tops from the menu bar at the top of the Main Module.

4.8.5.4 Round Top Values

This tool simply rounds the selected formation tops to the nearest foot or meter.

To open the Round Formation Tops tool select Compute>From FmTops>Round Top Values from the menu bar at the top of the Main Module.
Simply select the desired formation tops from the list, and click the "Round Tops..." button. Note that this operation is irreversible, so be careful when using this tool.

4.8.5.5 Fm Substitution

The Fm Substitution Tool can substitute a single formation top for one or more formation tops.

To open the Fm Substitution tool, select Compute>From FmTops>Fm Substitution... from the menu bar at the top of the Main Module.

Data Tab

The Data Tab sets the specific formation top substitution file, as well as the specific formation top names in the project that will be changed.

Apply Fm Substitution To The Following Data Types

ProdFm and FMatTD - This option applies the formation substitution to the well's "Prod. Fm" and "Fm at TD" entries displayed on the Main Module's Well Tab.

Fm Tops - This option applies the formation substitution to the project's formation tops available on the Main Module's FmTops Tab.

Projected FM - This option applies the formation substitution to the project's PROJFM data item in the WELLS zone.

DSTs - This option applies the formation substitution to the project's DSTs, available on the Main Module's Fm Tests Tab.

IP Tests - This option applies the formation substitution to the project's DSTs, available on the Main Module's IP Tests Tab.

Interval FMNAME - This option applies the formation substitution to the FMNAME column for all the project's interval tables. This will include the default LITH, CORE, PALEO tables, as well as any user-created interval tables.
Cores - This option applies the formation substitution to the "Formation" entries in the project's Cores, available on the Main Module's Cores Tab.

Prod Cum Data - This option applies the formation substitution to the "FMNAME" column in the project's Prod Cums, available on the Main Module's Prod Cums Tab.

Zone Cum Data - This option applies the formation substitution to the Zone Cumulate Production data items created by the Compute Cumulative Production tool.

Info Tab

The info tab simply illustrates the proper formatting for formation substitution files. These files can be created manually, or by using an existing project’s formation top aliases with the Save FmName Alias File tool.

4.8.5.6 Extract Fault gaps To Fm Tops...

Enter topic text here.

4.8.5.7 Copy Tops From Another Source

This tool copies the name and depths of tops from one source to another source.

To open the Copy Tops From Another Source Tool, select Compute>From FmTops>Copy Tops From Another Source... from the menu bar at the top of the Main Module.
Copy Tops FROM The Following Source - This dropdown sets the source of the tops that will be copied.

Copy Tops TO The Following Source - This dropdown sets the source of the tops that will receive the copied tops.

Options

The Options section controls how the tool handles overlaps between the "from" tops and the "to" tops. To be more specific, this section handles when the destination "to" tops already has a formation top name that is exactly the same as the "from" tops.

Do Not Replace Existing Values in the "To" Tops - This option will create new formation tops and values, but will not overwrite any values (including nulls) in the destination "to" tops.

Replace "To" Tops Only When "To" Top is NULL - This option will create new formation tops and values, but will not overwrite non-null values in the destination "to" tops.

Replace ALL Values in the "To" Tops - This option will create new formation tops and values, and will completely overwrite all values in the "to" tops.

Create Tops But DO NOT COPY Data - This option will only create the formation tops with the "to" source code. This option will not write any values to the tops.

4.8.5.8 Copy/Merge Tops...

This tool copies the values from one top to another top. This can be very useful in merging two separate tops in a database that actually reflect the same lithologic boundary.

To open the Copy/Merge Tops Tool, select Compute>From FmTops>Copy/Merge Tops... from the menu bar at the top of the Main Module.
From Top - This dropdown sets the formation top will be copied.

To Top - This dropdown sets the formation tops that will receive the copied top depths.

Data Merge Rules

This section controls how tool handles overlaps between the "from" tops and the "to" tops.

Update Values (Allow Overwrite Of Existing Values) - This option will overwrite formation tops in the "to" tops.

Add New Values - This option will only write depths where the "to" tops are blank. It will not overwrite any existing formation top depths.

Copy/Merge For

Petra can perform the copy/merge operation on all the wells in the project, or only the wells currently selected in the Main Module. Note that this section will be greyed out when all wells are currently selected in the Main Module.

Selected Wells Only - This option performs the copy/merge only on the currently selected wells in the Main Module. Wells not currently selected will retain both the old "to" and "from" formation top depths.

All Wells - This operation performs the copy/merge on all the wells in the project.

Copy/Merge Tops

This section controls how Petra treats the "from" tops after the copy.

Copy (Leave Source Top Entries Intact) - This option retains the "from" tops after the copy.

Merge (Remove Source Top Entries After Copy) - This option deletes the "from" tops after the copy. Note that this is irreversible, so be careful when selecting this option.
4.8.6 Using Locations

To open any of Petra's location compute tools, select Compute>From FmTops from the menu bar at the top of the Main Module.

- Calc XYs From LatLons & Calc LatLons from XYs
- Duplicate Location Report...
- Compute Well Lat-Lons From Spot Calls
- Set Secondary Well Locations to Primary Well Location
- Compute Distance From Surface to BH Location...
- Spot Well Using Reference Well
- Set Recompletion Locations to Original Hole Location

- Calc Surface or Bottom-Hole Loc From Dir Survey
- Pseudo Dir Surveys
- Rotate Dir Surveys
- Set Dev. Survey Grid Orientation
- Extend Dir. Survey To Total Depth
- Set Horizontal Well Flag
- Set Survey XY Units Flags
- Set Survey Depth Units Flags...
- Convert Survey Depths/Offsets to System Units...
- Fix Dir Survey Header Records

- Clear Misc Location Data
- Fix Bad T-R-S Values...

- Lock/Unlock Selected Well Locations
4.8.6.1 Calc XYs from LatLons / LatLons from XYs

Petra stores every well's location in two different ways - latitude and longitude, and XY. The "Calculate Well XYs from LatLons" and "Recompute Well Lat-Lons from XYs" functions recalculate and replaces one set of locations with another.

To recompute well LatLons in the project from the XYs, select To open the Fm Substitution tool, select Compute>From Locations>Calc LatLons from XYs... from the menu bar at the top of the Main Module.

To recompute well XYs in the project from the LatLons, select To open the Fm Substitution tool, select Compute>From Locations>Calc XYs from LatLons... from the menu bar at the top of the Main Module.

4.8.6.2 Duplicate Location Report

This tool looks for surface locations that are close to each other. This can be useful for finding duplicate well locations, or other location problems.

Petra will create a file called DUPLOC.TXT in the project's REPORTS directory. This file will contain the details of the distances between wells, their WSNs, and the wellspot symbols.

To use the Duplicate Location Report Tool, select Compute>From Locations>Duplicate Location Report.
The Duplicate Location Report Tool (left) and the DUPLOC.TXT report on locations (right)

Minimum Distance - This entry sets the distance that Petra will record a possible duplicate. Wells closer than this limit will be reported; wells further than this limit will not be reported.

Skip Multiple Completions - Petra treats multiple completions as separate wells with the same location. By default, this tool will report multiple locations as duplicate wells. This tool specifically excludes multiple completions.

Save Reported Wells To WSN List - This option saves the closely spaced wells to a WSN list. Selecting the "..." button sets the WSN filename and pathway.

Compare Wells with Symbols/With Wells with Symbols - These two lists control how Petra uses well symbols in the search. Setting a well symbol on the left "Compare Wells with Symbols" sets the wells Petra will search around, while the "With Wells with Symbols" is list sets the well symbols that Petra will look for. As an example, setting a Oil symbol in the left and a gas well in the right will restrict the search to only oil wells with close gas wells.
4.8.6.3 Compute Lat-Lons From Footage Calls

This function can be used to compute Latitude-Longitude coordinates for a group of selected wells using footage calls or "spot calls" referenced to a Township-Range-Section or Texas Survey-Block-Section land grid file. Several land grid files can be selected and processed simultaneously.

Special processing has been added to handle Texas Locations using survey, block and section. In this case, the TMC Texas format file is used as land grid files. A problem that Petra addresses is the ability to equivalence mismatched survey names between IHS well data and TMC land grid files. For example, IHS might have the survey name as "UNIV LDS" while TMC has it as "UNIVERSITY LANDS". Petra provides for the use of an equivalence file to match these survey names. Petra can scan the TMC files and build a list of mismatched survey names which the user can then assign matches and save them to the equivalence file.

Data required for this function is:

1. Petra well database populated with footage calls, i.e., 1520 FNL, 660 FWL, or quarter "Spot Calls", i.e., NESW in the Location>Township or Location>Texas information.

2. A land grid file containing section boundaries in latitude-longitude. Petra supports the following formats of land grid data sets:
   - Tobin Infobase
   - Topographic Mapping Company (TMC)
   - Platte River (same as TMC)
   - Whitestar Data in TMC format
   - TMC Texas format

After selecting the appropriate options, click the "Compute" button to process the wells. After viewing or printing the report, exit the screen by clicking the "Done" button.
Data Tab

Land Grid File(s)

Use the browse button to select one or more data files containing land grid information. All files selected must be of the same format. See valid formats above.

Scan For Survey Name Match... - If using TMC Texas locations format, you will have this optional button. First, you should specify the "Survey Equivalence File" (see below) before clicking this button. It will process all land grid files and find any well data survey names that do not match the land grid files. A new tab will appear labeled "Survey Name Match" for you to assign matches. (See Assigning Survey Name Matches)

DB Records Containing Footages

Select which database records have been populated with footage values. Areas outside Texas normally use the "Township Records" option while projects in Texas will normally use the "Texas Location Records" options.

Texas (TMC) Locations Survey Name Match

This section contains options for matching Texas survey names when using Texas TMC land grid files.

Percentage Compare - Well data survey names are first compared with the land grid survey names using a "percentage" matching technique. You may enter a value from 1-100%. Higher numbers mean the names must match more precisely.

Use Survey Equivalence File - This file contains survey names and alias or equivalent names that aid in matching survey names. Each survey equivalence is represented by 2 (or more) records. The first record begins with a "1" and identifies the survey name at it appears in the well data base. This is followed by one or more alias records which begin with a "2". The alias name is the name as it appears in the land grid file. The format of this file is as follows:

1SURVEYNAME
2SURVEYNAMEALIAS
2SURVEYNAMEALIAS
1SURVEYNAME
2SURVEYNAMEALIAS

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The survey equivalence file can be viewed or modified using a text editor if you wish. Care must be taken not to alter the format of the items listed in the file.

Options Tab

Wells Which Get Locations Computed

This option can be used to restrict which wells will have their locations computed. The "All Selected Wells" will attempt to compute locations for all wells currently selected in the main module. The "Only Wells With Zero-Valued Lat-Lons" option will skip any selected well that does not have a latitude and longitude of zero.

Calculate Locations For

This option determines with location is computed. Choose either "Surface Locations" or "Bottom-Hole Locations" option.

Backup Original Locations

This option can be used to save old well lat-lon values to a file prior to computing new locations. Check the "Create Backup File" option and use the browse button to select or enter a file name. It is highly recommended that you make a backup of the original well locations during this process. The backup file is an ASCII file containing the UWI (or API#), Latitude and Longitude as a comma separated format.

Method Tab

Location Source

Either footage call values or spot calls, such as, "NE SE NW" can be used.

The current version of this function will compute locations for full sections when the "footage reference" value is blank or contains the string "SEC". When the reference value contains one or more occurrences of the keyword "QTR", then the footages are interpreted as being from a quarter section line and not from the section line. In
this case, the section polygon is converted to a "regular" 640-acre section then subdivided into the appropriate quarter. If the reference contains QTR QTR then the quarter subdivision is repeated a second time. Also, this quarter subdivision relies on having a valid spot call which ends in values such as NE, NW, SE or SW, etc.

Use Spot Call if footages can not be used...

Check this option to force the use of spot calls if the footages do not reference a full section.

Output Mode

This option is **critical** and determines what happens with newly computed locations. Use this option to preview or test the calculations prior to modifying the locations in the database. All options generate a process summary report (see report tab for details).

- **Generate Report Only (Do Not Modify Locations)** - This option computes new locations but does NOT UPDATE the database with them.
- **Compute new Locations In the Database** - This option computes new locations and UPDATES the locations in the database. It is wise to create a backup file of the original locations when using this option (see data tab for details)
- **Export New Locations to an ASCII File** - This option will write the new locations to a data file but will NOT UPDATE locations in the database. Enter a file name or use the browse button to define the output file.

Report File

A report file called SPOTWELLS.TXT in the project's "reports" directory records a summary of the location calculation process. Each well is listed showing its processing status. Wells with new locations computed will show the new Lat-Lon values and the distance in feet or meters, depending on the map projection, from the original location (if non-zero). The location line is prefixed with a letter indicating how the location was computed. The prefixes are "F" for footage from section line, "Q" for footage from quarter section line, and "S" for spot call calculation.

The report is displayed in NOTEPAD and can be printed or saved to a new file. Note, this file is overwritten with each execution.
Survey Name Tab

This tab is displayed after scanning for survey name matches using Texas TMC files. The left side shows the well data survey names that Petra could not match with any of the TMC land grid file survey names shown on the right.

Assigning Survey Name Matches

You can assign alias or equivalent survey names by choosing one or more items from the right side list that match with a single item from the left side list. Once you've made your assignments, add them to the survey equivalence file by clicking the "Add To Equiv. File" button.

Editing the Survey Equivalence File

You may view or edit the equivalence file at any time by clicking the "Edit Equiv. File" button. Just be careful not to alter the format of the items listed in the file.

4.8.6.4 Set Secondary Well Location to Primary Well Locations

Petra stores a vertical pilot hole and directional well combination as a separate "primary" and "secondary" wells. Generally, the primary vertical well have a 14 digit API number ending in 0000, while additional directional wells from the same pad will simply append 0001, 0002, 0003, and so on. This tool overwrites these recompleted wells' locations with the primary location's location.

To move secondary locations to the primary location, select Compute>From Locations>Set Secondary Well Locations to Primary Well Location from the menu bar at the top of the Main Module.
Surface Options

Set Surface Location Only - This option simply moves the secondary wells’ surface locations. Bottom hole locations will remain unchanged.

Set Surface Location and Shift BH Location By Same Amount - This option moves the secondary wells surface location to the primary well's surface location. This option also moves the recompletion's bottom hole locations by the same amount.

For deviated wells copy the survey data from the primary well into the secondary well - This option will copy the directional survey data from the primary well into the secondary wells.

4.8.6.5 Compute Well Borehole Length

This tool calculates the length of boreholes inside the project and stores the length and optional azimuth to user-selected zone data items.

To calculate well borehole length, select Compute>From Locations>Compute Distance from Surface to BH Location from the menu bar at the top of the Main Module.
Borehole Length Calculation Method

This option controls how the tool calculates the length of the borehole.

**Horizontal Distance From Surface to BH Location** - This method just calculates the distance from the surface location's LatLon to the bottom hole location's LatLon. This method does not factor in any depths.

**XYZ Distance From Surface to BH Location at TD** - This method calculates the direct linear distance between the surface and bottom hole location at depth.

Borehole Azimuth Calculation Method

**Azimuth Btwn Surface and BH Location** - This method uses the azimuth between the surface location and the bottom hole location. This option is a good choice for most, but can be skewed by a sudden deviation at the end of the lateral.

**Local Azimuth Near BH Location** - This method uses the azimuth immediately around the bottom hole location.

Compute For

**All Selected Wells** - This option attempts to calculate borehole lengths for all selected wells in the **Main Module**.

**Deviated Wells with Dev Survey** - This option limits the borehole length calculation to only wells with a **directional survey**.

**Deviated Wells Without Dev Survey (use BH Location)** - This option limits the borehole length calculation to wells without directional survey data. This option will only use BH
locations listed on the Main Module’s Location Tab.

Use BH Location Only (ignore Dev survey) - This option will perform the borehole length calculation to any well with a difference between the surface and bottom hole location. Note that this method will ignore directional survey data, and will only use bottom hole locations.

Output Results To

These entries set the zone and data item to store the output borehole length.

Zone - This dropdown selects the zone that will store the length (and optionally the azimuth) data item. By default, this is the WELL zone.

Length - This dropdown selects the data item that will contain the length data item. Note that you can select an existing data item, or enter the name of a new data item. By default, this dropdown is set to BHLEN.

Azimuth - This dropdown saves the azimuth used in the calculation to a data item. This will reflect the "Borehole Azimuth Calculation Method" selected above. Leaving this dropdown blank will not save the azimuth value.

4.8.6.6 Spot Well using Reference Well

This tool changes the location of a selected well to a location that is a set XY distance and azimuth from another reference well. This can be useful for updating well locations with data from surveys.

This tool will change the location of the selected well on the Main Module, so make sure to select the desired well before starting this tool.

To use the Duplicate Location Report Tool, select Compute>From Locations>Spot Well using Reference Well.

Next, enter the WSN of the reference well.
Next enter the distance between the reference well and the respotted well.

Finally, enter the azimuth of the direction from the reference well and the respotted well.

4.8.6.7 Set Recompletion Locations to Original Hole Location

Petra stores recompletions as separate wells. Generally, the primary completion will have a 14 digit API number ending in 0000, while additional recompletions will simply append 0001, 0002, 0003, and so on. This tool overwrites these recompleted wells' locations with the primary location's location.

To move recompletion locations to the primary location, select Compute->From Locations->Set Secondary Well Locations to Primary Well Location from the menu bar at the top of the Main Module.
Surface Options

Set Surface Location Only - This option simply moves the recompleted wells’ surface locations. Bottom hole locations will remain unchanged.

Set Surface Location and Shift BH Location By Same Amount - This option moves the recompleted wells surface location to the primary well’s surface location. This option also moves the recompletion's bottom hole locations by the same amount.

4.8.6.8 Compute Location from Deviation Survey

This tool recalculates wells' bottom hole locations or surface locations from directional survey data. This can be useful particularly for replacing reported BHLs with a bhl calculated from directional survey data.

To recalculate either the surface or bottom hole locations, select Compute>From Locations>Calc Surface or Bottom-Hole Loc From Dir Survey from the menu bar at the top of the Main Module. Note that this tool will work on all selected wells.

Compute BOTTOM HOLE Location - This option recalculates the bottom hole location using the surface location and the directional survey data.

Compute SURFACE Location - This option recalculates the bottom hole location using
the bottom hole location and the directional survey data.

4.8.6.9 Pseudo Dir Surveys

This tool calculates a pseudo directional survey from the surface location, bottom hole location, and TD.

To recalculate either the surface or bottom hole locations, select Compute>From Locations>Calc Surface or Bottom-Hole Loc From Dir Survey from the menu bar at the top of the Main Module. Note that this tool will work on all selected wells.

2 Pts Method

The 2 points method creates two directional survey points - one at the surface location, and one at the BH location. Note that Petra will assume a straight line the two using the well's TD as a distance. Importantly, this method will grossly misrepresent directional wells.
3 Pts Method

![Diagram of 3 Pts Method showing Surface Loc, BHL, 2 Pts Method, TO (or MD), and Calculated TVD.]

The main diagram shows a graphical representation of the 3 Pts Method, illustrating how to calculate the horizontal location (H) using the surface location (Surface Loc) and bottom hole location (BHL) for a given depth (TO or MD). The diagram includes the following elements:

- **Surface Loc**: The starting point on the surface.
- **BHL**: The point in the wellbore.
- **2 Pts Method**: The method used to calculate the horizontal location.
- **TO (or MD)**: The True Vertical Depth or measured depth from the surface to the point of interest.
- **Calculated TVD**: The calculated true vertical depth from the surface location to the wellbore.

Below the diagram is a screenshot of a user interface titled "Pseudo Survey Compute Options," which includes fields for entering values for longitude or X coord, latitude or Y coord, and depth options. The interface is used to input survey data and compute the horizontal location based on the entered parameters.

The calculation process involves selecting the appropriate method (2 Pts Using Surface and Bottom Hole Location or 5 Pts Using Surface, Kick Pt and Bottom Hole Location) and specifying the necessary coordinates and depth options. The interface provides a visual and interactive way to input data and verify the accuracy of the calculated horizontal location.
Longitude or X Coord - These dropdowns select the zone and data item containing the longitude, X coordinate, or offset of the kick off point. The dropdown at the bottom of this window will set what the selected data item represents.

Latitude or Y Coord - These dropdowns select the zone and data item containing the latitude, Y coordinate, or offset of the kick off point. The dropdown at the bottom of this window will set what the selected data item represents.

Depth Option - This option sets the kickoffpoint’s depth. This entry can be either set to a formation depth, constant value in measured depth, or the well's TD.

Location Zone Dropdown

Location Zone Items are Lat-Long Values - This dropdown sets the kickoff points as latitude and longitude values.

Location Zone Items are X-Y Coordinates - This dropdown sets the kickoff points as X and Y

Location Zone Items are XY Offsets From Survey Location - This dropdown sets the kickoff points as X and Y offsets from the surface point.

Kick Point Same as Surface Location - This dropdown sets the kickoffpoint as being directly beneath the surface location.

4.8.6.10 Rotate Dir Surveys

This tool rotates directional surveys around the surface location. Generally, this tool should not be used to apply a convergence angle correction to directional wells.

To recalculate either the surface or bottom hole locations, select Compute>From Locations>Rotate Dir Surveys from the menu bar at the top of the Main Module. Note that this tool will work on all selected wells.
4.8.6.11  Extend Dir Surveys

On a directional tool string, the survey tool is behind the bit. As such, the survey will always be just short of the well’s TD. Some directional surveys will include the projection to bit, but others will just end at the final actual survey point. This tool simply projects the active directional survey data out to the total depth. This tool can also recalculate the bottom hole location using the bit projection.

To extend the directional survey, select Compute>From Locations>Extend Dir Surveys from the menu bar at the top of the Main Module. Note that this tool will work on all selected wells.

4.8.6.12  Set Horizontal Well Flag

Petra has a dedicated "Horizontal Well" entry for every well in the project database. This entry, or "flag", simply records whether the well is a horizontal well. This flag can be useful for searches and calculations elsewhere in Petra, such as in the Search Wells by Data Criteria tool.

This flag can be set individually in the Directional Survey Tool's General Tab, but this tool can set the flag for all selected wells at once.

To set the horizontal well flag for multiple wells, select Compute>From Locations>Set Horizontal Well Flag from the menu bar at the top of the Main Module. Note that this tool will work on all selected wells.
4.8.6.13 Set Survey XY Units Flags

The Set Survey XY Units Flags

To set the XY Units Flags, select Compute>From Locations>Set Survey XY Units Flags from the menu bar at the top of the Main Module.

4.8.6.14 Convert Survey Depths/Offsets to System Units

Enter topic text here.

4.8.6.15 Fix Dir Survey Header Records

Enter topic text here.

4.8.6.16 Clear Misc Location Data

Enter topic text here.

4.8.6.17 Fix Bad T-R-S Values

Enter topic text here.

4.8.7 Using Interval Data

To open any of Petra's interval compute tools, select Compute>From FmTops from
the menu bar at the top of the Main Module.

**Extract Interval to Zone**

**Extract Interval to Curve**

**Find and Replace Data**

4.8.7.1 **Extract Interval Data to Zone**

It’s sometimes useful to extract data from intervals to a zone. Zones are easily used in calculations and mapping.

To save zone data to intervals, select Compute>From Interval Data>Extract Interval Data To Zone from the menu bar at the top of the Main Module.

**Data Tab**

![Extract Interval Data to Zone dialog box]

**Extract Interval Data From**

This section selects the desired interval table and field, as well as what will actually be saved to the zone.

**Table** - This dropdown selects the desired interval data table. The selected table will control the available fields in the next dropdown.

**Field** - This dropdown selects the desired interval field.

**Method** - This tool can either extract the interval field data or the interval thicknesses. In the example above Petra will calculate an average of the “RW from SP” interval data. Since a single zone can contain multiple or overlapping intervals, there are a few different ways to extract this field or interval thickness data:

First/Last value
Min/Max of values
Average of values (weighted or unweighted by thickness on the Options Tab)
Sum of values
Count of values
Sum of interval thicknesses
Average of Thicknesses
Count of intervals

**Extract To**

This section selects the zone and data item where the interval data will be stored. Note that this tool uses the selected zone’s definitions (where fm tops or depths define the top and base of the zone) to limit the extraction only to intervals intersecting the zone. A default zone definition of -99999’ to 99999’ will include every interval in the wellbore.

**When**

Petra can store the interval data meets the following criteria:

*When the item is present* – This option stores the interval field value to the zone data item when the interval data contains a value. This is useful for most applications, such as storing a petrophysical value to a zone.

*Item is absent* – This option stores the value when the interval data field is null. Practically, this option is only useful when extracting the sum/average of interval thicknesses or interval counts. As an example, extracting a count of intervals when the porosity interval data is absent generates a well-by-well count of intervals missing porosity values.

*Range* – This option stores the interval field value when the field value falls between a minimum and maximum value.

*Contains text* – This option stores the interval field data when the interval field contains specified text.

*Matches text* - This option stores the interval field data when the interval field exactly matches the specified text.

**Options Tab**

The Options Tab contains further options for limiting the intervals used in the extraction.
Restrict Intervals By Selected Zone - By default, Petra only uses intervals that intersect the selected zone's definitions (where fm tops or depths define the top and base of the zone). Note that undefined zones extend from -99999' to 99999' MD, which includes every interval in the wellbore. Deselecting “Restrict Intervals By Selected Zone” will not limit intervals by zone definitions. Alternatively, intervals can also be limited by interval quality codes or FmName fields.

Method to Compute Average Values - When computing an average value for the interval, Petra normally uses weighted averages, where thicker intervals contribute more to the average than thin intervals. Selecting “Compute UnWeighted Average” gives equal weight to all values regardless of interval thickness.

Set Computed Values of Zero to NULL - Remember that a null is not equal to zero. Mistaking the two can generate spurious maps and calculations. The “Set Computed values of zero to null” sets extracted values of zero to a null value.

Use Filter to Restrict Intervals - Filters provide more control over which intervals are used in the zone extraction. Intervals that do not meet the filter criteria do not contribute to a zone data item. To create or modify a set of filters, select the “Set Filters…” button on the Filters tab. For more information on filters see the “Using Filters” section of this document.

4.8.7.2 Extract Interval Data to Curve

It’s sometimes useful to extract numerical data from intervals to a log curve. Logs curves are easily displayed on cross sections and can be used in petrophysical calculations to create new composite curves.

To create curves from interval data, select Compute>From Interval Data>Extract Interval Data To Curve from the menu bar at the top of the main module.
Data Tab
Extract Interval Data From

This section sets the interval table and field that will create the log curve. In the example above, the “RW from SP” interval data is selected from the “Petrophysics” table.

Extract To Log Curve

Petra extracts an interval field data value and applies it to that interval’s corresponding footage on a log curve. As an example, an interval from 1500 to 2000’ with a RW of 0.06 will translate into a log curve with a repeating RW of 0.06 from 1500 to 2000’, as shown in the example below.

Intervals often have gaps and overlaps between intervals. Gaps between intervals are simply stored as null values on the curve. Where log intervals overlap, the bottom interval overprints the upper interval. To resolve these gaps and overlaps in the data, see Resolving Gaps and Overlaps in this document.

Under the Extract Interval Data from dropdown menus, select the appropriate interval table and field. Next, select the name of the log curve. In the example below, the
“RW from SP” from the “Petrophysics” table will be stored as a new “RW” curve. These curves can be stored at any sample rate, though 1 foot- and ½ foot-spacing are the most common.

Options Tab

The Options Tab sets an additional filter to limit the intervals used in the extraction. Filters provide more control over which intervals are used in the zone extraction. Intervals that do not meet the filter criteria do not contribute to the log curve. To create or modify a set of filters, select the Set Filters button.

4.9 Advanced Volumetrics

The Advanced Volumetrics Module is a straightforward way to calculate volumetrics with a set of specific reservoir and fluid properties using either a deterministic model or a probabilistic Monte Carlo model.

A deterministic model uses a fixed set of inputs and generates a single calculated volume. A Monte Carlo simulation, on the other hand, uses a range of inputs to calculate a large number of possible reservoir volumes. The outputs are then arranged to give a probability density and cumulative distribution. Practically, both these Monte Carlo simulation plots show the likelihood for a different hydrocarbon reserves based on the range of possible reservoir parameters.

To open the Advanced Volumetrics Module, select Tools>Advanced Volumetrics… from the menu bar at the top of the Main Module.

When to use the Advanced Volumetrics Module

Mathematically, the Advanced Volumetrics tool calculates reservoir volumetrics based on a single set of averaged reservoir and fluid properties inside a cube with a defined volume. The Monte Carlo simulation performs this same deterministic calculation with
values selected from a possible range of these same average values. This simplification is ideal for “back-of-the-envelope” calculations or for estimations of exploratory reservoirs.

**Well-drilled fields with large amounts of petrophysical data are better served by a grid-based volumetrics calculation.** In contrast to the deterministic method, Petra uses grids of mapped thickness, water saturation, and porosity to calculate reservoir properties for heterogeneous reservoirs. For more information on using grids, see here.

**Units Setup**

The first step is to select the desired units for the volumetrics calculation. This tool can import and export in different units.
To use the Advanced Volumetrics Module, enter all the relevant numbers for your reservoir. Petra creates a report on the right side of the screen. This report screen is automatically updated to reflect the most recent volumetric parameters entered.

While some entries are necessary for the calculation (like TVD), other values are optional and exist only to override values Petra calculates automatically (such as the Z Factor). An “*” next to the entry name signifies mandatory entries.

Once all the entries are set, Petra automatically performs the reservoir calculation and displays a report on the right side of the screen.

1 - Reservoir Info

Though it’s optional, the first step is to enter the name of company, the field, the reservoir, and the county. These entries show up on the top of all reports.
2 - Reservoir Properties

**Drive Mechanism** - This dropdown menu governs how Petra treats reservoir depletion due to production.

*Water Drive (100 Percent Pressure Maintenance)* – Use this method when an underlying aquifer is strong enough to replace a barrel of oil produced with a barrel of water, or when the rate of production is very small relative to the rate of water influx. Importantly, this method assumes no pressure loss with production. If the reservoir experiences a pressure drop with production, use a combination drive mechanism instead.

*Solution Gas Drive (Volumetric Depletion)* – Use this method with undersaturated volumetric reservoirs with no water drive. Solution gas drive reservoirs have two stages of production: the liquid expansion stage from initial discovery pressure to the bubble point and the gas expansion stage from bubble point to abandonment pressure. This method assumes that all solution gas is either produced or remains in the pore space; there is no provision for the formation of a secondary gas cap. The solution drive dive reserves calculation particularly depends on the accuracy of the Kg/Ko vs. gas saturation curve.

*Gas Cap Drive* – Use this method when an expanding gas cap forces the oil lower in the formation with production.

*Combination Drive (Solution + Gas Cap + Water)* – Use this method with reservoirs that do not produce exclusively by one of the previously discussed drive mechanisms.

**Average TVD of Reservoir** - Enter the average true vertical depth of the horizon. Petra accepts values between 300 and 35000’.

**Initial Reservoir Pressure** - Enter the average reservoir pressure at initial conditions. Petra accepts values between 14.7 and 20,000 psia.

**Abandonment Reservoir Pressure** - Enter average reservoir pressure at final conditions. Petra accepts values between 14.7 and 500 psia. This entry is not used for water drive reservoirs because abandonment reservoir pressure equals the initial reservoir pressure.

**Temperature** - Enter the temperature of the producing horizon. Petra accepts values between 40 and 500 degrees.

**Connate Water Saturation** - Enter the connate water saturation of the producing horizon in percent. Petra accepts values between 1 and 99.99 percent. Remember to use whole numbers instead of decimal percentages.

**Vertical Conformance Factor** - Enter the efficiency of the water sweeping the oil zone. By default, Petra assumes 85 percent efficiency. Remember to use whole numbers instead of decimal percentages. Note this box is grayed out for gas cap and solution gas drives, since they assume no water drive.
Average Porosity* - Enter the volume-weighted average porosity of the producing formation in percent. Petra accepts values between 0.01 and 100 percent. Remember to use whole numbers instead of decimal percentages.

Residual Oil Saturation* – Enter the residual oil saturation after production. Petra accepts values between 1 and 100 percent. Remember to use whole numbers instead of decimal percentages. This entry is grayed out for gas cap and solution gas drives.

Net Interest* - Enter the company’s working interest before royalty. Petra accepts values between .01 and 100 percent. Remember to use whole numbers instead of decimal percentages.

3 - Oil Reservoir Volumes

Total Reservoir Volume* – Enter the size of the reservoir in acre-feet.

Water Invaded Volume* - Enter the size of the water-invaded part of the reservoir in acre-feet.

4 - Oil Fluid Properties

PVT correlation* – This dropdown governs the fluids in the system expand or contract under different PVT conditions.

Standing – This option uses the Standing PVT correlation. This correlation is based on data points from 22 Californiacrudes of gravities ranging from 16.5 to 63.8°API.

Glaso – This option uses the Glaso PVT correlation. This correlation is based on 45 oils (mostly from the North Sea) with gravities ranging from 22.3 - 48.1°API.

Vazquez and Beggs – This option uses the Vazquez and Beggs PVT correlation. This correlation is based on an extensive amount of data, with oil gravities ranging from 15.3 to 59.5°API.

Separator Gas Gravity* - Enter specific gravity of the solution gas relative to air. Petra accepts values between 0.55 and 10.

Separator Oil Gravity* - Enter specific gravity of the oil. Petra accepts values between 1 and 200° API.

Initial Z-factor - Enter the initial z-factor to override the internally-calculated value. By default, Petra calculates the z-factor with the Hall-Yarborough correlation, based on the Starling-Carnahan equation of state. This method agrees very well with the Standing-Katz chart. The program does not make corrections for impurities. Petra accepts values between 0 and 200.

The Hall-Yarborough correlation uses the following equations.
\[ z = \frac{0.06125(P_r)(t) e^{(12)(1-t)^2}}{y} \]

where:

\( P_r \) = Pseudo-reduced pressure

\( t \) = Reciprocal pseudo-reduced temperature

\( y \) = "Reduced" density

The "reduced density" or "y" term comes from the Newton-Ralphson technique:

\[
-0.06125(P_r)(t)\exp[(-1.2)(1-t)^2] + \frac{y + y^2 + y^3 + y^4}{(1-y)^3} - (14.76t - 9.76t^2 + 4.58t^3)y^2 + (90.7t - 242.21t^2 + 42.4t^3)y^{(2.38+2.82t)} = 0
\]

Reference Pressure* - Enter the standard reference pressure for delivery point measurements. Petra accepts values between 14 and 20 psia.

Oil Compressibility - Enter the oil compressibility to override the internally-calculated value. Petra accepts values between 0 and 10,000 1/psi E-6. By default, Petra uses the following Mobil Correlation chart.
Water Compressibility - Enter the water compressibility to override the internally-calculated value. Petra accepts values between 0 and 200 1/psi E-6. By default, Petra calculates water compressibility using Meehan's correlation.

\[ C_w = A1 + (B1 \times T) + (C1 \times T \times T) \]

where:

- \( C_w \) = Water compressibility in microsips (psi-1 * 10-6)
- \( A1 = -0.00014765 \times \Pi + 3.916801021 \)
- \( B1 = (6.379 \times 10^{-7})\Pi - 0.011441478 \)
- \( C1 = (-1.3536114 \times 10^{-10})\Pi + 4.238314 \times 10^{-5} \)
- \( \Pi \) = Initial reservoir pressure, psia
- \( T \) = Temperature

Formation Compressibility - Enter the formation compressibility to override the internally-calculated value. Petra accepts values between 0 and 200 1/psi E-6. By default, Petra calculates formation compressibility using Hall's method.

\[ C_f = 1.87(\phi_o^{-0.45}) \]

where:

- \( C_f \) = Formation compressibility, microsips
- \( \phi_o \) = Oil zone porosity, fraction

Bubble Point Pressure* - Enter the bubble point pressure (Pb) for the reservoir. Petra accepts values between 14.7 and 3000 psia. Typically, the ranges for Pb depend on drive type:

- **100% Water Drive**: 14.7 < Pb < \Pi (psia)
- **Solution Drive**: 14.7 < Pb < \Pi (psia)
- **Gas Cap Drive**: This entry is not available for Gas Cap Drive because Pb = \Pi is set automatically and the corresponding GOR at Pb is calculated.
- **Combination Drive (no gas cap)**: 14.7 < Pb < \Pi (p150sia)
- **Combination Drive (with gas cap)**: Pb = \Pi (where \Pi is the Initial Reservoir Pressure)

5 - Gas Cap Properties

Gas Cap Porosity* – Enter the average porosity of the rock containing the gas cap. Petra accepts values between .01 and 100 percent. Remember to use whole
numbers instead of decimal percentages.

Gas Cap Volume – Enter the volume of the gas cap.

Gas Produced from Gas Cap – Enter the volume of gas produced from the gas cap.

6 - Oil Cumulative Production

Oil* - Enter the total oil production from the discovery date to the date of reserve determination.

Gas* - Enter the total solution gas production from the discovery date to the date of reserve

Relative Permeability Input

The relative permeability input governs how the reservoir model handles the relative permeability of gas and oil versus different gas saturations. Petra comes with three default curves, which are typical for unconsolidated south Louisiana sandstone. To use a different curve, select the Corey Equation option, and enter in values for Eo, Sro, Smo, No, Eg, Srg, Smg, and Ng. Select “Calculate” to calculate the Corey equation and use the values in the volumetrics calculation.

4.9.2 Gas Volumetrics

To use the Advanced Volumetrics Module, enter in the relevant numbers for the reservoir. Petra creates a report on the right side of the screen. This report screen is automatically updated to reflect the most recent volumetric parameters entered.

While some entries are necessary for the calculation (like TVD), other values are optional and exist only to override values Petra calculates automatically (such as the Z Factor). An “**” next to the entry name signifies mandatory entries.

Once all the entries are set, Petra automatically performs the reservoir calculation and displays a report on the right side of the screen.

1 - Reservoir Info

Though it’s optional, the first step is to enter the name of company, the field, the reservoir, and the county. These entries show up on the top of all reports.

2 - Reservoir Properties

Drive Mechanism* - This dropdown menu governs how Petra treats reservoir depletion due to production.

Volumetric – Use this method for reservoirs that are driven by volumetric expansion of
gas after a drop from initial reservoir pressures. The effects of water and formation compressibility are also included in this method.

Water Drive (100 Percent Pressure Maintenance) – Use this method when all gas recovery is due to water sweeping the entire drainage area. Importantly, this method assumes no pressure loss with production. Initial and abandonment pressures are assumed to be equal.

Partial Water Drive – Use this method with a mixed system of volumetric and water drives. This method assumes two-part depletion: a volumetric depletion to abandonment pressure and then an additional recovery in the water-swept zone.

Average TVD of Reservoir* - Enter the average true vertical depth of the horizon. Petra accepts values between 300 and 35,000'.

Formation Pressure Gradient* - Enter the formation pressure gradient. Petra accepts values between 0.05 and psi/ft.

Average Porosity* - Enter the volume-weighted average porosity of the producing formation in percent. Petra accepts values between 0.01 and 100 percent. Remember to use whole numbers instead of decimal percentages.

Formation Compressibility* – Enter the average compressibility of the formation. Petra accepts values between 0.01 and 200 1/psi(E-6).

Connate Water Saturation* - Enter the connate water saturation of the producing horizon in percent. Petra accepts values between 1 and 99.99 percent. Remember to use whole numbers instead of decimal percentages.

Residual Gas Saturation - Enter the residual gas saturation to override the internally-calculated value. By default, Petra calculates the residual gas saturation with the Legatski-Katz correlation for clean sands. This entry is only used for 100% Water Drive and Partial Water Drive reservoirs. Remember to use whole numbers instead of decimal percentages.

\[
S_r = 0.617 - 1.286 \phi
\]

where:

\( S_r \) = Residual gas saturation, percent

\( \phi \) = Porosity, percent

Initial Pressure* - Enter average reservoir pressure at final conditions. Petra accepts values between 14 and 20,000 psia.

Abandonment Pressure* - Enter average reservoir pressure at final conditions. Petra accepts values between 14.7 and 500 psia. This entry is not used for water drive reservoirs because abandonment reservoir pressure equals the initial reservoir pressure.
pressure.

Reservoir Temperature* - Enter the temperature of the producing horizon. Petra accepts values between 40 and 500 degrees.

Vertical Conformance Factor - Enter the vertical conformance factor, which is a measure of the uniformity of vertical permeability. It is usually calculated as volumetric sweep efficiency divided by the areal pattern efficiency, and is assumed to equal the fraction of waterswept portion of the reservoir actually contacted by water. In a sense, it is a measure of water-drive efficiency.

Net Interest* - Enter the company's working interest before royalty. Petra accepts values between .01 and 100 percent. Remember to use whole numbers instead of decimal percentages.

3 – Gas Reservoir Volumes

Total Reservoir Volume* – Enter the size of the reservoir in acre-feet. Petra accepts values between 0.01 and 1xE13 acre-feet.

Water Invaded Volume* - Enter the size of the water-invaded part of the reservoir in acre-feet. Petra accepts values between 0.01 and 1xE9 acre-feet.

4 - Gas Fluid Properties

Type of Gas Gravity* – This dropdown governs how Petra handles gas gravity.

Wellstream Gas Gravity – This option indicates the gas gravity was measured at the wellstream.

Separator Gas Gravity – This option indicates the gas gravity was measured at the separator.

Gas Gravity* - Enter specific gravity of the solution gas relative to air. Petra accepts values between 0.55 and 10.

Condensate Loss Method* - In the absence of PVT information, this option helps to account for the effect of retrograde condensate on ultimate recovery.

Eaton-Jacoby – The Eaton-Jacoby uses a series of curves to estimate the percentage of production lost to retrograde condensate. It is limited to reservoirs between 4,000-12,000 psi, 160-290 f, 2,500 to 60,000 scf/STBO, and 5-65 oil gravities.
Modified Eaton-Jacoby — The original Eaton-Jacoby method was modified by Amoco to better suit reservoirs in the Gulf of Mexico.
Condensate Yield – Enter the ratio of condensate produced per MMSCF. Petra accepts values between 1 and 200. Setting this yield to zero sets the fractional retrograde loss to zero.

Condensate Gravity - Enter the condensate gravity. Petra accepts values between 1 and 200.

Condensate Gas Equivalent - Enter the condensate gas equivalent. Petra accepts values between 0 and 1000000.

Fuel Factor* - Enter the percent of the separator gas used to power process equipment. Petra accepts values between .01 and 100 percent. Remember to use whole numbers instead of decimal percentages.

Nitrogen - Enter the mole percent of nitrogen in the produced gas. Petra accepts values between 0 and 90 percent. Remember to use whole numbers instead of decimal percentages.

Carbon Dioxide - Enter the mole percent of carbon dioxide in the produced gas. Petra accepts values between 0 and 90 percent. Remember to use whole numbers instead of decimal percentages.

Hydrogen Sulfide - Enter the mole percent of hydrogen sulfide in the produced gas. Petra accepts values between 0 and 90 percent. Remember to use whole numbers instead of decimal percentages.

5 - Gas Cumulative Production

Gas at Separator* - Enter the total amount of separator gas produced from the discovery date to the date of reserve determination. Make sure to include gas used as fuel.

Condensate* - Enter the total condensate from the discovery date to the date of reserve.

4.9.3 Monte Carlo Simulation

A Monte Carlo simulation calculates probability of recoverable gas in place using a range of inputs for variable volume, porosity, gas saturation, recovery factor, and gas formation volume factor. The Monte Carlo Simulation is a standalone tool, and does not use any of the options entered on the Gas or Oil Volumetrics Tab.

Simulation Models

For oil reserve simulation, Petra uses the following model:
For gas reserve simulation, Petra uses the following model:

\[ N_o = \frac{AhS_oR_o}{B_o} \]

where:
- \( N_o \) = Recoverable oil volume
- \( A \) = Reservoir area
- \( h \) = Reservoir thickness
- \( \phi \) = Reservoir rock porosity
- \( S_o \) = Oil saturation
- \( R_o \) = Oil recovery factor
- \( B_o \) = Oil formation volume factor

\[ N_g = \frac{AhS_oR_g}{B_g} \]

where:
- \( S_g \) = Gas saturation
- \( R_g \) = Gas recovery factor
- \( B_g \) = Gas formation volume factor

**Reservoir Options**

**Volume** – Enter the range of possible reservoir volumes in acre-ft.

**Porosity** – Enter the range of possible reservoir porosities. Remember to use whole numbers instead of decimal percentages.

**Gas Saturation** – Enter the range of possible gas saturations. Remember to use whole numbers instead of decimal percentages.

**Recovery Factor** – Enter the range of possible recovery factors. Remember to use whole numbers instead of decimal percentages.

**Gas Formation Volume Factor** – Enter the range of possible gas formation volume factors in RB/MSCF.

**Reservoir Option Ranges and Probability**

Each of the reservoir parameters can vary in a few different probability distributions. For more detail on using probability distributions as well as strategies on estimating standard deviation, see the appendix at the end of this document.

**Uniform** – In a uniform distribution, all values between the minimum and maximum values are equally likely. To use a uniform distribution, simply enter the minimum and maximum values.
Triangular – In a triangular distribution, the “most likely” value has the highest probability with a gradually decreasing probability towards the minimum and maximum. To enter a triangular distribution, enter the minimum, maximum, and most likely values. The most likely value will be treated with the highest probability, with a linearly decreasing occurrence of values towards the minimum and maximum values.

Normal - In a normal distribution, values are more probable around a single arithmetic mean, or average. This creates a “bell curve” where values closer to the mean are more likely, where the standard deviation measures the average difference of the values from the mean. To use a normal distribution, simply enter the mean and standard deviation.
Log-Normal – In a log-normal distribution, values are more probable around a single mean with an even distribution of the logarithms of surrounding values. Log-normal distributions are common when there is multiplication of two or more normally distributed factors. To use a log-normal distribution, simply enter the mean and standard deviation.

Constant – A constant distribution actually has no variability at all and only contains a single value. An example of a constant is the ultimate mortality rate, which is holding steady at 100%.

Monte Carlo Outputs

A Monte Carlos simulation generates many different possible reserves values, some of which are more likely to occur than others. Petra displays these statistics in a few different ways on tabs next to the Monte Carlo tab.
Report Output

The report output tabs shows recap of the initial reservoir parameters, a percentile breakdown of the simulation results (P10, P50, P90, mean reserves, and expected reserves), and a cumulative distribution table.

The summary gives a brief statistical breakdown of the probability of different calculated reserves. There is a 10% chance that the reservoir is equal to or less than the P10 value, a 50% chance the reservoir is equal to or less than the P50 value, and a 90% chance that the reservoir is less than the P90 value. The mean reserves value is a simple average of all the calculated reserves values, while the expected reserves value instead weights results by probability.

The cumulative distribution table expands the calculated percentiles to cover every 5%. Each percentile gives the chance of the reservoir being equal to or less than the calculated reserves. As an example, there is a 55% chance that the reservoir is equal to or less than the reserves value across from cumulative distribution of 55.

Probability Plot

This plot displays the probability density on the Y axis versus the range of possible reserves on the X axis. Low reserves estimates on the left side of the graph are the result when everything goes wrong; this includes when the total volume, porosity, oil saturation, etc. are all on the lower end of the possible ranges. Since the probability of all these different factors going wrong is low, the corresponding probability of these low end reserves is low. The high side of the graph with large reserves, on the other hand is the result of everything going well, which also has a correspondingly low probability. The bump in the middle of the graph corresponds to the highest probabilities; these are the outcomes of the more common reservoir parameters.

Cumulative Distribution Plot

This plot displays the cumulative probability on the Y axis versus the range of possible reserves on the X axis. Each point on the line reflects the probability of the reservoir being equal to or less than the calculated reserves. As an example, there is a 55% chance of the reservoir being equal to or less than the reserves value across from accumulative distribution of 55.

4.9.4 Drive Configurations

100% Water Drive

The 100% water drive reservoir calculation is best suited for reservoirs in which no pressure loss occurs with production. Any pressure drop that occurs with production affects the calculation accuracy. Use combination drive if a pressure drop occurs.
Oil Recovery

The initial discovery reservoir pressure must be greater than or equal to the bubble point pressure of the reservoir oil. This calculation assumes total pressure maintenance by the aquifer such that recovery is given by:

\[ H_{2}O.\text{RECOV} = \frac{7758 \phi_o (S_{oi} - S_{mw}) VCONFW}{B_o} \]

where:
- \( H_{2}O.\text{RECOV} \) = Oil recovery, STB/acre-ft
- \( S_{oi} \) = Initial oil saturation, fraction
- \( VCONFW \) = Vertical conformance factor, fraction. Default is .85
- \( S_{mw} \) = Residual oil saturation in the water invaded zone. \( S_{mw} \) is calculated using the Legatsky-Katz correlation given by:
  \[ S_{mw} = 0.6 - 1.25 \phi_o \]
- \( \phi_o \) = Average porosity of the oil zone, fraction
- \( B_o \) = Initial oil formation volume factor, bbl/STB
- 7758 = Conversion factor, bbl/acre-foot

The oil recovery as calculated above is applied to the water invaded zone. This method of calculation implies that the aquifer must be strong enough to replace a barrel of oil produced with a barrel of water influx, or the rate of production very small relative to the rate of water influx.

The total oil recover is calculated using:

\[ NW = H_{2}O.\text{RECOV} \times H_{2}O.ACF / 1000 \]

where:
- \( NW \) = Recoverable oil, MSTB
- \( H_{2}O.\text{RECOV} \) = Oil recovery due to water drive, STB/acre-ft
- \( H_{2}O.ACF \) = Input water invaded volume, acre feet

The recovery factor is calculated using:
Solution Gas

The solution gas produced is equal to the gas that comes out of solution as the oil is produced and brought to the surface. It is calculated by the following equation:

\[
\text{GRFW} = \frac{\text{H}_2\text{O.RECOV}}{\text{OOIP}}
\]

where:
- \( \text{RFW} \) = Water drive recovery factor, fraction
- \( \text{OOIP} \) = Original oil in place in STB/acre-ft

\[
\text{GH}_2\text{O.RECOVER} = \frac{\text{H}_2\text{O.RECOVER} \times \text{R}_{sb}}{1000}
\]

where:
- \( \text{GH}_2\text{O.RECOVER} \) = Gas recovery, MSCF/acre-ft
- \( \text{R}_{sb} \) = Solution gas-oil ratio at initial bubble point, SCF/STB

The total gas production is calculated using:

\[
\text{GW} = \text{NW} \times \frac{\text{R}_{sb}}{1000}
\]

where:
- \( \text{GW} \) = Total gas produced due to water drive, MMSCF
- \( \text{NW} \) = Total oil produced in MSTB as calculated in equation
- \( \text{R}_{sb} \) = Gas-oil ratio at initial bubble point pressure, SCF/STB

The gas recovery factor is calculated using:

\[
\text{GRFW} = \frac{\text{GW}}{\text{OSGIP}}
\]

Gas Recovery

100% water drive recovery is best suited for reservoirs where very little
pressure loss occurs with production. This calculation assumes total pressure maintenance by the aquifer such that recovery is given by:

\[ \text{WGRECov} = \text{WGI} P \left( 1 - \frac{S_g}{1 - S_w} \right) (\text{VCONFW}) \text{MMSCF/acre-ft} \]

The recovery factor calculated above applies to the entire hydrocarbon zone. This method of calculation implies that the aquifer must be very strong or the rate of production very small relative to the rate of water influx.

**Solution Gas (Depletion) Drive**

The solution drive mechanism is applicable to undersaturated volumetric reservoirs.

Initial reservoir pressure must be at or above the bubble point pressure. Production from the initial discovery pressure down to the bubble point pressure is by liquid expansion and results in a rapid decline in reservoir pressure. Typical recoveries for this stage of the production life of the reservoir are a fraction of a percent to a few percent of the original oil in place. The gas-oil ratio remains equal to the initial gas-oil ratio.

Below the bubble point, gas liberates in the reservoir pore space. The reservoir then produces by gas expansion, as indicated by a slower rate of pressure decline and increasing produced gas-oil ratios. Typical recoveries are 10 to 25 percent of the original oil in place.

The oil volumetrics calculator makes the following assumptions for solution drive mechanism:

- All gas that comes out of solution is either produced or remains in the same pore space where it was liberated. The calculator makes no provision for additional production due to the formation of a secondary gas cap.
- No water influx
- Uniform gas saturation throughout the oil zone
The recovery factor for solution drive has two parts:

- Recovery factor from discovery pressure down to bubble point pressure (if the initial pressure is greater than bubble point pressure)
- Recovery factor from bubble point pressure down to abandonment pressure

**Recovery Factor from Discovery Pressure to Bubble Point Pressure**

The recovery factor from discovery pressure down to bubble point pressure (if the initial pressure is greater than bubble point pressure) is calculated by:

\[
FR_{ABP} = C_f \cdot \left( \frac{P_i - P_b}{B_{ob}} \right)
\]

where:
- FR\(_{ABP}\) = Fraction of recovery due to expansion down to bubble point pressure in fraction of one stock tank barrel in place
- P\(_i\) = Initial discovery reservoir pressure, psia
- P\(_b\) = Initial bubble point pressure for the reservoir, psia
- B\(_{ob}\) = Formation volume factor at the initial bubble point pressure, bbl/STB
- B\(_{oi}\) = Initial formation volume factor, bbl/STB
- C\(_f\) = Effective compressibility for the reservoir, microsips. Includes compressibility of the reservoir oil, water, and formation.

The above fractional recovery is calculated as the fraction of a stock tank barrel of oil that is recovered by the expansion of that barrel due to a pressure drop from the initial pressure down to the bubble point pressure.

**Recovery Factor from Bubble Point Pressure to Abandonment Pressure**

The recovery that occurs from bubble point pressure down to abandonment pressure is calculated using Tracy's material balance method. The iterative procedure calculates the recovery fraction for each 200 psia drop in reservoir pressure and keeps a running total of the recovery fraction down to abandonment pressure. The calculation procedure is discussed below along with Tracy's PHI function. Tracy rearranged the general material balance equation by defining three functions of fluid properties dependent on reservoir pressure. This permitted the estimation of change in produced gas-oil ratio, rather than incremental oil production, for each pressure step. Performance calculations are made in a series of pressure steps from known reservoir conditions at the previous pressure to calculated conditions at the next lower
pressure. The calculated results then become the "knowns" at the next lower pressure. This calculation sequence is repeated until abandonment pressure is reached.

The following steps trace the calculation used to determine the recovery factor for solution drive:

1. Initially calculate the pressure, \( P \), by subtracting 200 psia from the bubble point pressure. On subsequent iterations, subtract 200 psia from the previous pressure.
2. Calculate solution gas-oil ratio, \( R_s \), using a correlation.
3. If this is the first pressure below bubble point, calculate estimated produced gas-oil ratio, \( R \), by adding 100 to \( R_s \) (calculated in step 2). If this is not the first pressure below bubble point, average the previous value of \( R \) with the current value of \( R_{\text{CALC}} \) (as calculated in step 7).
   \[ R = (R_{\text{previous}} + R_{\text{CALC}})/2 \]
4. Calculate incremental production.
   \[ \Delta NP = (1 - ((NP' * v_o) + (GP' * v_g)) / (v_o + (R' * v_g))) \]
   \[ NP = NP' + \Delta NP \]
5. Calculate oil saturation, \( S_o \), and gas saturation, \( S_g \).
   \[ S_o = (1 - S_{wi}) * (1 - NP) * (B_o / B_R) \]
   \[ S_g = 1 - S_o - S_{wi} \]
6. Obtain a \( K_e/K_o \) value for the \( S_e \) calculated in step 5.
7. Calculate \( R_{\text{CALC}} \).
   \[ R_{\text{CALC}} = (K_e/K_o) * (v_o / \mu_g) * (B_o / B_R) + R_s \]
8. Compare \( R \) in step 3 with \( R_{\text{CALC}} \) from step 7. If the values are within acceptable tolerance of 0.5%, proceed to step 9. If not within the tolerance, recalculate \( R \) with latest value of \( R_{\text{CALC}} \) and repeat from step 3.
   \[ GP = GP' + (\Delta NP * R) \]
10. Verify Tracy's material balance equation.
   \[ ((NP * v_o) + (GP * v_g)) = 1 = .005 \]
11. Repeat from step 1 until you reach abandonment pressure.

The equations for Tracy's functions are:
Probably the one most important factor in the solution drive calculations is the Kg/Ko vs. gas saturation curve. You must verify the three curves stored in the program before you use them. A relatively small change in the curve can change the recovery by 5 to 8 percent. The default curves are typical for an unconsolidated south Louisiana sandstone.

**Total Fractional Recovery**

The total fractional recovery is calculated using the following equation to combine the recovery fraction above and below the bubble point.

\[
RFS = ((1 - FRABP) \times FRBBP) + FRABP
\]

where:
- \( RFS \) = Recovery fraction for the total pressure drop in units of fraction of a reservoir barrel of oil
- \( FRABP \) = Recovery fraction above the bubble point
- \( FRBBP \) = Recovery fraction below the bubble point

**Oil Recovery**

The oil recovery for the solution drive method is calculated by the following equation:
\[
\text{SOL.RECOVER} = \text{RFS} \times 7758 \times \phi_o (1 - S_{wi}) / B_{oi}
\]

where:
- \(\text{SOL.RECOVER}\) = Oil recovery due to solution drive, STB/acre-ft
- \(\text{RFS}\) = Recovery fraction as calculated above
- \(\phi_o\) = Average oil zone porosity, fraction
- \(S_{wi}\) = Initial connate water saturation, fraction
- \(B_{oi}\) = Initial formation volume factor, res.bbl/STB

The total recovery is determined by:

\[
\text{NS} = \text{SOL.RECOVER} \times \text{TOT.ACFT} / 1000
\]

where:
- \(\text{NS}\) = Total oil recovery, STB
- \(\text{SOL.RECOVER}\) = As calculated above
- \(\text{TOT.ACFT}\) = Volume of original oil in place, acre-ft

**Gas Recovery**

The solution gas recovery is calculated by:

\[
\text{GSOL.RECOVER} = ((\text{GRFS} \times \text{OOIP} \times (1 - \text{FRABP}))
+ (\text{FRABP} \times \text{OOIP} \times R_{sb})) / 1000
\]

where:
- \(\text{GSOL.RECOVER}\) = Solution gas recovery, MCF/acre-ft (includes recovery above and below the bubble point)
- \(\text{GRFS}\) = Gas recovery factor in SCF/STB, as calculated above (GP)
- \(\text{OOIP}\) = Original oil in place, STB/acre-ft
- \(R_{sb}\) = Gas-oil ratio at initial bubble point pressure, SCF/STB

Total gas recovery is determined by:
Use the gas cap drive mechanism for reservoirs with a gas cap. Oil accumulations often occur in which there are greater volumes of light hydrocarbons present than would dissolve in the oil at reservoir temperature and pressure. Over time, these light materials migrate to the top of the reservoir to form a gas cap.

There are two sources of energy, due to the pressure drop caused by oil production, that produce a gas cap drive reservoir:

- Expansion of the gas cap gas
- Expansion of the dissolved gas as it is liberated

In the gas cap drive reservoir, the oil level in the reservoir falls as oil production occurs due to the expanding gas cap forcing the oil lower in the formation. Gas cap drive reservoirs tend to maintain higher pressures than solution drive reservoirs. The pressure decline rate is inversely related to the volume of gas in the gas cap. The larger the volume of gas in the gas cap, the less the pressure declines as oil is produced. Recovery fractions for this type of reservoir normally range between 20 and 40 percent of the original oil in place.

The oil volumetric calculator calculates oil recovery due to both gas cap expansion and solution gas expansion. It does not take into account gravity, which can significantly increase oil recovery in steeply dipping reservoirs. Also, well placement in the reservoir can affect the expected oil recovery. This can happen when wells are completed up-dip and must start producing the advancing gas cap due to early breakthrough. Note: The calculator does not account for migration of reservoir oil into the gas cap.
The volumetrics calculator allows entry of a produced gas from gas cap. You could possibly use this feature in a one well reservoir where either the well cannot be recompleted in a lower interval or it is not economical to do so.

Note: Production of gas cap gas from a gas cap drive reservoir reduces the oil recovery and therefore is NOT the recommended way to produce the reservoir.

The method used for gas cap drive assumes that the oil saturation at any time step is uniform throughout the original oil zone and that gas cap gas expansion across the original gas-oil contact immediately spreads uniformly through the oil zone. The calculated gas-oil ratios will be too high before gas breakthrough to the wells and too low after breakthrough, which will reduce the reliability of the reserve estimates.

Tracy’s Method
The same iterative procedure used to calculate solution drive production is used in the gas cap drive with a few additional parameters in Tracy’s method. The calculation procedure is repeated below with the gas cap parameters included.
The equations for Tracy's functions are:

\[ \psi_o = \frac{(B_o - (R_e \cdot B_g))}{DEN} \]

\[ \psi_g = \frac{B_g}{DEN} \]

\[ \psi_{ge} = \frac{B_{ge}}{DEN} \]
The following lists definitions and equations for the variables listed earlier:

\[
DEN = (B_w - B_{wi} + ((R_s - R_a) * B_g)) + (M * B_{si} * \frac{B_{gw} - B_{gi}}{B_{wi}})
\]

- \(S_{wi}\) = Initial connate water saturation, fraction
- \(B_w\) = Formation volume factor for gas at initial pressure, bbl/SCF
- \(B_o\) = Formation volume factor for oil at the pressure of interest, bbl/STB
- \(B_{oi}\) = Formation volume factor for oil at initial pressure, bbl/STB
- \(B_g\) = Formation volume factor for gas at the pressure of interest, bbl/SCF
- \(B_{gg}\) = Bubble point formation volume factor for oil, bbl/STB
- \(B_{go}\) = Formation volume factor for the gas cap at the pressure of interest, bbl/SCF
- \(R_s\) = Solution gas/oil ratio, SCF/STB
- \(R_a\) = Initial solution gas oil ratio, SCF/STB
- \(\mu_o\) = Oil viscosity, cp
- \(M\) = Ratio of gas cap volume to oil zone volume, fraction
- \(\mu_g\) = Gas viscosity, cp
- \(\Delta GPC\) = Gas cap gas produced for the reservoir pressure drop

**Oil Recovery**

The oil recovery for the gas cap drive method is calculated by:

\[
GC.RECOVER = NP * 7758 * \frac{\phi_o}{(1 - S_{wi})} / B_{wi}
\]

where:

- \(GC.RECOVER\) = Oil recovery due to gas cap drive, STB/acre-ft
- \(NP\) = Recovery fraction as calculated above
- \(\phi_o\) = Average oil zone porosity, fraction
- \(S_{wi}\) = Initial connate water saturation, fraction
- \(B_{wi}\) = Initial formation volume factor, bbl/STB

Total oil recovery is determined by:

\[
NPG = GC.RECOV * TOT.ACFT / 1000,
\]

where:

- \(NPG\) = Total oil recovery in MSTB for gas cap drive
- \(TOT.ACFT\) = Acre-ft of original oil in place

**Gas Recovery**

The solution gas recovery due to gas cap drive is calculated by the following equation:
The gas cap production is the total gas cap production as input. The gas cap gas production for each 200 psia decrement is calculated as a function of the change in Z/P for the 200 psia reservoir pressure drop to the total change in Z/P from initial conditions to abandonment condition. This gas cap gas production scheme skews the gas cap production toward the end of the reservoir production life to approximate actual production practice.

The formula for delta GPC is:

\[
\Delta \text{GPC} = \frac{GFC \left( \frac{Z_{\text{m}}}{P_{\text{m}}} - \frac{Z_{\text{m+1}}}{P_{\text{m+1}}} \right)}{\frac{Z_{\text{m}}}{P_{\text{m}}} - \frac{Z_{\text{m+1}}}{P_{\text{m+1}}}}
\]

where:
- \( \Delta \text{GPC} \) = Gas cap gas produced during the pressure drop
- \( GFC \) = Total gas cap production in SCF/STB of OOIP
- \( Z_{\text{m}} \) = Z-factor at current pressure
- \( P_{\text{m}} \) = Current pressure, psia
- \( Z_{\text{m+1}} \) = Z-factor at previous pressure
- \( P_{\text{m+1}} \) = Previous pressure, psia
- \( Z \) = Z-factor at initial reservoir pressure
- \( P_i \) = Initial reservoir pressure, psia
- \( Z_{a} \) = Z-factor at abandonment pressure
- \( P_a \) = Abandonment pressure, psia

\[
GPG = \text{GSOL.RECOVER} \times \text{TOT.ACFT} / 1000,
\]

where:
- \( GPG \) = Total solution gas recovery in MMCF for gas cap drive
- \( \text{GSOL.RECOVER} \) = Calculated in equation 7-15
- \( \text{TOT.ACFT} \) = Acre-ft of original oil in place

**Combination Drive**

Few oil reservoirs produce exclusively by one of the previously discussed drive mechanisms. In most cases, the reservoir uses at least two or possibly all
three of the mechanisms. The combination drive mechanism allows you to specify any combination of the water drive, solution drive, and gas cap drive for a recovery calculation.

Note that for a partial water drive with a gas cap, the water invasion zone cannot extend into the gas cap. If this occurs the gas cap expansion is set to zero and the water invaded volume is set equal to the total oil in place volume. Gravity effects are ignored.

In order for oil volumetrics calculator to calculate a recovery for each specific drive mechanism to include in the recovery calculation, you must input a volume for each drive mechanism. To allow a gas cap drive, the initial discovery pressure must be equal to the reservoir bubble point pressure. The program displays a warning message if these pressures are not equal and will not allow you to input gas cap parameters. All recovery calculations are carried out at in the specific drive calculations with the exception of water drive.

The modified water drive recovery equation is:

\[
H_2O\text{RECOV} = 7758 \times \alpha_w (S_{o1}/B_o) - (S_{o2}/B_{o2}) \times V\text{CONFW},
\]

and

\[
GH_2O\text{RECOVER} = 7758 \times \alpha_w ( (S_{o1} \times R_{oi}/B_{oi}) (S_{oi}/R_{oi}/B_{oi}) - (S_{o2}/B_{o2}) \times V\text{CONFW},
\]

where:

- \( H_2O\text{RECOVER} \) = Oil recovery due to water invasion in a combination drive, STB/acre-ft
- \( GH_2O\text{RECOVER} \) = Gas recovery due to water invasion in a combination drive, SCF/acre-ft
- \( \alpha_w \) = Average porosity of the oil zone, fraction
- \( S_o \) = Initial oil saturation in the oil zone, fraction
- \( S_{o2} \) = Residual oil saturation in the water invaded zone, fraction
- \( B_o \) = Initial oil formation volume factor, bbl/STB
- \( B_{o2} \) = Oil formation volume factor at abandonment, bbl/STB
- \( V\text{CONFW} \) = Vertical conformance factor of the water invaded zone, fraction
- \( R_o \) = Initial solution gas oil ratio, SCF/STB
- \( R_{o2} \) = Solution gas oil ratio at abandonment, SCF/STB
- \( B_{o2} \) = Gas formation volume factor at abandonment, bbl/SCF
- \( S_{o2} \) = Residual gas saturation in the invaded zone (trapped gas)

The total recovery for a combination drive reservoir is:
Use of SOL.RECOVER or GC.RECOVER is dependent on whether gas cap drive is included as part of the combination drive.

The fractional recovery for the combination drive is:

\[ FRC = \frac{NP}{OOIP}, \]

and

\[ GFRC = \frac{(GP - GPGC) OSGIP}{OOIP}, \]

where:
- \( FRC \) = Oil fraction recovered due to combination drive
- \( GFRC \) = Solution gas fraction recovered due to combination drive

**Partial Water Drive**

The following two factors affect partial water-drive recovery:

- Strength of the associated aquifer
- Residual gas saturation

Because the gas volumetric calculator does not perform time-step calculations, it makes certain simplifying assumptions to calculate partial water-drive recovery. First, the entire reservoir is assumed to undergo volumetric depletion to abandonment pressure. At this time, determining any additional recovery in the water-swept zone accounts for the effect of water influx.
After the residual saturation is determined, separate recovery factors are then calculated for volumetric and water drive performance of the reservoir:

\[
\text{WGRECOV1} = 0.4356 \phi (1 - S_o) B_o \left[ 1 - \frac{P_i Z_o}{P_o Z_i} \left( 1 - \frac{\Delta P(C_o S_o + C_i)}{S_v} \right) \right]
\]

\[
\text{WGRECOV2} = 0.4356 \phi (1 - S_o) B_o \left( \frac{S_v}{1 - S_v} \right) (VCONFW) \text{MMSCF/acre-ft}
\]

where:

- \( \text{WGRECOV1} \) = Volumetric recovery factor, MMSCF/acre-ft
- \( \text{WGRECOV2} \) = Water drive recovery factor, MMSCF/acre-ft
- \( B_o \) = Gas formation volume factor at abandonment, reservoir ft³/MMSCF

The volumetric recovery factor is multiplied by the total reservoir volume while the water-drive factor is applied only to the estimated volume swept by water. Because no water-influx is assumed to occur until abandonment pressure is reached, this method is most applicable if the rate of water influx is low relative to the rate of gas withdrawal from the reservoir.

Total recovery from partial water drive reservoirs is thus calculated as the sum of the volumetric and water drive recoveries:

\[
\text{WGRECOV} = (\text{WGRECOV1}) \text{ (acre-ft}_v \text{)} + (\text{WGRECOV2}) \text{ (acre-ft}_w \text{)}
\]

\[
\text{PCTRECOV} = \frac{\text{WGRECOV}}{\text{WGIP}} \times 100
\]

where:

- \( \text{PCTRECOV} \) = overall percent recovery

Acre-ftv refers to the entire existing hydrocarbon zone, while acre-ftw represents the anticipated portion of acre-ftv that will be swept by water. Recovery efficiency is therefore considerably affected by the quantity acre-ftw. Naturally, if the water-swept portion is set equal to the volumetric (total) volume, the theoretical maximum recovery will be calculated.

Estimation of the reservoir volume swept by the advancing aquifer is difficult. Unless the water-drive is extremely weak, it is recommended that the water-swept zone be taken as the volume down-dip of the highest well on the
structure. If formation stratigraphy indicates a potential for coning, this volume must be adjusted downward.

Aquifer response also represents an important factor in determining ultimate recovery due to the effect it has on the absolute quantity of gas left in the reservoir. The trapped gas saturation has been found to be largely independent of the pressure at which the gas is trapped, but generally ranges from 30% to 50% of the pore volume. Although this trapped saturation is essentially independent of pressure, it can be shown that identical saturations can represent vastly different quantities of gas through use of the ideal gas law.

Applying the ideal gas equation to the gas trapped in one cubic foot of pore volume behind the front, we have:

\[
(P) (1 \text{ ft}^3) (S_g) = znRT
\]

Because \(S_g\) is independent of pressure and the RT term remains constant if the reservoir produces isothermally, the actual moles of trapped gas is directly proportional to pressure:

\[
P/z = n
\]

Thus, high pressure maintenance due to rapid water-influx will lower ultimate recovery significantly due to the high molar-density of residual gas. In cases of strong pressure maintenance, it is reasonable to assume a 10% pressure loss if no other information is available. Sometimes you can make better estimates by analogy with similar reservoirs, but you should exercise careful judgment in order to select a reservoir with similar characteristics.
Chapter 5
The Map Module creates maps of a wide variety of Petra data. The Map Module also creates grids and displays contour maps based on those grids. Importantly, the Map Module is only available when there is at least 1 well in the project.

To open the Map Module, select Tools>Mapping from the menu bar at the top of the Main Module, or select the icon on the Main Module's Toolbar.

5 Map Module

Getting Started

Plotting Well Symbols
Adding Culture and Annotations with Overlay Data
Posting Data around Well Symbols
Creating Grids and Contour Maps
Adding Attribute Maps
Adding Bubble Maps
Adding Symbol Highlights
Adding Drainage Ellipses around Well Symbols
Displaying Log Curves under Well Symbols
Adding Production Charts around Well Symbols
Displaying Seismic Lines on the Map
Adding Dip Symbols
Posting IP/DST around Well Symbols
Adding LatLon and XY Ticks to the Map
Adding WMS Aerial and Satellite Imagery
WMS Imagery
Working with Deviated Wells
Setting the directional well's symbol location
Displaying interval data on deviated well paths
Formation tops on deviated well paths
Adding dip-azimuth arrows on deviated well paths

Keyboard Shortcuts

ESC Key - While redrawing the screen, terminates drawing and returns control to the mouse.

Space Bar - While redrawing the screen, terminates current map element and begins drawing the next element.

F1 Key - Snaps mouse cursor to nearest well.

F2 Key - Snaps mouse cursor to nearest overlay line control point with 0.1” tolerance.

F3 Key - Snaps mouse cursor to nearest quarter section grid intersection.

F4 Key - Hot key to activate moving posted data-by-well.

F5 Key - If an overlay line is selected, F5 shows the next overlay line sharing the common location.

F9 Key - Toggles on/off a readout of the XY or Latlon coordinates of the cursor location.

CTRL+F9 - Toggles between approximate and true screen scaling mode.

"+" Key - While in zoomed mode, pressing the "+" key zooms in by 1/4 of the zoomed map extents.
"-" Key  - While in zoomed mode, pressing the "-" key zooms out by 1/4 of the zoomed map extents.

Delete Key  - Drop last well picked during cross-section well selection, deletes the currently selected overlay line or text item, drops last point while drawing an overlay line

Shift+Arrow Keys  - Scroll the map while in zoom mode.

Alt+Arrow Keys  - Move cursor one pixel on screen.

Control Key  - Hold down the control key when doing a quarter section auto snap to find polygons containing more than 5 pts.

Mouse Shortcuts

Left Mouse Button

Single click on a WELL symbol to select the well for moving, deleting, etc.

Double click on a WELL symbol to jump to the Main module and SHOW WELL DATA for the well.

Double click on a Contour CONTROL PT to modify or delete it.

Single click, hold and drag to move a selected OVERLAY LINE control point.

Single click on a well while holding down the CTRL-Key will choose the next well that is plotted in the exact location, such as, with multiple completions which post on top of each other.

While SEISMIC LINE DIGITIZING, click while holding down the CTRL-Key to skip the next shotpoint.

Double-click while holding down the CTRL and ALT keys to edit a posted GRID NODE VALUE.

While moving posted well data, if the SHIFT-Key is held down, then the other posted blocks of text move by the same xy delta as the selected block.

Single click while holding down the SHIFT+CTRL keys to select multiple overlay line or text items

Right Mouse Button

Single click on a WELL to show a popup menu containing general well information.

Single click while holding down the SHIFT KEY to search for and display the nearest SEISMIC shot point number.

Single click while holding down the ALT KEY to move an OVERLAY LINE or TEXT item.
Single click while moving posted well text to reset the text to the default location.

5.1 Map Quick Lists

The Map Module’s Quick List modifies the active features on a map. Relative to selecting the "active" button for each feature, the Quick List is a much faster way of changing elements on the map.

To display the Quick List Panel, select the icon on the tool bar, or select View>Quicklist>Show on the menu bar at the top of the Map Module.

To hide the Quick List Panel, select the button on the upper right corner of the Quick List Panel, or select View>Quicklist>Show on the menu bar at the top of the Map Module.
Map Data Section

The Map Data section toggles and modifies various map display features.
Double-clicking any item in the list will bring up the appropriate dialog box to set the display parameters for that item.

Double-clicking on the "Wells" item brings up the "Select Wells by Data Criteria" search function.

**Overlay Layers Section**

The Overlay Layers section toggles the layers inside the currently loaded overlay file.

- This option refreshes the map to reflect any changes to the selected overlay layers. Select this option after adding or removing checks to the listed overlay layers.
- This option reloads the overlay file. Any changes made to the overlay will be lost.
- This option saves the overlay file. This will overwrite the old file with any changes made in the Map Module.
- This option adds a check to all overlay layers. You'll still need to refresh the map in order for the changes affect the Map Module.
- This option removes the checks from all all overlay layers. You'll still need to refresh the map in order for the changes affect the Map Module.

**Show Overlay** - This option toggles the overlay layer.

**Active Layer** - This option sets a specific overlay layer as the "active layer." Only items in this can be selected with the mouse. If the active layer is a read-only or associated layer, you will NOT be able to select any items.
WSN Well Lists Section

The WSN List section manages well selection using multiple WSN list files. This tool toggles selections of wells in the one or more WSN list files.

Using any of the "Select Wells" menu functions will cause the WSN List files to be "unchecked."

Also, when the list is cleared or when all items are "unchecked", the map reverts back to a "default" well list that was established prior to selecting WSN list files.

- This option refreshes the map to reflect any changes to the selected overlay layers. Select this option after adding or removing checks to the listed overlay layers.

+ - This option adds a WSN List to the WSN List Section. In the "Select One or More WSN List Files" section, navigate to the desired directory and select the relevant WSN files.

- This option drops the selected WSN list off the WSN List section. Note that this does not delete the WSN list.
- This option drops all WSN lists off the WSN List section.

**Imagery Section**

- This option opens the [WMS Imagery Settings](#) tool.
- This option refreshes the WMS Image from the WMS Server

**Map Image Active** - This option toggles the WMS Image on the Map Module.

**Map Navigation Section**

This section displays a small thumbnail picture of the map. When zoomed in, this section will display a red rectangle outlining the extents of the area shown on the screen relative to the entire map area. Moving this red rectangle will pan the area displayed on the Map Module. Resizing the red rectangle will change the area displayed on the Map Module.

For more information, see [Map Navigation](#).

**Inactive Map Navigation**

- This option captures a screenshot of the Map Module for the Map Navigation.
section. The Map Module must be completely zoomed out before selecting this button.

**Active Map Navigation**

With a screenshot, Petra draws a red rectangle or "Zoom Window" on the Map Navigation window to show the extents of the current screen relative to the full extent of the map. Zooming in and out will change the dimensions of this rectangle. Dragging the zoom window will scroll around the full map. Resizing the zoom window will change the zoom on the Map Module.

![Map Navigation Tools](image)

- This option closes the Map Navigation section.
- This option refreshes the map.
- This option zooms in by 2X.
- This option zooms out by 2X.
- This option zooms out to the full extent of the map.

**5.1.1 Map Navigation Tool**

This section displays a small thumbnail picture of the map. When zoomed in, this section will display a red rectangle outlining the extents of the area shown on the screen relative to the entire map area. Moving this red rectangle will pan the area displayed on the Map Module. Resizing the red rectangle will change the area displayed on the Map Module.

**Inactive Map Navigation**
Capturing a Map Screenshot with the Green "Open" button

- This option captures a screenshot of the Map Module for the Map Navigation section. The Map Module must be completely zoomed out before selecting this button.

Active Map Navigation

When active, Petra draws a red rectangle or “Zoom Window” on the Map Navigation window to show the extents of the current screen relative to the full extent of the map. Zooming in and out will change the dimensions of this rectangle. Dragging the zoom window will scroll around the full map. Resizing the zoom window will change the zoom on the Map Module.

- This option closes the Map Navigation section.
- This option refreshes the map.
- This option zooms in by 2X.
- This option zooms out by 2X.
- This option zooms out to the full extent of the map.
Dragging the Zoom Window
5.2 Map Right Mouse Button

The right mouse button acts as a shortcut to many functions on the Map Module. Spending a couple of minutes learning these commands can save a huge amount of time and effort.

This tool is context-sensitive. Clicking the right mouse button over a well brings up an
additional set of options that pertain to the well.

Layers - This option opens the Overlay Layers tool

Active/Inactive Options... - This option opens the Disable and Enable Map Options, which enables and disables different map elements.

Show Well Data (selected well only) - This option opens the selected well on the Main Module.

User Favorites (selected well only) - This option displays the user favorites dropdown display. The specific well header and zone data is set by the individual user.

Change Symbol Size... (selected well only) - This option changes the well symbol size of the selected well relative to the default well symbol size.

Add Well to Cross-Section - This option adds the selected well to the end of the cross section in the Cross-Section Module.

Add Well to Log Correlation - This option adds the selected well to the end of the cross section in the Log Correlation Module.

Disable Well (do not plot) (selected well only) - This option disables the selected well on the Map Module. Disabled wells do not plot, but are still honored during gridding. To re-enable wells, select Wells>Enable Wells Single Wells By WSN or Wells>Enable All wells that have been Disabled on the menu bar at the top of the Map Module.
Save Disabled Wells to File - This option saves the disabled wells to a WSN list.

Load Disabled Wells from File - This option disables the wells on a WSN list.

Bing Map at Location - This option opens a Petra Map Browser window with a satellite map around the location at the cursor.

Copy Location Lat/Lon to Clipboard - This option copies the cursor location's latitude and longitude to the clipboard. This can be useful for copying into other software packages or for planning new wells.

Well Information (selected well only) - This option displays well header information at the bottom of the right mouse menu. This includes the WSN, UWI, well label, and other information.

5.3 WMS Imagery

WMS

WMS stands for “Web Mapping Service”, which is a protocol for requesting and downloading georeferenced map images over a computer network. A WMS server stores map data, assembles map images based on specific requests from client computers, and delivers these images back to the clients over a network. While some companies have their own in-house WMS servers, most users will be downloading images from a server on the Internet.

WMS and Petra
Petra’s Map Module acts as the client that requests data from a WMS server. With a WMS connection active, Petra sends a request for a map to the WMS server every time the user moves the screen, zooms in/out, or redraws, Petra requests a new map from the server. The WMS assembles a map based on the requested layers, map boundaries, and map projection and sends it back to Petra. Petra then draws the received WMS map in the map module. Since each image is already georeferenced, Petra can display these maps in the proper scale and place automatically. Petra draws WMS images underneath other map features such as landgrids and wellspots. Importantly, these images are only stored temporarily.

WMS and Map Projection

Just like all other geospatial data, WMS data rely on map projections to convert information on the round shape of the earth to a flat image on a computer screen or piece of paper. WMS data store map projection information for each image in a series of “EPSG codes.” Each EPSG code records the reference datum and coordinate system used to create the image. Similarly, a Petra project’s reference datum and coordinate system can also be described as an EPSG code.

Both the WMS EPSG code and the Petra project’s EPSG code need to match for WMS data to plot correctly. Petra actually requests a map based on the location of the NW and SE corners of the map. The more precisely the WMS and Petra agree on the location of these two points, the more accurate the WMS data is in the Map Module. If Petra and the WMS server can agree on an EPSG code with both a reference datum and coordinate system, Petra can request images with foot/meter precision. Conversely, If Petra and the WMS server can only agree on an EPSG code with a reference datum but not a coordinate system, Petra can request images with LatLon precision. Note that Petra will try to find the best common map projection on its own.

Standard Coordinate Systems

Petra projects using “standard” (Blue Marble) map projections tend to have the best results with WMS data. Standard projections already have EPSG codes, so the translation is more precise, assuming there’s an equivalent EPSG code available on the WMS server. In this case, Petra and the WMS will both use the same reference datum and coordinate system, so the XY values of the boundaries of the map will agree.

Custom Coordinate Systems

Petra projects with “custom” map projections are usually older Petra projects created before the Blue Marble map projection system was implemented. For custom coordinate systems, Petra will use the reference datum’s ESPG code. Without agreement on the coordinate system that converts LatLons to XYs, Petra and the WMS can only use LatLons to establish the boundary of the requested map.
image. This method is less precise.

**When there is no Match**

Remember that not all WMS Servers support all map projections. Occasionally, Petra and the WMS just won't have an EPSG code in common.

**Important:** Petra does not re-project WMS maps out of the original projection since the task of repeatedly downloading and re-projecting every pixel on the image would simply take too long. The only solutions are to contact the WMS administrator to support the Petra project’s projection, or re-project the entire Petra project to use one of the available WMS projections.

Some servers do not publish all the projections they support in the capabilities file. By disregarding error messages, Petra will still request the map using the best EPSG code it can resolve with the server.

The EPSG registry at http://www.epsg-registry.org/ provides a lookup feature to search for EPSG codes by location or name, or to translate EPSG codes directly into datum and coordinate systems.

**Related Topics:**

- Configuring WMS
- Add/Edit WMS Servers
- Image Layer Thumbnails

### 5.3.1 Configuring WMS

Selecting and configuring WMS servers and image layers is done through the **Imagery Settings** dialog box.

From the **Imagery Settings** dialog you can:

- Add or remove WMS servers
- Enter or edit WMS server settings and credentials
- Select order of server images and image layers on the Petra map
- Restore default order of layers as defined in the Petra or GEOPLUS.INI file

**Accessing the WMS Imagery Settings**

There are two ways to access the WMS Imagery Settings dialog box:
• From the Map Module menu, **Display>WMS Imagery Settings**

• Clicking the blue wrench icon 🛠️ on the “**Imagery**” section of the Map Module’s **Quick List**.

![The WMS Imagery Settings Dialog](image)

**WMS Imagery Performance Options**

Petra’s default WMS settings are designed to find a balance between image detail and speed. WMS performance largely depends on the connection to the WMS server. However, there are options to change how Petra downloads and displays WMS data.

**Do Not Refresh Images During Zoom** – By default, Petra downloads a new copy of the image every time you zoom in on the map. With this option selected, Petra resizes the existing image without downloading another copy. This can reduce waiting times.

**Store Images to Temp Folder/Store Images to PriParms Folder** – This dropdown simply sets where Petra stores the temporary copies of the WMS images. Some network administrators limit access to the PriParms directory. If you’re having trouble with WMS downloads, try switching to use a Temp directory.
Do Not Display Wait Image During Image Download – By default, Petra displays a “Wait” message while it is downloading images from the WMS server. This option simply turns that off.

Image Resolution – On the “Normal” setting, Petra downloads a downsampled copy of the original WMS image. By only downloading half the detail, loading time is greatly accelerated at the cost of some image blurriness. Setting this option to “Fine” tells Petra to download the entire image, which increases both image sharpness and load times.

Related Topics
WMS Imagery
Add/Edit WMS Servers
Image Layers

5.3.2 Add/Edit WMS Servers

Add WMS Servers
1. Display>WMS Imagery Settings
2. Click the Add button next to the Servers list.
3. Select either:
   • Add from List
     Displays the list of WMS servers in the WMS section of either the Petra.INI (Shared Mode) or GEOPLUS.INI (Private Mode) file.
     1. Select desired WMS server(s) for your project.
     2. Click OK.
   • Add New
     Displays the Web Map Service dialog box.
There are two options to add a WMS server in the Web Map Service dialog box. You can:

- Click on the Get Spatial Energy button to add a WMS server provided by IHS Petra partner Spatial Energy. See "Image Layer Thumbnails" below.

- Enter a URL directly.

**IMPORTANT:** WMS server URL’s end in a “?”, it may be necessary to delete text past the question mark from the end of a provided URL.

For example:

http://www.earth.com/ecwp/ecw_wms.dll?request=GetCapabilities&service=wms

should be:

http://www.earth.com/ecwp/ecw_wms.dll?

4. Click OK.

**Image Layer Thumbnails**

Adding a WMS server using the Add New option will populate the Web Map Services dialog box with thumbnail images once the WMS server is contacted. To select layers, click on a thumbnail once. Selected layers will be indicated with a yellow border. When all the desired layers are selected click OK.
Edit WMS Server settings

Available server settings include:

- User defined server description
- Users credentials
- ESPG Code
- Timeouts
- Image opacity

1. From the Map Module menu, **Display>WMS Imagery Settings**.
2. Select desired servers checkbox(s) from the Servers list.
3. Click the **Edit Server Settings** button.
4. Make edits.
5. Click OK.
5.3.3 Image Layers

Selecting and Sorting Order of WMS Layers

Once linked to the WMS server, Petra compares the project’s EPSG code with the server's available data's EPSG codes and displays the WMS layers that are available. If multiple layers are requested, the WMS server stacks these layers into a single image and delivers it to Petra. One of the complications of multiple layers is that it’s often necessary to manually change the drawing order. As an example, reordering might be required to put vector data (like pipelines and roads) on top of non-vector data (like aerial and satellite photos).

To select and change the order of available layers

Display>WMS Imagery Settings

1. Select the desired WMS server(s) from the Servers list.

2. Double click, or use the controls to move desired Layers from the Layers Available list to the Layers Selected list box.

3. Select individual layer in the Selected Layers list box and use the UP or Down controls to arrange order of layers.

4. Click OK.
IMPORTANT: Layers on the top of the list are drawn before (and below) layers on the bottom of the list.

Related Topics

WMS Imagery
Configuring WMS
Add/Edit WMS Servers

5.4 Graphics Plotting Order

The Select Graphics Plotting Order tool changes how Petra Draws elements on the Map Module. Items at the top of the list are drawn first. Practically, items at the top of the list will be below items at the bottom of the list.

To change the list order, select the desired element and drag and drop it to the desired position on the list. Conversely, use the arrows to move the element.
The Select Graphics Plotting Order Tool

**Reset** - This option resets the items to the default graphics plotting order. This is generally a good choice for most maps.

**Use Default Order** - This option overrides the graphics plotting order list, and uses a default plotting order.

**Plot Overlay as Single Pass using Layer Order Only** - This option draws every layer in the overlay at one time. This option overrides the order of overlay-specific items like "Overlay Filled Areas" and "Overlay Filled Contours."

5.5 **Map Data Limits**

Data limits define the maximum aerial extent of the data that Petra keeps in memory and can display. Put another way, data limits define how far you can zoom out.

Data limits can be set to automatically extend to cover the selected wells, the overlay, or an arbitrary area from XYs or Lat-Lons.

To change the data limits, select **Display>Data Limits>....**
Auto Limits From Data - This option sets the data limits around the wells displayed on the Map Module. Note that this option isn't affected by disabled wells. This option is on by default, and is a great choice for most interpretation work. Selecting a different set of wells can change the extents of the map module.

Set/Enter Limits - This option manually sets the map limits by either LatLons or XYs.

Set Mid Pt and Scale - This option manually sets the center of the map and the map scale. First, select the center of the map, and then manually set the map scale in ft/inches.

Load Limits - This option replaces the currently set limits with the limits from an external *.LIM file.

Save Limits - This option saves the current limits to an external *.LIM file.

Save Limits for PetraSeis Limits - This option saves the current limits to an external *.LIM file, suitable for use in PetraSeis.

Use Overlay Extents - This option sets the limits based on the extents of the elements in the loaded overlay file. Note that this option will use the extents of all elements in the overlay, whether they are displayed or not. Some culture data (like country outlines) are huge and will zoom very far out.

5.6 Data Border Gap

The data border gap establishes a space between the extent of the wells and the border. Without a gap, wells would fall right on the border, making them difficult to
see.

To establish a data border gap, select Display>Data Border Gap on the menu bar at the top of the Map Module.
5.7 Map Margins and Preferences

The Map Margins and Preferences tool controls how Petra displays map, especially on paper.

To establish a data border gap, select Display > Options on the menu bar at the top of the Map Module.

General Tab

The General Tab controls a few of the details on how Petra displays data on the Map Module.

Data Extents

This section sets how the Map Module treats data limits. To rapidly switch between the two modes, select CTRL + W in the Map Module.

Extend Data to Border Frame - This option will expand the map to fill the Map Module. This option will sometimes draw the map beyond the data limits.

Clip data at Margin Limits - This option limits the border to only the data limits. Depending on the shape of the data limits, this can leave a fair amount of white space on the Map Module.
The "Expand Data to Border Frame" (left) and "Clip Data at Margin Limits" (right) options

**Miscellaneous**

- **Hide Lower Right Corner Map Scale Bar** - This option turns off the scale bar in the lower right corner of the screen. With this option selected, the map scale will not plot on the screen or on paper.

- **Hide Map Title** - This option turns off the map title at the top of the screen.

- **Hide Map Border** - When the "Show Margin Frame On Screen" option is selected on the Margins Tab, this option disables the Map Border (Data Limits + Margin) frame.
Disable Clipping - This option disables contour clipping polygons set on the Overlay Line Attributes tool.

Show Overlay Name - This option displays the name and location of the currently loaded overlay file in the lower left corner of the Map Module.

Measure Tool Shows XY instead of LatLon - By default, the Map Module's Measure Tool displays the endpoint's location in latitude and longitude. This option instead displays the endpoint in XY units.

Measure Tool Shows MILES or KM - By default, the Map Module's Measure Tool displays the distance between the start and endpoints in feet or meters. This option instead displays the distance in miles or kilometers.

Hide Boundary Polygon - This option hides the outlines of boundary polygons on the Map Module.

Hide Well Info at Mouse - By default, hovering the cursor over a well symbol displays the well's WSN and UWI in the lower left corner of the Map Module. This option disables the display.

Show well list for Xsect Selection -

Map Scale bar Offsets from Corner - These options set the spacing of the scale bar away from the lower right corner

F9 "Fly By" Position - The F9 button superimposes the cursor's location in XY or LatLon. This dropdown sets the location of the text above, below, left, or right of the cursor.

Margins, Gutter, Cut Line Tabs

The Margins, Gutter and Cut Line Tabs set the extents of margins on paper maps.
Margins can be used in place of the Data Border Gap to specify and exact amount of space between the well or seismic data and the border. Overlay data will plot in the margin area. It is recommended that the Data Border Gap be deactivated when a margin is added.

The Gutter is like a "picture frame" around the map margins. Overlay data will not extend into the gutter area unless the user allows it.

The Cut Line only appears on a plotted map and provides a box, or "cut line" around the whole map. The Cut Line is required if the map title block is to placed in the lower right-hand corner, below the map (position 8).
North Arrow Tab

The North Arrow Tab controls how the north arrow plots on the Map Module. The north arrow serves to illustrate the effect of the convergence angle. In other words, when the project area is away from the map projection's central meridian, the north arrow will always point at the local grid north.
Show North Arrow When Convergence Angle is Not Zero - This option only displays the north arrow when grid north (defined by the location relative to the map projection's central meridian) is different than true north (at the top of the screen). The difference between the two is the "convergence angle."

Always Show North Arrow - This option always shows the north arrow, even when grid north and true north are both directly at the top of the screen.

Do Not Show North Arrow - This option disables the north arrow on the map.

Position - This dropdown sets the location of the north arrow on the map. Options include the NW, NE, SW, and SE corners of the map.

5.8 Highlight Wells

The Highlight Wells tools quickly distinguishes between different sets of wells with a colored circle. This tool can distinguish wells based on data criteria, wells selected on the cross-section Module, or wells selected on the Cross Plot Module.

This tool is available under Wells>Highlight Wells>...

To change the well highlight color, change the "Well Map Highlight" option under Display>Colors.
Select Wells by Data Criteria - This selects wells using the Select Wells by Data Criteria tool.

Cross-Section Wells - This option highlights the wells currently selected in the Cross-Section Module

Cross-Plot Wells - This option highlights the wells currently selected in the Log Cross-Plot Module

None - This option disables the well highlight.

Set Symbol Well Factor - This option sets the diameter of the well highlight symbols scaled to the size of the well symbol. The default size of 1 is just a little bigger than the well symbols.

5.9 Move A Well Location On The Map

Moving Vertical Wells

First, select the well to move by clicking the left mouse button on the well symbol. The symbol will become highlighted to indicate it is selected.

Select Well>Edit>Move Well Location on the menu bar at the top of the Map
The cursor will change to a cross hair and a "rubber band" line will connect the cursor to the selected well symbol.

Move the cursor to the new well location and click the left mouse button. You will be prompted to confirm the new well location. After updating the location in the database, the map will be redrawn.

Moving Deviated and Directional Wells

Wells contain a surface and a bottom hole location in the database. When you move a well the coordinates updated are determined by the well display mode. If you are plotting surface locations only, then only the surface location will be updated. If you are plotting bottom hole locations only, then the bottom hole location will be updated. If you are plotting surface and bottom hole locations, the bottom hole location will become the location at the cursor and the surface location will be adjusted by the same amount of movement.

The location of the selected well can be moved using the mouse to select the new location.

Note: Directional survey data must be disabled before you can edit well locations.

Survey data is enabled whenever the "Well>Directional Survey>Enabled" has a check mark by it. Click this menu to toggle the survey option off.

5.10 Data Offsets File Manager

In fields with tightly packed wells, label overposting can be a problem. When a user moves a well's labels, Petra stores the new location in the project database. These offsets can also be saved to an external file. It can be useful to store multiple data offset files for different maps.

To open the Data Offsets File Manager, select Wells>Data Offsets File Manager from the menu bar at the top of the Map Module.

Enabled - This option enables the Data Offsets File Manager.

Disabled - This option disables the Data Offsets File manager.

Load Offsets File - This button loads an existing offsets file (*.OFF).

Save Offsets File - This button saves the current offsets to an eternal offsets file.
Clear Offsets - This option removes all user-created label offsets, and restores the labels to the default position.

Copy DB Offsets - This option copies the offsets from the project database.

5.11 Well Symbol Style

The Wells Symbol Style window sets how the Map Module draws well symbols and establishes a simple well labeling system. The well label is a single line of text and can be used as an alternative to using Data Posting.

To open the Well Symbol Style Screen, select Wells>Symbol Location and Size... from the menu bar at the top of the Main Module.

Symbol Tab

Symbol Size

These settings control how the Map Module displays well symbols.

Small - This sets the well symbol size to 0.05 inches.

Medium - This sets the well symbols to 0.075 inches.

Large - This sets the well symbols to 0.12 inches.

Custom - This option sets the well symbols to a specified size. This size can be set in inches or XY units on the Options Tab.

Enlarge with zoom - This option enlarges well symbols as you zoom in.
**Limits** - The Min and Max entries set the minimum and maximum size in inches for the well symbol. Setting this entry to "0" turns off the limit.

**Symbol Location**

This option sets the location of the well symbol. This also sets the default location of data points along deviated wells for some gridding applications.

- **Surface Location Only** - This option displays the well symbol only at the surface location.
- **Bottom Hole Location Only** - This option displays the well symbol only at the bottom hole location.
- **Surface & B-Hole w/ Symbol at B-Hole** - This option plots the well symbol at the surface location with the "BH Marker" at the bottom hole location.
- **Surface & B-Hole w/ Symbol at Surface** - This option plots the well symbol at the bottom hole location with the "Surface Marker" at the surface hole location.

**Symbol Color**

- **Use Default Color Only** - This option draws all well symbols using the "well symbol default color" defined in the System Color and Style Definitions tool.
- **Use Symbol Definitions** - This option draws well symbols using each wells' symbol definition specified on the Main Module. These defaults can be modified with the Well Symbol Descriptions section.

**Annotation Tab**

This tab sets up simple well labeling around all wells. It only appears when the "Allow Simple Well Labeling" option is selected on the Options Tab.

This annotation system is independent from the more elaborate and comprehensive data posting system.
The Well Symbol Style Annotation Tab

**Well Label** - This option sets the label that will appear around each well. Options include:
- No Label (Suppress the well label)
- Unique Well Id (UWI or API Number)
- API Series No. (5-digit series number or the UWI)
- Well Short Name
- Well Label
- Well Seq No. (WSN)

**Font** - This option sets the desired font for the label.

**Position** - This option sets the position of the label to above, below, left or right of the well symbol.

**Label Size** - This option sets the size of the label. Options include:
- Small - This sets the text size to 0.05 inches.
- Medium - This sets the text size to 0.075 inches.
- Large - This sets the text size to 0.12 inches.
- Enlarge with zoom - This option enlarges the annotation text as you zoom in.

**Options Tab**
Custom Sizes Are Specified As

**Inches** - This option sets the symbol custom size in inches.

**XY Map Units** - This option sets the symbol custom size in XY map units.

**Flag "Unknown" Symbol Codes with X** - This option will draw an X on all of the open circle well symbols that do not have a description defined for the symbol code. By default, Petra draws an open circle for these wells, which is identical to the “LOC” symbol.

**Use Opaque Symbols** - This option causes open wells symbols, such as a gas or dry hole symbols, to be plotted using the background color (normally white) to fill the interior of the symbol. Use this option when you wish the well symbols to stand out against a colored background.

**Disable Mouse Selection of Wells That Are Not Initial Completions** - This option prevents recompletions from being selected on the Map Module. With this option turned on you will not be able to select a well if the UWI does not have 14 characters or it does not end in 00.

**Allow Simple Well Labeling** - This option allows simple

**Plot Wells Even if Location is Outside Limits** -

**Exclude "Pseudo" Wells When Loading Wells** -

**Zoom Factor When Hilite Well from Main (0-200)** -

**Surpress Detailed Deviation Surveys for Scales >...** -
Wells Tab

The Wells Tab establishes "Primary" and "Secondary" wells. Secondary wells are grayed out and can be plotted at half scale. This can be useful for distinguishing between the relevant wells in a project and wells that are too shallow or otherwise lack useful information.

Spot All Wells With Normal Size and Color - This option plots all wells normally.

Spot Primary Wells In Normal Mode with Secondary Wells Plotted 1/2 Size and Grayed Out - This option plots wells NOT in the WSN list at the bottom of the screen at half size and grayed out.

Spot Primary Wells in Normal Mode with Secondary Wells Plotted Full Size and Grayed Out - This option plots wells NOT in the WSN list at the bottom of the screen at full size and grayed out.

5.12 Overlay Graphics

Overlay files contain lines, shapes, text, or images drawn on top of other data drawn on a map. Commonly, overlays represent leases, contours, roads, aerial photos, or comments. Overlay layers can also include geological information like contour lines, fault lines/polygons, or unconformities.

"Overlays" and "Layers"
Petra stores overlay data in a single overlay file (*.OVL). Each overlay file can contain up to 256 different layers of data. Usually, every layer contains a set of data that’s somehow related—single layer of data. You might want to think of a layer file as a single layer exported from an overlay file. Layer files can be loaded into any overlay file (actually loaded into memory and saved to an overlay file).

Layers can be turned on or off easily by either using the Overlay Preferences (menu or toolbar icon) and double clicking specific layers, or by clicking on individual layers in the Quick List. Petra draws items at the top of the layer list first with items lower in the list being drawn last; in other words, layers at the top of the list will be covered by layers at the bottom of the list.

Layers can also be saved to an external file and read as an Associated Layer Files, which can make keeping data updated in a multi-user environment much easier.

While well and seismic data is drawn dynamically from the project database, other graphics, such as, land grid lines, lease outlines, culture, rivers and roads are displayed from layers in the overlay. Individual layers in Petra can be shown or hidden depending on the desired displayed.

**Overlay Files and Multiple Users**

**Don’t share overlay files between multiple users. Every user should have their own file.**

Graphics in the overlay are loaded into memory. Once loaded, the overlay file is not accessed again unless the user saves the overlay back to the same file. Additions and changes to the overlay data are made to the memory copy of the data. Other users sharing the same project, each have their own copy of the original overlay file in their memory. So everyone’s changes are isolated from each other. This is analogous to several people loading the same spreadsheet file, making changes, then saving back to the same file. Only the last changes are kept. One great way around this problem is to use Associated Layer Files.

**Getting Started**

- Importing Cartographic data into the Overlay
- Using the Overlay Tool Bar
- Editing Individual Lines, Text and Images
- Modifying the Lines and Text in Entire Overlay Layer
- Loading Overlay Layer Files (*.LAY), Saving Overlay Layer Files
- Sharing Data between Users with Associated Layer Files
- Using the Auto Save Feature
5.12.1 Importing Overlay Data

Petra can import and display cartographic data from a variety of sources. This can include "culture" data like roads, or geological data like contour lines. This data is stored in the open overlay file.

To import overlay data, select Overlay>Import from the menu bar at the top of the Map Module.

**File Tab**

The file tab sets the location of the file, and how the data will be stored in the overlay.

![Import Cartographic Data](image)

**File To Import** - This option selects the desired file to import. Select the "Browse" button to navigate to the desired file.

**Layer Update Mode** - This option sets how Petra treats data in the destination overlay layer. "Merge with Current Layer Data" will add the data from the file into the overlay layer, while "Replace Current Layer With The Imported Data" will completely erase the selected overlay layer and overwrite it with the imported data.
File Type - This dropdown selects the file type of the imported data.

Load Into Layer - This option sets the overlay layer that will store the imported data. The "Rename Layer" button will rename the currently selected overlay layer.

Load into Specified Layer - This option brings all the imported data into a single layer.

Load Separate Layers - This option attempts to differentiate between the different overlay items in the imported file and place them into separate layers.

Limits Tab

Importing irrelevant data such as particularly detailed road and subdivision outlines can dramatically slow performance and redrawing. The Limits Tab sets the limits of the import, which are shown by the longitude and latitude boxes.

The Import Cartographic Data Limits Tab

- Do Not Restrict Data By Limits – The entire file is loaded, regardless of location.
- Use Full Data Limits – This option only imports data inside the area defined by selected wells in the map module.
- Use Current Border Limits – Data inside the current, completely zoomed out data limits (set in the Map Module under Display>Data Limits>Set/Enter Limits) is loaded.

Misc Tab

The Misc Tab deals with some of the tweaks necessary for certain data types.
The Import Cartographic Misc Tab

**Auto Close Polygons** – this automatically closes all polylines in a layer during import. This can be useful when importing polygons like contours or lease polygons.

**Create Labels for Polygons for CDF Files** - This automatically creates overlay text labels for CDF Culture files.

**Create Volumetrics Labels** – This creates appropriate volumetric polygon names that are accessible in the Overlay Line Attribute box under the "Volm" tab.

**File is Old Tobin XY Format** – Old (mid 1980's) Tobin files have a different file format. This option helps with backwards compatibility.

**ZMap Contour File is Really Lat-Lon Data with XY Headers** – This tells Petra to ignore bad header data in a ZMap file and import Longitude and Latitude data as such.

**Translate Tab**

Some file formats encode specific information about each entity in the file. Petra can use a "translation file" to sort the cartographic data in a file directly into specified overlay layers.
Use Entity Code Translation File - This entry enables sorting by the translation file. Note that if a translation file is enabled, only entities matching the file will be imported into the overlay file. Data not translated by the file will not make it into the overlay file.

Translation File Name - This entry sets the location of the translation file.

File Types
Tobin Land Grid (TBRBM)
Tobin Infobase
Plat River Assoc. TwnRgeSec
Z-Map Plus Vertex
Z-Map Plus Text
Contour SegID
Digitized Contours (X,Y,Z) and (Lon,Lat,Z)
Z-Map Plus ASCII Contours
Landmark ASCII Metafile
TMC Township/Range Format
TMC Texas Landgrid
GES Cartographic Data Format (CDF)
Z-Map Fault File (X,Y, SegID)
ESRI Shape File (LatLon) and (XY)
AutoCAD DXF (LatLon) and (XY)
InfoPipe MID-MIF
GeoQuest CPS-3 Contours
MapInfo MID-MIF
Petra ASCII Overlay File
SMT Planimeter File
WhiteStar CartoBase File
Tobin GII
AccuMap Grid File (GRD)
AccuMap Culture File (CDF)

5.12.1.1 Batch Import Into Map Overlay

The Map Module's "Overlay>Load>Import" function allows for the batch import of similar type cartographic files. Each file to be imported in batch mode is listed in an external "batch file". The batch file is in comma delimited format. Each line in the batch file contains a file name and optionally, a layer name and layer number. The layer name is optional. The layer name is only entered if you wish to rename the layer which the file is loaded into. The layer number is normally required but can be dropped if you wish to use the layer selected from the import screen (see example below).

The following example shows 4 files to be imported. Any line with a "!" in column 1 is a comment line.

!Example Overlay Batch Import File
"c:\data\culture\actlease1.cdf","Active Leases",3
"c:\data\culture\actlease2.cdf",3
"c:\data\culture\sections.cdf",4
"c:\data\culture\townships.cdf"

The first file, "actlease1.cdf", is loaded into layer 3 and layer 3 is renamed to "Active Leases".

The second file, "actlease2.cdf", is also loaded into layer 3 (note the double commas where the layer name is not entered).

The third file, "sections.cdf", is loaded into layer 4 (note the layer is it not renamed).

The forth file, "townships.cdf", is loaded into the default layer selected from the import screen.
5.12.1.2 Import ASCII Overlay File - Map

The import ASCII Overlay File function is used to load land grid lines or text, and digitized contours, faults, or polygons from a tabular (fixed column) ASCII data file. All items in the file must be of the same data type, i.e., Lines, Text, Polygons, Faults, or Contours.

Overlay>Load File>Generic ASCII File

Select the appropriate options then click the OK button to begin loading the file.

FILE TAB

Specify the input data file, file contents, coordinate type, and text units.

File To Import

Enter the complete path name or use the "Browse" button to search for the file to be imported.

File Data Contents

Choose one of the data types you are importing. Options are:

- **LINES** - Normal line segments such as section lines. Line records can include one or two coordinate pairs.
- **TEXT** - Names of places to be posted in the map. Text records can include one or two base line reference points, a height and angle.
- **FAULTS** - Same as lines but get flagged and treated as faults.
- **POLYGONS** - Same as lines but get flagged and treated as closed polygons.
- **CONTOURS** - Contours must have a Z value for each coordinate pair.

File Coordinates Are

Choose Lat-Lon if the data file contains latitude and longitude coordinates. Choose X-Y if the coordinates are XY map units. XY coordinates MUST BE THE SAME as those of the map, ie, if your map is a UTM map, the XYs imported must also be UTM.

Text Height Is Specified In

The text height read from the file can be either inches or map units. When inches are used, the height is assumed to be the text size on a 1"=8000' map scale. Text heights specified in map units are scale independent.

FORMAT TAB

Select Data Columns

One defines the data fields to be imported by setting the starting and ending column
numbers and which data type the column is associated with.

Each field is selected for import when it is added to the "Select Data Columns" list box by clicking the add button beside the "Data Column Type" list. Fields can be modified by clicking the replace button. Drop a field from the selection list by clicking the "->" drop button or clear all selected fields by clicking the ">>" button.

The "# Implied Decimals" option allows imported data fields to be scaled by a factor or 10 as they are read in. For example, a value of 1 will divide the incoming data by 10, a value of 2 will divide the incoming data by 100, etc. Implied decimals are especially useful for data fields which do not contain a decimal point but include digits right of an implied decimal point.

**Data Column Type**

Use this list to choose the type of data each column of the input file contains. Use the X1 and Y1 fields for files with a single coordinate pair per record. Specify X1,Y1 and X2,Y2 when you have a file with two coordinate pairs defining line segments or the baseline for text. Text height will default to 0.1 inches if no height field is selected. Text angle can be read from the file or computed when X1,Y1-X2,Y2 mode is used. Otherwise, a text angle of zero will be set. Use the SEGMENT ID field to control grouping or data points into a single polyline or to determine when to break a contour line into separate segments. Refer to the line delimiter section on the Options tab for more about controlling how lines are grouped.

*Dragging the mouse across a scrollable data record can set columns. Two records of the actual data file are shown.*

**Data Record -**

This section displays two consecutive data records and provides scrolling through the data file for data field or column selection. Use the up and down arrows located to the right of the record window to read forward or backward in the file. The data record can be scrolled left or right by placing the cursor in the record window and using the left or right cursor keys.

Number of records to skip before 1st data record - This option allows header or comment records to be skipped at the beginning of the data file prior to the first true data record. Click the "Set Skip" button to set the number of skipped records based on the record currently in the data record window.

**Saving Your Work** - Once the format (column and field definitions) has been defined, the "Save" button will write the format to a disk file which can later be used by selecting the "Load" button.

**OPTIONS TAB**

**Load Data Into Layer**
Select the overlay layer into which the imported data will be stored. Also specify whether you want the imported data to be merged with the other data stored in the overlay or if you want to replace it with the imported data.

**Auto Close Polygons**
Check this option to have the program close all polygons loaded to insure there is not a gap between the first and last point in the polygon.

**Lines Delimited By**
Select the method in which lines, polygons, faults and contours are separated into groups of points called polylines. Some options check the input file against a user-supplied "Delimiter Value". When the value is read, a new line, polygon, fault, or contour is started and the record is discarded.

- **Segment ID** - This option breaks the lines whenever the segment ID value changes.
- **X Coordinate** - This option checks the X1 or LON1 value against the Delimiter Value.
- **Y Coordinate** - This option checks the Y1 or LAT1 value against the Delimiter Value.
- **Z Value** - This option checks for a change in the Z Value.
- **Distance Btwn Points Exceed Value** - This option computes the distance between consecutive data points and starts a new segment if the distance exceeds the Delimiter Value.

5.12.1.3 **Importing Shape Files**

**Overlay Shape File Import and Direct Connect Grid & Culture Import**
Overlay>Import Shape Files function allows ESRI shape files to be imported and colorized using predefined templates. The primary purpose of this option is a "Direct Connect" download and import of IHS grid and culture data. Of course, you will need the appropriate licensing to access this data (contact your local IHS sales rep for details).

This function can also be used to load any shape files copied to the "Shapes" folder of your project.
Customers with Direct Connect access and entitlements to IHS Grid and Culture data can use a new method to retrieve and import shape file data into the Petra Map Overlay. Users may also copy custom shape files into the Shapes folder of the project for direct import into the overlay. Map menu Overlay->Import Shape File.

Import Grid and Culture Data – upon entry all shape files contained in the current project “Shapes” folder will be displayed in the Current Shape Files list box. Custom shape files may be copied into the Shapes folder manually or selected and copied using the Browse to Shape Files button.

Click the (IHS Direct Connect) Download Grid and Culture button to view the layers that are available from IHS Direct Connect. Note that the user must have entitlements to this data and that not all geographic areas have all possible shape layers.

Select the appropriate Quick Set button for rapid selection of the most common shape layers. Other layers may be selected as desired. Click OK to download the
layers from IHS Direct Connect.

Upon retrieval of the shape files an information dialog will show the shape files that were available and downloaded.

The shape files are now shown in the Import dialog with default attributes. These attributes may be customized as desired by the user.
Shape File Import

Attributes Tab
User selection of import line attributes, fill attributes, and text attributes of the selected shape file. Text attributes are applied to the data extracted from the shape DB file fields. The text is made by concatenating the fields specified by the Assign Fields dialog that is shown on the Fields edit box.

Layers Tab
Set the overlay layer for each shape file to be imported. More than one shape file may be imported into the same overlay layer. The buttons at the top assign the selected shape file or files to the layer or layers.

Misc. Tab
Set Lat/Lon extents for the Direct Connect shape file request

Path
Set the desired shape file path if other than the project Shapes folder.

Preview
Shows a preview of selected shape file using the extents of the shape file

Volumetrics
Sets a shape DB field value for associated polygon. Can be used for later Map
volumetrics calculations.

Press Import button to import the checked shape files into the overlay. The attributes and settings are saved as part of the import process. Note that only the checked shape files are imported into the overlay.

5.12.1.4 CDF Entity Code Translation

Certain file formats have entity codes that can sort different elements into different overlay layers during import. Petra uses a translation file to map the entity codes to
overlay layer numbers. If a layer translation file is used, only codes listed in the translation file will be loaded. Items without entity codes in the translation file will not be imported.

Petra comes with a few sample translation files in the installation's parms directory. By default, this is located at C:\geoplus1\parms\ These files are just intended as examples to explain the format and as a template to be modified by the user to meet their specific demands.

Tobin Layer Translation.dat
GES Layer Translation.dat
AccuMap_CDF_TRANSLATION.dat

Translation files are comma-delimited and consist a layer definition section and a entity code translation section. Records beginning with an "!" are considered comments.

Layer Definition Section

The Layer Definition Section is an optional part of the file that just renames one or more of the Petra's overlay layers. When present, this section must precede the entity code section. Each record has the following format:

LAYERDEF,LayerNumber,LayerName

Where: LAYERDEF is a key word
LayerNumber is a layer number from 1 thru 256
LayerName is the name of the layer (NO EMBEDDED COMMAS)

Examples: LAYERDEF,1,Roads
LAYERDEF,2,Rivers
LAYERDEF,3,Populated Place Names

Entity Code Section

The Entity Code Section follows the layer definitions and is in the following format:

LayerNumber,MajorEntity,MinorEntity,Comment

Where: LayerNumber is overlay layer number from 1 thru 256
MajorEntity is the 3-digit major entity code
MinorEntity is the 4-digit minor entity code (may be -1)
Comment is an optional comment (not read)

Examples:
1,32,3020, Major City
1,32,5240, Populated Place Names
2,50,-1, All Rivers and Streams (see note 1 below)

Note 1: A minor entity code of -1 means the program will only check the major code. All entity codes matching the major code will be loaded into the specified layer. Place -1 codes at the end of the translation list.

Example File:
! Example Petra Layer Translation File.
!
LAYERDEF, 1, ROADS
LAYERDEF, 2, RIVERS
LAYERDEF, 3, BOUNDARIES
!
1,32,-1, All Roads
1,32,-1, All Roads
2,50,-1, All Streams
3,90,-1, Boundaries

5.12.2 Overlay Tool Bar - Map

The overlay tool bar contains icons to manipulate overlay lines and text.

Select overlay line or text item.
Show attributes of the selected item.

Add a line, polygon, contour, or fault to the map.

Activates the "Auto Set Polygon" function. After clicking this button, the user then clicks inside an overlay polygon. The attributes (style) of the polygon is then set to predefined settings. These predefined settings are set using the 'Overlay>>Edit>>Set "Auto Set Polygon" Attributes' menu.

Add text to the map. Click 3 points. First point is the start of text baseline, second point is the end of text baseline, third point indicates text size.

Add a "text box" by drawing a rectangle on the map. A text box contains multiple lines of horizontal text.

Add a box or rectangle to the map.

Add a circle to the map. Click once for center, then drag mouse to enlarge circle, then click to set the radius.

Add an Image reference to plot a Windows metafile or bitmap file. Click and drag to draw a rectangle to define the position and size of the image.

Add an Arrow to the map. Click once at the start of arrow head, then click again for arrow tail. Use the line attributes of area fill for a solid arrow. Use the Text tool to label the interior of the arrow.

Smooth the selected line, contour, or fault by creating a new control point between each of the current control point.

Simplify the selected line, contour, or fault by reducing the number of control points making up the item.

Break a line, contour or fault at the exact point where the item was selected.

Connect the selected line, fault or contour to its nearest neighbor.

Change the plotting order of the selected item so that it plots on top of all others.

Change the plotting order of the selected item so that it plots behind of all others.

Clip all graphics items that fall inside a selected rectangle.
Clip all graphics items that fall outside a selected rectangle.

Delete one or more control points from the selected item. After selecting an item, click the left mouse button on one or more control points, then click the right mouse button. The indicated control points will be removed.

Add one or more control points to the selected item. After selecting an item, click the left mouse button between one or more control points, then click the right mouse button. New control points will be added between the original points.

Display the area enclosed by the selected line.

Undo the last edit or deletion.

Delete the selected item.

Clip all visible and non-read only items outside of a user-defined polygon. Click the left button to define the polygon. Click the right button when all points are defined.

Copy the selected item into the overlay clipboard function.

Paste the item from the overlay clipboard onto the screen.

Displays this help screen.

Display Layer & Preferences screen which provides global editing options.

Imports an Overlay File from disk.

Saves the Overlay in memory to an overlay file on disk.

Load a "layer file" from disk. A layer file contains a single layer exported from another overlay.

Saves (exports) a single to a layer file on disk.

Constructs filled polygons from a layer of contour lines.

Used to find and highlight a particular text string on the map.
5.12.3 Editing Overlay Lines, Text, and Images

All of the following instructions are based on the use of the Overlay Tool Bar. To hide or show the Overlay Tool Bar, select Overlay> Show/Hide Tool Bar from the menu bar at the top of the Map Module.

Lines

Creating New Lines

To set lines in Petra, select on the button on the toolbox. Next, click where you want the beginning of the line to start. Clicking the left mouse button again will add further control points, while clicking the right button will end the line. The DELETE key will remove the last node point. After you finish adding control points on the line, the Overlay Line Attributes dialogue box will pop up.

Drawing an Arrow

To add an arrow, simply click on the arrow icon on the mapping toolbox. This will change your mouse to a crosshair. To add the arrow, first click on position for the head of the arrow, and then click again to place the tail.

Editing Existing Lines

To select and edit lines, depress the SHIFT KEY and then click on pre existing lines with the left mouse button. Another method of selecting lines is to first click on the red arrow on the toolbar, which brings up a crosshair for your mouse on the map module, and then select the line you wish to edit with one click of the left mouse button. In either case, selecting a line changes the color of your line to blue and shows all the control point points in the line. Occasionally after making many changes to lines, it is necessary to redraw the screen to see the changes or to continue editing.

Moving individual control points - change the location of any blue boxed "control point" on the line by clicking and dragging it to a new position.

Moving whole lines - To move a whole line unchanged, press the ALT KEY and click on the line with the RIGHT MOUSE button.

Adjusting sections of line - To move entire sections of a line, press the CTRL KEY and choose two points on the line using the LEFT MOUSE button. Depressing the CTRL KEY and moving any section of the line in between the two selected points will stretch that entire section of the line.

Adding control points - select the "Add Ctrl. Point" button that looks like and add
control points where necessary.

Dropping any control point - select the "Drop Ctrl. Point" button that looks like ![Drop Ctrl. Point] and click on existing control points for the selected line.

Increasing or decreasing the total number of control points to the line - choose "Smooth" or "Simplify" on the toolbar. "Smoothing" the line or polygon will place a new control point between every existing point, while "simplifying" the line or polygon will reduce the number of control points.

Copying a line - click on the copy button that looks like ![Copy] To paste the line, click on the button and place the text.

Text

Creating Text

To set text, click on the "abc" icon button on the toolbar. Petra first asks you to establish a baseline that shows where you want the text and then builds a rectangle to establish the height of the text.

Editing Text

To edit pre existing text, first depress shift and then click on the text you wish to edit. Another method of editing text it to click on the red arrow button on the toolbar, which brings up a crosshair for your mouse on the map module, and then click on the text you wish to edit with one click of the left mouse button. Either method brings up a blue box around your text and allows you to edit the text. Sometimes after manipulating a piece of text multiple times, it may become necessary to refresh the screen to see the blue box that highlights text.

Editing Text Boxes - double click anywhere inside the blue box. This brings up the Overlay Text Attributes dialogue box that allows you precise control over features, including degree of angle and text height.

Changing the location of the text - press the ALT KEY and click the RIGHT MOUSE button somewhere inside the box and drag it to the new location.

Changing the angle of the text manually - press the ALT KEY and click the RIGHT MOUSE button on one of the original control points that established the baseline on the bottom of the blue box.

Copying a text box - click on the copy button. To paste the text, click on the button and place the text.

Working with Multiple Lines/Text Boxes Simultaneously
Multiple line or text items can be selected and edited as a group. To select a group of items, click the LEFT MOUSE button on each item while holding down the SHIFT and CTRL keys. You can select multiple lines as a group or multiple text items as a group, but not lines and text together. Once a group of items is selected. The "attributes" dialog can be used to edit properties such as color, layer, font, etc. Group selection of lines is limited to similar type of lines. For example, if the first line selected is a fault, then all other selected lines must be a fault. The same can be said for contour lines.

Images

Importing an Image File

To add an image file, simply click on the "Add Image File" button on the toolbar that looks like 📷. After clicking this, Petra will ask you to establish a rectangle on the map screen where the image file will be placed. Then, Petra will ask you for the location of the file and the layer you want it to go into. Various scaling options are available under the "Options" tab.

Working with GeoTIFF Files

To insert a Geo-referenced image, click on the "Options" tab and then on "GeoTIFF World File". A dialogue box will pop up asking you for the name and location of the file (*.tfw).

Before importing a Geo-referenced file, make sure your project is in the UTM map projection. (For more information on how to do this, see Map Projections)

Clipping an Overlay

To concentrate on a specific area or exclude map data that isn't relevant to your interests in a specific field, use the clipping tools to remove superfluous information. Clipping an area in the map module will cut lines and drop text anywhere within that area, but will leave images alone.

Remove all overlay data inside a user-defined rectangle - select the "Clip Inside" tool.

Removing all overlay data outside of a user defined rectangle - select the "Clip Outside" tool.

To remove all overlay data outside of a user defined polygon - select the "Clip Outside Polygon."

Note: All of these are permanent to your overlay lines and text - Undo isn't available after clipping the overlay data.
5.12.3.1 Overlay Line Attributes - Map

Every overlay line has a series of attributes that define the type of line and its appearance.

To edit a line’s attributes, select the red arrow button, and double-click a node on the desired line.

General Tab

The General Tab sets the basics of the line, including its layer and class.

Layer - This dropdown sets the layer that will contain the line. Since the Map Module can selectively display or hide entire layers, related lines (such as land grid or lease outlines) should generally be in the same layer. Each set of contour lines should have its own layer.

Line Class

While normal lines are just for displaying visual information (like section outlines or roads), contour, unconformity, and fault lines can also be used to influence the gridding process.

Normal Line - Normal lines have no specific attributes beyond a color and fill. Normal lines are useful for display purposes, including lease lines and arrows.

Contour Line - Contour lines have a specific value, and are useful for modifying
Petra’s gridding process. Selecting the "Contour Line" class enables the Contour Tab, which sets the specific line's value. For more information on using contour lines during gridding see the "Hybrid Method" under "How to Make a Contour Map."

Unconformity Line - Unconformity lines illustrate an unconformable surface contact with a squiggly line on the map.

Fault Trace - Fault traces break grids into two separate parts. Selecting the "Fault Trace" class enables the Faults Tab, which sets the strength and appearance of the fault. For more information on using fault lines during gridding see the "Hybrid Method" under "How to Make a Contour Map."

Line Width - This dropdown sets the line widths for drawing the line. Line widths range from narrow to extra-wide. This dropdown also can select the 4 custom "User-1" through "User 4" line widths. These line widths can be modified on the Petra Program Options' Font/Graphics Tab in the Main Module.

Line Style - This dropdown sets the line to use one of the predefined drawing styles to draw a solid or dashed line.

Smooth Line Points - By default, Petra draws a straight line between the node points that make up a line. This option instead draws a smoothed line through the line's nod points.

Closed Polygon - This option forces the starting and ending points to match when drawing polygons. This switch should be specified when using area fill options.

Contour Clipping Polygon - This option tells Petra to use the polygon to clip gridded contours. Grids outside the polygon will not plot. This can be useful for trimming off anomalous or otherwise bad parts of grids.

Allow in Map Gutter - This option allows the line or polygon to be plotted in the gutter, which is set on the Map Module's Data Map Margins and Preferences tool.

Line is Invisible - This option prevents the line from displaying on the Map Module, even when the layer containing the line is visible. Invisible lines can still affect gridding, and can still be selected.

Colors Tab
Line Color - This dropdown sets the color of the line. For closed polygons, this will set the shape's outline. To change the available colors on this dropdown, select the "Palette..." button. To restore the default colors, select the "Default" button.

Fill Color - This dropdown sets the color of the fill inside a polygon. To change the available colors on this dropdown, select the "Palette..." button. To restore the default colors, select the "Default" button.

Drawing Mode

Normal - This option draws the line or polygon element with an opaque color. Lines or polygons with a normal drawing mode will cover elements that are below them.

Transparent - This option draws the line or polygon with a transparent color. With a transparent drawing mode, other elements will be visible through the line or polygon.

Combine Colors - This option will display overlapping lines and polygons with a different color. In practice, this option is a great way to demonstrate regions of overlap on the overlay.
Patterns

Petra can draw patterns inside polygons. The left up/down button sets the pattern, while the right up/down button sets the density of the pattern.

Pattern Color - This dropdown sets the color of the pattern inside a polygon **when the "Use Pattern Color" option is selected.**

Pattern Line Mode

**Use Thin Black** - This option draws the selected pattern using thin black lines. This option will override the "Pattern Color" dropdown.

**Use Line Color & Width** - This option draws the selected pattern using the line color (selected on the Colors Tab) and thickness (selected on the General Tab). This option will override the "Pattern Color" dropdown.

**Use Pattern Color** - This option uses the color set by the Pattern Color dropdown immediately to the left.

Pattern Filled polygons with "Use Thin Black" (Left), "Use Line Color & Width" (Center), and "Use Pattern Color" (Right)

Area Fill Tab

The Area Fill Tab controls how Petra fills polygons.
The Overlay Line Attributes Area Fill Tab

Do Not Fill - This option will turn off any polygon fill.

Fill Interior - This option will fill the polygon with the "Fill Color" selected on the Colors Tab.

Frame Fill Only - This option will only fill the outermost edge of a polygon. The thickness of this fill is set by the "Frame Width in Map Units" option.

Frame Dashed Outline Only - This option will create a dashed outline inside the polygon. The distance between the outer edge of the polygon and the inner dashed fill is set by the Frame Width in Map Units option.

Frame Width in Map Units - This option determines the width of the shading inward from the polygon borders. The frame width is specified in the currently selected map units (feet or meters). This is commonly used to display partial ownership of a lease.

Volm Tab

The Volm Tab sets up a closed polygon as a volumetric polygon. Petra can use these polygons during volumetric calculations.
Volumetrics Polygon Name - This entry sets the name of the volumetric polygon. Generally, this will be the lease name.

Plot Polygon Name - This option plots the volumetric name in the center of the polygon.

Working Interest Applied to Volumetrics Calculations - This option sets the working interest of the polygon. Petra can multiply the volumetrics calculation by the working interest set here.

Designate a Well to Store Computed Volume for this Polygon - This entry sets a "designated well" that will store the computed volume for the polygon. Note that this entry uses the WSN rather than API/UWI numbers.

Note that volumetric polygons can also have an area plotted on their label. See the Overlay Layer Preferences' Misc Tab for more information.

Contours Tab

This section sets individual contour line values and settings. This section is only available when the "Contour Line" class is selected on the General Tab.
**Contour Value** - This entry sets the value for the contour line.

**Label Contour Line** - This option enables or disables contour line labeling.

**Label Height** - This option sets the height of the contour label in inches.

**Hachures** - This option adds hachures to inside or outside of a contour line.

### Faults Tab

This section controls how Petra handles a fault line. This section is only available when the "Fault" class is selected on the General Tab.

![The Overlay Line Attributes Faults Tab](image)

**Fault Strength** - The strength of a fault affects gridding. The more transparent a fault trace is, the less effect it has on the grid. Totally opaque faults do not allow the gridding process to use data points which are on the opposite side of the fault from the grid node being computed. Set the fault strength somewhere between Transparent and Opaque.
Fault Throw Dies Out At Starting Point - The starting point of a fault is the first point digitized. Set this option if the throw is zero at the starting point.

Fault Throw Dies Out At Ending Point - The ending point of a fault is the last point digitized. Set this option if the throw is zero at the ending point.

If the throw does not die out at either end point, the gridding algorithm treats the fault as totally opaque.

Fault Symbol Style - This option adds fault symbols to the line. Note that the size of the fault symbols can be increased or decreased by the slider bar on the right side of the window. Importantly, these fault symbols are purely cosmetic and have no bearing on the gridding process.

Fault Direction - This option controls how Petra draws fault symbols on the line. "Down to the Left" and "Down to the Right" are relative to the starting point and the ending point. A rule of thumb is to assume you are standing on the start point and looking out towards the first segment - what is on your left is left, and what is on your right is right. Importantly, these fault symbols are purely cosmetic and have no bearing on the gridding process.

Arrow Tab

This section allows arrow heads to be added to the line end points. Note that Petra can only draw arrows on lines with a "Normal Line" line class selected on the
General Tab.

![Image of Overlay Line Attributes Faults Tab]

**The Overlay Line Attributes Faults Tab**

**Arrow Type** - This dropdown sets the appearance of the arrow. Note that the arrows are directional. An arrow pointing to the right will put the arrowhead at the end of the line, while an arrow pointing to the left will put the arrowhead at the beginning of the line.

**Size** - This option sets the size of the arrow in map XY units.

**Misc Tab**

The Misc Tab controls a couple of additional options relating to overlay contour color fill and shifting an individual polygon.

![Image of Overlay Line Attributes Misc Tab]

**Contour Fill Control Line Type**

This section controls how the selected line is used with the [Color-Fill Overlay Contours](#) tool.
None - This option specifies that the selected line isn’t a control or join line. Most lines should keep this option.

Control Line - Control lines connect multiple contour lines.

Join Line - Join lines connect two otherwise disconnected contour lines to create a polygon.

Shift Location

This tool moves the selected line or polygon.

DX and DY - This tool shifts the line or polygon a set number of map XY units. For DX, positive numbers are east and negative numbers are west. For DY, positive numbers are north and negative numbers are south.

Distance and Angle - This tool shifts the line or polygon a set number of map XY units in a compass direction. The Distance is in map XY units, and the angle is in compass values (E=0, N=90, W=180, and S-270). This tool does not rotate the item.

Label Tab

This tab adds a single label without using a dedicated text box.

Label Text - This entry contains the line’s label for labeling the line. LEAVE BLANK for not labeling the line.

Stretch Label Over Percentage of Line Length (1-100%) - This determines the overall length of the plotted annotation. Large values will cause the text to be stretch out while small values will make the text appear compressed.

Text Height - This entry sets the height of the text in in XY map units.

Text Color - This option sets the text’s color. The "Line" button sets the text to
match the line color.

**Position** - This dropdown sets the placement of the line label as Above, Below, or On the Line.

**Font** - This dropdown sets the desired font for the annotation text.

### 5.12.3.2 Overlay Text Attributes - Map

This section defines the attributes associated with an overlay text element.

![The Overlay Text Attributes Window](image)

**Text** - This entry sets the text for the text box. The Map Module can accommodate up to 255 characters.

**Height in Map Units** - This entry sets the height of the text in XY map units. Since the height is specified in a map scale, the text will enlarge as you zoom in and out of the map.

**Text Angle** - This entry sets the angle of the text box. Note that entry will reflect how the text box was drawn on the Map Module. Flat is 0 degrees.

**Layer** - This dropdown sets the layer that will contain the text. Since entire layers can be made visible or invisible, related text should generally be placed in the same layer.

**Text Color** - This dropdown sets the color of the text. To change the available colors on this dropdown, select the "Palette..." button. To restore the default colors, select the "Default" button.

**Justification** - Text justification can be set to a combination of Top/Middle/Bottom and Left/Center/Right.

**Opaque Background** - Set this option to draw the text using the map background color as the background of the text. Opaque text will cover up underlying data.
Allow in Map Gutter - This entry allows the text box to plot in the gutter. Note that the gutter is set on the Map Margins and Preferences’ Gutter Tab.

5.12.4 Load Overlay Layer File

To load an existing overlay file, select Overlay>Load File>Overlay Layer File… on the menu bar at the top of the Map Module.

Data tab

The Load Overlay Layer File Data Tab

Load Layer File As

Normal Overlay Data - This option copies the layer into the overlay file.

Associated (Read Only) Layer - This option stores a link to the layer file. As an associated layer, Petra loads information from the external layer file, rather than from the overlay layer. This is a good choice for shared data that is frequently updated.

Layer File To Load

Browse - This button navigates to the Overlay Layer File (*.LAY) to import.

Load Into Layer

The Load Into Layer dropdown menu, click the drop down box to select the layer where Petra is to store the layer File.

Replace Current Data in Layer - This option completely clears the selected
destination layer before importing the layer file.

**Merge File with Current Data In Layer** - This option adds new data to the overlay layer without erasing any old data in the layer.

## Options Tab

The Options tab gives further control over how Petra imports these Layer Files. For most imports, leave these on the default settings shown below.

![Image of Load Overlay Layer File Options Tab]

**Recompute XY’s from LatLons During Load** – This option uses the LatLons from the overlay layer file to recalculate the XY position. When the LatLons from the file use the same reference datum as the project, this option ensures that the XYs are using the correct map projection. This option is on by default, and should be left on for most layer files.

**Rename Layer Using Layer Name In File** – This option renames the active overlay layer to use the layer name from the origin overlay file. Deselecting this option leaves the layer name as is.

**Replace Overlay Palette with Palette From Layer File** – Overlay Palettes are the sets of colors Petra uses to draw overlay features. There is one set for lines and text, as well as one set for fill colors. Changing colors in the palette will change all of one color to another color. For example, replacing red with green in the line and text color palette will change all red text and lines in the overlay to green. This option will tell Petra to replace the existing Palette of colors with those stored in the overlay layer file.
5.12.5 Save Overlay Layer File

Overlay Layer Files (*.LAY) store the data from a single overlay layer to an external file. This can be useful for sharing data between, or for setting up an associated layer for multiple users.

In the Map Module, select Overlay>Save File(s)>Overlay Layer File from the menu bar at the top of the screen.

Layer File - This entry sets the location of the saved layer file. When creating associated layers, make sure to save this file in a location accessible to all users, such as on a network.

Password Protect Layer File - This option adds an additional password to the overlay file. This can be useful when working with proprietary or sensitive information.

Save Data From Layer - This option sets the overlay layer that will be exported to the external file.

5.12.6 Associated Layer Files

Unlike regular layers, which are stored inside overlay files (*.OVL), associated layers are read from an external layer file (*.LAY) that is stored elsewhere. As this external layer file changes, so does every other associated layer tied to that file. As such, associated layers are a great way to make sure that multiple users in the same project all have access to the most current overlay data. This is especially useful in a multi-disciplinary environment where one person updates a specific piece of information that is useful to the whole team.

Saving an overlay Layer

Select Overlay>Save File(s)>Overlay Layer File... to export the individual overlay layer to a *.LAY file. Since this file will be accessed by multiple other users, it's
important to save this file in an accessible and safe location. If this external file is
moved or deleted, all associated layers tied to that file will be empty. Any changes in
a layer must be re-saved to the exact same Overlay Layer File (*.LAY) for other
users to see the changes.

![Save Overlay Layer File](image)

Saving a overlay layer to a layer file (*.LAY)

**Loading a Layer File as an Associated File**

Now that the Layer File is saved on a network, any other user can load this Layer
File as a read-only Associated File. In the Map Module, Overlay>Load File>Overlay
Layer File...

This brings up the Load Overlay Layer dialogue box. Choose the layer file that
contains the data you want to read. Click the Associated (Read Only) Layer radio
button, and load the Layer File into a selected layer.

![Load Overlay Layer File](image)

Loading the layer file as an associated layer.

**Other Notes on Associated Files**

The [Overlay Preferences and Layers](image) Misc Tab has a couple of additional option to
change how the Map Module works with associated layers.
Keep Assoc Layers in Memory – This option can accelerate redrawing when turning Associated Layers off and on. Normally, Petra refreshes Associated Layers from the network every time the layer is turned off and back on. With a large Layer File and a slow network, this can translate to slow redrawing. This option tells Petra to load the Layer File once and keep it in local memory rather than continually refreshing the Layer File from the network. By eliminating waiting on the network, this option accelerates redrawing. With this option selected, Associated Layers are only refreshed manually (see below) or by closing and reopening the Overlay File.

Refresh All Associated Layer Files - This forces Petra to re-read all Layer Files into Associated Layers. Use this if changes have been made to Layer Files. Petra also brings up a dialogue box to find and re-tie missing or deleted Layer Files.

Convert Associated Layer to Normal Layer - This reads and imports an Associated Layer File to a regular Layer File in the same layer. This saves a little time rather than the normal loading overlay Layer File process.
5.12.7 Auto Save Feature

The Map Module automatically saves the active overlay to a set of backup files at a set interval.

This "Auto Save" feature is designed to help backup any changes made, and is enabled by default. This feature only creates a backup file if changes have been made since the previous automatic backup. Note that Petra also attempts to save the overlay immediately after each data import.

To quickly disable or enable this function, select the Auto Save icon located near the bottom of the Overlay toolbar at the right edge of the map.

To modify the Auto Save options, select Overlay>Set Auto Save... from the menu bar at the top of the Map Module.

Options Tab

Auto Save Active - This option enables and disables the Auto Save.

Audible Sound During Save - When this option is selected, Petra will play a sound every time it automatically saves the overlay file.

Interval Tab
Interval Between Saves - This option changes the interval (in minutes) between attempts to save the overlay.

Number of Revisions to Keep - This option sets the total number of backup files. By default, Petra stores 5 backup files.

Path Tab

Save Overlay Backup Files In Directory - This option sets the location of the overlay backup files. By default, Petra stores these backup files in the user's private parms folder. To minimize the time for saving the file, you might consider pointing the Auto Save Path to a folder on your local drive.
InterAction Tab

This option changes the level of user involvement.

Fully Automatic with No User Interaction - With this option, the Auto Save function just saves files with no additional input from the user.

Prompt User during each cycle to Allow continuation of Save - This option prompts the user before every automatic save attempt.

Backup File Name Conventions

Method 1:

If you load an existing overlay file, then backup files will use the overlay file prefixed with ~$. In other words, if you loaded an overlay called MyData.OVL then the backup files would be named;

~$MyData_1.Ovl, ~$MyData_2.Ovl, ~$MyData_3.Ovl, etc. up to the "file count" setting.

Method 2:

When you start without an overlay and begin to import or manually add data, the backup files will be named; ~$Auto Save_1.Ovl, ~$Auto Save_2.Ovl, ~$Auto Save_3.Ovl, etc. Once you save your overlay with a filename, the backups will created using method 1.
5.12.8 Overlay Preferences & Layers

The Overlay Layers tool enables and disables individual layers, sets the layer plotting order, and performs other high-level changes to the currently loaded overlay file.

To open the Overlay Layers Tool, select Overlay>Preferences & Layers from the menu bar at the top of the Map Module. Alternatively, double-click "Overlay" on the Map Data part of the Quick List, or double-click a single layer on the Overlay Layers section of the Quick List.
Layers Tab (and Group View)
Options Tab
Update Layer Data Tab
General Tab
Move/Copy Tab
Images Tab
Contours Tab
Faults Tab
Misc Tab
Volm Tab

5.12.8.1 Layers Tab

Layers Tab

Layer Name List

Visible for both Properties and Preview Tabs, the list box shows all layer names in the open Overlay file.

This list selects the currently active layer - as an example, to change the state outline.
color to red, you’d need to select the "State" overlay layer here first.

The Layer Name List displays the current status of all the layers in the overlay file. Layers which are not currently visible are indicated by a small symbol. The layer’s default color, which is the color assigned to newly added items, is shown on the right edge of the list.

The Layers Tab has two tabs: Properties and Preview. The Properties Tab changes layer visibility, layer names, and update status. The Preview Tab displays a quick preview of the data inside the specified layer. These two tabs are on the upper right corner of the Overlay Layers tool.

Group View - This button toggles to the Group Tab, a slightly different way of working with groups of related layers.

Layers Tab (Properties)

The Layers Tab sets a few of the basics for the layers in the overlay file. This includes changing layer names, visibility, and update status.
Layer Properties

Layer Name - To change the name of a layer, first select the layer in the Layers lists. Type a new layer name and click the "Apply" button.

Layer Default Color - To change the default color of a layer, first select the layer in the Layers list. Select a new color from the drop down color list and click the "Apply" button.

Layer Visibility - Use this section to "Show" or "Hide" individual layers. Double clicking the layers list will toggle a layer's visible state.

Layer Update Status - This section toggles the status of the selected layer. A "Read Only" layer cannot be changed or edited, and has a red "R" beside the layer name on the Layer Name List. "Modify" layers can be edited and changed.

Plot All Items In This Layer - This option changes how Petra handles overlaps between overlay objects and the wells on the Map Module. "Before Wells" will plot objects before (and below) well symbols, while "After Wells" will plot the overlay objects in the the selected layer on top of well spots. Generally, most users will want to use the default "Before Wells" option.

Σ - This button opens an Information window about the selected overlay layer. This displays information on the total number of items, including lines, text boxes, and images. This window also displays the total range of the selected overlay in both XY
map units and latitude and longitude.

- This option can be used to delete all data associated with the selected layer. You will be prompted to verify the clearing process. Data is only removed from memory. It does not effect any saved overlay files unless you overwrite them with the modified overlay.

**Layers Tab (Preview)**

The Layers Tab displays a quick preview of the data in the selected layer.

![The Overlay Layers' Layers Tab (Preview Tab)](image)

**Preview Layer** - This option displays a preview of the selected overlay layer in the main part of the window.

**Refresh** - This option redraws the preview based on the latest version of the overlay file.

**Use Full Overlay Extents** - By default, the preview window zooms in on the data in the selected overlay layer. This option instead zooms out to use the full overlay extents. This can be particularly useful for troubleshooting overlay data, such as data with a different reference datum.
5.12.8.2 Groups Tab

The Groups Tab displays overlay layers in nested groups.

Layer View - This button toggles between Layer View described on this page, and Group View.

To move a layer into (or out of) a group, simply drag and drop the layer into the relevant group folder. Alternatively use the "Move Items" tool described below.

Add New Group - Enter a text string in the entry field and click the Add New Group button. The new group will appear at the bottom of the list.

Rename Group - This option renames the selected layer group

Delete Current Group - This button deletes the currently selected group. Overlay layers inside the deleted group will be moved into the previous group. You cannot delete the last group.

Rename Layer - This option renames the currently selected layer. Note that this option is greyed out when a group is selected.

Include Group Name When Renaming - This option adds the group name to the beginning of the layer name whenever the layer is renamed.

Do Not Show Layer Number - This option hides layer numbers.

Toggle Read Only Status - This option changes the status of an individual layer.

Make Default Groups - This button creates a single group called Default and includes all layers.
Move Items - Select one or more layers using the left mouse button along with the control or shift keys. Click the Move Items button. Finally, click on the layer to move items into.

Load Template - This option saves the overlay groups to a template (*.OVG file). These files can be useful for applying similar grouping to other overlay files.

Save Template - This option restores the overlay groups from a template file. The groups loaded from this file will overwrite

RIGHT MOUSE POPUP MENU

Move Layer to Top of Group - Moves the selected layer to the top position of its group.

Show Layer(s) - All selected layers are activated.

Hide Layer(s) - All selected layers are de-activated.

Expand All Showing Data - Any group that contains a visible layer is expanded.

Move Items to Another Group - Same as Move Items button.

Hide All Layers in Group - All layers in the group are activated.

Show All Layers in Group - All layers in the group are de-activated.

Sort by ICON - The list is sorted so that activated layers appear at the top of the group, followed by de-activated layers, and finally empty layers.

5.12.8.3 Options Tab

Options Tab

The Options Tab hides all text and contour labels for the selected layer, or adds grid lines to the polygons in the layer.
The Overlay Layers' Options Tab

**Suppress Text** - This option hides text in text boxes in the selected layer. This option does not erase text, and deselecting this option will display the text again.

**Suppress Contour Labels** - This option turns off all contour line labels in the selected layer. This option does not erase text, and deselecting this option will display the text again.

**Auto Fill With Grid Tool** - This tool automatically puts grids inside the selected layer's polygons. This can be useful for automatically subdividing township and range sections in the overlay. Options include Quarter Section Grid, Canadian Target Area 1, Canadian Target Area 2, and Canadian Legal Sub Div (LSD)

Quarter Section Grid (left), Canadian Target Area 1 (center left), Canadian Target Area 2 (center right), and Canadian Legal Sub Div/LSD (right)

**Simplify Lines & Polygons** - This option applies reduces the number of node points in the layer's lines. This will smooth and simplify the lines in the layer - note that the
option cannot be undone. Make sure to save your overlay before using this tool, so you can restore the lines if necessary.

5.12.8.4 Update Layer Data Tab

Update Layer Data Tab

The Update Layer Data changes all overlay lines, text boxes, and polygons within a layer. This tool is useful for changing the appearance (color, thickness, fills, etc) of simple lines and polygons and for changing the behavior of lines (changing line class).

This tab is only available when a modifiable layer is selected on the Layers Tab; this tab will not appear when a "Read Only" layer is selected.

This tool is divided into several tabs, each of which applies to a specific type of object in an overlay layer.

Once you've set the changes to the overlay layer, select the "Update Layer..." button in the upper right corner of the Tab.

The Overlay Layers' Update Layer Tab

Updating Lines
Updating Polygons
Updating Text
Updating Contours
Updating Faults
**Miscellaneous**

5.12.8.4.1 Lines Tab

![The Update Layers Lines Tab](image)

**Line Color** - This dropdown sets the color of the line. For closed polygons, this will set the shape's outline. To change the available colors on this dropdown, select the "Palette..." button. To restore the default colors, select the "Default" button.

**Line Thickness** - This dropdown sets the line widths for drawing the line. Line widths range from narrow to extra-wide. This dropdown also can select the 4 custom "User-1" through "User 4" line widths. These line widths can be modified on the Petra Program Options' Font/Graphics Tab in the Main Module.

**Line Style** - This dropdown sets the line to use one of the predefined drawing styles to draw a solid or dashed line.

**Drawing Mode**

**Normal** - This option draws the line or polygon element with an opaque color. Lines or polygons with a normal drawing mode will cover elements that are below them.

**Transparent** - This option draws the line or polygon with a transparent color. With a transparent drawing mode, other elements will be visible through the line or polygon.

**Combine Colors** - This option will display overlapping lines and polygons with a different color. In practice, this option is a great way to demonstrate regions of overlap on the overlay.
Clear All Line Labels - This option removes all line labels (set on the Overlay Line Attributes' Label Tab). This is permanent - all lines in the selected layer will lose their labels.

Clear "Invisible" Flags - This option

Auto Close All Line Segments - This option forces the starting and ending points to match when drawing polygons. This switch should be specified when using area fill options.

Smooth Line Points - By default, Petra draws a straight line between the node points that make up a line. This option instead draws a smoothed line through the line's nod points.

Unsmooth Lines

Arrows

Do Not Change Arrows - This default option does not change any lines in the selected layer.

Change Arrow Type for Existing Arrows Only - This option only modifies lines in the selected layer that already have an arrowhead.

Change Arrow Type for All Lines - This option modifies all lines in the overlay layer.

Arrow Type - This dropdown sets the appearance of the arrow. Note that the arrows are directional. An arrow pointing to the right will put the arrowhead at the end of the line, while an arrow pointing to the left will put the arrowhead at the beginning of the line.

Size - This option sets the size of the arrow in map XY units.
5.12.8.4.2 Polygons Tab

**Fill Color** - This dropdown sets the color of the fill inside a polygon.

**Patterns**

Petra can draw patterns inside polygons. The left up/down button sets the pattern, while the lower scrollbar button sets the density of the pattern.

**Pattern Color** - This dropdown sets the color of the pattern inside a polygon *when the "Use Pattern Color" option is selected.*

**Pattern Mode**

**Use Thin Black** - This option draws the selected pattern using thin black lines. This option will override the "Pattern Color" dropdown.

**Use Line Color & Width** - This option draws the selected pattern using the line color (selected on the Colors Tab) and thickness (selected on the General Tab). This option will override the "Pattern Color" dropdown.

**Use Pattern Color** - This option uses the color set by the Pattern Color dropdown immediately to the left.
Pattern Filled polygons with "Use Thin Black" (Left), "Use Line Color & Width" (Center), and "Use Pattern Color" (Right)

Do Not Fill - This option will turn off any polygon fill.

Solid Fill Polygons - This option will fill the polygon with the "Fill Color" selected on the Overlay Line Attributes' Colors Tab. Selecting a different fill color here will override every polygon's current fill color.

Frame Fill Only - This option will only fill the outermost edge of a polygon. The thickness of this fill is set by the "Frame Width in Map Units" option.

A Frame Fill Polygon

Label Volume Polygons - This option displays the volumetric polygon names for all polygons in the selected layer.

Don't Label Volume Polygons - This option hides all volumetric polygon names in the selected layer.

Working Interest - This option applies a set working interest to all volumetric polygons in the layer.

Auto-Create Volumetric Polygon Names - This option automatically creates volumetric polygon names to all polygons in the selected layer. Petra will use creation order of the polygon - the first polygon created will be named "1", the second will be named "2", and so on. Note that this tool can have a prefix added to the beginning of the volumetric names.

Re-Classify as Contour Clipping Polygons - This option sets all polygons in the selected layer as contour clipping polygons. Contour clipping polygons clip contoured grids; grids outside the polygons do not show on the Map Module.
5.12.8.4.3 Text Tab

The Update Layers Text Tab

Text Color - This dropdown sets the color of the text. To change the available colors on this dropdown, select the "Palette..." button. To restore the default colors, select the "Default" button.

Text Size - This entry sets the height of the text in XY map units. Since the height is specified in a map scale, the text will enlarge as you zoom in and out of the map.

Text Font - This option sets the text font.

Scale Text By - This option changes all the text in the specified layer by a scale factor. Setting this option to 0.5 will decrease the text by 50%, for example.

Text Angle - This entry sets the angle of the text box. Note that entry will reflect how the text box was drawn on the Map Module. Flat is 0 degrees.

Text Justify - Text justification can be set to a combination of Top/Middle/Bottom and Left/Center/Right.

Opaque Text - This option sets how Petra handles text overlapping other elements in the Map Module. Opaque text will cover up underlying data.
Update Contour Lines - This option allows contour lines in the layer to be updated and changed.

Contour Smoothing - This option adds an additional smoothing to contour lines.

Contour Labels - This option displays and hides contour line labels for all contour lines in the selected layer.

Change All Contour Lines to Normal Lines - This option changes all contour lines in the selected layer to a "Normal Line" line class. This option will erase all the contour line's contour values.

5.12.8.4.5 Faults Tab

The Faults Tab converts lines to and from the "Fault Trace" line class, and sets some fault symbol options for all faults in the selected overlay layer.

For more information on line classes, see Overlay Line Attributes.

For more information on using fault and contour lines during gridding see the "Hybrid Method" under "How to Make a Contour Map."
The Update Layers Faults Tab

Convert All Lines in Layer to FAULTS - By itself, this option converts "Normal Line" and "Unconformity Line" lines to "Fault Trace" lines.

Including Contours This option also converts "Contour Line" line classes to "Fault Trace" lines.

Convert All Faults in Layer to be Normal Lines - This option converts "Fault Trace" lines to "Normal Line" lines.

Change All Fault Symbol Types to - This option changes the fault symbols of all "Fault Trace" lines in the selected layer. Available fault symbols include normal, reverse, vertical, or none. Importantly, these fault symbols are purely cosmetic and have no bearing on the gridding process.

Change All Fault Directions To - This option changes how Petra draws fault symbols for all "Fault Trace" lines in the selected layer. "Down to the Left" and "Down to the Right" are relative to the starting point and the ending point. A rule of thumb is to assume you are standing on the start point and looking out towards the first segment - what is on your left is left, and what is on your right is right. Importantly, these fault symbols are purely cosmetic and have no bearing on the gridding process.

Change All Faults to Default Strength and Throw Dies at both EndPts - This option restores all faults in the overlay layer to the default "semi-transparent" strength. At this default strength, Petra's gridding allows the grid to flex a little across the fault, rather than be completely unchanged by a transparent fault or completely broken by a opaque fault.
Fault strength's effect on throw and fault drag. The default strength effectively creates some fault drag during gridding.

This option also sets the fault throw to zero at both the starting and end points of all faults in the layer. Effectively, Petra will attempt to connect data points around the ends of fault lines.

Reset Fault Symbol Scale Factor - This option resets the fault symbols for all "Fault Trace" lines in the selected layer.

5.12.8.4.6 Misc Tab
**Make All Layer Items Use Layer Default Color** - This option resets all items in the selected overlay layer to use the default color set on the **Layers Tab**.

**Shift Location**

This tool moves every overlay object in the selected layer.

**DX and DY** - This tool shifts the line or polygon a set number of map XY units. For DX, positive numbers are east and negative numbers are west. For DY, positive numbers are north and negative numbers are south.

**Distance and Angle** - This tool shifts the line or polygon a set number of map XY units in a compass direction. The Distance is in map XY units, and the angle is in compass values (E=0, N=90, W=180, and S=270). **This tool does not rotate the item.**

**5.12.8.5 Layer Order Tab**

The Layer Order tab changes how Petra orders objects in different layers. Layers at the top of the list are plotted before (and underneath) layers coming later in the list.
The Overlay Layers' Layer Order Tab

- These buttons move the selected overlay layer up or down in the list.

- These buttons move the selected overlay layer to the top or bottom of the list.

- This button resets the view order to reflect the layer order. As an example, this will move layer 1 to the top of the list, layer 2 to second place, and so on.

5.12.8.6 General Tab

The General Tab changes how Petra works with colors, sets the size of overlay object control points, and a couple of other high-level options.
Modify Line and Text Color Palette

This tool changes the color palette used by text boxes and lines. Changing red to green, for example, will change every red line and text box to use green.

To change a color, use the dropdown to select the color to change. Next, select the \textit{Edit} button to open the color dialog. Here, set the desired color to replace the color selected in the dropdown.

Modify Area Fill Color Palette

This tool changes the color palette used by area fill polygons. Changing red to green, for example, will change every red filled polygon to green.

To change a color, use the dropdown to select the color to change. Next, select the \textit{Edit} button to open the color dialog. Here, set the desired color to replace the color selected in the dropdown.

General

\textbf{Control Point Size} - This entry sets the size of overlay line, polygon, and text control points. Larger control points can be useful for more easily modifying overlay objects, but can overlap at a higher control point densities.
Smooth Line Scale Factor - The smooth line factor changes how Petra applies the "Smooth Line' option on the Overlay Line Attributes window. Generally, a scale factor at or below 1 will smooth pointed corners, while a scale factor above 1 will increasingly simplify the line. In general, it's a better bet to spend your time manually editing and modifying polygons rather than attempting to modify the polygons with this factor.

Calculate Polygon Text Location Using Simple Centroid to Avoid Errors - This option uses a simple centroid to plot a polygon's text in the center.

5.12.8.7 Move/Copy Tab

The Move/Copy Tab moves and copies selected overlay objects from one layer to another.
Move Data FROM LAYER - This dropdown sets the overlay layer containing the objects to be moved or copied.

Move Data TO LAYER - This dropdown sets the destination for the moved or copied overlay objects.

Data Types To Be Moved

This section sets which types of overlay objects are moved or copied from one layer to another. This can be useful for separating out a specific kind of overlay element.

Lines - This option moves lines with the "Normal Line" line class set on the Overlay Line Attributes tool.

Polygons - This option moves "Normal Line" and "Unconformity Trace" lines with the "Closed Polygon" option set on the Overlay Line Attributes tool. This option will not move "Fault Lines" or "Contour Trace" lines.

Text - This option moves text boxes.

Contours - This option moves lines with the "Contour Line" line class set on the Overlay Line Attributes tool.

Faults - This option moves lines with a "Fault Trace" line class set on the Overlay Line Attributes tool.

Images - This option moves only images from one layer to another. Remember that the overlay only keeps a link to an external image file, and not the image itself. Once
you move or copy an image from one layer to another, the external file still needs to be accessible by the computer running Petra.

**Move Data** - This option moves the overlay objects. Moved objects do not remain in the original overlay layer.

**Copy Data** - This option copies the overlay objects. Copied objects remain in the original overlay layer, as well as in the destination overlay layer.

### 5.12.8.8 Images Tab

The Images Tab controls how the Map Module displays image files on the overlay. This tab is most useful for reducing RAM/bandwidth-heavy visibility options and fixing broken links to external image files.

#### Visibility

**Plot Image Contents** - This option plots images on the Map Module.

**Plot Frame Outline Only** - Large aerial or satellite image files can use a large amount of computer resources and network bandwidth. This option plots a frame outline of the image extents rather than the image itself.
Use Screen Plot Technique When Printing - This tool changes how Petra sends images to the printer. Use this option if images are not appearing correctly in printed maps.

Display Warning Messages While Drawing - This option enables or disables drawing warning messages. It's sometimes useful to disable these for frequent errors.

Image File Names List

It's important to remember that Petra doesn't actually store any images in the overlay file. Instead, it simply keeps a link to the external file.

List Image File Names - This option displays the list of linked image files and their paths.

Rename - This option changes the name and pathway of the selected file. This is useful for keeping the same settings (such as GeoTIFF locations) while replacing the name. This can also be useful for fixing bad or outdated pathways.

Find File... - This option instead opens a window to navigate to the new location of the selected file. Note that Petra will retain the old settings for the image.

Drop - This option drops the existing image file from the list. Petra will not retain the link to the image file, but will not delete any files off the network or local hard drive.

Locate Images - This option uses the search criteria established by ImageSearch.TXT to permanently fix the links to the image file. Depending on the number of missing files and the specificity of the search criteria, this can take a very long time.

5.12.8.9 Contours Tab

The Contours Tab Controls a few additional high-level options for contour lines in the selected overlay layer.
Options

Suppress "Averaging" Filter During Smoothing -

Disable Clipping Polygons - This option prevents the Map Module from using clipping polygons

Hide Clipping Polygons - This option hides clipping polygons so that they don't show up on the map. This can be useful for plotting out presentation maps.

Color Fill

Color Fill Closed Contour Polygons - This option applies a color fill to all closed contour lines. This is a simpler version of the Color-Fill Overlay Contours tool, which can handle faults and better work with open contour lines.

Color Fill - This option opens the Color Interval Definition window to set the individual colors and intervals.

Compute Range - This option opens the Color Interval Definition window to set the individual colors and intervals. In contrast to the "Color Fill" option, this tool attempts to automatically calculate a range for the displayed contour lines on the Map module.

Contour Sorting - This option changes how
Labeling

Contour Label Size - This option sets the height of the contour label in map XY units. When this value is set to "0", Petra will automatically calculate a decent value.

Distance Between Labels - This option sets the distance between contour labels in XY units. When this value is set to "0", Petra will automatically calculate a decent value.

Label Contour if Multiple of - This option sets a multiple for labeling contour lines. As an example, when this value is set to "5", Petra will only label every 5th contour line. When this value is set to "0", Petra will label all contour lines.

Bold Contour If Multiple of - This option sets a multiple for drawing thicker, bold contour lines. As an example, when this value is set to "5", Petra will draw every 5th contour line thicker. When this value is set to "0", Petra will not bold any contour lines.

Number of Decimals - By default, Petra trims trailing zeros off contour line labels. This option instead forces Petra to leave additional decimal points on contour line labels.

Use Line Color For labels - By default, Petra draws contour line labels in black. This option instead forces Petra to use the line color.

Hachure Distance - This option sets the distance between hatchures in XY units. When this value is set to "0", Petra will automatically calculate a decent value.

Hachure Size - This option sets the height of the hachures in map XY units. When this value is set to "0", Petra will automatically calculate a decent value.

5.12.8.10 Faults Tab
The Overlay Layers’ Faults Tab

Distance Between Symbols (Map Units) - This option sets the distance between fault symbols for all faults in the selected layer.

Symbol Size - This option sets the size for fault symbols for all faults in the selected layer.

Solid Fill Normal Fault Symbols - This option adds a solid fill to normal fault symbols. Deselecting this option keeps the normal fault symbols empty.

![A solid fill normal fault symbol (left) and a non-solid fill normal fault symbol (right)](image1)

Fill Reverse Fault Symbols - This option adds a solid fill to normal reverse fault symbols. Deselecting this option keeps the reverse fault symbols empty.

![A solid fill reverse fault symbol (left) and a non-solid fill reverse fault symbol (right)](image2)

Fault Polygon Angle Tolerance -

5.12.8.11 Misc Tab

The Misc Tab controls a couple of additional options for associated layers, auto-labels, and exporting a list of the overlay layers.

![Misc Tab interface](image3)
The Overlay Layers' Misc Tab

Keep Assoc Layers in Memory – This option can accelerate redrawing when turning Associated Layers off and on. Normally, Petra refreshes Associated Layers from the network every time the layer is turned off and back on. With a large Layer File and a slow network, this can translate to slow redrawing. This option tells Petra to load the Layer File once and keep it in local memory rather than continually refreshing the Layer File from the network. By eliminating waiting on the network, this option accelerates redrawing. With this option selected, Associated Layers are only refreshed manually (see below) or by closing and reopening the Overlay File.

Method to Auto-Label Polygons with Area - This option adds an area label to volumetric polygons. Note that this label can be in square feet/meters, square miles/kilometers, or acres.

Export Layer List - This option exports a simple text file called Layers.TXT that contains a list of the layers in the open overlay file.

Layers.TXT, exported by the "Export Layer List" option

Refresh All Associated Layer Files - This forces Petra to re-read all Layer Files into Associated Layers. Use this if changes have been made to Layer Files. Petra also brings up a dialogue box to find and re-tie missing or deleted Layer Files.

Convert Associated Layer to Normal Layer - This reads and imports an Associated Layer File to a regular Layer File in the same layer. This saves a little time rather than the normal loading overlay Layer File process.

5.12.8.12 Volm Tab

The Volm Tab controls a few options on how the Map Module displays volumetric polygon information.
The Overlay Layers' Volm Tab

Disable Plotting Working Interest Values With Polygon Names - This option prevents polygon working interests (set on the Overlay Line Attributes tool's Volm Tab) from plotting on the map.

Plot Volume WSN Values with Polygon Name - This option plots the WSN of the polygon's designated well inside the polygon.

Volume Polygon Name Scale Factor - This option sets the volume polygon label's scale factor. This number is multiplied by the normal label height - setting this value to 0.5, for example, will decrease the size of the label by 50%.

5.12.9 Color-Fill Overlay Contours

By themselves, contour lines aren't filled in. This tool creates a set of color-filled polygons based on an set of contour lines.

To add a color fill to a set of overlay contours, select the button on the Overlay Toolbar.
A set of contour lines before (Left) and after (Right) adding a overlay contour color-fill

Contours Tab

Overlay Layer Containing Contours To Fill - This dropdown selects the overlay layer containing the contour lines. Note that Petra will use all contour lines in the overlay layer.

Overlay Layer to Receive Color-Filled Polygons Built from Contours - This option selects the overlay layer that will contain the color-filled polygons. It's usually a good idea to store these in a different layer than the original contours.

Overwrite Layer With New Polygons - This option completely overwrites the layer with the color-filled polygons. Any data in the overlay layer selected in the "Overlay
Layer to Receive Color-Filled Polygons Built from Contours” dropdown will be completely erased.

Colors

**Color Fill** - This option opens the Color Interval Definition window to set the individual colors and intervals.

**Load Template** - This option saves the current color-fill settings to an external file.

**Save Template** - This option replaces the current color-fill settings with those from an external file.

Faults Tab

![The Color-Fill Overlay Contours Faults Tab](image)

**Overlay Layer Containing Faults** - This dropdown selects the overlay layer containing the fault lines. Note that Petra will use all fault lines and polygons in the overlay layer.

**Use Faults Layer** - This option simply toggles the use of the fault lines. When this option is deselected, Petra will not use any fault lines in creating the color-fill polygons.

Control Tab

Complex contour lines can confuse the contour color-fill algorithm, and lead to odd color fills. The Control Tab sets the layer containing Control and Join Lines that help better constrain the color-fill process.

**Overlay Layer Containing Control and Join Lines** - This dropdown selects the overlay layer that contains the control and join lines.
Use Control Layer - This option simply toggles the use of the control and join lines.

Using Control and Join Lines

Control lines
Control lines connect multiple (in red) were drawn as normal lines with "control" option set in misc tab of line attributes screen along the ends of the group in the SE corner.

In the example below, the color-fill process has gotten confused around the 0’ contours in the lower SW corner of the map. In the center figure, control lines (drawn in red) connect multiple contour lines to create filled polygons. After running the color-fill again, Petra recognizes that the contour lines mark off three separate intervals, and should be filled with the colors specified on the Contours Tab.

Join Lines
Join lines connect two different contour lines. This effectively creates a closed polygon for the color-fill.

In the example below, the SW corner of the map has a blank spot bound by two disconnected 0 contour lines (marked with an X on the center figure). In the center figure, the two 0 contour lines are connected with two join lines (in blue) that connect the two lines and form a closed polygon. After running the color-fill again, Petra recognizes that the region is should be filled with a blue color.
5.12.10 Lineament Analysis and Rose Diagrams

This feature analyzes line data from an overlay layer and generates rose diagrams illustrating orientation and coverage of the lineament features on a regional basis.

Region Grid Cells
Lineament or fracture data in an overlay layer is subdivided into a series of regional grid cells. The outlines of the grids can be seen in Figure 1. The total length of lines within each cell is summed and a histogram is built based on the orientation of each line segment. Only the portion of a line lying within a cell is considered in these calculations.

Area Coverage Values
Each regional grid cells is, in turn, subdivided into a series of 10x10 grid cells. This sub-grid is used to determine the percent of area coverage by lineaments of fractures. If a line crosses a subgrid cell, then the area of the subcell, or 1% of the regional grid cell, is summed as "area coverage" value and can be posted. These values are indicated as A:nnn.

Length Values
Values can be posted that provide a relative length of lines in a regional grid cell. These values are computed as follows. The total length of all lines inside a regional cell are totaled. Then, the maximum of these lengths is found. The "length value" for a cell is the percent of the cell's length to the maximum length. These values are indicated as L:nnn.

Dominant Angle Values
The dominant angle of orientation for each regional grid cell can be posted above the rose diagram. The dominant angle is the "mode" of the histogram, i.e., the orientation that has the longest line segments.
General Tab

The regional grid is defined as a rectangular box in XY map units. The cell size of increment also defined in XY map units. If you wish to have the region divided into a 10 rows by 10 columns, simply enter 10 in the "NxN" field and click the "Set" button. The appropriate x and y increment will be computed.

There are two button to set the grid extents to the current screen limits or the limits defined by the well data on the map.

Layers Tab

Analyze Lines From Layer - This dropdown sets the overlay layer containing all lines, fractures, lineaments, etc. used to compute the rose diagrams.
Store Results In Layer - This dropdown contains the layer name of the layer receiving the rose diagrams, text and other graphics. **Petra will completely replace the contents of this layer before storing new data.** This layer can not be in a read-only mode. The "R" button renames the output layer.

**Rose Tab**

The Rose Tab sets a few additional details on how the rose diagram plots.

![Rose Tab](image)

**Line Color** - This option sets the overlay color for the rose diagrams' outline.

**Fill Color** - This option sets the overlay color for the rose diagrams' interior fill.

**Maximum Diameter (XY Map Units)** - This option sets the size of the largest rose diagram. It's best to set this values no larger than the grid cell size.

**Rose "Petal" Width (1 to 90 Degrees)** - This option sets the the angle increment used when building orientation histograms.

**Include Grid Cell Lines** - This option plots the regional grid outlines on the Map Module.

**Include "Dominant Angle" Text (Deg)** - This option plots the lineaments' dominant angle above each rose diagram.

**Include "Length" Text (%)** - This option posts the relative length of lines within each cell.

**Include "Coverage" Text (%)** - This option posts the area covered by fractures in each cell.
5.13 Well Data Posting

The Map Module can post well header info, zone data items, or production data around the well symbols.

To open the Data Posting tool, select the button on the toolbar at the top of the Map Module, or select Options>Data Posting on the menu bar at the top of the Map Module.

Data Tab
Options Tab
Wells Tab
PdCum Tab
Misc Tab
Overposting Tab and Moving Posted Data

5.13.1 Moving Posted Data

Moving Posted Data
1) Left-click on the well
2) Hit F4 or click the button on the toolbar at the top of the Map Module
3) Left-click on the text "block" to move
4) Move the mouse to the new position
5) Left-click the new position

**Resetting a Posted Data Text Box to its Original Position**

1) Left-click on the well
2) Hit F4 or click the move posted data icon
3) Right-click on the text "block" to reset it to the default position

### 5.13.2 Data Posting Data

The **Data Posting** Data Tab controls how data is posted around the well symbols on the Map Module.

To open the Data Posting tool, select the button on the toolbar at the top of the Map Module, or select **Options>Data Posting** on the menu bar at the top of the Map Module.

![Data Posting Tool](image)

**Available Data Items**

To add an item to the data posting, select the desired well header, zone data item, or pd cum value on the Available Data Items List and select the button immediately to the right. Note that there are three buttons - the upper button adds the item selected on the "Well Header Items" dropdown, for example.

**Well Header Items** - This dropdown selects well header info to add to the data posting box. This is most commonly used to add well identifier information, such as well name and number.

**Zone Data Items** - These two dropdowns select the zone and data item to add to the
data posting. The upper dropdown selects the specific zone, while the lower dropdown selects the data item in the selected zone. Note that Petra treats formation tops as a zone - to add a formation top, select the "FMTOPS" zone on the upper dropdown and the desired top on the lower dropdown. The \(\text{\textcopyright 2014}\) button resorts the items on the lower data item dropdown into alphabetical order - this can be helpful for large numbers of tops.

**Pd Cum Items** - This dropdown adds cumulative production data, visible on the Main Module's Prod Cum Tab. This includes formation names, tops/base, and cumulative values.

**Selected Data Items**
This list box displays all the well data items displayed on the Map Module.

- Petra displays items on the selected data items from top to bottom. The up and down buttons change the order of a selected data item by moving the item up and down.
- This item removes the selected data item on the Selected Data Items list.
- This item removes all items from the Selected Data Items list.

**Data Posting Tabs**

**Style Tab**
Each posted data item contains posting attributes including the position relative to the well symbol, text color and size, number of numeric decimal places and how the value is labeled. Additional attributes can be set for formation tops including whether to use alias names and whether to post subsea values. All Z values can have the "quality" code and "units" posted following the value.

![Image](image)

**Post Quality Code** - Check this option to have the quality code posted following a zone data or top item. Null values will show only the quality code.

**SS Datum = 0 If Null** - This option is used in conjunction with the subsea tops option and causes posted subsea tops to be computed using a datum value of zero if the datum is null. Otherwise, the subsea top value will post as a null value when the datum
Post Subsea Top - Use the option when posting formation tops and you want to see subsea values. Subsea values are computed as: SS=Datum-Top.

Post Times - This option appends the seismic time (ms) to the posted depth value. Times are calculated using the active velocity function for each well (from the "other" tab in main).

Suppress Source - This option suppresses the display of the source portion of the item name when the Label Style includes the name.

Use Aliases - If you have defined aliases, use this option to have the aliases searched for when posting a value.

Post Units - This option causes the units value to be posted following the zone or top value.

Post Remarks - This option causes the remark field associated with the top or zone value to be posted.

Text Height - This section sets the text height for the selected data item. Text heights or sizes are specified in either inches or map XY units, e.g., feet, depending on the size option located on the Options Tab. When using XY map units, text will vary in height depending on the map scale. When specified in inches, text is also the specified height, regardless of the map scale. Inch text heights will enlarge slightly when you zoom in if the "Enlarge With Zoom" option is selected. Click the ALL button to set all text to the same height.

Position - Text items can be posted in four positions around the well spot. Select the position to place the text item Above, Below, Left or Right of the well symbol on the map.

Decimals - Set the number of decimal places to the right of the decimal point for numeric values. Whole numbers will still post as integer numbers. Only values with fractional parts will show the number of specified decimals.

Text Color - Each text line item can be plotted in a different color. Choose from the palette provided by clicking on the color cell. Click the ALL button to set all text to the same color.

HiLite By Quality - This section allows you to highlight individual lines of text based on the quality code associated with the zone or tops data value. You may specify one or more text strings, separated by a semicolon (;), that will be search for in the quality code field. When the quality code is found, the line that one well will be highlighted using the selected color as the text background color.

Font - Each line item can have a font specified from the font list.

Label Style - Several labeling styles are provided and control whether variable names are posted along with the value.
Scaling Tab

This option scales a displayed data item. This can be useful for displaying production in 1000s of barrels or changing imperial to metric units. Note that this option does not change the data in the database - it only changes the value for display.

Do Not Scale Value - This option leaves the values displayed as is. This option is on by default.

Scale Factor (Multiply By) - This option multiplies the selected data item by a constant. Multiplying a constant less than 1 will divide the data item.

Scaled Value Units - This changes the value units displayed on the map module.

Convert Zone or Tops Units - This section converts imperial and metric units. The "Apply To All" will convert all displayed zones and tops to use the selected unit.

Misc Tab

Truncate to First Word Only - This option only posts the first word in the data item.

 Suppress Commas in Values - By default, Petra puts commas at every third decimal point. This option removes commas in the values. Note that this option will not affect text items.

 Suppress Source In Posted Name - The "Zone: Item - Value" and "Item Name - Value" options post the source code for posted formation tops. This option removes the source in the posted name.

 Flag Aliased Tops By Appending an * to the Value - This option distinguishes between actual top and aliased tops. Petra will add an "**" at the end of the formation top value.

 Skip Posting if Quality Code Is - This option prevents the selected label's plot when
the data item's quality code matches one of the quality codes inside the entry box. Separate multiple quality codes with a semi-colon.

Display Zero Top Values and Zone Item Values as NULLS (blanks) - This option posts tops or zone data items with zero values as a blank. This option only affects the item highlighted on the Selected Data Items list. Note that this tool only affects the display on the Map Module, and does not change the values inside the database.

5.13.3 Data Posting Options

The Data Posting Options Tab controls how well data is posted around the well symbols on the Map Module.

To open the Data Posting tool, select the Data Posting button on the toolbar at the top of the Map Module, or select Options>Data Posting on the menu bar at the top of the Map Module.

**Active** - When the "Active" option is checked, data will be posted by each well. Uncheck the option to disable data posting.

**Enlarge With Zoom** - Check this option to have the posted text enlarged when you zoom in.

**Drop Missing Data Lines** - Check this option to suppress posted data lines that are blank due to missing data. Blank lines added as data lines are not suppressed.

**Opaque Text** - Check this option for posting text with an opaque background. Opaque text is useful when posting over color-filled contours.

**Combine Perfs For Completions** - This option is used when the depths for perfed intervals are posted. Only the initially completed wells, designated by a 14-digit API number ending with "00", will be posted. Perfs from all other completions will be...
included in the listed perfs.

**Post Only Primary Completions ("00" wells)** - This option will only post a well if it is a 14-digit API number ending in "00".

**Gap Btwn Well And Data** - Enter the height of the gap between the well symbol and the posted data items. Enter a value that is relative to the "Sizes" option discussed below.

**Line Spacing** - Enter the height of the gap between each posted text line. Enter a value that is relative to the "Sizes" option discussed below.

**Global Scale Factor** - Enter a multiplying scale factor greater than 1.0 to enlarge all text or less than 1.0 but greater than 0.0 to reduce the text.

**All Sizes Are In** - Select the mode for specifying text heights. You can enter sizes in inches or in the xy units of the map, such as, feet or meters. Using the "inches" mode will cause the posted text to maintain the same size regardless of the map scale. Using the "Map XYs" option produces text heights dependent on the map scale.

**Save Template and Load Template** - Frequently used selected items list can be saved to disk using the "Save" button. Saved lists can later be reloaded using the "Load" button.

### 5.13.4 Data Posting Wells

The **Data Posting** Wells Tab limits the well data posting to only specific wells. This tab also sets up "Primary" and "Secondary" wells. "Primary" wells post well labels at full size, while "Secondary" wells either have their labels posted smaller and grey or skipped completely.

To open the Data Posting tool, select the **button** on the toolbar at the top of the Map Module, or select **Options>Data Posting** on the menu bar at the top of the Map Module.
Wells To Be Labeled (Primary Wells)

This section controls how Petra selects primary wells.

**All Wells On Map** - This option posts all wells as primary wells. All well labels are plotted at full size. This option is on by default.

**Highlighted Wells** - This option sets highlighted wells (Set on the Wells>Hilite Wells) as primary wells. This option works whether highlighting is enabled or disabled.

**Wells From a WSN List** - This option uses a WSN well list to select the primary wells for posting. To create a WSN list, select Wells>Select Wells>By Data Criteria. Be sure to save a WSN list and not a UWI list.

Secondary Wells (Wells Not Selected As Primary)

This section controls how the Map Module draws secondary well labels.

**Do Not Post Secondary Wells** - This option just drops labels on the secondary wells.

**Post Secondary Wells As Background** - This option posts the labels on secondary wells at 1/2 the specified size and with a grey color.
5.13.5 Data Posting PdCum

The Data Posting PdCum Tab controls how well data is posted around the well symbols on the Map Module.

To open the Data Posting tool, select the button on the toolbar at the top of the Map Module, or select Options>Data Posting on the menu bar at the top of the Map Module.

Combine PdCum Top and Base as Single Line Posting - When the "PdCum - TOP" data item is on the Selected Data Items list, this option appends the base to the data posted. Note that this does not affect the "PdCum - BASE" data entry.

Combine From and To Dates as Single Line Posting - When the "PdCum - FROM
DATE" data item is on the Selected Data Items list, this option appends the "TO DATE" to the production cum. Note that this does not affect the "PdCum - TO DATE" data entry.

"Not Available" Indicator - This entry sets the text that will substitute in for missing production cum data.

5.13.6 Data Posting Misc

The Data Posting Misc Tab controls how well data is posted around the well symbols on the Map Module.

To open the Data Posting tool, select the button on the toolbar at the top of of the Map Module, or select Options>Data Posting on the menu bar at the top of the Map Module.

Zone Items Legend Option

This section sets the specific text on the "Posted Well Data" part of the Map Module's title block.

Post Zone-Item-Description - This option plots the active zone and item on the title block.

Post Item Description Only - This option plots only the item description on the title block.
The “Post Zone Item Description” option (left) and the “Post Item Description Only” option (right)

Legend Text Size Multiplication Factor - This option sets the size factor for the legend.

Wrap Zone Text Items to - This option sets the wordwrap for the title block.

Well Symbol in Legend - This dropdown sets the specific well symbol displayed on the title block.

5.13.7 Data Posting Overposting

The Data Posting Overposting Tab controls how well data is posted around the well symbols on the Map Module.

To open the Data Posting tool, select the button on the toolbar at the top of the Map Module, or select Options>Data Posting on the menu bar at the top of the Map Module.
Manually Shifted Text Options

Petra’s default data posting can sometimes create overlapping or illegible text blocks. This section controls how Petra handles manually shifted text sometimes plot (above, below, left, and right) can be moved or repositioned relative to the well spot using the mouse. To manually move data posting, select the well and click the button on the toolbar to reposition the data posting box.

Disable Shifted Text - This option disables all manual data shifting, but retains the settings in the database. Petra will draw the data posting text boxes in the default locations.

Use Offsets From DB - This option uses the data shifting saved in the project database.

Use Offsets From Offset File - This option uses the data offsets from the Data Offsets File Manager.

Automatic Overpost Resolution

This tool automatically shifts data post boxes to resolve over posting conflicts.

None - This option turns off the automatic resolution, but retains the settings in the database. Petra will return the data post boxes to their original locations.

Resolve All Overposting Automatically - This option changes all overposted data post boxes.

Resolve Overposting for Items Not manually Shifted - This option moves only the text that hasn’t been moved manually. This can be useful for moving the some of the text yourself, and have Petra move the rest.

Maximum Distance To Move Data From Well - This sets the maximum distance that Petra will move the data overposting. Setting this entry too high can move data posting very far away.

Clear DB Shifted Text - This option removes all the database shifting stored in the project.

5.14 Grids and Contours

Petra generates and shows a computer-generated grid in two different steps. The first step is to create a grid, and the second step is to display contours or color fills based on that grid. Grids can also be used in calculations, are easily used in volumetric estimations, and can quickly highlight different aspects of the same map by modifying colorbars.

For a more general guide, see "How to Make a Contour Map."
Getting Started

Creating a grid from well data

Adding color contours and/or contour lines to a grid

Adding interpretation to a grid

Adding a grid to a cross-section profile

Advanced Tools

Exporting a grid to ASCII, Exporting a grid to other file formats

Resampling a grid

Performing a simple arithmetic and curvature analysis on a grid

Calculating an isopach from two grids

Applying an equation to one or more grids

Advanced modeling with grids

Interpolating seismic values from a grid

Calculating volumetrics from a grid

5.14.1 Create a Grid

For more information about editing contours in the map module, see here.

For a more general guide, see "How to Make a Contour Map."
Create Contour Grid Tool

Data Tab
Method Tab
Trend/Bias Tab
Limits Tab
Advanced Tab
Triangulation Tab
Misc Tab
Tops Tab
Interval Data Tab

5.14.1.1 Create Contour Grid - Data Tab

Click Here for a "How-To" guide on creating Contour Grids

The Data Tab selects the specific data that will be used, as well as the new grid’s name and location on a local computer or network.

The Create Contour Grid Data Tab

Grid Folder - This box shows the currently selected grid folder, where any created grids will be stored. Selecting the “… ” button on the right of this box changes the grid folder’s path. By default, Petra looks in the active project’s GRIDS directory.

Grid Title - This option sets the title for the grid. This title will be placed in the grid
file header and displayed as the map title whenever a contour map is generated from the grid. A default title is created whenever well data items or seismic z values is selected.

**Output Grid File Name** - This is the external file name for the computed grid file. Petra creates a default file name when well data items or seismic z values are selected. The file extension for grid files is .GRD.

**Zone Data To Grid**

Making a map often means using different kinds of data. When making a grid, Petra can use well data, external control points, seismic data, and drawn contour lines and faults. Petra can use any one or combination of these different data sets to create a single grid.

**Zone Data** – This option selects well data visible from the Zones Tab on the Main Module. Simply select the zone and the appropriate zone data item. The “FMTOPS” zone includes all created fm top data. The adjacent drop down selects whether the fm top will be gridded as a MD, SS, SSTVD (if directional surveys are loaded and enabled), or Seis Time (if velocity functions are loaded). A grid using this data will use well data from for every selected well on the Map Module. Wells that have been dropped from the map will not be used in the grid.

Disabled wells, on the other hand are still honored when gridding, even though they don’t appear on the map. To disable a well, first select the well in the Map Module with the left mouse button. Then, right click and select “Disable (Do Not Plot”). If disabled wells contain bad data points, Petra will still try to grid using that data, which may result in bulls eyes or other anomalies.

**View Data** - This option opens the [View/Edit Zone Data](#) tool.

**Well Dist** – This option calculates some basic statistics about well spacing, which can be particularly useful when establishing grid spacing. This tool will calculate distance statistics between all wells displayed on a map without discerning if they have data or not. In other words, if you have a large number of closely spaced wells but only a few of those wells have data, this well distribution box will give you an average distance that is too small.
Seismic - This option grids Z values stored in each shot point. This option only is available if 2D shot points are loaded into Petra. The "Active Lines Only" option restricts gridding to only use seismic lines currently set as active. Remember that Petra will attempt to grid all checked data types, which can lead to bizarre maps if formation tops (stored in the thousands of feet or meters) are gridded along with seismic (stored in only a few seconds). When gridding only seismic data, be sure to uncheck the Zone Data option.

Overlay Contour Lines – This option uses ALL VISIBLE overlay contour lines on the map module to influence the gridding. Overlay contour lines are a powerful way of adding human geological knowledge to an otherwise completely computer-driven process. When drawing a contour line in the Map Module, setting a the overlay line’s Line Class to “Contour Line” reveals the Contour Tab, where the contour line’s value is set and can be edited.

Since Petra will use all visible contours during gridding, it’s a good idea to keep different sets of contours separated into different overlay layers. Before gridding, make sure to only have the relevant contour lines visible. As an example, keeping structural contours (measured in negative thousands of feet) and net sand contours (measured in tens of positive feet) both active at the same time during gridding will result in bizarre maps as Petra will try to honor both sets of values.

Include Control Points – Control points are data points not tied to a particular well. Control can come from a wide variety of sources including seismic data, topographic surveys, or from legacy computer-generated grids. Control points can either be loaded into Petra’s internal memory (under the Contours>Control Pts>Load File... in the Map Module) or simply displayed from an external control point file (under the Contours>Control Pts>Display External Control Point Files... in the Map Module). Control points can also be created from scratch inside Petra (under the Contours>Control Pts>Add... in the Map Module).

Include Faults – This option uses ALL VISIBLE overlay fault lines on the map module to influence the gridding. Fault lines break the normal process of interpolation between different data points. When drawing a fault in the Map Module, setting a drawn overlay line’s Line Class to “Fault Trace” reveals the Fault Tab. The Fault Tab sets the fault line’s value strength (determining the amount of fault drag), and the
display of any fault symbols.

Since Petra will use all visible faults during gridding, it’s a good idea to keep different sets of faults separated into different overlay layers. When using faults during gridding, make sure to only have the relevant fault traces for that particular surface visible.

**Apply SS(TVD) to Zone Items** – This option grids SS (for vertical wells) or SSTVD (for deviated wells with loaded and enabled survey data) formation tops instead of MD formation tops. In areas with any surface topography, this option is essential to generate accurate subsurface structure maps.

**Calc XY For Dev Wells At Top** – This option forces the data point to be contoured at the map position of a specific formation top. By default, Petra plots and calculates grids based on the location of the well symbol. On deviated or horizontal wells, however, this can mean that the data value can be gridded thousands of feet away from where the value was actually measured. This can significantly change an interpretation – especially if the lateral part of the well is long or if there is faulting involved. Select the appropriate top from the drop down menu, Petra will calculate the map location of that fm top from survey data, and use that specific point instead of the well symbol location for gridding.

5.14.1.2 Create Contour Grid - Method Tab

[Click Here for a "How-To" guide on creating Contour Grids]

The Method Tab controls the grid size and surface style of the gridding. The grid
size of a grid largely controls how many points are in a calculated grid, which has a direct bearing on contour line smoothness and how well the computer-generated contour lines “honor the data.” The grid method, on the other hand controls how Petra interpolates the grid from one data point to another.

The Create Contour Grid Method Tab

**Grid Size**

On a rectangular grid, the grid size determines the spacing between horizontal and vertical interpolated grid node values, as shown in the example below where the blue grid nodes are evenly spaced between a set of wells. A grid spacing of 900’ translates to grid nodes 900’ apart both north-south and east-west. Small spacing leads to more grid nodes, which generally “honor the data” better but require much more computer time. Large spacing, on the other hand, tends to generate smoother contours with less computer time but at the cost of a less rigorous tie to data points. The grid size section offers several methods for setting the grid size.
Use Grid Size of (XY units) – This option sets grid spacing to a user-input X and X grid size in map units (feet or meters). A good rule of thumb here is to use ½ the average well spacing.

To calculate average well spacing, select the “Well Dist…” button on the Data Tab (highlighted below on the left). The Well Dist… button on the gridding screen (on the right) gives statistical information on distances between wells, including average distances. This tool will calculate distance statistics between all wells displayed on a map without discerning if they have data or not. In other words, if you have a large number of closely spaced wells but only a few of those wells have data, this well distribution box will give you an average distance that is too small.

Compute Optimum Size From Z Data - During gridding, Petra will compute a grid size based on the well data distribution.

Set Rows and Columns Slider Bar – Instead of setting a specific grid size, this option
instead sets the total number of horizontal and vertical rows for the grid. Sliding the “Coarse to Fine” slider bar changes the number of rows and columns used in the grid. Notice that as these are changed, the x and y grid spacing sizes change accordingly.

Match Grid Size of Grid – This option sets the grid size of the new grid to exactly match the grid size of an old grid. Select this option, and use the drop down menu to select the grid file to be matched. Note that the X and Y sizes are updated to show the grid sizes used.

Mathematical calculations between two or more different grids require the size and spacing of each grid to match exactly. As an example, creating a hydrocarbon pore volume grid (where HPV = thickness * porosity * hydrocarbon saturation) would require the isopach, porosity, and water saturation maps to all have the same grid spacing. Using this option to match the porosity and hydrocarbon saturation grid size to the initial isopach grid will save considerable time later.

Surface Style

This option determines the shape and characteristics of the gridded surface by applying different mathematical functions to the original data. Surface styles interpolate the data between data points on both rectangular and triangular grids.

Highly Connected Features - This is Petra’s default gridding style. It uses a least squares gridding algorithm that tends to preserve trends in the data and works well for most data, particularly structure maps and gently changing petrophysical data. The Highly Connected Features surface style works well with faulted reservoirs. This surface style tends to not do well with rapidly changing or large contrasts between data points such as production in a closely-drilled field.

This method tends to avoid geologically unrealistic contours (or “artifacts”) on the edges of the grid, though contours can be somewhat jagged and uneven with small grid sizes. The application of surface flexing (“Smooth Contours Using Grid Flexing” immediately below the Surface Style drop down menu) works well with this surface style, as it tends to smooth and even out the spacing between contour lines.

Disconnected Features – This surface style uses a linear projection algorithm that tends to produce closed-off features. This surface style can useful for mapping patch reefs or isolated channels. The Disconnected Features surface style can be used with faults. Contours generated from this surface style can be uneven and jagged, but this is easily remedied by adding surface flexing (“Smooth Contours Using Grid Flexing” immediately below the Surface Style drop down menu).

Since this method calculates grid values from a projected linear slope between one data point to the next, the Disconnected Features surface style is susceptible to a couple of different types of gridding artifacts. At the edge of a map this surface style extends the nearest linear projection when calculating Z values, making it particularly prone to “runaway grid values” on the edge of the map. The
disconnected nature of the surface style also tends to make “bumpy” maps where two adjacent wells form an adjacent dome and a bowl instead of a more generalized trend.

**Simple Weighting With Slopes** – This surface style calculates a grid using three steps. Petra first calculates a slope for each data point based on surrounding data points. These slopes are then used to project the data points’ Z values out to each individual grid node. Finally, this surface style takes the weighted average of the projected Z values.

The Distance Weighting Damping Factor on the Advanced Tab can greatly affect this surface style. This option uses any value from 1 to 8, with a recommended default setting of 2. With a small factor, more distant data points have more influence on an individual data point which tends to average the grid node; this usually results in a smoother grid. With a larger factor, close data points influence the individual grid much more than more distant data points. The recommended value for this factor is 2. For more information, see the help file on the Advanced Tab.

**Simple Weighting Without Slopes** – This surface style applies a weighted average to the data points around each grid node. In contrast to the Simple Weighting With Slopes surface style, no slope information is used. This option is useful for very dense control such as 3D seismic bin locations.

The Distance Weighting Damping Factor on the Advanced Tab can greatly affect this surface style. This option uses any value from 1 to 8, with a recommended default setting of 2. With a small factor, more distant data points have more influence on an individual data point which tends to average the grid node; this usually results in a smoother grid. With a larger factor, close data points influence the individual grid much more than more distant data points. The recommended value for this factor is 2. For more information, see the help file on the Advanced Tab.

**Distance Grid** - This surface style calculates the distance to the nearest data point for every grid point. Put another way, the grid right next to a data point will have a low Z value, while a grid a great distance from any data point will have a high Z value. Contouring this distance grid can be a useful way of visualizing drainage and bypassed parts of the reservoir. Parts of the grid with a high distance to the nearest well are less likely to be drained than parts of the grid with a low distance.
Again, this method only calculates distance to the nearest selected data point, which can include contour lines and control points in addition to wells. If “Use Overlay Contour Lines” is selected on the Data Tab, the surface style will calculate the distance from the nearest well or the nearest contour line. This renders any visualization of drainage useless, so be sure to only select “Zone Data” for this surface style.

Closest Point - This option simply sets each grid node to the value of the closest data point. It doesn't interpolate between data points, and is really more useful for resampling existing grids. It is best used with very dense data such as 3D seismic coverage or with legacy XYZ grids.

Minimum Curvature (no faults) - This surface style attempts to create a very smooth, gradual surface. Contour lines with this method are smooth and evenly spaced, which makes this style a good choice for gently changing petrophysical properties and simple structural settings.

This method cannot be used with faults. Since the minimum curvature algorithm is also available under the “Smooth Contours Using Grid Flexing” option (immediately below the Surface Style drop down menu), so you can use the Highly Connected surface style (which works well with faults) along with the grid flexing option. Since this method strives to have as simple a surface as possible (one with a “minimum curvature”), this surface style tends to smooth over some of the variation in data points. In short, this method has the potential to “not honor the data” as well as other methods. Edge effects with “runaway Z values” are also common with this method.

The Min Curvature Tension setting on the Advanced Tab can greatly affect this surface style. Practically, high tension grids – particularly above 5 - have smoother and more even contours but may not honor the original data as well as lower tension grids.
Adjust Zero Contour for Isopach Surface – This option helps to make more geologically reasonable isopach maps where there are zero-valued data points. When creating a grid, Petra attempts to connect data points. As an example, the grid will attempt to connect a 15’ data point with another 15’ data point, resulting in a 15’ contour line connecting the two points.

Zero-valued data points are a little different. Since Petra attempts to connect all zero points, the grid can unrealistically oscillate around zero. The “Adjust Zero Contour for Isopach Surface” option instead forces Petra to assume that the actual zero isopach line for the grid is midway between a zero value and a non-zero value. Effectively, this creates a more realistic isopach map.

Smooth Contours Using Grid Flexing – This option adds an additional step after gridding to generate smoother, more even contour lines. When this option is selected, Petra first uses the selected surface style to interpolate between the data points to create grid nodes. Next, Petra applies the minimum curvature surface style to both the original data points and to a decimated sample of the newly-interpolated grid values.

The relative strength of the grid flexing option is set by the “Flex Grid Factor” on the Advanced Tab. This option can be set anywhere between 0 and 12. Setting a low grid factor will keep a relatively strong primary surface style, while a high grid factor will increase the relative strength of the minimum curvature surface style.

Grid flexing is also influenced by the “Min Curvature Tension” option on the Advanced Tab. Practically, high tension grids – particularly above 5 - have smoother and more even contours but may not honor the original data as well as lower tension grids.

5.14.1.3 Create Contour Grid - Trend/Bias Tab

Click Here for a "How-To" guide on creating Contour Grids

The Trend/Bias Tab allows for the calculation of Trend and Residual grids to highlight hidden anomalies and to introduce a directional bias (i.e. North to South features are
connected) to grids.

The Create Contour Grid Trend/Bias Tab

Trend Residual Surface

Surfaces with a strong trend can often obscure smaller regional anomalies. As an example, a strong regional dip can easily hide subtle bumps that make great traps. Trend-Residual mapping is a way to subtract the effect of the generalized “Trend” from the original surface to reveal the “Residual.” This Residual map shows anomalies that are above and below the trend.

The Trend surface is a simplified version of the original surface. In essence, Petra fits a polynomial function to the data. The "Order of Fit" option determines the order of this function. As an example, a 1st order fit is a plane, a 2nd order polynomial shows some curvature, and a 3rd order polynomial is a saddle. Generally, higher order trend surfaces fit the original surface better, which tends to minimize the residual surface. To model a monoclinal dip, select a 1st order of fit.
No Trend Residual - This is the default option, and is used for normal gridding. It produces a normal grid of the original data instead of a trend or residual derived from the original data.

Create Trend Surface - Select this option to create only a trend surface to the data. As mentioned earlier, the "Order of Fit" option determines the function fit to the data. While it’s a good idea to create a trend surface for quality control, it’s not necessary to create a separate trend surface in order to see a residual.

Create Trend Residual Surface – Select this option to calculate a residual from a trend. This option automatically creates a trend surface, subtracts the trend surface from the original grid, and displays the residual without this step.

Directional Bias

It’s sometimes useful to add a directional bias on computer-created grids. With this option selected, Petra will attempt to connect data points along this direction. This can aid in modeling sand distribution in specific depositional environments like channels or barrier islands, for example.

Active – This option turns on the directional bias.

Direction – This sets the bias’ direction.

Strength – This option sets the strength of the bias. A stronger bias will attempt to connect more distant data points together.

5.14.1.4 Create Contour Grid - Limits Tab

Click Here for a "How-To" guide on creating Contour Grids

The Limits Tab sets the extents and edges of a calculated grid.
Grid Extrapolation

By default, the gridded surface extends only over the area of the map containing wells. Alternatively, you may have the grid values computed over the entire range of the grid limits. Extrapolating beyond the data control points can sometimes result in unreliable or runaway grid values. Also, see "Extrapolation Distance" in the Advanced section to control the amount of extrapolation produced.

Do not Grid beyond Data – This option limits gridding only to the data points in the Map Module.

Extrapolate values to Edge of Grid – This option extrapolates the slope of the grid beyond the selected data points.

Grid Limits

The grid limits govern the extents of a grid. For aesthetics or to save gridding time, it’s often useful to limit gridding to only the relevant area.

Use Grid Limits of Well Data – This option extends gridding out to all selected wells in the Map Module with data.

Use Grid Limits Specified Below – This option limits data to the X and Y limits defined in the “User Defined Grid Limits” box below.

User Defined Grid Limits – This field has 4 boxes outlining the maximum and minimum X (East-West) and Y (North-South) values. You can enter your own grid area XY limits. Selecting the “Screen Limits” button automatically populates these boxes with the current view on the map, while the “Well Limits” button populates
these boxes with the extents of all selected wells.

Blanking Method

The blanking method determines how Petra handles the edges of rectangular grids when the “Do Not Grid Beyond Data” option is selected on the Limits Tab. Since triangular grids only interpolate directly between data points, blanking methods have no effect on these types of grids.

**Neighbor Search** – This method draws color fills and contours out to the edges of the grid, which most often will be the extrapolation distance. This can result in a jagged grid edge around corner wells on rectangular grids.

**Convex Hull** - This method trims grids beyond a polygon defined by the outer-most data points. This results in smoother edges.

5.14.1.5 Create Contour Grid - Advanced Tab

**Click Here for a "How-To" guide on creating Contour Grids**

The Advanced Tab changes settings on how Petra creates grids. While a couple of these settings actually modify how Petra uses missing or poor quality data (Substitute Zero for Missing SS Datums, and Skip Well if Quality Code Includes), most of the settings govern the specific settings of the gridding algorithms.

**It’s generally quicker to focus time and effort on drawing a few contour lines to add interpretation rather than using these settings.** Remember, it’s not necessary to draw a complete set of contour lines in order to greatly enhance the gridding process. Even just a few key contour lines can have an enormous (and quick) effect on the computer-generated grid.

The “Defaults” button on the lower right corner of this tab reverts all settings back to the default settings. The default settings are a good all-around choice for most gridding.
Misc Options

"Substitute Zero For Missing SS Datums" – Plotting maps in subsea (or “SS”) attempts to eliminate the effect of surface topography on subsurface structures. Instead of plotting subsurface features according to their measured depth (MD), SS depths are referenced to sea level at 0’ elevation; depths below sea level are in negative numbers and depths above sea level are positive. The equation to calculate a fm top’s SS is straightforward: Elevation – MD = SS. Elevation is usually provided as ground level (GR), kelly bushing (KB), or derrick floor (DF).

In the example below, the reservoir in the subsurface is perfectly flat. There’s a significant change in elevation across the area (blue arrows), however, which has a large effect on the overall measured depth (black arrows) to the reservoir. The best way to illustrate the true nature of the reservoir’s structure is with SS depths (red arrows), which are exactly the same for all wells. The third well, however, is missing an elevation datum, so accurately calculating its SS depth is impossible. Normally, when the reference datum is missing, Petra simply leaves the SS depth null. These null values have no effect on gridding SS surfaces.

Selecting the “Substitute Zero For Missing SS Datums” option, however, will substitute in a zero for the missing elevation. For areas of uniformly low elevation this is a reasonable assumption. For areas with changing elevation, however, this can grossly distort the map. In the example below on the right, a zero elevation substitution ignores the effect of elevation, which causes a large (and entirely fake) syncline underneath the well missing a elevation datum.
Use Simplified Fault Traces – This option simplifies the number of points on drawn fault lines in order to accelerate gridding. Fault lines on the overlay – particularly those drawn using the “stream” mode - can contain a large number of redundant points. Since faulted grids require triangulation of each fault line node, simplifying the fault can greatly accelerate gridding time and reduce overall grid file size. This option does not change the fault line as drawn on the overlay.

Optimize Data Search For Speed – This option presorts data points by location in order to accelerate gridding. This clustered data, however, tends to generate radial grid artifacts. Most modern computers are fast enough to not need this option.

Enable Grid Substitution - Use this option to use values from another grid file to fill in sparse control point areas. This unlocks the Grid Subst Tab. Here, select an existing grid in the default grid directory. Petra will substitute values from this grid wherever there are missing values on the new grid.

Do Not Resample Contour Lines – In order to use a drawn contour line, Petra needs to resample the line into a set of discrete points. By default, Petra calculates an optimum sample based on the specific grid’s spacing. This option instead forces Petra to use all available data points from the contour line, which can greatly oversample the data and generate erroneous ties to the contour line.
Skip Well if Quality Code Contains – This option skips data points from wells that have specified quality codes. Here, enter one or more values separated by a semicolon to indicate wells that are NOT to be used for gridding.

Disconnected Features Weight Option – The Disconnected Features surface style depends on “weighted averages”, in which nearby data points contribute more to an individual grid point’s average than distant data points. This option changes how the Disconnected Features surface style averages different data points.

The weighting of different data points is determined by a ratio between the distance of a data point to the grid node and a “total distance.” This option simply sets how Petra defines this “total distance.” Distance to Farthest Neighbor uses the distance to the furthest well used in the octant search, while the Search Radius option instead uses the entire search radius (which by default is half the diagonal of the gridded area). Effectively, the nearest neighbor distance creates a localized weighting relationship for every grid node, while the search radius setting uses the same weighting relationship for every grid node.

Apply Log10 Transform – Highly variable data such as production information can generate anomalously broad contours during normal gridding. This option applies a transform to the data to “tighten” contour lines around highly variable data. The output grid will have the original Z value units.

Mathematically, the Log10 transform has three steps. First, the filter applies a Log10 transform to all data points. In the example below, the six wells with values of 10 surround one well with a value of 1000 shown on figure A. Taking the LOG10 of these data points changes them to six wells with a value of 1 surrounding a single well with a value of 3 (Log10(10) = 1, Log10(100) = 3). Gridding these transformed values generates a simple grid with values between 1 and 3 as shown on figure B. Finally, Petra converts the data points and the new grid back to their original data points with the inverse of Log10, 10^X. Effectively, this changes the original linear slope between the central, large data point and the outlying smaller data points from a linear relationship to a power relationship.
Practically, the transformed grid reduces the regional effect of the large value in the center. Generally, adding the LOG10 transformation will generate a more conservative grid with highly variable data than a simple linear surface style alone.

**Fault Gap XY Tolerance** – Faulted grids sometimes have small white triangles on color-filled grids near fault node points. Changing this option changes how Petra constructs a faulted grid, which can eliminate these artifacts. The default value is 1.0 XY unit, and should be kept between 0.5 and 3.0. A value that is too large may cause other unwanted white space between grid cells.

On rectangular grids, Petra handles faults by creating a triangular grid inside the regular rectangular network of grid nodes. Where the overlay fault crosses a set of four grid nodes (as in the example below), Petra adds more data points a small distance away from the drawn overlay fault line on the normal rectangular grid spacing. Petra then constructs a triangular grid using these new points to break the grid across the fault. This “Fault Spacing” option sets the maximum distance between the drawn fault and the newly created points.
Fault Gap Tolerance

Max Pts Per Octant – Petra interpolates the value of each grid node from surrounding data points. This option sets the maximum number of data points in each octant used for each grid node, and can be anywhere from 1 to 8. For example, with a value of 2 the gridding process will use a maximum of 16 data points (2 for each octant) distributed around the grid node.

When determining which data points will be used for each grid node, Petra first divides the area around the grid node into eight wedges, or “octants.” Petra then uses the closest data points (up to the maximum set by this option) in each octant for calculating an individual grid node’s value. Dividing the surrounding data into octants helps avoid grid nodes that are too heavily biased by data points in one direction.

Flex Grid Factor – This option changes the relative strength of the “Smooth Contours using Grid Flexing” option. Low Grid Flex Factor create final grids that look like the original surface style, while higher Grid Flex Factors will create a grid that looks more like a Minimum Curvature grid.

When the “Smooth Contours using Grid Flexing” option is selected (on the Method Tab), Petra first interpolates the data points with the selected surface style, then adds an additional step to interpolate both the original data points and the newly created grid values with the minimum curvature gridding algorithm.
Mathematically, this option controls the decimation of the initial grid, and can be set from 2 to 12. When this option is set to 2, every other original grid point will be used in the Minimum Curvature step. In this case, a large number of initial grid points remain which constrains much further interpolation from the second minimum curvature interpolation. When this option is set to 12, only every 12th original grid point will remain. The relative low number of initial grid points allows for more interpolation from the Minimum Curvature step. In short, the lower the Grid Flex Factor, the more the final grid will look like the original surface style. Higher Grid Flex Factors will create a grid that looks more like a Minimum Curvature grid.

Min Curvature Tension – This option sets the flexibility, or “tension”, of the Minimum Curvature surface style and the Grid Flexing option available on the Method Tab. This value can be set between 0 and 9. A grid with a low tension setting easily folds and bends to accommodate changes in the data, while grids with a higher tension folds less easily. Practically, high tension grids – particularly above 5 - have smoother and more even contours but may not honor the original data as well as lower tension grids.

Specific Surface Style Options
Distance Weighting Damping Factor – Both the Sample Weighing With Slopes and Sample Weighing Without Slopes surface styles depend on “weighted averages”, in which nearby data points contribute more to an individual grid point’s average than distant data points. This parameter determines the relative contribution of close data points versus more distant data points to the final data grid value. Petra can use any value from 1 to 8, with a recommended default setting of 2. With a small factor, more distant data points have more influence on an individual data point which tends to average the grid node; this usually results in a smoother grid. With a larger factor, close data points influence the individual grid much more than more distant data points. The recommended value for this factor is 2.

Mathematically, when either of the sample weighing surface styles calculates an individual grid node, Petra uses the adjacent data points and multiplies them by an inverse of the distance to the grid node \((1/D^n)\). Multiplying by the inverse of the distance minimizes the contribution of more distant datapoints (with a larger D) relative to more proximal ones (with a smaller D). The Distance Weighting Damping Factor, \(n\), is the power of the distance in the inverse, which magnifies or minimizes the inverse’s effect on distant data points.

The example below walks through a single grid node (the + in the center) calculated from three surrounding points. The map view on the left shows that two data points have values of 15 and are 10 units away from the grid node, while one data point has a value of 10 and is 3 units away from the grid node. The formula for the calculating the grid node is below the map view. Filling in the values on the left side of the figure, it is a little easier to see how the Distance Weighting Damping Factor, \(n\),
affects the formula. Larger values of \( n \) decrease the relative contribution of the more distant wells with a value of 15, which drops the averaged grid node value.

**Search Radius** – To calculate a single grid node, Petra interpolates values from surrounding data points. Most rectangular gridding uses an “octant” search, where Petra uses only the nearest data points (set by the “Max Pts Per Octant” setting) from each of the eight pie-shaped wedges, or “octants.” This option sets the radius of this search in XY units. The default, set with a zero value, is a fairly large search radius of half the diagonal of the gridded area.

Dividing the surrounding data into octants helps avoid grid nodes that are too heavily biased by data points in one direction. If the specified search limit is too small, the grid may contain null values in areas of sparse data control.

**Extrapolation Distance** - This option sets the distance (in XY units) to extrapolate the grid beyond the data points. The default value of 0.0 extrapolates the grid two grid cells beyond the actual data points or up to the data limits set by the "Grid Extrapolation" option selected in the Limits section.

The extrapolation distance will only extend the grid in multiples of the grid spacing. The "convex hull" blanking method (on the Limits Tab) also automatically nulls any grids beyond a polygon defined by the outer-most data points, which can negate any
changes made to the extrapolation distance.

Skip Data Pts Closer than (XY Map Units) – Close data points can cause unwanted gridding artifacts. When Petra finds two data points that are within this setting’s value of XY units together, it only uses the first one it finds. As an example, setting this value to 100 will skip any other data points within 100 XY map units. For well data, Petra will use the well with the lower WSN.

Use Natural Neighbors – This option causes most surface styles to use a “natural neighbors” triangulation search instead of the normal octant search when selecting data points to interpolate for each grid node. This tends to provide a more localized interpolation, which can benefit grids with dense data point coverage. Since this adds an additional pre-gridding triangulation stop, this option can increase gridding time.

When deciding which data points to use for each grid node, most rectangular grids styles (Highly Connected Features, Disconnected features, Simple Weighting With/Without Slopes) use an octant search where the area around a grid node is divided into eight wedges, or “octants.” This octant search ensures that data points used for the grid point interpolation are evenly geographically distributed. A natural neighbors search, in contrast, selects surrounding data points that can be connected by a triangular network. This option just changes how Petra selects the data points for interpolation, so the output will be a normal rectangular grid.

Equal Distance Alg. - This option adds additional triangulated data points in between widely spaced data points before normal gridding. This helps to fill in areas of sparse data coverage to better preserve regional trends on the grid.

Mathematically, this step performs a simple triangulation between distant data points and adds them to the grid before performing the normal gridding with the selected surface style. These triangulated data points can have a refinement of 1, 2, or 3, as set by the adjacent drop down menu (for more information on refinement, see the
“Triangle Refinement” in the Triangulation Help document). These additional data points are used along with the original data points during the normal gridding. It’s worth noting that with a normal rectangular surface style the final output grid will be rectangular – the triangled data points created by the Equal Distance Algorithm are not saved in the final output grid.

Practically, this option is useful for keeping a small grid size when the grid has areas of sparse data coverage and areas of tight data coverage. This option works best with the "Highly Connected Features" gridding surface style method.

5.14.1.6 Create Contour Grid - Triangulation Tab

Click Here for a "How-To" guide on creating Contour Grids

The Triangulation Tab sets changes the gridding from rectangular to triangular gridding. Triangular grids always “honor the data” at the cost of sometimes unrealistic changes in slope or dip. Refinement adds more interpolation inside these triangles, which smooths these grids. Interior angle clipping reduces grid artifacts caused by widely separated wells on the edge of the map.

Instead of interpolating values for nodes at regularly spaced X and Y intervals, triangulation instead constructs a network of nearest neighbors using the data points. Essentially, Petra calculates node values along lines (shown with lines) between data points. These nodes form triangles known as “Delaunay triangles.” Notice also that there is a node value directly on top of each well. The resulting contours “honor the data” better because they are drawn using the actual values as opposed to interpolated data in rectangular gridding. Triangular grids are better suited to closely spaced, or highly-variable data rather than widely separated data.
Check the Triangulate box to perform triangulation instead of rectangular gridding.

Triangle Refinement — In a simple triangular grid, each Delaunay triangle is independent from every other triangle so calculated gradients on one triangle can differ significantly from an adjacent triangle. This can lead to rapidly changing, geologically unrealistic dips and angular contour lines. Contours from these simple triangular grids can look strange and can even cross.

Petra smoothes these triangular contours with a process called “triangle refinement.” Refinement adds more points inside a Delaunay triangle to smooth the grid’s surface.
and contour lines. These points inside the triangle are interpolated using Petra's surface style (such as “Highly Connected Features”). selected on the Method Tab and surrounding data points. The refinement value selected here determines the number of additional points, which in turn governs the smoothness of the contours. A refinement of 1 simply uses the existing data points with no interpolation, while a refinement of 16 adds a great deal of interpolated points inside each triangle. Practically, a highly refined grid will have smoother contour lines than a grid with lower or no refinement.

Interior Angle – Triangular grids attempt to connect all data points together regardless of how far apart they are. The part of the grid based on an interpolation between distant data points often shows geologically unrealistic contours – especially on the edge of the map. On the right side of the example below, two highlighted triangles have high interior angles of 172 and 160 degrees. The area of the grid represented by these two triangles probably interpolates the data too far and should be removed.

The triangular grid between these distant wells has one corner with a large angle. Filtering out triangles with this high interior angle helps to trim out overly-interpolated or geologically unrealistic parts of the grid on the edge of the map. Setting the value here to 150, as in the example below, will eliminate all triangles with an internal angle above 150 degrees. The smaller the angle, more edge triangles are removed. Suggested values are 120 to 160 degrees.
Fast Local Slope Interpolation Method – Normal refinement uses the selected surface style to interpolate data points inside each Delaunay triangle based on the surrounding “neighborhood” of data points. The “Fast Local Slope” method instead uses partial derivatives to interpolate inside each triangle. In other words, while the normal refinement method attempts to make a more coherent regional picture based on outside data, this method simply uses only the data points in the Delaunay triangle. Consequently, this method is quick, but is prone to geologically unreasonable dip changes and other artifacts.

5.14.1.7 Create Contour Grid - Misc Tab

Click Here for a "How-To" guide on creating Contour Grids

The Misc Tab controls a few miscellaneous gridding options including the user-specific grid file directory, seismic shot point decimation, the preview window, grid scaling and grid templates.
Default Grid File Directory
By default, Petra stores all grids into a single GRIDS folder inside the project’s directory. Particularly in large projects with multiple interpreters, it’s sometimes useful to designate multiple grid folders. Changing this setting just affects the individual user, and not the default grid file of the project as a whole.

Seismic SP Decimation
A single seismic survey can contain far too many points to usefully grid. It’s often useful to thin seismic data coverage down to accelerate gridding. This option only disregards data during gridding, and does not erase any seismic data.

Use every Nth Pt – This option decimates data points just by occurrence, where Petra will use every Nth point and disregard the rest. Setting the N value to 5 will start with the first available SP point, such as SP 7, 12, 17, 22, etc.

Use SP Multiples of N – This option decimates data points with a little more control over which specific SP points are selected. Setting the N value to 5 ensures that Petra will use SP 0, 5, 10, 15, etc.

Show Preview Window While Gridding
This option simply adds a preview window to the normal gridding screen. During gridding, this preview shows a small thumbnail of the grid as its created. This is particularly useful for early QC of large, time-consuming gridding processes.
Scale Output Grid By
This option provides a way to quickly rescale grids. This is particularly useful for rescaling grids based in feet to meters and vice versa. In a project where depths are stored as feet, selecting the “Convert Feet To Meters” option before gridding will multiply all values in the grid by 0.3048, for example.

Gridding Templates
A template saves all the settings associated with creating a grid file in a *.gt file. Loading this template restores these settings. This can be particularly useful in an iterative environment where several grids are being updated and modified continuously.

5.14.1.8 Create Contour Grid - Tops Tab

Click Here for a "How-To" guide on creating Contour Grids

Horizontal wells commonly pop in and out of a specific interval of stratigraphy. Each occurrence of this bed boundary is a potentially useful data point. One of the best ways to capture this information is with multiple, related formation tops.

In the example below, the wellbore enters the target rock once at point A, exits the interval at point B, and enters again at point C. Every time the wellbore crosses this boundary, it creates a potentially useful data point with a latitude, longitude, and a TVD value.

Petra can only store one named top for each well, so it’s necessary to create a set of tops. It’s usually best to keep this simple by simply naming the tops successively. In the example below, points A, B, and C are named “Sycamore1”, “Sycamore2”, and “Sycamore3”. All three tops reflect the same stratigraphic surface, but at three different points on the same wellbore.
This tab aliases multiple formation tops on horizontal wells to a single formation top during gridding. In the example below, gridding the “SCMR” top will also use the “SYCAMORE1”, “SYCAMORE2”, and “SYCAMORE3” tops as additional data points.

It’s worth noting that TVD values of these tops from horizontal wells commonly don’t line up with existing subsea maps – and is usually wrong in multiples of 30’. Pipe tally errors can easily add or subtract footage from MD. A single wrong MD leads to incorrect calculations of TVD for every successive survey point.

5.14.1.9 Create Contour Grid - Interval Data Tab

Deviated and horizontal wells can generate data spread along the wellbore’s path. Interval data is a good way of displaying and incorporating multiple data points along
a wellpath into a grid. Petra can grid any numerical interval field designated as a “real value.” Date and text interval fields can’t be used in gridding.

In the Map Module select Contours>Create Grid… from the menu bar at the top of the screen. Here, select the relevant data, grid size, and surface style; Petra can integrate interval data into a grid using zone data, tops, overlay contour lines, or other XYZ data. On the Interval Data Tab, select the “Active” option to use the selected interval table and numerical interval field in gridding.

Note that there are a couple of ways to modify which intervals are used in gridding: intervals can be pared down by quality codes, zones, or interval filters. The “Skip Well if Quality Code Contains” option allows the user to skip wells that have specified quality codes. Here, enter one or more values separated by a semicolon to indicate intervals that are NOT to be used for gridding.

This “Intervals must Fall within Depths of Zone” option limits which intervals are used in gridding to only the intervals inside the specified zone definitions. The “WELL” zone covers all depths, and consequently all intervals. Be careful when using zones and horizontal wells. Note that this zone criteria works uses the zone interval definitions, which are often defined by tops. Horizontal wells that stay entirely within a zone and never reach the base will not have a base top picked, and will consequently be excluded from gridding.

The “Apply Interval data Filters” option provides more direct control over which intervals are used in gridding. Intervals that do not meet the filter criteria are not gridded. To create or modify a set of filters, select the “Set Filters…” button on the Filters tab. For more information on filters see the “Using Filters” section of this document.

The “Use Interval Top/Middle/Base Depth” is option sets where numerical “real value” interval fields are contoured. Especially with longer intervals in horizontal wells, this difference can significantly change where a data point is plotted. Note that this option is grayed out when gridding interval tops and bases.

In the example below, a single interval in the wellbore is outlined in with a box on the cross section on the left. While the top and base of the interval have a specific XY location on the map, other data (such as an average porosity value) can grid that value at the XY position at top of the interval, at the middle of the interval, and at the base of the interval.
By default, Petra uses the survey’s TVD when contouring the top and base of intervals. The Apply Subsea TVD Correction to Interval Field Value option instead corrects to SSTVD by subtracting the KB elevation. This option is essential when incorporating interval data into SS structure maps.

The “Export XYZ File Containing Int Data Used in Gridding” option creates a text file containing the X and Y coordinates (using the project’s map projection) along with the interval value used in gridding. Specifically, Petra creates a *.XYZ file in the project’s GRIDS folder. This file will be named after output grid file name with a “_INTDATA.XYZ” suffix.

5.14.2 Contour a Grid

For a more general guide, see "How to Make a Contour Map.”

A computer-generated grid by itself is just a set of numbers that reflect a X coordinate, a Y coordinate, and a Z value. A big part of interpretation is representing this data clearly and concisely with contour lines and color.
5.14.2.1 Contour a Grid - Grid Tab

The Grid Tab establishes the specific grid file to contour and display on the map, as well as the colorbar.

Grid Tab
Options Tab
Style Tab
Advanced Tab
File Tab
The Contour a Grid window's Grid Tab

Grid File

This section defines the grid file that will produce the contours.

Grid Directory - This window displays the currently selected grid directory. By default, Petra will look in the project’s GRIDS folder. To change this folder, select the "..." button to the right. This grid directory affects the grids displayed on the following dropdown menu; if a grid isn’t showing up, make sure to check that the folder containing the desired grid is selected.

Grid Dropdown - This dropdown lists all the available grids in the selected grid directory; if a grid isn’t showing up, make sure to check that the folder containing the desired grid is selected. These grids can be arranged by creation date, or by file name in alphabetical order. Note that the selected grid's title shows in the "Title" window at the bottom of the Grid File Section.

Delete - This option deletes the currently selected grid.

Rename - This option renames the currently selected grid.

Default Range - This option attempts to automatically set the contour range based on the minimum and maximum values in the grid.

Stats - This option displays a histogram and other statistical data about the z values in the grid.
Grid Info - This option displays information about the grid file, including creation date, grid size and location in XY units, and map projection details.

Contour Range

Min - This option sets the minimum contour value.
Max - This option sets the maximum contour value

Interval - This option sets the interval between different contours and colorfils. Plain lines can handle an unlimited number of contour intervals. For color filled contours, a "Normal" colorbar can use a maximum of 46 contour intervals and an "Enhanced" colorbars can use a maximum of 512 contour intervals.

Units - This option displays the units of the contour lines.

Colors

This button changes the colorbar for the grid contours. Petra has two ways of displaying color on computer-created grids: normal and enhanced.

Normal colorbars have greater flexibility in changing colors and irregularly spaced intervals, but tends to be a little more work to set up and has a more limited total
number of intervals.

Enhanced colorbars are generally simpler than the normal method and allows a greater number of color intervals (512), but can only handle regularly spaced intervals and is less flexible in interpolating between colors.

The two types of colorbars: normal (Left) and enhanced (Right)

Show Thumbnail - This option displays a small picture of the grid. This can be useful for checking the contour interval and colorbar settings.

5.14.2.1.1 Color Interval Definition (Normal)

The normal colorbar is Petra’s default way of selecting the colors for a grid. This system gives greater flexibility in changing colors and irregularly spaced intervals, but tends to be a little more work to set up and has a more limited total number of intervals.

The Color Interval Definition Window
Edit Value

Each selection of the interval list box displays the interval "z" value in the Edit Value entry field. Use the Apply button to modify the z value. Intervals need not be a constant increment, however, z values must increase from top to bottom.

Set Interval

Min - This option sets the maximum contour. Grid values below this minimum won't appear on the contours.

Max - This option sets the maximum contour. Grid values above this maximum won't appear on the contours.

Interval - This option sets the desired contour interval.

Apply - This button creates intervals from the minimum to maximum.

Number of Intervals

This option displays and modifies the total number of intervals on the interval list. The normal colorbar can handle a total of 46 different intervals, starting with the minimum and counting up towards the maximum. Decreasing intervals will drop the highest intervals first. Similarly, adding additional intervals will add intervals above the maximum.

Color Scheme

Load... - This button loads a previously saved set of intervals and colors.

Save... - This button saves the current set of intervals and colorbar to a *.ZPL file.

Default Colors - This button resets the color palette and intervals to the grid defaults.

Palette

Changing An Interval Color - To change the color for a particular interval, select the interval by clicking the left mouse button on the list box in the center of the screen. The interval color will be highlighted in the color palette. Click the left mouse button on any color palette color cell to change the interval's color.

Set Colors... - This button changes the the selected palette's color. Alternatively, doubleclick the palette color

The system color selection dialog is activated for changing the cell's color. The system color dialog can also be used to define several additional customized colors. Use

Interp - This button will interpolate the entire palette starting with the upper left corner and ending with the lower right corner. If you want to interpolate between two specific
cells, click the starting cell then hold down the CONTROL KEY and click the ending cell. All intermediate cells will be interpolated.

Load... - This button loads a previously saved customized color palette.

Save... - This button saves the current color palette to a *.ZPL file.

- The "Fill with Pallette" button fills the color scheme with the current palette from top to bottom starting with the upper left corner palette cell. If the number of color intervals is less than the number of palette colors, then only the beginning palette colors will be used. See the "Stretch Fill" option to fill the color scheme with all palette colors.

- The "Flip Colors" button inverts the colors in the internal list box from top to bottom.

- The "Stretch Fill With Palette" button will fill the color scheme starting with the upper left-most palette color. The entire palette will be "stretched" over the color interval range.

Default - This option selects one of Petra "default" colorbars. By default, these ZPL files are stored in C:\geoplus1\Parms.

Auto Incr - This option advances the interval list box item following color selection for a particular interval. Use this feature to quickly set the colors for all items in the interval list box. Simply select the first numeric interval and begin selecting colors from the palette. Each click of the palette sets the color for the current interval and advances to the next interval. Continue until all interval colors are selected.

Changing Colors on a Normal Colorbar Walkthrough

Changing the palette on the right side of the screen directly changes the colors used on the colorbar. To change a color on the palette, double click inside any color box to bring up a color tool. This screen has a set of basic colors, though you can use any color by selecting the color box on the right, or enter values using Hue/Saturation/Lightness or Red/Blue/Green.
Changing a palette color (Left), selecting red on the color screen (Right)

The palette color changed to red

Filling an entire palette by selecting individual colors is slow and creates blocky color transitions. Interpolating between colors in different palette cells is easier and leads to smoother transitions. Interpolation proceeds from upper left to lower right. To interpolate between two specific cells, click the starting cell then hold down the CTRL key and click the ending cell. All intermediate cells will be interpolated. In the example below, the interpolation is from the white cell in the upper left corner to the red cell created in the example above. Repeat the process with different cells to create a smooth transition between several different colors.

Interpolating between colors with the CTRL key. Before (Left) and after (Right)

For a single color colorbar, set the upper left and lower right colors to the starting and
ending colors. Next, select the “Interp..” button to interpolate the entire palette starting with the upper left corner and ending with the lower right corner. In the example below, the upper left color is white, and the lower right color is pink. Using the “Interp…” button interpolates between white and pink, as shown in the example below.

![Using the "Interp..." button. Before (Left) and after (Right)](image)

5.14.2.1.2 Color Interval Definition (Enhanced)

The enhanced colorbar is a slightly different way of selecting the colors for a grid. This system is generally simpler than the normal method and allows a greater number of color intervals (512), but can only handle regularly spaced intervals and is less flexible in interpolating between colors.

After opening the enhanced Color Scale window, the first thing to do is set the interval with the minimum Z value, maximum Z value, and the interval. Select “Apply Z” to set the scale.

To change the colors on the enhanced colorbar, select a color from the palette and then select a specific interval. This “paints” the interval in the selected color.
Z-Min - This option sets the minimum value for the colorbar.

Z-Max - This option sets the maximum value for the colorbar.

Z-Int - This option sets the colorbar interval value for the colorbar.

Apply Z - This option applies any changes made to the Z-Min, Z-Max, or Z-Int entries to the colorbar.

Z Stats - This option opens an additional "Data Statistics" window that displays a histogram of the selected grid's values, along with the min, max, mean, standard deviation, mode, and sum of all grid values. Note that the histogram can either be a normal "bin" histogram, or a cumulative histogram.

This tool can also be used to automatically calculate the minimum and maximum for the colorbar.

Custom - This option changes the currently selected color interval. Selecting this option opens the Color window. Here, select a new color for the desired interval.
The Color window changes the selected color interval to a custom color.

Clear All - This option sets the entire color bar to black.

Interpolate - This option interpolates color between the first and last color on the colorbar.

Reverse - This option reverses the colors on the colorbar.

Shift Left - This option shifts the colors on the colorbar towards the color on the far left interval. As an example, shifting towards a red color will every interval on the colorbar redder.

Shift Right - This option shifts the colors on the colorbar towards the color on the far right interval. As an example, shifting towards a red color will every interval on the colorbar redder.

Rotate Left - This option scrolls the colors on the colorbar by one interval to the left. The far left color will wrap around to the far right.

Rotate Right - This option scrolls the colors on the color bar by one interval to the right. The far right color will wrap around to the far left.

Original - This option resets the colorbar.

Undo Last - This option undoes the last change made to the colorbar.

Save - This option saves the enhanced colorbar to an external *.COL file.
Load - This option loads an enhanced colorbar from an external *.COL file.
Apply Preset - This option uses one of several preset enhanced colorbars.
- These buttons lighten and darken the entire colorbar.

5.14.2.2 Contour a Grid - Options Tab

The Options Tab sets how Petra displays grid contour lines and color fills.

The Contour a Grid window's Grid Tab

Color Filled Contours - This option uses the colorbar set on the Grid Tab color-fill the gridded surface.

Draw Color Scale Bar - This option draws a small color scale showing the color associated with each contour interval. The adjacent dropdown selects the location of the scale bar, which can be either on the upper left or upper right side of the map.

Draw Contour Lines - This option draws contour lines on the grid. These lines will start at the "Min" contour range on the Grid Tab and proceed up to the "Max" contour range using the contour "Interval" value.

Label Contours - This option control whether any contours are labeled. Refer to the style tab for labeling options.
Draw Lines In Default Color - By default, Petra draws contours using the colors from the colorbar. This option instead draws all contour lines using the default color (which is usually black). To change the default color, select Display>Colors on the menu bar at the top of the Map Module.

Smooth Contour Lines - This option smooths contour lines. For jagged or triangular grids, this may force grids to not "honor the data."

Draw Lines Using Color Intervals - Normally, contour lines are drawn at regular intervals, using the minimum, maximum and interval. Contour interval is independent of the color range and intervals specified. This option draws contour lines only at the intervals specified by the color range option. This option can be used to draw contour lines at irregular contour intervals. When checked, the normal contour min, max, and interval are ignored and the color bar intervals are used instead.

Use Transparent Background Color Fill - This option suppresses area filling of contours which match the map's background color, which is normally white. Use this option in conjunction with the overlay Draw Filled Items First option to plot color filled contours on top of filled lease outlines but not cover up the leases when the grid color is the same as the background (white).

For Isopachs, Use WHITE For Values Less Than Zero - This option automatically changes the color for values less than zero to be white so that isopachs are not color-contoured below zero.

Automatically Save/Load Contouring Template With Grid - This option automatically saves and restores the contouring parameters with the grid file. Whenever the OK button is clicked, a file is saved to the grids folder using the grid file name and an extension of .GDT. Whenever a grid is selected from the grid file list, the template is loaded to restore the settings last used to contour the grid.

5.14.2.3 Contour a Grid - Style Tab

The Style Tab changes how Petra draws and labels grid contour lines.

Petra can draw lines either as a "normal" or "bold." Bold lines can be useful for decreasing visual clutter or for showing a larger interval - bolding every 4th line on 25' contour interval quickly shows a gradation of 100', for example.
The Contour a Grid window’s Style Tab

Normal Line Width - This option sets the line width for drawing normal contour lines.

Normal Line Style - This option sets the style for drawing normal contour lines.

Number of Decimals in Label - This option changes the number of decimals displayed on the label.

Bold Line Width - This option sets the line width for drawing bold contour lines.

Bold Line Style - This option sets the style for drawing bold contour lines.

Bold Every Nth Contour Where N= - This sets the interval for drawing bold contour lines.

Label Every Nth Contour Where N= - This sets the interval for labeling contour lines.

Label Size (XY Map Units) - This option sets the height of the contour labels in XY map units, i.e., feet or meters on the earth's surface. Set the size to zero for the default of 0.1 inches.

Label Distance (XY Map Units) - This option sets the distance between contour labels in map XY units, i.e., feet or meters. Set the distance to zero for default value.

5.14.2.4 Contour a Grid - Advanced Tab

This screen offers options for more advanced contouring. These options are important if you need to edit contours and regrid using the map overlay contours.
Capture Contour For Import to Map Overlay

This option provides a mechanism to save the contour lines as they are drawn. Once these are in the overlay, the contours can be modified and used as input to create another grid file.

Do Not Capture Contours - This option draws contour lines and colorfills normally, and does not save anything to the overlay file. This option is on by default.

Capture Contours Directly Into Layer - This option saves the gridded contour lines to the overlay layer selected in the "Layer to Capture Into" dropdown box. Captured lines will be saved as a "Contour Line" line class, which preserves the contour line's value.

Capture Contour Fill to Overlay Layer - This option saves a set of closed polygons with the appropriate color fill to the overlay layer selected in the "Layer to Capture Into" dropdown box.

Capture Contours Into Overlay *.SEG File - This option saves the contours to the selected *SEG file. Use the "Browse" button to select the desired file.

Grid Gradient Arrows

This section plots arrows at grid nodes indicating the direction and magnitude of the slope.

Draw Gradient Arrows - This option draws arrows at grid nodes.
Draw Every Nth Grid Cell - This option sets whether and how Petra skips grid nodes for arrows. As an example, N = 1 plots arrows at every grid cell, while N=3 plots arrows at every third node.

Grid Arrow Scale Factor - This option sets the length of the gradient arrows. A scale factor less than 1.0 shortens arrows, while a scale factor greater than 1.0 lengthens arrows.

Reverse Dip Direction - This option draws the arrows to point updip rather than downdip.

Grid Node Values

Post Grid Nodes - This section causes the grid node values to be posted at each grid node location. Set the "Label Size" to the appropriate xy map units or leave the default of 0.0 for labels of 0.1 inch. When you label grid nodes, you can edit them by double-clicking on a node value while holding down the CTRL and ALT keys. Changes here are made directly to the grid file and there is no undo or backup.

Miscellaneous

Quick Grid Cell Fill - This option will color fill each grid cell with a single color. Color contour bands are not drawn.

Draw Grid Cell Outlines - This option causes grid lines to be drawn along each grid row and column. This can be useful for demonstrating the resolution of the grid relative to the actual data points.

5.14.2.5 Contour a Grid - File Tab

The File Tab saves grid contour templates.
5.14.3 Adding Interpretation to Grids

A great way to have both the benefits of a human interpretation with the speed and flexibility of using a computer is to adopt a hybrid approach of shaping computer grids with interpreter-drawn contour lines and points.

There are several ways to modify and alter a computer-generated grid into a more geologically-sound interpretation: hand drawn overlay lines, adding control points, and individually tweaking grid points. Overlay lines come in several different “classes” – normal, contour, unconformity, and fault. While normal lines are just for displaying visual information (like section outlines or roads), contour, unconformity, and fault lines can also be used to influence the gridding process. Contour lines can be edited via the map overlay feature. Contour lines can be "captured" into one of the overlay layers and manipulated as any other overlay line.

Related Topics

Adding Hand Drawn Overlay Lines and Faults
Capturing Contour Lines to the Overlay
5.14.3.1 Adding Overlay Contour Lines

Use Overlay Contour Lines and Include Faults options on the Create Contour Grid tool's Data Tab.

**Contour Lines**

Hand-drawn contour lines are a great way to add geologic interpretation to a computer-generated grid. Since each line is assigned a value, Petra’s gridding tries to honor those values when creating a grid. Since Petra uses all the displayed contours when it grids, it’s a good idea to store each related set of contours in its own overlay layer.

**Zero Contour Lines**

Though the “Adjust Zero Contour for Isopach Surface” option helps to reduce grid artifacts around the zero line, hand drawn contours are probably the best way to create a smooth, realistic surface. To continue to use the computer generated zero contour line, it’s also possible to use a very small contour value (around 0.1).
Faults

In the Map Module, faults are treated as a special class of overlay line. Just like any other overlay line, faults lines have width, color, and an assigned layer. Unlike other overlay lines, however, faults have a special tab labeled “Faults.” This tab controls how fault symbols are drawn, as well as how Petra handles the fault during the creating a computer-generated grid. Since faults are irregular surfaces, Petra uses triangulation when creating a faulted grid.

High-angle, near-vertical faults are drawn as a line, while low-angle faults with aerially missing section can be drawn as two separate faults that form a polygon. Since computer-gridding can create contours inside these fault polygons (where the surface should be missing), it’s a good idea to blank these polygons out with an opaque polygon.

Fault Strength

On a hand-drawn contour map, a fault breaks contour lines. Put another way, a fault breaks a map into two different parts. Data on one side of the fault is only relevant to
that fault block, and has less (if any) relevance to the map on the other side of the fault.

Similarly, a drawn fault tells Petra to interpolate the gridded data up to the fault and ignore data across the fault. The “opacity” of the fault determines the strength of this break. A low opacity fault will still be largely connected, while a completely opaque fault will ignore data across the fault entirely. Practically, this means that the opacity of the fault influences both the fault’s throw and the amount of fault drag. High opacity faults have greater throw and more independent fault blocks, while transparent faults have lower throw and greater amount of fault drag. Completely opaque faults cause grid nodes to be nulled along the fault, which can create a saw-tooth effect of color-filled grid along the fault.

![Fault strength's effect on throw and fault drag](image)

5.14.3.2 Capturing contour lines to the overlay

This method captures contour lines from a grid to an overlay layer. Once these lines are overlay contour lines, they are editable just like any other line. This technique can be useful for letting Petra build a quick first pass at contour lines, and then using an interpreter’s skill to modify them into a more reasonable geological interpretation. **Depending on the complexity of your contours, this can be very labor- and time-intensive. For most contour maps, it’s almost certainly faster and better to hand-draw overlay contour lines from scratch.**

Under the Advanced Tab, select “Capture Contours Directly Into Layer”, and then select the Overlay layer you want to contain these contours. The “R” button allows you to rename the layer. In the example below, the overlay layer has been renamed.
Capturing contours to the overlay

Use the "Contours>Display Contours" menu and go to the "Advanced" tab. Choose the option to capture the contours directly into an overlay layer and select the appropriate layer. As the contours are drawn they will be stored into the overlay. Next, turn off the contours from the Contours menu. You should see the contours that are in the overlay. These contours can be edited as any other overlay item.

Selecting the contour to be edited

Select the contour line to be edited using the ARROW icon located at the top of the overlay tool bar. The overlay tool bar is located along the right side of the mapping module window. It is displayed using the "Overlay>Show Tool Bar" map menu. After clicking the ARROW icon, click the left mouse button once on a contour. Selection is indicated by small squares drawn at each "control point". Double clicking the contour line will show the attribute screen as will clicking the overlay "attributes" icon containing a small letter "i".

Changing the contour line attributes

After selecting a contour line, double click any point on the line or click the "attributes" icon located in the upper right corner of the overlay tool bar.

Adjusting individual contour line control points

The location of each contour line control point can be repositioned by clicking and dragging the control point using the left mouse button. Position any of the control points, then click the right mouse button to redraw the screen show the modified contour line.

Adjusting sections of a contour line

Entire sections of a selected contour line can be adjusted, stretched or skewed using a rubber band splining technique in combination with the CTRL KEY. The process involves holding down the CTRL KEY and picking two anchor points with the left mouse button. The anchor points are identified by small Xs and define the section to
be adjusted. The points between the two anchors can be dragged into position using the left mouse while holding down the CTRL KEY. Releasing the CTRL KEY can still move individual points. The section adjustment is maximum at the point be dragged and minimum at the two anchor points. New anchor points can be selected for the currently selected line by holding down the ALT KEY and clicking with the left button. Again, hold down the CTRL KEY to modify or drag the section between the anchor points. When done, either select another contour line or click the right mouse button to redraw the screen.

Linking short segments of contours together

Occasionally, contour lines are generated that are short in length and do not connect with other contours. A selected contour line can be connected to another contour of the same Z value if one of its end control points is close enough to another line. You can force two contour segments to be close by dragging one of the end points very near the end of the other line. With one segment selected, click the "connect" icon located on the overlay tool bar which looks like a black line with a red section in the middle. After joining, the control points of both segments will be highlighted.

Breaking a contour into two separate segments

A single contour line can be broken into two separate segments. When selecting the line, click on the exact spot at which the line should be broken. Then click the "break line" icon on the overlay tool bar. One of the segments will remain highlighted and the other will be off.

Deleting a contour line

Select a contour line and click the "delete" icon (trash can) located on the overlay tool bar.

5.14.4 Grid Operations

In addition to simple display, grids are also useful in a variety of calculations.

Isopach and TST
Grid to Grid
Grid Equation Transform
Grid Calc Transform
Curvature Grid Calculations
Compute Statistics Around Wells
Sample Grid to Wells
Sample Grid to Seismic
Sample Grid to Control Points
Resample Grids to Match
Shaded Relief Grid
Convert Triangular to Rectangular Grid

5.14.4.1 Isopach and TST Calculations

The Wells drilled through steeply dipping beds can generate anomalously thick results. This tool attempts to calculate the true stratigraphic thickness of a lithologic package bounded by two calculated grids.

To open the Isopach from Grids tool, select Contours>Grids>Isopach and TST from the menu bar at the top of the Map Module.

Data Tab

Upper Surface Grid - This dropdown sets the upper surface grid. Generally, this will be a grid of the top of the formation.

Lower Surface Grid - This dropdown sets the upper surface grid. Generally, this will be a grid of the top of the formation.

Output Isopach Grid - This entry sets the name of the newly calculated isopach grid. Either enter a new name, or select an existing grid to overwrite.

Isopach Grid Title - This option sets the title of the computed isopach grid.
TST Tab

Apply TST Correction - This option applies the true stratigraphic thickness correction $TST = TVD \times (\cos \theta)$, where $\theta$ is the true formation dip.

Grids are Seismic Times - By default, Petra assumes that the upper and lower grids are formation tops in TVD. This option adds an additional step to multiply the values in the grid by a specified velocity.

Calculated Dip From - This dropdown sets how the TST calculation finds formation dip. Formation dip can be calculated from the top grid, the bottom grid, or an average of the two.

Dir Tab
5.14.4.2 Grid To Grid Calculations

The Grid-To-Grid Operations tool is a powerful general purpose tool to quickly perform over 30 different grid calculations. This tool is useful for simple mathematical operations, merging two different grids into a single grid, clipping specific grid values, or a variety of other calculations. The Grid-To-Grid tool also contains many of the equations used elsewhere, including trend-residual analysis and curvature analysis.

Note: All grids used in this process must have the same number of rows and columns, grid dimensions and extents.

To open the Grid-To-Grid Operations tool, select Contours>Grids>Grid-to-Grid Operations… from the menu bar at the top of the Map Module.

Note that the Grid Equation Transform is a slightly simpler tool that can be used for more basic single-grid operations.

Data Tab
Grid Folder

Output Grid File - This entry sets the name of the newly calculated isopach grid. Either enter a new name, or select an existing grid to overwrite.

Grid Title - This option sets the title of the output grid file.

Grid Operation - This dropdown selects the desired grid operations. Note that "A" and "B" refer to input grids. "C" refers to the output grid.

Basic Mathematical Operations

C = A + B
C = A – B
C = A * B
C = A / B
C = A + Constant
C = A * Constant

Merging Two Grids

C = Minimum of A or B
C = Maximum of A or B
C = Substitute B for A when A is NULL
C = Merge Deepest of A and B
C = Merge Shallowest of A and B
C = Union of A and B

Clipping Specific Grid Values
C = Maximum of A or Constant (clip above constant)
C = Minimum of A or Constant (clip above constant)
C = NULL if A is less than Constant
C = NULL if A is equal to Constant
C = NULL if A is greater than Constant
C = Constant if A is NULL

Extended Mathematical Operations
C = SQRT(A)
C = Log10(A)
C = NaturalLog(A)
C = AntiLog10(A)
C = AntiNaturalLog(A)

Curvature Analysis
C = Dip Azimuth of A in degrees
C = Dip Magnitude of A in degrees times Constant
C = Slope In X direction times Constant
C = Slope in Y direction times Constant

Smoothing
C = Smooth (A) Grid (Constant = number of filter points)

Time-Depth Conversion
Time-Depth conversion operations use an additional time-depth file, selected on the "Auxiliary File" entry on the bottom of the Data Tab. This file can be either columnar or comma-delimited. The Grid-To-Grid operations tab also adds a "Time-Depth Tab to handle further formatting of the time-depth pairs.
C = Convert Time Grid (A) to Depth (Uses Auxiliary File)
C = Convert Depth Grid (A) to Time (Uses Auxiliary File)

Isopachs
C = Truncated Isopach using Top (A), Base (B) and Fluid Contact (Constant)
C = Truncated Isopach using Top (A), Isopach (B) and Fluid Contact (Constant)
C = Sum of Isopach Grids A and B
Trend-Residual Analysis

C = Trend Surface of A (Constant = Trend Order)
C = Trend Residual Surface of A (Constant = Trend Order)
C = Truncated Isopach using Top (A), Base (B), and 2 Fluid Contacts (Constant 1 and 2)
C = Truncated Isopach using Top (A), Isopach (B), and 2 Fluid Contacts (Constant 1 and 2)

**Input Grids** - Assign the grid files to the "A" and "B" variables in the grid operation. Use the "Grid Info" buttons to view grid details.

**Constant** - If the operation calls for a constant value, enter the value here.

**List Grids By** - This option changes how grids are sorted on the import and export dropdown menus.

**Compare AB** - This option displays a comparison of grid information between the A and B grids.

**Auxiliary File** - This entry establishes an ASCII or CSV file used for time-depth conversions.

Time-Depth Tab

The Time-Depth Tab only appears when a Time-Depth Conversion operation is selected on the Data Tab
The Grid-To-Grid Calculation Time-Depth Tab

**Auxiliary File Contains** - This option sets the general type of time-depth pairs. Select whether the pairs are "Depth, Time" or "Time, Depth".

**Seismic Times Are**
- **Grid File** - This option sets whether the grid uses 1-way or 2-way travel time.
- **Aux File** - This option sets whether the auxiliary file uses 1-way or 2-way travel time.

**Seismic Time Units Are**
- **Grid File** - This option sets whether the grid uses seconds or milliseconds.
- **Aux File** - This option sets whether the auxiliary file uses seconds or milliseconds.

**Misc Tab**
The Misc Tab contains one option for setting the zero azimuth. This option is only used for some curvature analysis calculations, and references all calculated azimuths to the selected direction.
5.14.4.3 Grid Equation Transform

While the Grid-To-Grid Operations tool can handle most simple equations, the Grid Data Equation Transform is built to handle larger custom equations.

To open this tool, select Contours>Grids>Grid Equation Transform.

Equation Tab

The Equation Tab sets the actual equation using variables and mathematical operators.
The variable on the left side of the equal sign is the result grid, while variables to the right are the input grids and constants. Variables can either be very specific (such as “AVG_POROSITY” or “ISOPACH”) or general (such as “A” or “B”).

Equations entered here obey standard order of operations:Parentheses, Exponents/Roots, Multiplication, Division, Addition, and Subtraction.

**Basic Mathematical Operators:**

+ Addition  
- Subtraction  
* Multiplication  
/ Division  
** Exponent

**Mathematical and Trigonometric Functions:**

ABS(x) Absolute value of x  
ACOS(x) Arcosine of x (in radians)  
ASIN(x) Arcsine of x (in radians)  
ATAN(x) Arctangent of x (in radians)  
COS(x) Cosine of x in radians  
COSH(x) Hyperbolic cosine of x (radians)  
EXP(x) e to power of x  
INT(x) Truncated value of x  
LOG(x),LN(x) Natural Log of x  
LOG10(x) Log base 10 of x  
MAX(x,y) Maximum of x and y  
MIN(x,y) Minimum of x and y  
ROUND(x) Rounded value of x  
SIN(x) Sine of x in radians  
SQRT(x) Square root of x  
SQR(x) x squared  
SINH(x) Hyperbolic sine of x (radians)
TAN(x)  Tangent of x in radians  
TANH(x)  Hyperbolic tangent of x (radians)

Options Tab

The Options Tab has a couple of options that mostly pertain to calculations involving isopachs.

Substitute Zero For Nulls - This option causes null-valued grid values to be set to zero prior to executing the equation. A null value anywhere inside the equation generates a null result, which can create holes in a summed isopach.

Set Negatives to Zero - This option causes negative grid values to be set to zero prior to executing the equation. Summing negative values actually reduces the total footage, so it may be useful to substitute zero values for negative numbers.

Assign Z Data Equation Variables

After setting the variables, the next step is to assign grids and constants to the variables.
Output Grid

**Grid** - This entry sets the name of the newly calculated isopach grid. By default, Petra will create a grid using the variable name outlined in the equation, but users can enter a new name or select an existing grid to overwrite.

**Title** - This option sets the title of the new grid.

**Equation Variable Assignments**

This section sets which variables in the equation are which grids and constants. Select the equation variable on the Equation Variable Assignments list and select the correct grid or constant. Select the "Assign" button to finalize each variable.

5.14.4.4 Grid Calc Transform

The Grid Calc Transform function applies user-defined programs to perform grid-to-grid operations. The grid calc models are text files that contain the programming logic to perform complicated, multi-line equation and conditional operations on grids. The model is executed one time through for each grid node. One or more grids can
be produced as output from a grid calc model. The model list is pre loaded with all model files found in the GRIDS sub directory under the project directory. All models must end with a .TXT extension. Select a model file from the drop-down model list then click the "Compile Model" button.

To open the Grid Calc Transform tool, select Contours>Grids>Grid Calc Transform from the menu bar at the top of the Map Module.

Compiling The Model

Grid calc models are stored in text form and must be "compiled" into an executable form prior to execution. Compiling the model loads the input and output variables into the assignment list boxes.

Assigning Model Variables

Input Variables

Input variables may be grids, constant values, or NULL values. Each input variable should be assigned to the appropriate identifier.

To assign a model variable, click once on the variable name listed in the "Input Variable Assignments" list. Then choose a "Grid File", "Constant" value, or "Null" item. After making the choice, click on the Apply button to set the assignment. The new assignment will appear in the input variable list.

Note: All input grids must have matching data limits, rows and columns, and grid sizes.

Output Grids

The result of the model is one or more grid files. These grids can be selectively assigned to one of the existing grid files or can be assigned a new grid name. Output variables are assigned using the same technique described in the input variable section. Output grids should have a title specified.

Temporary output grids computed in the model but not stored back to the disk can be specified as "UNASSIGNED".
Model Execution

Once the model is compiled and all input and output variables are assigned, press the "Execute Model" button to start the user model transformation process.

Grid Calc Model Programming Syntax

Grid calc models are text files that contain the programming logic to perform complicated, multi-line equation and conditional operations on grids. The model is executed one time through for each grid node value including Null nodes.

Users should be familiar with programming languages such as FORTRAN before attempting to create or modify a user model file.

Statements

Each statement in the model consists of variables, operators, and key words. Each statement in the model is terminated with a semicolon (;). Statements may be continued over more than one line. An operator or delimiter, such as, a space or parenthesis separates constants, variables, and numbers. Statements which control the flow of the program logic contain key words "GOTO", "IF...THEN...ELSE", or "BEGIN...END". Branching is done using statement LABELS placed on a line prior to the point of continued processing. Each label consists of a character string terminated by a colon (:). Examples of labels are LABEL1:, L999: and DONE:.

Model Comments

An exclamation mark (!) defines the beginning of a comment. Entire lines may be commented by placing an ! in column one. In-line comments may be placed on executable statements by placing the ! and comment following the semicolon (;) line terminator. Blank lines in the model are ignored.

Comment examples:

```
! this is a commented line.
A = B + C; ! this is an in-line comment.
```

Symbols and Keywords

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(;)</td>
<td>End of statement terminator</td>
</tr>
<tr>
<td>(!)</td>
<td>Comment indicator (start comment)</td>
</tr>
</tbody>
</table>
(:) Label terminator

space Delimiter

IF Test control word

THEN statement Continuation of test

THEN BEGIN Starts "TRUE" condition of test

ELSE BEGIN Starts "FALSE" condition of test

GOTO Branch to a label

CONSTANT Declare constant

GRID Declare grid variable

IN Declare GRID as input variable

OUT Declare GRID as output variable

DO Do loop

END End THEN BEGIN or ELSE BEGIN section

ENDDO End Do Loop

ENDMOD Terminates the model

---

Functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Keyword</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>add</td>
<td>+</td>
<td>A+B</td>
</tr>
<tr>
<td>subtract</td>
<td>-</td>
<td>A-B</td>
</tr>
<tr>
<td>multiply</td>
<td>*</td>
<td>A*B</td>
</tr>
<tr>
<td>divide</td>
<td>/</td>
<td>A/B</td>
</tr>
<tr>
<td>exponential</td>
<td>**</td>
<td>A**2 (A squared)</td>
</tr>
<tr>
<td>assign</td>
<td>=</td>
<td>A = 1.0</td>
</tr>
<tr>
<td>compare equal</td>
<td>= or .EQ.</td>
<td>IF(A=B) THEN... or IF</td>
</tr>
<tr>
<td>(A.EQ.B) THEN...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>logical AND</td>
<td>.AND.</td>
<td>IF((A=B).AND.</td>
</tr>
<tr>
<td>(C=D))...</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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logical OR  .OR.  IF((A=B).OR. (C=D))...
greater than  >  .GT.  IF(A.GT.B)...
less than  <  .LT.  IF(A< B)...
greater or equal  >=  .GE.  IF(A. GE. B)...
less or equal  <=  .LE.  IF(A. LE. B)...
E to power of X  EXP(x)
log (natural)  LN(x)
log (base 10)  LOG10(x)
absolute value  ABS(x)
square root  SQRT(x)
negative (-x)  NEG(x)
truncate to integer  TRUNC(x)
sign of number times 1  SIGN(x)  IF(SIGN(x)=-1)...
round to 2 dec places  ROUND(x)
maximum of x and y  MAX(x,y)
minimum of x and y  MIN(x,y)
remainder of x / y  MOD(x,y)

Parenthesis

Binary operators are defined as an expression enclosed within parentheses, such as, (x+y) or (x*y). Statements require parentheses only when more than one binary operation is used or when one wishes to force the evaluation precedence. The normal operator precedence from lowest to highest is:

+ and -
* and /
**
unary - (minus sign)

The expression,
A+B*C**D/E-F is equivalent to (A+((B*(C**D))/E))-F
and would be evaluated in the following steps. Intermediate expressions are shown in braces.

K = C**D  
L = B*K  
M = L/E  
N = A+M  
O = N-F

Parenthesis force the sub-expression enclosed to be evaluated first, as illustrated below.

(A+B)*C**D/(E-F)
K = A+B  
L = C**D  
M = K*L  
N = E-F  
O = M/N

Declaration Section

The declaration section is the first part of a model program in which the input and output logs and constants are defined. Each declare statement consists of a "type" keyword, a variable name, and a "use" keyword. It is not necessary to declare temporary variables, Temporary variables are defined for the first time as the result of an assignment statement.

Examples:

GRID              UPPER              IN;
GRID              LOWER              IN;
GRID              ISOPACH            OUT;
CONSTANT          SAND              2.5;  ! value is optional
CONSTANT          NULL;              ! assumed to represent NULL grid
                     value
Executable Statement

An executable statement is any statement in which an equation type calculation is performed or an assignment is made. The general form is:

\[
\text{ASSIGNMENT\_VARIABLE} = \text{executable\_statement};
\]

Examples

\[
x = a \times b;
\]
\[
x = (a^*(b+c))/(x-y);
\]

Note that each line is terminated with a semi-colon (;) and the equal sign (=) is required. Variables appearing on the right side of the equation must either be declared as constants or grids or be temporary variables defined as the result of an earlier assignment statement.

GOTO and LABEL Statement

The "GOTO" keyword and following label is use to branch to another part of the program.

Example

```
IF ( x > 0.0 ) THEN GOTO DIVIDE;
y = 0.0;
GOTO MORE;
DIVIDE:
y = y / x;
MORE:
statement;
statement;
etc.
```

IF-THEN STATEMENT

The IF-THEN statement conditionally executes a single assignment statement, GOTO, or BEGIN-END group based on the results of a logical comparison.

Example

```
IF( SW > 0.75 ) THEN BEGIN;
```
\[
SW_3 = (1-SW)^3; \\
SW = 1-(16/3)*SW_3*(5-128*SW_3); \\
END;
\]

**IF-THEN-ELSE STATEMENT**

The IF-THEN-ELSE compound statement provides conditional processing in a clear and efficient manner without the use of a GOTO.

**Examples:**

```plaintext
IF ( logical expression ) THEN BEGIN;
    statement;
    statement;
    etc.
END;
ELSE BEGIN;
    statement;
    statement;
    etc.
END;
```

**DO-LOOP STATEMENT**

The DO loop statement is used to repeat a section of the model a set number of times.

The general format of the DO loop is:

```plaintext
DO counter = first TO last;
    statement;
    statement;
    etc.
ENDDO;
```

The following example sums values from 1 to 10. "A" is summed when \( K \) is even and "B" is summed when \( K \) is odd.

```plaintext
SUM = 0.0;
N = 10;
DO K = 1 TO N;
    IF( MOD(K,2)=0 ) THEN BEGIN;
        SUM = SUM + A;
    END;
    ELSE BEGIN;
        SUM = SUM + B;
    END;
ENDDO;
```

**EXAMPLE GRID CALC MODEL**

```
! ISOPACH.TXT - GRID CALC MODEL TRANSFORM
!
! COMPUTES ISOPACH BETWEEN TWO STRUCTURE GRIDS
```
5.14.4.5 Curvature Grid Calculations

Petra can perform a wide variety of curvature analysis techniques on existing rectangular grids. Curvature analysis can be useful for spotting faults, regional jointing and lineaments, as well as highlighting differential compaction.

Importantly, the accuracy of curvature analysis depends on the accuracy of its input map. In other words, the veracity of curvature analysis relies on good grids with tight control. The “Minimum Curvature” surface style will tend to minimize curvature, while the “Disconnected Features” surface style will tend to amplify curvature. Grids in areas of sparse well data will be smooth and will have low curvature as a result. Data busts and bulls eyes caused by a bad datum or missing survey data, on the other hand, will create anomalously high curvature.

To open the Compute Grid Curvature tool, select the Contours>Grids>Curvature Grid Calculations from the menu bar in the Map Module.

Grids Tab

The Grids Tab sets the input grid used in the calculation and the name of the output curvature grid.
The Compute Grid Curvature Grids Tab

**Input Grid** - This dropdown selects the grid used in the curvature calculation. To change the directory, select the Grid Folder at the bottom of the tab.

**Output Grid** - This entry sets the name of the output grid that will store the calculated curvature grid. Select an existing grid, or enter a new name.

**Curvature Tab**

The Curvature Tab selects curvature calculation to perform.
Mean Curvature - This operation calculates the average curvature for all azimuth directions. It’s used mostly for deriving other curvature attributes, and isn't particularly useful for geological interpretation.

Gaussian Curvature - This operation calculates the product of the minimum and maximum curvatures. Though it’s been suggested that this method is useful for faults (Lisle, 1994; Wen & Townsend, 1997), Roberts (2001) states that the Gaussian curvature switches between positive and negative values too often to be useful. Though this sign-switching problem could be mitigated by using the absolute values, Gaussian curvature is mostly used for deriving other curvature attributes.

Maximum Curvature - This operation calculates the highest curvature for every point regardless of azimuth or sign. Points with large positive values here have convex curvature, while the negative values reflect concave curvature at some azimuth. Roberts (2001) suggests that maximum curvature is useful for outlining faults and fault geometries.

Without any faults drawn in the overlay, Petra’s gridding algorithms attempt to create a continuous surface between the data points. As such, gridding will inherently smooth over faulting, which creates regions of higher curvature. Upthrown sides of faults exhibit a positive curvature while downthrown sides have negative curvature. In theory, the zero crossing between the positive and negative curvature is the center of the fault.
Faulting calculated from grid curvature. Modified from Roberts (2001)

**Minimum Curvature** - This operation calculates the smallest, flattest curvature for every point regardless of azimuth or sign. Points that still have fairly large minimum curvature values can indicate possible fractures and faults.

**Most Positive Curvature** - This operation calculates the highest positive (convex) curvature regardless of azimuth. As mentioned earlier, convex structures can be tied to the upthrown sides of faults.

**Most Negative Curvature** - This operation calculates the highest negative (concave) curvature regardless of azimuth. As mentioned earlier, convex structures can be tied to the downthrown sides of faults.

**Dip Curvature** - This operation plots curvature in the direction of maximum dip. Effectively, this curvature is a measure of the rate of change of dip in the maximum dip direction. This tends to exaggerate local relief on the structure, which can enhance differential compaction on channel sands and debris flows (Roberts, 2001).

**Strike Curvature** - This operation plots curvature in the direction of strike. In other words, this measurement highlights ridges and valleys along strike, where positive numbers reflect a ridge and negative numbers reflect a valley. Typically, this operation is used in topographic terrain analysis to help analyze gravity-driven processes like soil-erosion and drainage. More specifically, this method better illustrates where valleys will aid drainage and where ridges will block it. In an oil & gas industry setting, strike curvature can be turned upside-down to help illustrate how the top surface of a reservoir will aid or block the migration of hydrocarbons (Roberts, 2001). In other words, a ridge of positive curvature at the top of a reservoir will act as a conduit for migration, while a valley digging into the top of a reservoir will block migration.

**Curvedness** - This operation plots the magnitude of curvature independent of shape. This gives a general measurement of the total curvature present within the surface.

**Dip Angle (Slope)** - This operation calculates the angle of dip for each point.

**Dip Azimuth (Direction)** - This operation plots the azimuth of dip. Rapid changes in this
may indicate faulting or lineaments.

**Shape Index** - This operation calculates the Sharpe Index (Si), which is a numerical measurement of shape. The Sharpe Index ranges from -1 to +1, where -1 indicates a point that is shaped like a bowl, 0 is perfectly flat, and +1 is dome shaped. Values between -1 and 0 are valleys, while values between 0 and +1 are ridges. Geologically, this index can be used to emphasize subtle faults or lineaments.

*The Sharpe Index. Modified from Roberts (2001)*

**Output Grid Title** - This entry sets the title of the created grid.

**Options Tab**

The Options Tab sets a few additional options for the curvature calculation.

![Compute Grid Curvature Grids Tab](image)

**Smoothing**

**Apply Smoothing Filter Using** - This option applies a rolling average to the calculation.
The entry specifies the total number of points to include in the rolling average.

**Resolution of Analysis**

*Number of Rows (Cols) Btwn Samples* - This option decimates the data to only analyze every N'th sample. Setting this value to 2, for instance, would only calculate the curvature on every other grid node. Setting this value to 5 would only load every 5th sample. By default, this option is set at 1 to analyze every grid node on the selected grid.

**Normalization**

*Normalize Output Grid From* - This option converts the values calculated by the curvature calculation to instead use a user-specified minimum and maximum. This can be useful for better illustrating some grids that normally would have a gradient too small to usefully display on a grid.

*Convert Negative Surface to Positive Values* - This option simply applies the absolute value of all surface calculations. With this option, Petra will substitute a positive value for negative values.

*Output Azimuth as...* - This option changes how Petra exports azimuth values. This can be useful for exporting grids to other software packages that handle azimuth a little differently.

**Reference Tab**

The Reference Tab simply provides the reference for the curvature calculations.
5.14.4.6 Compute Statistics Around Wells

This function uses a contour grid file to compute values within an area around each well on the map. You can compute either volumetrics within a circle or statistics within an elliptical area around each well.

DATA TAB

Value to Compute at Each Well on Map

Grid Volume At the Well - This option computes values equal to the volume within a specified radius around each well. (see Volumes Tab)
Grid Statistics (Average, Min, Max, etc) - This option computes statistical values within an oriented ellipse around each well. (see Statistics Tab)

Grid File To Compute Values From

Select the grid file used for calculations.

Zone Item To Store Computed Value For Each Well

Select the zone and zone item for storing the computed results for each well. You may select an existing zone item of type in a name to create a new item in the selected zone.

VOLUME TAB

This section describes options available when the volume option is chosen on the data tab.

Area Specified As

Radius In XY Units - The area parameter (see below) is specified as a radius of a circle in xy map units (feet or meters).

Acres - The area parameter (see below) is specified as the number of acres in a circle around each well.

Area Around Each Well Is

This option allows the area value to be set as a constant value for all wells or it can vary from well to well by using a zone item for the area. In either case, the value must be in the units specified by the 'Area Specified As' parameter.
Volumetrics Lower Data Limit

This option allows you to set a lower limit for volume calculations. For example, if a grid contained values from 0 to 100, a lower limit of 50 would restrict the volumes to be computed for 50 to 100 only.

Scale Resulting Volumes By

Enter any multiplication factor you wish to be applied to the computed volumes. Note that when the 'Area Specified As' parameter is acres, then the volume will automatically be scaled to acre/ft as well.

STATISTICS TAB

This section describes options available when the statistics option is chosen on the data tab. Results are determine using all grid node values and grid cell center points falling inside a specified elliptical area around each well.

Statistical Value To Be Computed

Select the type of value to be computed around each well. Options are:
- Average Value
- Minimum Value
- Maximum Value
- Sum

Compute Values Within an Oriented Ellipse with the Following Dimensions

Define the dimensions and orientation of an ellipse by specifying the length (semi-major axis), width (semi-minor axis) and azimuth relative to a compass heading.
You can also use the "Compute Dimensions From Acres" button to set the length and width values by entering the area of the ellipse in acres and the ratio of length to width.

**Output Ellipses To \GRIDS\ELLIPS.TXT**

Check this option to export a file called "ellips.txt" to the project's "grids" folder containing polygons suitable for importing into the map overlay. Each polygon is an ellipse centered at a well. The file contains x, y, and segid and can be imported as polygons using the "Overlay>>Load>>Generic ASCII File"

5.14.4.7 **Sample Grid to Wells**

This operation calculates the grid value at a well’s location and store it to the well’s data item.

To sample a grid to a set of wells, select Contours>Grids>Sample Grid to Wells.

**Data Tab**

The Data Tab sets the grid to sample and the data item that stores the grid value.
Grid File To Sample

This dropdown selects the grid to sample to the wells. This list of wells can be reordered by creation date or by name.

Well Z Data To Sample To

Zone - This dropdown selects the zone containing the desired data item.

Item - This dropdown selects the data item containing the sampled grid value.

Set Zs not sampled from Grid to a NULL value - This option will overwrite the data item with a null wherever there is no grid value.

Sample to NULL Values Only - This option will only sample data values to empty data items. In other words, this option will prevent the grid from overwriting preexisting values.

Apply Datum Elevation (SS Structure Grids Only) - This option will use each well's datum elevation to create a pseudo-MD data value.
Sample Increment for Directional Wells (in Depth Units) - This option sets the sample increment.

Assign Quality Code to Sampled Wells - This option assigns a quality code to all sampled data items.

Limits Tab

The Limits Tab restricts how Petra handles wells that do not penetrate the grid.

5.14.4.8 Sample Grid To Seismic

The sample grid to seismic option can back interpolate z values from a contour grid onto seismic shot point locations.

Grid File To Sample
This section contains a list of the current grid files in the project. Choose the grid to sample onto the seismic locations. Use the "Grid Info" button to view the grid details or to check grid statistics.

**Sample To Seismic Z Variable**

This section defines the seismic Z data item which will receive the interpolated values from the grid. Select one of the defined seismic Z data items or type in a new Z name. If you enter a new name, you will be prompted for the Z data description, units, and remarks.

The "Sample to Active lines only" option can be used to restrict the grid sampling to only the seismic lines which are currently in the active state. Turn this option off if you want to sample the grid to all seismic lines and shot points.

Turn on the "Only Sample to Null Z Values" option if you do not want to overwrite valid values with the interpolated grid values. Only seismic Z values containing a Null value will be replaced.

**5.14.4.9 Sample Grid to Control Points**

Enter topic text here.

**5.14.4.10 Resample Grids to Match**

The Resample Grids function can be used to resample one or more grid files to match a specific source grid or to a new grid size. Resampling may be necessary if grid-to-grid operations are to be performed.

Two methods are available for resampling grids:

**(1) Grid To Match All Resampled Grids (Source) -**

The grid node locations of this grid will become the nodes of the resampled grids. All resampled grids will match the number of rows and columns and grid dimensions of this grid. Use the "Grid Info..." button to display grid header information of the source grid.

**(2) New X and Y Grid Size -**

The number of rows and columns of the resampled grids will be computed from the
X and Y grid sizes. The new grid limits will not change.

**Grids To Resample -**

Choose one or more grids which will be resampled to match the source grid. Do not include the source grid in the selection list. Change the "Sort Grids By" option to resort the grid list by date or name.

**Method -**

**Neighbor Search** - This method averages several grid node values around the xy point to be sampled. This is usually the most accurate method.

**Direct Interpolation** - The method averages the 4 grid nodes of the grid cell containing the xy point.

**Direct Interpolation (faster)** - Similar the previous method.

*Note: resampled grids are modified in place. If you wish to retain a copy or the original grid, make a backup copy using Windows Explorer. The grids are stored in the "GRIDS" directory under the project primary directory.*

Click the OK button to begin the resampling process.

5.14.4.11 Shaded Relief Grid

Enter topic text here.

5.14.4.12 Convert Triangular to Rectangular Grid

Enter topic text here.

5.14.5 Export Grid File - Map

Petra grid files can be exported in various commercial and ASCII formats.

**Files Tab**

**Output File** - Enter or use the "Browse" button to select the file name to receive the
output grid file.

**Grid File To Export** - Select the Petra grid file you wish to export. Use the "Info" button view a grid file's header or see the grid histogram stats.

### Format Tab

**Output Grid Format** - Select the format of the exported grid file.

"Zycor Grid Format" - Choose this format to export a grid as an ASCII file with the appropriate header information to be loaded into Zycor Zmap software.

"ASCII Tabular File" - Choose this format to output the grid as a simple tabular or columnar file. The following options are provided to further specify this format.

"Max Values Per Record" - Set the number of grid values written to each output record. If each output record contains a grid row, the number of values written to the record will not exceed the number of columns.

"Data Value Column Width" - Set the number of characters for each data value.

"Grid Origin" - Select the order in which the grid rows and columns are written to the file. Each record may represent a row or a column and the first value written may be the upper left corner or the lower left corner of the grid.

"Null Value Indicator" - This is the value written when the grid node contains a null value. Be sure the column width is large enough to include this value. The null indicator is written as a string value and need not be numeric.

### 5.14.6 Export Grid As XYZ - Map

Petra grid files can be exported as an ASCII file in which each record contains the X, Y, and Z values for each grid node. These XYZ grids can be used in other software packages, or for other kinds of modeling.

To export a Petra grid as an XYZ file, select Grids>Export>Grid as XYZ Points.. on the menu bar at the top of the Map Module.

### Files Tab
XYZ Output File - Enter or use the "Browse" button to select the file name to receive the output xyz file.

Grid File To Export - Select the Petra grid file you wish to export. Use the "Info" button to view a grid file's header or see the grid histogram stats.

Include Active Control Points in the Output File - By default, Petra only exports the points from the interpolated grid. This option also includes the control points loaded into Petra's active memory.

Format Tab

Columns

Fixed Columns - Choose this option for fixed column output and set the "Column Width" to the appropriate value.

Separate Values With - Choose this option for delimited value output and select the desired value delimiter. Data may be separated by a comma, a space, or a semi-colon.

Coordinates

X-Y-Z - Choose this option to export X,Y coordinates.
LON-LAT-Z - Choose this option to export Latitude, Longitude coordinates.

5.14.7 Grid Volumetrics

The Map Module’s “Compute Volume from a Grid” tool calculates volumetrics from a single grid. With a good quality isopach, pore volume, or hydrocarbon pore volume grid, this method can generate accurate estimations of the area occupied by hydrocarbons, and can divide these volumetrics into different lease polygons.

Once the overlay volumetric polygons are set-up, select Contours>Volumetrics>Compute Volume From a Grid… on the menu bar at the top of the Map Module to open the volumetrics tool.

Data Tab

Grid File Used For Volumes

Here, select the grid and grid type to be used in the calculation from the dropdown labeled “Grid File Used For Volumes.” In the example below the “HPV” grid is selected. To change the grid directory, select a different file path on the Dir Tab. Note that grids on this dropdown menu can be sorted alphabetically by selecting the button. The button selects the most recently created grid in the directory.
Grid Units

When calculating volumetrics, it’s important to make sure the units are correct. Petra stores the default XY and depth units of measurement (feet or meters) in the Map Projections Settings. When Petra calculates a grid, it uses these XY coordinate units. The units used to create the selected grid are shown under Grid XY Units.

By default, Petra assumes that the Z units for the grid are the “Default Depths Units” selected on the Map Projection Settings. Make sure the units selected here reflect the units of the grid.

Grid Type - “Iso”

The “Grid Type” dropdown tells Petra what the numerical values in the grid actually mean. A grid used in volumetrics can be one of three types: “Iso” type data with values from zero to positive numbers, structure data with structural highs as larger numbers, or structural data with structural highs as smaller numbers. In the example below, the SCMR ISOPACH grid is selected as an isopach.

With “Iso” grids (including isopach grids, pore volume grids, and hydrocarbon pore volume grids), Petra uses the thickness to calculate the volume underneath the grid nodes. This is the most common and easiest way to calculate volumetrics with a grid. Note that Petra will ignore the effect of negative numbers in “Iso” type grids.

Grid Type - Structure

Though Petra can use a structure grid in a volumetric calculation, it is almost always better to use an isopach grid. In practice, using a structure grid really only works with small, simple structures with a thick, homogenous reservoir and a discrete water contact.

The numerical representation of a structural high or low is dependent on the reference datum (Measured Depth/MD or SubSea/SS). SS grids store structural highs as larger numbers (e.g. +2,000 SS is higher than +1,000 SS and -1,000’ SS is higher than -2,000’ SS). MD grids store structural highs as smaller numbers (e.g. 1,000’ MD is higher than 2,000’ MD). Practically, grids referenced to SS use the “Structural Highs as Larger Numbers” option, while grids referenced to MD use “Structural Highs as Smaller Numbers” option.
A single structure map only represents the elevations of a surface and doesn’t inherently have any measurement of thickness. When using a structure map, Petra calculates thickness by using the volume of the grid between the minimum and maximum Z values set on the Data Tab. In the example below, Petra will calculate a thickness between -1200’ SS and -2200’ SS. It’s important to note that setting a limit below the bottom of the grid will add a large extra bulk to the volumetric calculation. The example below will have an additional 200’ of section added to the volumetric calculation.

Calculating volumetrics with a structure map can also lead to problems if the thickness of the reservoir rock is thinner than the difference between the grid and the bounding lower z value. With a sufficiently thick reservoir, the bounds are completely covered by reservoir rock. With thinner reservoirs, the volumetric calculation can include a volume that doesn’t actually include reservoir rock, thus overestimating the volume.
Compute Volume for Following Area(s)

This section tells Petra whether the volume underneath a grid will be broken out by different volumetric polygons. The “Generate Volumes for Each Visible Overlay Volumetric Polygon” option will calculate the volume of the grid covered by every visible overlay polygon. Recall that a line defining these polygons need to be closed on the line’s General Tab and named on the line’s Volm Tab. If these polygons overlap, Petra will count the volume of the shared area twice. Setting this option to “Generate Volume For Entire Grid Only” will instead ignore visible polygons and calculate the volume over the entire grid.

Compute Volumes Between

The Minimum and Maximum Z values set limits on the overall volumetric calculation. Though these settings are critical when using a structure grid, the limits can also be useful when calculating volumetrics on thickness or “iso” maps. In particular, setting the limits can help to reduce the effect of a large, thin uneconomic area on the calculation.

Horizontal Slice Volumes

It’s also possible to calculate volumetrics for horizontal slices from the minimum z value to the maximum z value through the reservoir. In the example below, horizontal slices will be calculated for 0-10’ of thickness, 10-20’, 20-30’, and so on through the entire section. With large grids and small increments, this additional step can be fairly time-consuming.

Options Tab

The Options tab provides a few more options for the volumetrics calculation.
Ignore Volume if Thickness is Less Than - This option sets the minimum thickness necessary for Petra to consider in the volumetric calculation; anything below this thickness isn’t included. By default, this thickness cutoff is set at zero, which means that all the entire positive volume of the grid is used. Setting this thickness higher can help to reduce the influence of a large thin or uneconomic area. Note that the cutoff thickness is relative to the selected grid units – a 10’ cutoff applied to an isopach grid is very different than a 10’ cutoff applied to a HPV grid.

Grid Refinement - The Grid Refinement option breaks larger grid cells into smaller triangular areas. This slightly increases the accuracy of the volumetrics calculation at the cost of more computing time.

Also Output Volumes to CSV File - The "Also Output Volumes to CSV File" option writes a CSV file containing the name, area (both a total area of the polygon and the total area of the grid underneath the polygon), relevant calculated volume, an average grid thickness (if selected), the working interest, and the WSN of the polygon’s “designated well.” Petra creates a CSV file using the volumetric grid name in the project’s GRIDS directory. Using the example above, Petra creates a file named HPV.CSV. Leaving this CSV file open while trying to calculate a new volume (and thus export data to the same CSV file) can create an IO error.

Print Average Value for each Polygon in Report - This option simply calculates the average grid thickness for each visible named polygon. What this thickness actually represents depends on the type of the grid used. The average Z value for a structure grid will be an average elevation rather than an average thickness.

Apply Working Interests Associated with Overlay Polygons - This option scales each volume inside a volumetrics polygon by the working interest.
Write Volumes to SHAPE FILE - This option saves currently visible volumetric polygons and data to a shape file. Select the option and navigate to the desired shape file. This copies all currently visible volumetric polygons to a single shape file.

Reserves Tab
The Reserves Tab selects the type of reserves calculation and specifies the type of input grid. The reserves types include basic volumes, recoverable oil in place, recoverable gas in place, coal bed methane, and coal tonnage. The map type tells Petra whether the input grid is an isopach, a pore volume map, or a hydrocarbon pore volume map. The Map Type only affects oil and gas reserve calculations. The options on the Reserves tab changes depending on the selected reservoir and map type. Similarly, the area and volume dropdowns at the bottom of the window show the relevant units for the specific reserves calculation.

Basic Volumes (No Scaling)
The simplest form of a volumetric calculation is the first option, “Basic Volumes (No Scaling).” This option simply calculates the volume occupied by the grid without any additional reservoir calculations. Note that the “Map Type” option has no effect on this calculation.

The “Basic Volume” calculation can display results in a variety of areas and formats. For area, the available units include raw units (as defined on the Units Tab), square feet, square meters, and acreage. For volume, the available units include raw units (as defined on the Units Tab), cubic feet, acre-feet, acre-meters, MBO, MMCF, and cubic meters.
Oil in Place with Recovery

Petra’s oil reserves calculations multiplies the total area of pore space occupied by hydrocarbons by a recovery factor. This volume is then divided by Bo to correct for differences in volume between hydrocarbons in the reservoir and the same hydrocarbon at surface conditions.

Recoverable Oil In Place: \( ROIP = \text{Volume} \times \text{Por} \times (1 - \text{Sw}) \times \text{Rf} / \text{Bo} \)

The three options for “Map Type” (isopach, pore volume, and hydrocarbon pore volume) simply tell Petra what the selected grid represents. Practically, the map type grays out irrelevant options.

An isopach grid just contains thickness and will need an average water saturation and porosity. A pore volume grid already contains the thickness and porosity information and just needs average water saturation. A hydrocarbon pore volume grids already contains all this information, and therefore needs no averaged porosity and saturation information.

The “Oil In Place with Recovery” calculation can display results in a variety of areas and formats. For area, the available units include raw units (as defined on the Units Tab), square feet, square meters, and acreage. For volume, the available units include raw units (as defined on the Units Tab), cubic feet, acre-feet, acre-meters, or MBO.

Gas in Place with Recovery

Petra’s oil reserves calculations multiplies the total area of pore space occupied by hydrocarbons by a recovery factor. This volume is then divided by Bg to correct for differences in volume between hydrocarbons in the reservoir and the same hydrocarbon at surface conditions.
Gas In Place: $GIP = \text{Volume} \times \text{Por} \times (1 - \text{Sw}) \times Rf / Bg$

Where $Bg = \frac{\text{Patm}}{P} \times (\frac{460 + T}{460 + 60}) \times Z$; $\text{Patm} = 1$

The three options here for “Map Type” (isopach, pore volume, and hydrocarbon pore volume) simply tell Petra what the selected grid represents. Practically, the map type grays irrelevant options out.

An isopach grid just contains thickness and will need an average water saturation and porosity. A pore volume grid already contains the thickness and porosity information and just needs average water saturation. A hydrocarbon pore volume grids already contains all this information, and therefore needs no averaged porosity and saturation information.

The recoverable gas in place calculation also requires a compressibility factor, reservoir pressure, and reservoir temperature. The calculation only uses the numbers on the imperial units side; SI units must be converted to imperial units. Using imperial units is fairly simple – simply enter the reservoir pressure and temperature in PSI and °F into the boxes on the left (highlighted in yellow). To use SI units, enter in the pressure and temperature in kPAA and °C into the boxes on the right (not highlighted) and select the arrow buttons for both pressure and temperature to convert to imperial units. After the SI pressure and temperature are converted, then compute the volumetrics normally.

The “Gas In Place with Recovery” calculation can display results in a variety of areas and formats. For area, the available units include raw units (as defined on the Units Tab), square feet, square meters, and acreage. For volume, the calculation is limited to MMCF.

Coal Bed Methane (CBM) in Place with Recovery
The “CBM Gas in Place with Recovery” option calculates reserves for a coal bed methane field. Note that the “Map Type” option has no effect on these calculations, and the grid is always assumed to be an isopach grid.

CBM Gas In Place: $\text{CBMGIP} = \text{Volume} \times \text{Cf} \times \text{Gc} \times \text{Sg} \times \text{Rf}$

where Cf converts bulk density in g/cc to tons/acre-ft

The “Coal Gas In Place with Recovery” calculation displays results in a variety of areas and formats. For area, the available units include raw units (as defined on the Units Tab), square feet, square meters, and acreage. For volume, the calculation is limited to MMCF.

Coal Tonnage

Coal tonnage simply calculates the volumetrics of an isopach grid and multiplies this value by an average coal density.

Coal (Tons) = $\text{Volume} \times \text{CoalDensity} \times \frac{62.42796061}{2000}$ when density is in gm/cc

Coal (Tons) = $\text{Volume} \times \text{CoalDensity} \times \frac{1}{1000}$ when density is in kg/m3

The “Coal Tonnage” calculation displays results in a variety of areas and formats. For area, the available units include raw units (as defined on the Units Tab), square feet, square meters, and acreage. For volume, the calculation is limited to Tons (2,000 lbs).
Wells Tab

Petra can copy the volumetric data for each named polygon to a specific well's designated zone and data item. Recall that each polygon's designated well is established by double-clicking the polygon in the map module to open its Overlay Line Attributes screen (see Initial Polygon Setup above). The “Store Polygon Volume in Each Polygon’s Designated Well” option stores the calculated volume to the designated well.

The “Zone To Store Polygon Volume” dropdown simply sets the zone where the relevant volumetric data will be stored. By default, volumetric data is saved in the WELL zone. In the example below, data will be stored in the “VOLUMETRICS” zone.
The “Item to Store Polygon Volume” selects the specific data item where the relevant volume is stored. In the example below, data will be stored in the “GIP” zone.

The “Item to Store AVG Z” selects the specific pre-existing data item where the average grid thickness for each visible named polygon is stored. What this thickness actually represents depends on the type of the grid used. Note that the “Print Average Value for each Polygon in Report” option on the Options Tab needs to be selected for this option to work. In the example below, data will be stored in the “GIP” data item in the VOLUMETRICS zone.

Dir Tab

This tab simply sets the directory of available grids. By default, this option is set to the project’s GRIDS folder.
5.15 Attribute Maps

Attribute maps show which wells meet some data criteria. Attribute maps can be set to show well header information, zone data items, digital and raster logs, or monthly production data. Attribute map criteria includes whether data are present or absent, whether the data fits within a numerical range, or by a specific text or value search.

To add an attribute map, select the button on the toolbar at the top of the Map Module, or select Options->Attribute Map from the menu bar at the top of the screen.
Available Data Items

The Available Data Items list shows the possible items for the attribute map. This includes: well header information, zone data items, log curves, monthly production data, or interval data. To add an item to the attribute map, select the relevant item and click the associated button to add the item to the Selected Attributes list.

Selected Attributes
The Selected Attributes list sets the order of the attribute wedges, as well as controls the individual settings. After adding the attribute from the available data items, use the "Settings" and "Colors" tabs to define the display parameters for the attribute. Use the button to remove an attribute from the list or the button to clear the list. Use the and buttons to reposition the attributes in list and the relative position in the attribute symbol.

**General Tab**

The General Tab controls a few settings that apply to the entire attribute map.

**General**

**Suppress Legend** - This option disables the screen legend showing the color and attribute description.

**Drop Missing Segments** - Check this option to drop segments when data does not meet the attribute "Show When" criteria on the Settings Tab.

**Suppress Outline** - This option removes the outline of the attribute map circle. This can reduce visual clutter, but also reduces the individual impact of a single attribute bubble.

**Style**

This option sets the overall style of the attribute map. Options include a doughnut that leaves a hole for the sell symbol, or a pie that does not.
Circle Size (Diameter) and Units

Enter the diameter of the attribute symbol in either inches or map units. When the inches option is selected, the attribute symbols will always plot at the specified diameter regardless of zoom. When map units are selected, the attribute diameter will vary in size based on the map scale.

Settings

Save - This button saves the current attribute settings to an external *.ATT file.

Load - This button loads attribute settings from an external *.ATT file. Note that this will replace all the current settings.

System Defaults - This button restores the system defaults and removes all attributes.

Settings Tab

Data Is Present - This option shows the attribute when the well header data is non-blank, zone data is not null, or when a log exists for the well.

Data Is Missing - This option shows the attribute when the well header data is blank, zone data is null, or when a log does not exist for the well.
Active Vel Func - This option restricts the "Any Velocity Function" search (on the Well Header Items dropdown) to only include wells with an active velocity function.

Uncalibrated Rasters - This option restricts a raster log attribute map (either "Any Raster Log" or a specific raster log) to only rasters without depth calibration points. This option will not affect non-raster log searches.

If Top Use SS Value - For a "Numeric Values" search on formation tops, this option uses the SS value rather than the MD value. This option will not affect non-formation top searches.

Numeric Values

Data Is In Range - This option shows the attribute when a zone data falls within the specified range. Enter the range as a minimum and maximum value.

Text Header or Zone Values

Data Contains Value - This option shows the attribute when a well header text item contains the specified text value. This option is not case sensitive.

Data Does Not Contain Value - This option shows the attribute when a well header text item does not contain the specified text value. This option is not case sensitive.

Data Exactly Matches Value - This option shows the attribute when a well header text item exactly matches the specified text value. This option is not case sensitive.

Show Unique Values - When a data item is selected on the Selected Attributes List, this button displays a list of the unique values in that data item.

WSN List

This option limits the attribute map for the selected data item to only those wells on a wsn list. This allows for attribute maps based on more complex, layered criteria. As an example, a WSN list can show wells that have a TD greater than 10,000', have raster logs, and were drilled in 1973. To do this, use the Select Wells By Data Criteria.
Use Aliases - This option uses the relevant alias for the highlighted option on the Selected Attributes List. This will use \textit{log} and \textit{zone} alias lists.

Disabled - This option disables the highlighted attribute on the Selected Attributes list. Disabled attributes will have a $\odot$ sign next to them.

Colors Tab

The Colors Tab sets the color for the selected attribute on the Selected Attributes list.

Color - This dropdown sets the color the selected attribute from the color drop down list. To change another attribute's color, select the relevant attribute on the Selected Attributes List on the lower left corner of the screen.

Randomize - This button randomizes the colors for each attribute.

Color Palette

This tool changes the colors in the "Color" dropdown above.

Save - This button saves the current palette to an external *.ZPL file

Load - This button replaces the current palette with a palette from an external *.ZPL file.

Edit Palette - This button opens the Windows Color dialog box for modifying individual colors in the color dropdown list.

Default Palette - This button restores the color palette to the Petra default.
Legend Tab

This tab controls a little about the attribute legend that normally appears in the bottom left corner of the Map Module.

![Legend Tab Image]

**Use Default Title In Legend** - This option just uses the default title for the legend. This will just report a brief summary of the color and data criteria.

**Override Title Using the Following Title** - This option replaces the attributes legend with custom text specified in the entry box below.

**Make Screen Legend Opaque Background** - This option puts an opaque white box behind the attribute legend.

**Include Well Counts for Each Item** - This option adds a total count of the wells satisfied by the criteria.

Wells Tab

The Wells Tab adds an additional criteria to limit the attribute map to only wells on a WSN list.
All Wells On Map - This option does not restrict the attribute to a well list, and will draw attributes on any well on the map that meets the data criteria. This is on by default.

Only Wells Listed in WSN List File Below - This option restricts the attribute symbols to only wells in the WSN list in the entry box. Wells that meet the data criteria but are not on the WSN list will not have attribute bubbles.

Auto Retain Well List of Posted Wells - This option keeps the well list in memory. Without having to read the WSN list off the network or hard drive, Petra can redraw attribute maps slightly faster.

Save WSN File of Wells with Attributes - This option creates a new WSN containing the wells that meet the selected attribute. It will save a new file ATTRMAP$$.WSN in the same location as the WSN file selected above. Note that this will use the attribute selected on the "Selected Attributes" list on the lower left corner of the screen.

5.16 Bubble Maps

Bubble maps display data items as color-filled circles or circle segments at each well. The bubble can change color or size with the data's value. Multi-bubble segments can be equal or proportional to the percentage of the total similar to a pie chart. Bubble maps are ideal for illustrating highly variable data sets such as cumulative production.

To add a bubble map, select the button on the Map Module toolbar, or select
Map Module 1005

Options>Bubble Map from the menu bar at the top of the screen.

![Bubble Map Options](image)

**Title** - This title appears in the legend for the bubble map

**Bubble Mode**

**Normal Bubble Mode** - Normal bubble mode produces a single or multi-segmented bubbles of equal proportions. The radius can be fixed or vary with the z value magnitude.

**Pie Bubble Mode** - This option produces a "pie chart" for multiple z values where each segment size is proportional to the percentage of the total. The radius can be fixed or vary with the magnitude of the sum of all z values.

**Discrete Bubble Mode** - This option can specify up to 8 discrete ranges so that all values with a given range will have the same bubble size.

**Data Items for Bubbles (max 32)**

The list box on the left of the screen shows each z data item selected for bubble map display. Z data items are chosen from the ZDATA TAB and added to the list box using the + button. List box Items can be replaced using the - button or dropped using the  button.

**Z Data Tab**

This section displays two drop down lists. The upper list contains all data groups and user-defined zones. Selecting an item from this list causes the lower list to display
all z-data items associated with the zone. Selecting a z-data item causes the "Value Range" to display a suggested data range based on the z-data statistics.

Select Z Data Used For Bubbles

Stats... - This button displays a histogram of the selected z-data item.

View Z Data - This button opens a zone data item viewer. Here, use the "+" button to the left of the desired zone to expand the tree, and then select the desired data item. Note that entries here can be edited as well.
The View/Edit Zone Data tool with no data item selected (left) and with a data item selected (right)

Use Aliases - This option enables zone aliases.

Disabled - This option disables the data item on the Data Items For Bubbles list. This is functionally the same as double clicking the item on the Data Items For Bubbles list. Disabled items will have a ☒ next to it.

Value Range

Default Value Range - This tool computes the range for the selected data item. Specifically, this tool sets the range +/- 2 standard deviations around the mean.

Colors - This tool opens the Color Interval Definition tool to set the color and interval boundaries over the selected z-data value range.

Radius Tab (Normal Bubble Mode)

Selecting the "Normal Bubble Mode" will enable the Radius Tab. The Radius Tab sets how the size of the bubbles.
Constant Radius - This option draws all bubbles at the same size, regardless of the value of the data item. The entry box and dropdown sets the desired units - note that the size of the bubble can be set in map inches, XY map units, and acres.

Vary Radius as Units/Inch - This option draws bubbles that vary with the values of the data item; wells with large values will have large bubbles. This entry varies the radius as units/inch.

Scale Maximum Z Value to XY Map Units - This option sets the maximum radius of all bubbles to a specified distance in XY map units (feet or meters). Since these options are in XY units, all bubbles remain at a relative size independent to the map scale. Bubbles will be limited in size to the maximum radius size in inches. No bubble will exceed the maximum radius size.

Scale ______ to XY Map Units - This entry sets the radius in XY units, divided by a scale factor. For example, a value of 200 and a scale entry of 2 will draw a bubble with a 100 XY unit radius.

Values are XY Units (Apply Map Scale) - This option sets the size of the bubble as directly proportional to the XY map units. For example, a value of 200 will draw a bubble with a 200 XY unit radius.

Limit Radius to - This entry sets the maximum radius of the bubble selected on the "Data Items For Bubbles" list. Note that this can be set in inches or XY units.

Pie Tab (Pie Bubble Mode)

The Pie Tab sets z value scaling information and sets the radius style for all pie bubbles. Each z value can be scaled using a multiplication factor. This allows z
values or differing units to be combined without one overwhelming the others.

**Multiply Data item By** - This option multiplies the data item by a constant. This can be useful for increasing the size of one data item in the pie relative to other data items.

**Pie Scaling**

**Constant Radius in Inches** - This option draws all pie bubbles with the same radius. Only the proportion of the pie slices will change. This entry sets the radius in inches.

**Vary Radius as Units/Inch** - This entry sets the radius in inches, divided by a scale factor. For example, a value of 200 and an entry of 200 will draw a bubble with a 1 inch radius.

**Scale Max Z To** - This entry sets the radius in XY units, divided by a scale factor. For example, a value of 2000 and an entry of 20 will draw a bubble with a 100 XY unit radius.

**Limit Radius To** - This option sets the maximum size of the pie. Pie bubbles will not be larger than this setting, regardless of the value. Note that this option is set in either inches or XY units immediately to the right.

**Min Radius** - This option sets the minimum size of the pie. Pie bubbles will not be smaller than this setting. Note that this option is set in either inches or XY units immediately to the right.

**Pie Normalization**

This option determines how the size of each pie bubble is computed.
Normalize to the SUM of all Items - This option sets the relative size of each slice in a proportion to the sum of all the data items displayed on the bubble map. This option is useful for displaying multiple equal variables, such as the relative proportion of production out of two or more intervals.

Normalize to the First Item Listed - This option sets the relative size of each slice in proportion to the value of the first data item displayed on the bubble map. This option is useful for displaying data relative to a single variable. As an example, this can be useful for plotting RR vs EUR production values, where the "EUR" would be the first item on the "Data Items For Bubbles" list.

Discrete Tab (Discrete Bubble Mode)

This screen allows you to set the low bound, high bound, radius and color for up to 8 discrete bubble sizes. When a bound cell is left blank, the associated range value is set to 1E30. If the radius is blank, the line is ignored during display.

Options Tab
Color Filled Circles - This option fills the bubble maps with the colors specified on the Z Data Tab. Deselecting this option will only draw outlines of the bubbles.

Black Outlines - This option draws a black outline around the bubbles. Disabling this option will draw open colored circles. Check the Black Outlines to have the color filled circles outlined using a black pen.

Show Color Scale On Screen - This option displays a color bar scale in the upper left corner of the map.

Display Color Scale on Printed Map - This option adds a color bar on the printed map, rather than the map on the computer screen.

Draw Multi-Bubbles as Full Circles - This option will draw bubbles as variable radius concentric circles instead of wedges.

Transparent Color Mode - By default, Petra draws bubble maps with an opaque color, and the bubble can cover other elements. This option instead draws the line or polygon with a transparent color. With a transparent drawing mode, other elements will be visible through the line or polygon.

Plot After Wells - By default, Petra draws well symbols after and on top of bubbles. This option instead draws the bubbles after the well symbols, so that the bubbles are on top.

Show Discrete Bubble Legend in Corner - This option adds a legend for the discrete radii and bounds set on the Discrete Tab in the upper left corner of the Map Module.
The Discrete Bubble Legend

Well Sort Order

The Data Sort Order section includes options for sorting the bubbles by Z value. Sorting in "Ascending" order results in smaller bubbles plotting on top or larger bubbles. Sorting in "Descending" order puts larger bubbles on top of smaller bubbles. The "Do Not Sort" option results in bubbles plotting in well sequence order.

Sample Tab

This tab shows a sample of the bubble map circle. When multiple z data items are displayed, the currently selected list box item is identified in the multi-segmented bubble as a highlighted color.

File Tab

The File Tab saves and loads bubble map settings to an external file. This can be useful for rapidly switching between several bubble map settings.
Load Settings - This option replaces the current bubble map settings with those from an external file.

Save Settings - This button saves the current bubble map settings to an external *.BUB file.

Well Tab

The Well Tab can limit the bubbles displayed on the Map Module to only the wells listed on a WSN list.
All Wells On Map - This option does not limit the bubbles, and displays bubbles for every well on the Map Module.

Wells From WSN List File Below - This option limits the bubbles to only the wells listed on the WSN list selected below.

WSN List File - This entry sets the location of the WSN file.

Synchronize All Items To Use This Setting - This option sets all data items on the "Data Items For Bubbles" list to use the WSN list settings.

5.17 Symbol Highlights

This function highlights wells with special well symbols, marker symbols, or picture files. This tool can be used in addition to the Attribute Map.

Optionally, each group of wells can have data items posted around the well location. Each group of selected wells is identified using a Well Sequence Number (WSN) list file. A maximum of 25 separate groups can be defined with different properties, such as, symbol type, symbol style, description and data posting.

To add symbol highlights, select Options>Highlight Symbols... from the menu bar at the top of the Map Module

Defining Well Groups

Begin with the Wells tab and proceed through each of the other tabs. Then click the "Add" button to add the group to the list. Each defined group is listed by symbol and description. A generic 'GAS' symbol is used for groups which use the current well symbol. Click the "Replace" button after making a change to a previously defined group. Drop a single group using the "Drop" button or remove all groups using the "Clear All" button.

Set the "Active" check box to the off state to disable previously defined highlight symbols but retain the template for later activation.

Wells Tab

The Wells Tab just selects the WSN list for each symbol highlight.
Highlight Selected Wells Defined by WSN File - Use the browse button (‘...’) to find and select the WSN file which identifies the wells to be highlighted.

Build WSN List File... - This button opens the Select Wells By Data Criteria tool. Here, select wells with the desired criteria, and save a new WSN list file. It's probably best to save the WSN list to a safe, regularly-backed-up location.

Symbol Tab

This tab selects the actual symbols around the wells on the Map Module.

Symbol Type

Click on one of the symbol type options listed below.

Selected Marker Symbol - Use this option when you wish to have a large circle, triangle, square, etc. plotted on top of the normal well symbol. The marker symbol is chosen from the "Markers" list box.
Current Well Symbol - Use this option when you want color-coded well symbols. Each well is plotted using the current well symbol. The color and size of the well symbol will be set by the symbol size and style attributes.

Windows Meta File - This option will plot a picture file in the Windows Meta File format, (emf or wmf), at each well location of the group. It will be sized using the symbol size attribute. Meta files are created external to Petra.

Get Symbol Color & Size

The symbol size mode attribute determines whether to use a user-defined size or the size of the current well symbol.

From "Style Tab" - Means to use the symbol size defined on the "Style Tab". Sizes are given in XY map units, i.e., feet or meters. Use this option when placing larger marker symbols over the well symbol.

From Current Well Descr. - Means to make the highlight symbol the same size as the current well symbol. Use this option along with the "Current Well Symbol" option to show color-coded well symbols.

Markers

This list sets the actual marker plotted around the selected WSN list.

Include a Slash over Marker - This option puts a slash over the selected marker. This can be useful for marking wells that fail some sort of criteria, such as wells that are too shallow or that failed to produce out of an interval.

Style Tab

This tab sets additional symbol properties, including a description and color.
Description - Enter a short text string that describes the group of highlighted wells. This text will appear in the legend.

Color - This option sets the color of the highlight symbol. Click the small browse button ("...") to choose a color.

Use Color From Current Symbol - This option just uses the color of the well symbol.

Pen Width - This option determines the line thickness of the highlight symbols. Choose from narrow to extra wide.

Symbol Size (Map Units) - Specify the height of the highlight symbol in XY map units (feet or meters).

Connect Highlighted Wells With A Line - This option draws a line between highlighted wells. This can be used as an alternative to the Display Selected Cross-Section Lines tool.

Meta File Tab

This tab appears whenever the symbol type is set to windows meta file. The meta file picture will be plotted at each well location defined by the groups WSN list.

Windows Meta File Used for Symbol - Click the small browse button ("...") to find and select the wmf or emf Windows Meta File.

Data Posting Tab

This feature allows data items to be posted for those wells in the group. Posting information is defined using a data posting template. The template must be created and saved under the data posting options located under the mapping Options>Data Posting menu.
Post Data By Wells Using Template File - Click the small browse button ("...") to locate and select the data posting template file (.dbw). LEAVE BLANK to indicate you do not wish to post data for the group.

General Tab

This tab defines properties relating to all groups.

Title Block Caption - This text string will appear as the title for the highlight symbols legend. It can be left blank if not title is needed.

Show Legend in Upper Corner of Map - Check this option on to have a legend displayed in the upper left corner of the map. This legend is not shown in zoom mode. There is also a highlight symbols legend available on the map title block.

Legend Symbol Size Factor - Enter a multiplier scale factor greater than zero to adjust the size of the legend symbol and text. For example, a size factor of 0.5 will
make the legend data 1/2 scale. A size factor of 2.0 will make the legend data twice as large.

Plot Wells on Top of Highlight Symbols - This option causes the highlight symbols to be plotted prior to plotting the well symbols so that the well symbols will not be covered up by the highlight symbols.

Save Template - You can save the highlight symbol settings for later retrieval.
Load Template - You can load previously saved highlight symbol settings.

5.18 Drainage Ellipses

The Map Module can draw elliptical drainage ellipses around well symbols on the Map Module. These can help illustrate already drained areas and aid plans for future development.

To add drainage ellipses, select Options>Drainage Radius from the menu bar at the top of the Map Module.

Drainage Area Tab

The Drainage Area Tab defines the size of the drainage ellipse for each well.

Zone/Item - To add a drainage ellipse, select the zone and item that contains the overall area drained by the specific well. Unlike the ratio and orientation for the ellipse, the size requires a data item value for every well; wells with a null value for the drainage area will not have a drainage ellipse.
**Area Units** - This drop down selects the units for the zone data item. This includes acres, square feet and meters, and hectares.

**Display As** - This drop down selects the type of area units displayed on the map.

**Minimum/Maximum** - These options set the minimum and maximum areas for the drainage radii. Wells with areas outside these limits either will not display on the map (when the "Ignore Data Outside Range" limit is selected), or just won't be any larger than the maximum or smaller than the minimum.

**Ignore Data Outside Range** - This option disables any drainage radii that are outside the minimum and maximum set on the option immediately above.

**Colors** - This tool can draw drainage radii in different colors based on their size. This button opens the [Normal Color Interval Definition](#) tool to set the desired color scheme.

### A/B Ratio Tab

The A/B Ratio Tab sets the ratio of the ellipses' semi-major axis (A) to the semi-minor axis (B). The higher the ratio, the skinnier and longer the drainage ellipse.

![Elliptical Drainage Radius Display](image)

**Zone Item** - Using a zone item allows the drainage ellipse to vary from well to well. Select the relevant zone and data item containing the ratio.

**Constant** - This entry sets a constant ratio across all wells with an ellipse.

### Orientation Tab

The Orientation Tab sets the compass direction of the drainage ellipse. Petra reads azimuth as increasing clockwise from north at 0: N = 0, E = 90, S = 180, and W = 270.
Zone Item - Using a zone item allows the direction of the ellipse to vary from well to well. Select the relevant zone and data item containing the azimuth of the drainage ellipse.

Constant - This entry sets a constant ratio across all wells with an ellipse.

Options Tab

The Options Tab controls a couple of additional option on how Petra draws and labels drainage ellipses.

Color Filled Drainage - This option fills the drainage ellipse with the color (or colors) specified on the Drainage Area tab. By default, this color fill is opaque and will obscure elements below. To change this option to a transparent color fill, select "Plot as Transparent" on the Options Tab.

Draw Color Scale Bar - When Petra uses multiple colors for the drainage ellipse, this option draws a scale bar on the map.

Outline Drainage Area in Black - This option adds a black outline to the drainage area.
This is a good option to select when the "Color Filled Drainage" option is deselected.

Multiply Each Z Value By -

Center Ellipse At Alternate Location of Fm Top - By default, Petra centers drainage ellipses on the well symbol. This option instead moves the drainage ellipse to the location of the formation top specified in the dropdown below. This can be useful for more accurately representing the location of drainage in deviated or directional wells.

Wells Tab

All Wells On Map - This option plots drainage ellipses on every well on the map. This option can create misleading maps, since it will include all wells on the map regardless of whether the produced out of the relevant formation or not.

Wells From WSN List - This option limits drainage ellipses to only wells listed on a WSN list. This option is good for limiting drainage ellipses to only wells producing out of the relevant horizon, but will need to be updated as new wells are drilled.

General Tab
Plot as Transparent - Petra normally plots drainage ellipses with an opaque color fill (when the "Color Filled Drainage" option is selected on the Options Tab). This option plots color filled drainage ellipses with a transparent color fill. This can be useful when the drainage ellipses cover other map elements.

Plot Rectangle Instead of Ellipses - This option posts a rectangle rather than an ellipse.

Load Settings - This button saves the drainage ellipse settings to an external *.DAM file.

Save Settings - This button replaces the current drainage ellipse settings with those from an external *.DAM file.

Overlay Tab

Capture Ellipses to Map Overlay Layer - This option captures the drainage ellipses to the overlay selected on the dropdown below.
R - This button renames the overlay layer selected on the dropdown menu. This can be useful for renaming a default layer name to something more descriptive.

Clear - This option completely removes all lines, text, and images from the overlay layer selected on the dropdown menu.

Include Polygon Labels - This option adds a volumetric polygon name (available on the Overlay Line Attribute's Volm Tab) based on the well's WSN.

Label Prefix - This option adds a prefix to the volumetric polygon name created by the "Include Polygon Labels" option.

5.19 Log Curve Display

The Plot Log Curves Beneath Wells tool controls how Petra displays log curves underneath well symbols on the Map Module.

To open the Plot Log Curves Beneath Wells Tool, select the button on the toolbar at the top of the Map Module, or select Options>Log Curve Map from the menu bar at the top of the Map Module.
The Plot Log Curves Beneath Wells tool (left) and log curves on the Map Module (right)

**Available Logs**

This dropdown displays all the logs available in the project. Selecting the *Digital* or *Raster* button selects the general type of log.

To add a log to the Selected Logs list, select the desired log on the Available Logs list and left click the button.

**Selected Logs**

The Selected Logs determines which logs are displayed on the Map Module.

To drop a log from the Selected Logs list, select the desired log on the Selected Logs list and left click the "<" button. To drop all logs from the Selected Logs list, left click the "<<" button.

To change the log plot order, select the or button. Logs at the top of the list are plotted first (and below) logs at the bottom of the list.

**Scale Tab (Digital)**

The Scale Tab changes the display settings for the selected log curve on the Selected Logs list. Note that the Scale Tab changes appearance based on whether a digital or raster log is highlighted on the Selected Logs list.

![The Plot Log Curves Beneath Wells Scale Tab (Digital Log Selected)](image)

**Track** - This entry sets the log’s track, or relative position against the well symbol. In the screenshot above, the GR curve is set to track 1, which is immediately to the left of the well symbol.
Log Scale

Compute Optimum Scale - This option dynamically computes the scale range at each well so that the log fills the track regardless of the data range. This option normalizes the scale so that all wells have the same appearance. Since this option changes the scale for every well, it can be misleading for quantitative analysis of well data.

Set Scale Range - This option sets a fixed left and right scale for the log curve. The "Defaults" button calculates a scale range that is 2 standard deviations around the mean using the first 20 wells with data.

Log 10 Scale - This option plots the curve on a logarithmic plot. Log scale values must be greater than zero and are normally entered as powers of 10.

Shading

This section sets how Petra draws the log curve.

Do Not Shade - This option just plots the plain curve without any shading or fills.

Shade Less Than Cutoff - This option fills the log curve when the log curve values are below the specified "Cutoff Value." Note that this option uses the "Color Below Cutoff" dropdown menu.

Shade Greater Than Cutoff - This option fills the log curve when the log curve values are above the specified "Cutoff Value." Note that this option uses the "Color Above Cutoff" dropdown menu.

GeoColumn Shading - This option enables the geocolumn shading, which fills the space under the log curve based on a log curve's values. Selecting this option enables the GeoCol Tab on the far right side of the Plot Log Curves Beneath Wells Tool. The GeoCol Tab controls the specifics of how Petra uses geocolumn shading.

Use Aliases - This option uses log curve aliases when the selected curve is absent. Disabling this option will force Petra to only use the exact curve name.
Use Transparent Color Fill - By default, Petra uses an opaque color fill that can obscure other items on the map. This option instead uses a transparent color fill that can still display items below the log curve display.

Put Raster Pay on Images - This option plots the raster pay intervals on the log.

Clip at Track Bounds - This option clips log data beyond the...

Scale Tab (Raster)

The Scale Tab changes the display settings for the selected raster log on the Selected Logs list. Note that the Scale Tab changes appearance based on whether a digital or raster log is highlighted on the Selected Logs list.

The Plot Log Curves Beneath Wells Scale Tab (Raster Log Selected)

Track - This entry sets the log's track, or relative position against the well symbol. In the screenshot above, the resistivity raster log is set to track 2, which is immediately to the right of the well symbol. Particularly for raster logs, it's often useful to put different group names in different tracks to prevent overprinting.

Use Aliases - This option allows Petra to use raster group name aliases. Raster aliasing forms a list of "equivalent" raster group names - when the primary group name is missing, Petra attempts to substitute another group name instead.
Transparent Color Fill - By default, Petra uses an opaque color fill that can obscure other items on the map. This option instead uses a transparent color fill that can still display items below the log curve display.

Plot Raster Pay on Images - This option displays all raster pay intervals on the log.

Clip at Track Bounds - This option trims the raster group on the edge of the track. Since Petra automatically scales the raster image to the desired height and width, this option is really only useful for digital logs.

Tracks Tab

The Tracks section applies to all logs plotted and contains options for setting the track width, height, and scale. The track dimensions define a rectangle in which each log is plotted.

Select or enter a “Track Width” value in units equivalent to the XY units or the map, i.e., feet or meters. The track width will be scale independent and will shrink or expand as the map scale changes.

Track Height

This option sets the height of an individual log curve.

Map Units - This option sets the height of the curve in the XY units on the Map Module. Since the height is in map units, the size of the curve will change proportionally by zooming in and out.

Depth Scale - This option sets the height of the curve in a set scale. For example, if the depth scale is 100 feet/inch, then 100 feet of log would occupy a space of 1 inch below the well spot. The size of the track does not change with the scale of the map; practically, this can lead to messy maps when fully zoomed out.

Depth Scale Units - This dropdown sets the scale units of the track.
**Track Gap** - This option adds additional space between the well symbol and the top of each track.

**Draw Track Outlines** option draws a rectangle at the track boundaries.

**Opaque Background** - This option draws an opaque background for all tracks. This makes the log curves easier to see, but can obscure other features on the map.

### Depths Tab

The Depths section shows the depth range over which the log curves will be displayed.

**Sample Decimation** - This option decimates the data to only export every N'th sample. Setting this value to 2, for instance, would only export every other data point. Setting this value to 5 would only export every 5th sample. By default, this option is set at 1 to export every datapoint in the curves.

**Set Depth Range** - In the Set Depth Range box, select the relevant top, MD, or TVD button. For MD and TVD, select the relevant button and enter the adjacent depth in the entry field. For tops, select the desired top from the “Fm Top Name” dropdown box. Notice that an offset can also be added or subtracted to the fm top; this offset will include data points above or below the actual fm top depth.

To set depths by a zone’s interval definitions, select the desired zone on the “Set Upper and Lower Depths From Zone” dropdown menu. Note that the WELL zone by default covers -1M MD to +1M MD, so it should cover the entire footage of all wells.
Tops Tab

The Tops Tab superimposes log curves on top of the displayed log curves.

### Draw Fm Tops

- **Draw Fm Tops** - This option enables or disables the formation tops on the log curve plot. Disabling this option turns the tops off, but retains the settings.

### Use Top Aliases

- **Use Top Aliases** - This option uses top aliases for the export. In practice, this option will attempt to replace the missing top with one of the other "equivalent" tops on the alias list.

### Supress Source Code from Label

- **Supress Source Code from Label** - By default, Petra adds every formation top's source code. This option removes the source code, and only plots the name of the top on the label.

File Tab

- **File Tab** - The File Tab saves the current settings to an external file or restores settings from an external file.
The Plot Log Curves Beneath Wells File Tab

Save - This button saves the current settings to an external file.
Load - This button replaces the current log curve settings with the settings from an external file.

Options Tab
The Options Tab changes how Petra handles shifted logs.

Clear DB Shifted Logs - This option resets the curve shifting stored in the database. This will remove all log curve shifting for all wells in the database, which will affect all users.

Repositioned Logs
This section controls how Petra handles repositioned log curves.
Disable Shifted Logs - This option temporarily disables any log curve shifting. The project retains the settings.
Use Offsets From DB - This option uses the curve shifting normally saved in the database.

Use Offsets From File - This option uses log curve shifting stored to an external file. For more information on external offset files, see Data Offsets File Manager.

Wells Tab
The Wells Tab can limit the wells displaying logs to only those wells on a WSN list. Wells not on the list will not display log curves.

The Plot Log Curves Beneath Wells Wells Tab

All Wells - This option allows log curves for all wells displayed on the Map Module.

Wells From the WSN List Below - This option only displays log curves for the wells on the user-selected WSN list selected below. Wells not on the WSN list will not display any curves.

GeoCol Tab
The GeoColumn tab provides options for displaying a curve using "geocolumn" shading. The GeoColumn feature shades a curve with multiple colors based on curve values.
Shading Direction - This option sets the direction of the shading. The shading can be to the left or right of the log curve.

Log Used For Shading - The values from the curve selected here are used to define the color "cutoff" ranges. This curve can be the same curve as being shaded or can be any other curve.

GeoColumn Base Line Value - Shading occurs from the curve traces back to either the track edge or a specified curve value.

5.20 Map Measure Tool

The Map Measure tool displays the distance and other information between two points on a user drawn line.

To use the Measure Tool, select Tool>Measure or the button on the toolbar at the top of the Map Module. First, left click anywhere on the map to set the start point. This draws a line between the start point and the cursor. Petra will display the distance, endpoint LatLon (or XY), the dx and dy in map units, and angle between the start and end points in the lower left module of the Map Module.

To display the endpoint's XY location instead of LatLon points, select the "Measure Tool Shows XY instead of LatLon" option on the Map Margin and Preferences tool.

To display distances in miles/kilometers rather than feet/meters, select the "Measure Tool Shows MILES or KM" option on the Map Margin and Preferences tool.
5.21 Map Monthly Production Chart

The monthly production chart displays up to 3 monthly production variables as a small graph next to the selected wells.

To set up monthly production charts select the button on the Map Module Toolbar, or select Options>Production Charts... from the menu bar at the top of the Map Module.

![Map Module with Monthly Production Charts](image)

The Map Module with Monthly Production Charts

Prod 1/2 Tab
Years Tab
Options Tab
File Tab
Wells Tab
5.21.1 Map Monthly Production Chart Prod1/2 Tab

The Prod 1 and Prod 2 Tabs set the production data shown on the production chart.

**Production Stream** - This dropdown selects the individual production stream. By default, the OIL, GAS, and WATER and water streams are set in green, red, and blue. Select "None" to disable the graph.

**Cumulative Values** - This option displays cumulative values for the selected stream at the bottom of the plot.

**Auto Scale** - This option automatically scales the selected production stream to use
the desired logarithmic decades set on the Options Tab.

**Linear** - By default, Petra plots production values on a logarithmic scale. This option forces Petra to instead use a linear scale.

**Manual Y-Max** - This entry specifies a maximum for the selected production stream. Values above this plot will be off the top of the chart. Note that the minimum will be determined by the number of log cycles.

**Color Box** - This bar sets the color of the stream on the plot. To change the color, select the color box, and select a new color on the

### Suppress Y Axis
- This option suppresses the labels on the Y axis.

#### 5.21.2 Map Monthly Production Chart Years Tab

![Years Tab](image)

The Years Tab sets the extents of the X axis

**Years**
Automatic - This option sets automatic scaling for the X axis of the production chart to the first and last month of production.

From & Through - These entries set limits on the duration of production data. By default, Petra displays data from 1900 through 2100, which will be much too big a range for most applications.

Include Historical Production in Manual Mode - Some states record historical production in a single historical year labeled "0." This option includes this historical year 0 in when years are set manually.

5.21.3 Map Monthly Production Chart Options Tab

The Options Tab sets some of the details and scaling for the monthly production charts.

Use Common Scale On All Graphs - This option forces all 3 graphs to use the maximum computed scale.

Number of Log Cycles on the Y-Axis - This entry sets the number of logarithmic decades.

Position Relative to Well Symbol - This option sets the location of the monthly production plot around the well symbol.

Text Scale Factor - This option resizes text. For example, setting this value to 1.5 changes the text to 150% of the default size.

Year Label Decimation - This option decimates the year labels by the specified number. As an example, setting this option to "5" will only display every 5th year label.

Plot Minor Y Grid Lines - This option draws the minor lines on the production axis.
With this option deselected, only the logarithmic decade markers will appear on the plots.

Plot As Opaque - This option plots the monthly production plots as opaque. Depending on draw order, this option may cover up other items on the map.

Draw Through Null Values - This option will draw a line to connect all values. By default, months with no production have gaps in the graph line.

Use Aliases - This option uses monthly production name aliases.

Suppress Labels - This option removes labels on the Y axis.

Color-Fill Charts - This option fills the area on the plots below the production curve. This can obscure other production data.

Suppress Cums - This option prevents cumulative production values from appearing on the bottom of the production charts.

Suppress Connecting Line - This option prevents a connecting line between the production plot and the well symbol.

Chart Size

Chart sizes are in - This dropdown sets the size of the production plot in inches or XY map units.

Chart Width - This entry sets the width of the production chart.

Chart Height - This entry sets the height of the production chart.

Gap Btwn Well Symbol - This option sets the space between the production chart and the well symbol.

Enlarge With Zoom - This option increases the size of the production plots when zoomed in on a smaller part of the map.
5.21.4 Map Monthly Production Chart File Tab

The File Tab saves and restores Monthly Production settings and globally changes the positioning if production charts.

Load Settings - This button loads previously saved production plot settings from a *PMO file.

Save Settings - This button saves the production plot settings to a *PMO file.

Clear Shifted Charts - This option resets all shifted charts back to the default position.

Moved Charts

Do Not Move Charts - This option overrides any manually shifted charts, and draws them back at the default position. Note that the positions are still saved in the DB and can be restored by selecting a different option.

Use Offsets from DB - This option uses the manually selected positions of the production charts.

Use Offsets from File - This option uses the currently selected file in the Data Offsets File Manager.
5.21.5 Map Monthly Production Chart Wells Tab

The wells tab section provides options for posting production plots only on a subset of the wells on the Map Module.

**All Wells On Map** - This option plots production plots on all wells on the Map Module.

**Wells From the WSN List below** - This option uses a well list to select the wells with production charts. Only wells on the WSN list will display production plots.

5.22 Seismic Line Mapping

The seismic mapping options provide settings for posting seismic shot point data. Seismic Z values can be posted and color coded for a quick line miss tie check.

Enable or disable seismic data posting by setting the "Seismic Active" check box at the bottom of the screen.

Posting Options Tab

**Plot Line Names** - This option causes each seismic line to be labeled at its starting and ending shot point.

**Plot SP Symbols** - This option plots a winged circle at the shot point location. The size and decimation interval can be set (see below).

**Plot SP Numbers** - This option labels shot points with the shot point number. The size and decimation interval can be set (see below).
Connect SPs with a Line - This option draws a straight line from shot point to shot point. This option helps delineate lines when decimating shot points.

Color Coded Lines - When checked, line names and the connecting line between shot points will be drawn using the color assigned to each line. Otherwise, the color assigned in the "Display>Colors" option will be used.

Plot Line End Pts Only - Activating this option results in only the starting and ending shot points being plotted. This option works best in conjunction with the line connection option and can provide a quick display when seismic details are not required.

Use Default Line Color Only - This option overrides the color that has been set for each seismic line. The default color can be changed using the Display>Colors option.

Show Active Lines Only - When this option is selected, only those seismic lines which have been designated as active in the seismic module will appear on the map.

Include Seismic In Auto Limits Mode - The auto map limits mode computes the map limits from the well locations. Set this option to have the seismic data included in this calculation.

Sizes - Select the symbol and text sizes for the shot point symbols, shot point number labels, and line end point labels. The Text Gap size controls the white space between the shot point symbol and the posted number or Z value. Select the "Enlarge With Zoom" option if you want the symbol and text sizes to increase whenever you zoom in.

Decimation Intervals - This section controls the intervals for posting shot point symbols and labeling shot point numbers. When the "Multiples Only" option is active, only those shot point numbers which are evenly divisible by the selected interval will be plotted. If not selected, then every Nth shot point (N=interval) will be plotted.

SP Number Position - The shot point number can be plotted to the left or right of the symbol.

Z Data Tab

The Z Data tab controls posting and color coding Z values.

Z Value - Choose the seismic Z value to be plotted.

Z Value Posting - To post a Z value by a shot point location, set the "Post Z Value" check box and select the appropriate decimation "Interval", text "Size", and number of "Decimals" to the right of the decimal point when formatting the posted value.

Color Coded Z Values - This section defines the attributes for color coding the Z value. Activate this option by setting the "Color Coded Z Value" check box. The "Z Color Range" button invokes the Z color palette for defining the range and interval of
the color scale. Use the "Compute Z Range" button to search the seismic Z values for an appropriate default color range. Set the "Cell Size (inches)" value to the preferred size of the color square plotted at each shot point symbol. Color-coding uses the "Interval" from the "Z Value Posting" section.

5.23 Dip Symbols

The Dip-Azimuth Indicators tool adds dip and strike indicators to the Map Module. Petra can either use dip and strike from zone data, or from an external data file. Note that dip symbols from zone data are limited to well locations, while external data files can display anywhere on the map.

To add dip highlights, select Options>Dip Symbols from the menu bar at the top of the Map Module.

General Tab

The General Tab sets the data type for the dip and azimuth data. Petra can either use dip and azimuth data from a data item in the database or from an external file.
Dip & Azimuth Data Stored in Zone Database - This option sets the dip and azimuth for each well from two zone items. This plots dip and azimuth at well locations, and will create the Zone Tab.

Dip-Azm Data Loaded From an External File - This option loads dip and azimuth from an external text file. This option isn't limited to posting dip and azimuth at well locations, and can actually plot the symbols anywhere on the map. This option requires access to the external file - moving or changing the file name will remove the dip symbols. This will create the "External File Tab.

Zone Data/External File Tab
Dip Data

These two dropdowns set the location of the dip data item. The upper dropdown sets the zone, and the lower dropdown sets the specific data item.

Azimuth Data

These two dropdowns set the location of the azimuth data item. The upper dropdown sets the zone, and the lower dropdown sets the specific data item.

Options Tab

Dip Symbol Size - This entry sets the size of the dip symbols in map units. Since these symbols are in map units, they will enlarge and shrink with zoom.

Symbol Position Around Location - This dropdown sets the position of the dip symbol around the well symbol. Dip symbols can be above, below, left, right, and centered.
right on top of the well symbol.

**Gap Between Well and Dip Symbol (XY Units)** - This entry sets the spacing between the well and dip symbol in map units. By default, this is set to 100 units. Since this distance is in map units, it will enlarge and shrink with zoom.

**Azimuth Representation**

There are a few different conventions for strike compass directions. This section tells what the azimuth numbers actually represent.

**Angles Measured in Direction of Dip/Strike** - This dropdown specifies whether the azimuth value represents the compass direction of the dip or the strike.

**Angles Measured in Clockwise from North** - This option sets the azimuth as measured clockwise from north. North is 0, East is 90, South is 180, and West is 270.

**Angles Measured in Counter-clockwise from East** - This option sets the azimuth as measured counterclockwise from East. East is 0, North is 90, West is 180, and South is 270.

**Plot Dip Labels** - This option adds labels for the dip. Deselecting this option will just add the dip symbols.

**Dip Label Size** - This option sets the size of the dip label. Since this distance is in map units, it will enlarge and shrink with zoom.

**Include Azimuth with Dip Label** - When the "Dip Label Size" option is selected, this option appends the azimuth data to the end of the dip label.

**Ignore Shifted Symbols** - This option posts the dip symbol at the original well location when well symbols have been shifted.

### 5.24 Lat-Lon and X-Y Ticks - Map

Maps can have latitude-longitude and/or x-y ticks labeled around the map edges. To add ticks, select **Options>Ticks** on the menu bar at the top of the Map Module.

**Lat-Lon Tab**

This section controls the display of LatLong ticks and labels. The "Show Lat-Lon Ticks" option enables LatLon ticks.
Compute Optimum Tick Interval From Map Scale - This option automatically calculates and posts LatLon ticks on the map.

Use The Following Tick Interval - This option specifies a particular lat-lon tick-labeling interval in degrees, minutes, and seconds. As an example, 0-30-0 would draw and label ticks at 30-minute intervals.

Label Direction

Internal Inward - This option draws the labels facing outward from the map.

Internal Outward - This option draws the labels outwards from the map.

Label Map Border - This option draws labels horizontally around the edges of the map.

In Gutter - This option draws ticks in the gutter. Note that the gutter is set with the Map Margins and Preferences tool.

Visibility

Show Lat-Lon Ticks - This option enables LatLon ticks on the Map Module.
Hide Lat-Lon Ticks - This option disables LatLon ticks on the Map Module.
No Internal Ticks - This option displays only the ticks inside the data limits.
Draw Lines - This option adds lines across the the LatLon Ticks.

X-Y Tab
This section controls the display of XY ticks and labels.

Compute Optimum Tick Interval From Map Scale - This option automatically calculates and posts XY ticks on the map.
Use The Following Tick Interval - This option specifies a particular XY tick-labeling interval in degrees, minutes, and seconds. As an example, 0-30-0 would draw and label ticks at 30-minute intervals.
Plot Outer Ticks Only - This option suppress all XY ticks except the outer edge of the map.
Fill Border Corresponding to XY Values - This option adds a filled region between xy points. This option makes it a little easier to see the distances between XY ticks.
Draw Lines Instead of Ticks - This option adds lines across the LatLon Ticks.

Text Angle

Normal - This option draws the labels along the outer border of the map. These labels will be horizontal along the top and bottom of the map, and vertical on the left and right edges.

Rotated - This option draws the labels at right angles on the outer border of the map. These labels will be vertical along the top and bottom of the map, and horizontal on the left and right edges.

Visibility

Show XY Ticks - This option enables XY ticks on the Map Module.

Hide XY Ticks - This option disables XY ticks on the Map Module.

Sizes Tab

This section controls the sizes of the tick labels and other attributes.
Lat-Lon Ticks - This option sets the size and style of the LatLon labels. Note that LatLons can be displayed in Degrees Minutes Seconds, Degrees Minutes, or in decimal degrees.

X-Y Ticks - This option sets the size and style of the XY labels. The "Label Every Nth" option decimates the XY ticks labels to only every Nth tick.

5.25 Post IP/Formation Tests

Petra can easily post IP and formation test information on the Map Module. Note that these IP and formation tests are in separate tools, but the two tools are very similar and work in almost the same way.

To open the IP Tests tool, select Options>Post IP Tests.

To open the Post Formation Tests tool, select Options>Post DSTs.
The IP and Formation Tests Items Tab

- **Items Tab**
- **Fm Name Tab**
- **Test Type Tab**
- **Dates Tab**
- **Style Tab**
- **Options Tab**
- **File Tab**

### 5.25.1 IP/FM Test Items Tab

The Items Tab sets the specific entries on the Map Module. To open the IP Tests tool, select **Options>Post IP Tests**. To open the Post Formation Tests tool, select **Options>Post DSTs**.
To add a specific test item, select the desired test item on the "Available Test Items To Post" list, and select the ">" button.

To add all test items, select the desired test item on the "Available Test Items To Post" list, and select the ">>" button.

To remove a specific test item, select the desired test item on the "Selected Test Items To Post" list, and select the "<" button.

To remove all test items, select "<<" button.

### 5.25.2 IP/FM Test Fm Name Tab

The Fm Name Tab limits the IP or DSTs on the Map Module to specific formation names. Tests not matching the names on this screen won't plot on the map.

To open the IP Tests tool, select Options>Post IP Tests.

To open the Post Formation Tests tool, select Options>Post DSTs.
Use Fm Names - This option enables or disables the formation name filtering.

Search DB For Fm Names - This option adds a list of the DST or IP formation names in the project. Selecting a name from this list will add it to the search criteria.

**5.25.3 IP/FM Test Type Tab**

This tab limits the posted tests only specific kinds of tests.

To open the IP Tests tool, select Options>Post IP Tests.

To open the Post Formation Tests tool, select Options>Post DSTs.
Preferred Test Only - This option only posts the tests with the "Preferred Test" flag set on Production Test Details window available on the IP Tests Tab or the FM Test Tab.

IP Tests Only (Post IP Tests Tool) - This option restricts the tests to only IP tests.

Any Test Type - This option does not limit the tests by type, and will plot anything. This option is on by default.

Selected Types - This option restricts the tests on the Main Module to only the tests with test types that match the user-entered text. Note that multiple types can be entered.

5.25.4 IP/FM Test Dates Tab

The Items Tab sets the specific entries on the Map Module.

To open the IP Tests tool, select Options>Post IP Tests.

To open the Post Formation Tests tool, select Options>Post DSTs.
Limit Tests to Those Within The Following Date Range - This option enables a date restriction for the tests plotted on the Map Module. Tests not inside this range will not plot on the Map Module.

From/To Date - These two entry boxes set the start and end dates in MM/DD/YYYY.

Limit Wells to Those Within the Following Depths (DST Only) - This option enables a depth restriction to the DSTs plotted. Only DSTS within a specified depth range will plot on the Map Module.

Set Depths (DST Only) - This opens the Set Depth Range tool that limits the tests to those within a depth range set by formation tops, a constant depth range (in MD, TVD), or a zone's interval definition.

5.25.5 IP/FM Test Style Tab

The Items Tab sets the specific entries on the Map Module.

To open the IP Tests tool, select Options>Post IP Tests.

To open the Post Formation Tests tool, select Options>Post DSTs.
Text Position - This option sets the location of the text relative to the well symbol.

Text Size - This option sets the text size. The Post IP tool can post data in either XY units or inches, while the Post Formation Tests Tool can only post in XY units.

Text Color - This option sets the text color. Select the box or the "..." button to open the color dialog.

Text Justification - This option sets the location of the text relative to its position. Text
can be to the left, right, or centered.

**Font** - This dropdown sets the font used for the IP of DST posting. By default, this is set to Arial.

**Gap Between Well and Posted Text** - This entry sets the gap between the well and the posted text. The Post IP tool can set this gap in either XY units or inches, while the Post Formation Tests Tool can only set this gap in XY units.

**Text Size Methods (Post IP Tests Only)** - This option changes who Petra sets text size and gaps. The Inches option will set distances and text sizes in inches, which stay the same size regardless of zoom. The XY option, on the other hand, will keep text and gaps at a set XY units on the map, which will scale with zoom.

### 5.25.6 IP/FM Test Options Tab

The Items Tab sets the specific entries on the Map Module.

To open the IP Tests tool, select **Options>Post IP Tests**.

To open the Post Formation Tests tool, select **Options>Post DSTs**.

![IP/FM Test Options Tab](image)

**Display Oil as MBO** - This option divides the oil result by 1000 to display oil in the
thousands of barrels.

**Display as MMCF** - This option divides the gas result by 1000 to display gas in the million cubic feet.

**Suppress Units** - This option prevents units from displaying on the Map Module.

**Suppress Name** - This option prevents units from displaying on the Map Module.

**Opaque Text** - This option adds an opaque box immediately behind the text. This can make the text significantly easier to read, but may obscure other map features.

**Post Zero Values** - By default, these tools assume that tests with zero values are bad, so they aren't posted on the Map Module. This option forces all tests to post on the map.

**Post All Tests Matching Criteria** - By default, these tools only post the first test matching the criteria. This option forces the Map Module to post all tests.

**Do Not Draw Connecting Line on Shifted Text** - By default, Petra draws a dotted line between the well symbol and shifted IP/DST text boxes. This option disables the line between the two. This can declutter the map, but might make it difficult to connect a test to a specific well - particularly with wells with large offsets.

### Manually Shifted Text Options

Petra's default data posting can sometimes create overlapping or illegible text blocks. This section controls how Petra handles manually shifted text sometimes plot (above, below, left, and right) can be moved or repositioned relative to the well spot using the mouse. To **manually move data posting**, select the well and click the button on the toolbar to reposition the data posting box.

**Use Offsets From DB** - This option uses the data shifting saved in the project database.

**Use Offsets File** - This option uses the data offsets from the Data Offsets File Manager.

**Do Not Apply Offsets** - This option disables all manual data shifting, but retains the settings in the database. Petra will draw the data posting text boxes in the default locations.

### Automatic Overpost Resolution Mode

This tool automatically shifts data post boxes to resolve over posting conflicts.

**None** - This option turns off the automatic resolution, but retains the settings in the database. Petra will return the data post boxes to their original locations.

**Resolve All Overposting Automatically** - This option changes all overposted data post boxes.
Resolve Overposting for Items Not manually Shifted - This option moves only the text that hasn't been moved manually. This can be useful for moving some of the text yourself, and have Petra move the rest.

### 5.25.7 IP/FM Test File Tab

The File Tab restricts the tests posted on the Map Module to only those wells listed in a WSN file, and saves the tool settings to an external file.

To open the IP Tests tool, select **Options>Post IP Tests**.

To open the Post Formation Tests tool, select **Options>Post DSTs**.

[Image of IP Tests tool]

**Use WSN List File** - This option enables or disables the WSN file restriction.

**WSN List File Name** - This entry sets the location of the WSN file.

[Image of Post Formation Tests tool]

**Load Template** - This replaces the current settings on the Post IP Tests or Post Formation Tests tool with the settings from an external *.IPP (for IP tests) or *.DSP
Directional wells present unique challenges for mapping. Unlike vertical wells that have a single XY location for their surface location, tops, and TD, deviated and directional wells occupy space along a wellbore that can extend thousands of feet away from the original surface location. Accurately spotting data on a map often means posting data well away from the surface or bottomhole location.

### Enabling Directional Wells

By default, Petra’s Map Module will only display a well’s surface location and bottomhole location - both of which are connected by a straight line.

To enable directional well "work paths" which project the well's active directional survey onto the map surface, select **Wells>Directional Survey>Enabled** on the menu bar at the top of the Map Module.

### Getting Started

- Setting the directional well's symbol location
- Displaying interval data on deviated well paths
- Formation tops on deviated well paths
- Adding dip-azimuth arrows on deviated well paths

### 5.26.1 Directional Well Symbol Location - Map

This option determines the computed location of the well symbol relative to the well's surface location.

To set the location of the directional well symbols, select **Wells Directional Survey>Set Location Depth**.
Well Location Method

Maximum Survey Depth - Well symbols are spotted at the position of the deepest survey depth.

Formation Top Depth - Wells are located at a depth defined by a formation top.

Measured Depth - Wells are located at a specified measured depth value.

True Vertical Depth - Wells are located at a specified TVD value.

Depth Parameters

This section is used to specify the location depth selected in the Well Location Method.

Misc

The surface location can be connected to the bottom-hole location by either a straight line or by drawing the actual survey "worm" track.

When the worm track is drawn, it can extend all the way to the maximum depth location or stop at the well symbol.

When the Formation Top Depth Well Location Method is used, you may select to spot the well symbol associated with the formation top instead of the normal well symbol.

Options Tab

Do Not Drop Survey Worms For Regional Scaled Maps -

5.26.2 Plotting Interval Data in the Map Module

The Map Module can show and grid interval data on deviated and horizontal wells.
Petra can show a rectangular area with the interval’s pattern and color along the wellbore, each interval’s marker symbol, or both. Intervals are a good way of showing the encountered lithology, or for quickly showing the wellbore’s footage spent in, above, or below a target stratigraphic unit.

**Plotting Interval Colors**

Interval colors are plotted in a filled rectangle along the wellpath. This is useful for aerially representing continuous information in a wellbore, such as changes in lithology, biostratigraphic assemblages, or even gas shows.

In the Map Module, select Options>Interval Data on Well Path… Select the appropriate interval table to display from the dropdown, and select the “Plot Filled Rectangle” option under the Interval Indicator dropdown. With this option, Petra fills the rectangle with each interval’s color.

Filters provide more control over which intervals are displayed on the Map Module. Intervals that do not meet the filter criteria are not displayed. To create or modify a set of filters, select the “Set Filters…” button on the Filters tab.. For more information on filters see the “Using Filters” section of this document.

**Plotting Interval Data Markers**

Interval markers are along the wellpath at the top, middle, or base of the interval. Unlike the filled rectangle, interval markers can be plotted at a user-defined orientation. Interval markers are useful for representing discrete markers, such as fractures or MWD tool changes.

In the Map Module, select Options>Interval Data on Well Path… Select the appropriate interval table to display from the dropdown, and select the “Plot Marker Symbol” option under the Interval Indicator dropdown. Next, select the position of each interval’s marker relative to the wellbore (middle, left, or right of the wellbore) and the position of the marker along the interval (top, base, midpoint). Note that filters can also be applied to the interval data; only intervals meeting the filter criteria are
shown. In the example below, the “Fractures” interval table stores a horizontal line marker for every interval.

To set the direction of each marker, select the Orientation Tab. Markers can be perpendicular to the borehole, parallel to the borehole, or have a user-defined orientation, or azimuth. This user-defined azimuth can either be a constant azimuth for all interval markers in all wells, set for all intervals markers for each well by a zone data item, or for each individual interval in each well by an interval data field. When storing individual fractures in a wellbore, storing azimuth data in each interval captures the most information and allows for each marker to have its own orientation. In the example below, the AZI data field gives the compass azimuth for each fracture.

To set the size of each marker, select the Size Tab. The size of each marker can either be a constant for all interval markers in all wells, set for each well by a zone, or for each individual interval in each well by an interval data field. Note that the marker size can either be set to use map XY units, feet, or meters. Selecting a constant size of 0 sets a default marker size, as shown in the example below. The Marker Scale Factor can scale the size of a zone- or interval field-defined marker by anything between 0 and 100.
5.26.3 Formation Tops Along Deviated Well Path - Map

Formation tops and markers can be spotted along the directional survey "worm" path.

This option can be found under the map Wells>Directional Survey>FmTops On Well Path menu option.

Tops are identified by an associated well symbol plotted on the survey path. The top's position along the borehole is defined by the measured depth or subsea TVD value of the formation top. Options are available to assign a single symbol to a top for all wells or display the well symbol that is stored in the database with the top value.

Formation plotting along the well path is both enabled and disabled by clicking the "Active" check box at the bottom of the entry form.

Tops Tab

The tops tab section defines which formation tops are plotted on the deviated well track. The "Available Tops" section contains a drop down list showing all tops defined in the project.

Tops which are plotted must first be selected from the "Available Tops" section and added to the "Selected Tops" list.

To select a top for display, select the top name in the drop down list, set the appropriate symbol and color options, and click the button to add the top the "Selected Tops" list.

You may change the symbol or colors for a selected top. First, click the top in the "Selected Tops" list. Then change the options in the "Available Tops" section, and click the button to update the top with the new values.
Remove individual items from the "Selected Tops" list by clicking the button. Clear all tops from the list by clicking the button.

**Use Symbol From Data** - Choose this option if you have assigned a numeric well symbol code to the individual top values for each well.

**Use This Symbol** - Choose this option to plot the symbol selected from the drop down symbol list.

**Screen Symbol Color** - Choose the color for the symbol drawn on the screen.

**Plotter Symbol Color** - Select the color for drawing the symbol on printed maps.

**Options Tab**

This section contains the labeling and size options. The deviated borehole path can be labeled with the measured depth or TV subsea depth for each posted top. In addition, the borehole path can show ticks with depth labels at a specified depth increment.

**Text Size (in)** - Select or enter the height in inches for the depth labels.

**Label Tops** - Check this option if you want the depth for each plotted top to be labeled.

**Symbol Size (in)** - Select or enter the height in inches for all well symbols marking the position of a top.

**Depth Tick Labels**

"Do Not Label Depths" - No ticks and labels will be drawn along the well path except for those labels for each top (see Label Tops option).

"Label Measured Depth Values" - The well path is labeled at specified intervals showing measured depths down the well borehole.

"Label Subsea TVD Values" - The well path is labeled at specified intervals showing subsea true vertical depths down the well borehole.

**Depth Ticks Every** - Select or enter the interval at which measured or subsea TVD values are to be labeled along the well path. The units for the directional survey data determine the units of this value.

**Starting Depth For Ticks** - Enter the minimum measured depth to limit drawing ticks and labels along the well path. This option can be minimized over posting near well surface locations.

**Enlarge Sizes With Zoom** - Select this option to have the label and symbol sizes increased whenever you zoom in on an area.
5.26.4 Dip-Azimuth Arrows on Deviation Path

Arrows indicating direction and magnitude of dip can be plotted along the directional survey "worm" path.

To open this tool, select Options>Dip/Azm Arrows On Survey Path menu option.

This feature requires two digital log curves defining the dip magnitude (dip curve) and direction (azimuth curve). Curve values must be in degrees. Arrows are drawn at specified intervals along the survey path oriented in the direction defined by the azimuth curve. The length of the arrows are either all the same length or proportional to the dip curve values.

Curves - Choose the dip and azimuth curves. Set the "Use Log Curve Aliases" if the dip or azimuth curves have been aliased.

Arrows - Options are available to set the arrow line length and arrow head size. These sizes are specified in map xy coordinates, i.e., feet or meters. When the "Proportional" option is checked, the arrow line length represents the maximum arrow length, i.e., 90 degree dip. Values with dips less than 90 degrees will have arrows proportionally shorter than the maximum. For example, a dip of 30 degrees will have an arrow that is 1/3 as long as the specified length.

Dip Labels - Optionally, you can post the dip magnitude. The dip is posted at the end of the arrow head at a height specified in map xy units.

Depth Increment - Arrows are placed along the survey path at a specified interval. This interval is given in curve depth units. For example, an increment of 100 would place arrows at 100ft (mtr) measured depth intervals along the survey path.

No. of Samples to Average - This feature allows the arrows and dip labels to represent averages of several values. For example, given a depth increment of 100 and an average value of 100, then the arrows plotted at 100ft increments would be the average of 50 samples above and 50 samples below the depth being posted.
5.27 Popup Menu Data Selection

The Map Module can add user-selected well header or zone data item to a "User Favorites" pop-up menu on the right mouse button.

To change the User Favorites, right-click on a well symbol on the Map Module, and select User Favorites->Select.
A User Favorites display with two formation tops (left), and the Well Data Selection Tool (right)

Selected Data Items

This list box displays all data items currently selected for popup menu display. To add an item to the Selected Data Items list, select the desired well header data or zone data item and select the "Add" button. To replace an item on the Selected Data Items list, highlight both the item on the Selected Data Items list and desired header or zone data item, and then select the "Replace" button. To remove a single item from the Selected Data Items list, select the item then click the ">" button. To remove all items, select the ">>" button.

The items on the User Favorites dropdown are listed in top to bottom display order. The order of an item can be changed by selecting the item then clicking the up or down arrow to move the item relative to the other items.

Well Header Data - Items are added to the popup menu by selecting the data from one of the two groups from the "Select Data Items" and clicking the Add button.

Well Header Data - This dropdown contains well header information such as UWI, well name, operator, locations, etc.

Zone Data Item - This dropdown contains zone data in the project. This also includes formation tops under the "FMTOPS" zone.

TVD Subsea Top - By default, the dropdown displays measure depth values for tops. This option instead displays TVD subsea values on the dropdown. Tops can be displayed as either measured or subsea depth.

Load/Save - Frequently used lists of data items can be saved to disk for future use. Click the Save button and specify the file name to save the list into. Use the Load button to reload the saved list.
5.28 Boundary Polygons - Creating A 9-Section Plat

The following illustrates the procedure to select an area containing only 9 sections and limiting data to only plot inside the 9-section plat.

1) Original map area limits showing 9-section plat area (in red).

2) Overlay menu showing option to select a "boundary polygon"
3) Select "9 section" area using a rectangle. You must include ALL points of the sections to be included.
After selecting the rectangle, the 9-section polygon area is outlined in red and you are given the option to keep it or not. If you keep the polygon, you are prompted to save the polygon to a "boundary polygon (.PLG) file and the map in #4 below is redraw.

4) Resultant "clipped" 9-section map area.

5) Since the 9-section polygon is saved in a "boundary polygon" (.PLG) file, you may reload the boundary polygon at any time using the "Display>Set Limits Using Boundary Polygon..." option

6) The outline of the boundary polygon is drawn using the color settings under "Display>Colors" and item called "Map Boundary Polygon"

**ALTERNATE METHOD:** Drawing a polygon and using it as a "boundary polygon"

1) Original map showing drawn polygon area (red dashed line)
2) Select the polygon and use the Overlay menu to save the polygon to a boundary polygon file.
3) Load the boundary polygon file using the "Display>Set Limits Using Boundary Polygon..." option

Note - you'll want to turn off the original polygon so it is not partially clipped by the boundary polygon.

5.29 Production Patterns - Map

Petra can automatically draw Production Patterns around groups of wells defining injector-producer patterns. Each pattern consists of a central "node" well and one of more surrounding wells. Each well in a pattern contains the percentage of production allocated to the pattern. Wells that belong to more than one pattern will have less than 100 percent allocated to each pattern. An "auto allocation" function can be used to compute the allocations based on sharing between patterns or angles around wells.

Probably the easiest way to use production patterns is to use the toolbar. To open the toolbar, select Tools>Production Patterns>Pattern Tool Bar on the top of the Map Module. Alternatively, select Tools>Production Patterns> to select individual tools.
or **Add Pattern** - This option starts the process of defining a new pattern of wells to the production pattern list. After choosing "add pattern", first click the left mouse button on the central NODE well. Then, left-click each well that is part of the pattern. Finally, click the right mouse button to end. A pattern definition screen will be displayed so you may set the percent allocations (100% by default).

or **Select Pattern** - Use this option to select a pattern by clicking the left mouse button on the NODE well. After selection, the pattern will be highlighted in green. Once highlighted, the pattern can be modified (with the pattern properties option) or deleted (with the trash can button).

or **Deselect Pattern** - This option deselects a highlighted pattern.

or **Pattern Properties** - This option opens the Prod Pattern Definition tool (see below), which can view or modify the pattern's well list and production allocation.

or **Delete Pattern** - This option removes the selected pattern. Note that Petra will ask for a verification will be prompted to verify that you want to delete the selected pattern.

or **Clear All Patterns** - All patterns will be removed from memory. Be sure to save a pattern file if you wish to retain the patterns.

or **Load Pattern File** - Use this option to reload a saves production pattern file (*.PAT).

or **Save Pattern File** - This option will save the production patterns to a file for later retrieval (*.PAT).

or **Create Pattern Polygons** - This function uses the wells in the patterns to construct and store closed polygons in the map overlay facility. These polygons can then be used for volumetrics.
**Compute Pattern Volumes** - This function computes a monthly production stream that is the summation of all wells in a pattern, multiplied by the appropriate allocation percentage. The resulting "allocated" production stream is stored in the NODE well.

**Pattern Tool Bar** - This function enables a small floating tool bar containing quick buttons for adding, selecting, deleting, etc. production patterns.

**Prod Pattern Definition Tool**

The Prod Pattern Definition tool sets the well's pattern name, wells, and allocations.

**Pattern Name** - Each pattern has its own name. By default, Petra sequentially names patterns as P1, P2, P3, and on.

**Pattern Wells** - This list displays the wells in the pattern. Note that the pattern's node well has a "><>NODE" annotation.

**This Is the Node Well** - This entry sets the node well in the pattern.

**Allocation** - This entry changes the allocation for the well selected on the Pattern Wells List. Select the well, set the allocation percentage, and select the "Apply" button.

**Drop Well** - This button removes the well selected on the Pattern Wells List

**Add Well** - This option adds a well by the well's UWI/API number.
Allocating Production

Auto Allocate Production - This tool computes the allocation percentage for wells in multiple patterns. This tool will compute the percentages between all patterns in the project.

Method 1

Petra sets the percentages for each well by the number of shared patterns. If a well is common to two patterns, the well's allocation percentage is 50% for each of the two patterns.

Method 2

This tool computes the angles formed by a well and its nearest neighbors in the pattern. The allocation percentage is the angle divided by 360.
5.30 Displaying Cross-Sections - Map

The Map Module can display cross-section lines.

Show Current Section on Map

This option displays the current cross section in the Cross Section Module. As the cross section changes, so will the outline on the map. To enable or disable this display, select CrosSection>Display Current Section on Map on the menu bar at the top of the Map Module.

Show Selected Sections

This option displays the outlines of multiple saved cross sections. In contrast to the "Show Current Section on Map" tool, this only displays the outlines of *.CSP files, though it has more options.

To enable or disable this display, select CrosSection>Display Selected Cross-Section on Map on the menu bar at the top of the Map Module.
Available Cross Section List

This list displays the available saved cross-section line files (*.CSP). By default, this tool will look in the user's Parms directory. To change the directory, select the "Browse" button and navigate to the location of other cross section files.

Add - This button adds the currently selected cross section file or files to the "Selected Cross-Section Lines" list. Only files on the "Selected Cross-Section Lines" list will be displayed.

Drop - This button drops the currently selected cross section file or files from the "Selected cross-Section Lines" list.

Clear - This button drops all cross section files from the "Selected Cross-Section Lines" list.

Selected Cross-Section Lines

The Selected Cross-Section Lines list displays the cross section that will be displayed on the map module. Selecting a cross section here also allows the specific properties below to be changed.

Properties

Start Label - This entry sets a label at the start of the cross section selected on the Selected Cross-Section Lines list. This can be useful for A to A' type labels.

End Label - This entry sets the label at the end of the cross section.

Color - This option changes the color of the cross section line displayed on the map.
Label Size - This option changes the size of the start and end labels at the edges of the cross section line. Note that this is in XY units, and will change with zoom.

Label Gap - This option changes the size of the gap between the label and the edges of the cross section line. Note that this is in XY units, and will change with zoom.
6 Cross-Section Module

The Cross-Section Module displays a profile view of a selected set of wells, generally with some combination of wireline log data, formation tops, and completion data. These cross sections demonstrate structural or stratigraphic relationships, and illustrate reservoir attributes.

To open the Cross-Section Module, select the button on the Main Module toolbar, or select Tools>Cross-Section on the menu bar at the top of the Main Module. This tool is also commonly opened directly from the Map Module whenever wells are selected for a cross-section.

For pure top picking, the Log Correlation Tool provides a streamlined interface with fewer plotting and display options. As another alternative, the Slip Log Module displays and pick tops on up to four horizontal raster logs.

Getting Started

Basics
- Selecting Wells for the Cross Section
- Changing the Spacing Between Wells
- Setting a Depth Range

Logs and Tops
- Displaying Digital Logs
- Displaying Raster Logs
- Displaying Formation Tops
- Correlating Formation Tops
- Adding a Correlation Slip Box

Annotations and Data Posting
- Posting Well Data around the Well Symbols
- Adding Annotations, Images, and Faults with the Overlay
- Plotting Perfs, Tests, Cores, and Shows
- Plotting Interval Data

Basic Shortcuts and Key Definitions
Highlighting a well - single click on the well’s depth track with the left mouse button

Displaying information about the well in the map module - single click on the well’s depth track with the right mouse button.

Show the data for a selected well in the main module - double-click on the well’s depth track with the left mouse button

While correlating tops, set a well’s top value to a null value - Delete

Terminating interactive process such as screen drawing or zooming - hit ESC

During screen drawing, skip to next graphic element - Space Bar

Drop the last point picked while drawing an overlay line - Delete

Drop the last well picked while picking wells for a cross-section - Delete

Delete a selected overlay item - Use the trash can icon on the toolbar.

Scroll map during zoom mode - Shift + Arrow Keys.

Advanced Tools

Using Unassigned Tops

Adding a Color Fill between Digital Logs

Adding a Grid Profile

6.1 Selecting Cross-Section Wells

The cross Section Module can select wells in two ways: from a list, or from the Map Module

Select Wells From List

The Cross-Section Module can only use a list to select wells. To open this tool, select Wells>Select Wells>From a List... from the menu bar at the top of the Cross-Section Module.
Selecting wells from a list

The “Available Wells” list on the left shows the currently selected wells in the module, which can be sorted by WSN, UWI/API, well name and number, or label. The “Wells Selected for Cross Section” list on the right shows wells currently displayed on the Cross Section Module. To add a well to the cross section, highlight a well from the “Available Wells” list and select the “>” button to move the well to the “Wells Selected For Cross Section” list. The well at the top of this list is plotted on the far left side of the cross section, while successive wells plot to the right. Removing a well from a cross section is similar – select the well on the “Wells Selected For Cross Section” list on the right and select the “<” button to drop the well from the list. Selecting the “<<” button drops all wells from the Cross Section Module.

Since wells are arranged by header information instead of by geography, this can be a fairly tedious way of creating a cross section of geographically proximal wells. The real advantage of using the list selection method is that it’s a fairly straightforward way to add or subtract wells, or to move the order of wells around in an existing cross section. Selecting the ▲ and ▼ buttons change the position of a selected well on the “Wells Selected for Cross Section” list. Again, wells at the top of the list plot on the left side of a cross section, while those on the bottom plot to the right side.

From the Map Module

The Map Module is usually a great way of selecting the wells for a cross section. This option graphically picks the wells for the cross section in a couple of different ways.

From inside the Cross-Section module, select Wells>Select>Switch to Mapping Tool from the menu bar at the top of the Cross-Section Module. This will switch to the Map Module.

From inside the Map Module, select, CrossSection>> and the relevent method from the
menu bar at the top of the screen.

![Selecting the wells for a cross section with the Map Module]

Well-to-Well

The well-to-well option is probably the most common way to generate a cross section. To select a well-to-well cross section select the icon on the tool bar at the top of the screen. Alternatively, select CrossSection>Well-To-Well… from the menu bar at the top of the screen. Selecting this option changes the mouse pointer to a crosshair. Next, simply left-click on the first wellspot on the map to add it to the cross section. Left-click on more wells to add them to the cross section. After selecting all the desired wells, right-click to finish and jump to the Cross-Section module.

Single Well Display

The single well display works very similarly to the well-to-well option. Select CrossSection>Single Well Display from the menu bar at the top of the screen. Simply left-click on the well, and the Cross-Section Module will show that single well. This option is also available from the Main Module at Logs>Single Well Cross Section… In the main module, the cross section will show the currently selected well.
Selecting a single well cross section from the Main Module

Line and Corridor

A well-to-well cross section zig-zags from well to well, so the cross section is never actually straight. The Line & Corridor selection option allows the user to define the “line” of the cross section as well as a “corridor.” All visible wells in the Map Module falling inside this corridor will be projected onto the line at a right angle.

To create a Line and Corridor cross section, first draw a line by left-clicking at the start and end of the cross section. Next, click at some distance perpendicular to the line to define a corridor. In the example below, the corridor extends above and below the cross section line by about 1000’. To finish the cross section, right click the mouse. All visible wells within the corridor will be projected onto the cross section. It’s worth remembering that all visible wells within the corridor will be projected onto the cross section, including wells without tops or logs. In projects where recompletions are stored as a separate well (usually with an API ending with 0001), these recompletion wells will be projected into the cross section as well.
Drawing a line for the cross section (Left). Setting the upper boundary of the corridor (Right)
By default, the Line and Corridor method projects wells into the cross section at right angles. Notice that each projection line has a small rectangle, or “node” where it touches the cross section line. Moving this node changes where a well is projected into the cross section. Select CrossSection > Move Line Node Projections or Ctrl N, and then select the desired line node. Dragging this line node to a new position can change the position or even order of the well on the cross section.
6.2 Width and Margins

The Cross Section Size Options tool sets the cross section width, margins, and well spacing.

To open the Cross Section Size Options window, select Scales>Width and Margins from the menu bar at the top of the Cross Section Module, or select the button on the toolbar.

Width Tab

The Width Tab sets how spaces wells on the cross section. The primary difference is whether wells are regularly spaced, or spaced relative to their actual distance on a map.

Set Width - This option sets the total width of the cross section from the left well symbol to the right well symbol. This option is only available for the "Relative to Well XY Locations (between Well Symbols)", "Relative to Well XY Locations (Between Tracks)", and "Constant Distance Between Well Symbols (in Inches)" spacing options. Deviated wells may be wider than the specified length if any bore hole deviates beyond the left or rightmost well.

Set Distance Btwn Wells - This option sets the distance between well symbols or track edges. This option is only available when the "constant distance" spacing modes are selected.

Auto size single well cross section - This option displays single well cross section in
the center of the cross section. In more detail, this option automatically sets the cross section length to 1.0 inches when there is only 1 well selected.

**Well Spacing Mode**

This determines how wells are positioned along the cross section.

**Relative to Well XY Location (Between Well Symbols)** - This option spaces out the wells on the cross section proportional to their distances between one another. With this option, Petra plots this data relative to the well symbol, so closely spaced wells on the cross section can overplot.

**Relative to Well XY Location (Between Tracks)** - This option spaces out the wells on the cross section proportional to their distances between one another. With this option, Petra plots this data relative to the edges of the well tracks, so closely spaced wells will not overplot.

**Constant Distance Between Well Symbols (in Inches)** - This option sets a constant distance between different well symbols. With multiple log tracks, well data can overprint.

**Constant Distance Between Well Track Edges (In Inches)** - This option sets a constant distance between well track edges. This prevents well data from overprinting, but can make it more difficult to visualize structural changes between wells.

**Margins Tab**

The Margins leave blank space around the cross section. Margins are measured in inches.
The Cross Section Size Options Margins Tab

Show Margins on Screen - This option draws a dashed box on the screen to show the extents of the margins. Overlay items not inside this box will not plot.

Misc Tab

The Misc Tab controls a few additional options on how Petra draws and rescales the cross section.

The Cross Section Size Options Misc Tab

Screen Scroll Percentage - This option controls how the screen shifts when the scroll arrows are selected. The range is the percentage of the screen that remains - the default value of .75 scrolls 75% of the screen so that only 25% of the original screen remains.

Horiz Scale Text Size - This option sets the size of the horizontal scale text.

Overpost Resolution - This option sets the upper limits for Petra overpost resolution function.

Section End Labels - label the left and right side of the cross-section with annotations, such as, A and A'.

Do Not Plot Border - This option prevents Petra from drawing the border around the cross section.

Do Not Plot Heading Title - This option prevents Petra from drawing the heading title on the top of the cross-section.

Angle for Deviated Borehole Projection of Single Well Display - the angle (in
degrees) of a plane-of-projection for "single well" cross-sections. It controls the direction the deviated borehole deflects away from the well location.

6.3 Posted Data - Cross Section

The Cross-Section Module can post well header or other zone data items around the well symbols at the top of the cross section.

To add data posting around the well symbols, select Options>Data Posting... on the menu bar at the top of the Cross-Section Module.

Note that an abbreviated, simpler version of this tool is available in the Well Symbol Style menu.

Data Tab

The Data Tab sets the items to display, as well as the details on the size, font, and color of each item.

Available/Selected Data Items

Posted data items are chosen from either the "Well Header Items" or "Zone Data Items" lists. Click the appropriate button beside the item list to add the item to the "Selected Data Items" list. Remove individual selected items by clicking the button or remove all selected items using the button. Reposition selected items using the up button or the down button.

Data Item Properties

Each posted data item contains posting attributes including the position relative to the
well symbol, text color and size, number of numeric decimal places and how the value is labeled. Additional attributes can be set for formation tops including whether to use alias names and whether to post subsea values. All Z values can have the "quality" code posted following the value.

**Position** - Text items can be posted in four positions around the well spot. Select the position to place the text item Above, Below, Left or Right of the well symbol on the cross section.

**Label Style** - Several labeling styles are provided and control whether variable names are posted along with the value.

**Font** - Each line item can have a font specified from the font list.

**Text Size** - This section sets the text height for the selected data item in inches. Text will enlarge slightly when you zoom in if the "Enlarge With Zoom" option is selected. Click the ALL button to set all text to the same height.

**Decimals** - Set the number of decimal places to the right of the decimal point for numeric values. Whole numbers will still post as integer numbers. Only values with fractional parts will show the number of specified decimals.

**Text Color** - Each text line item can be plotted in a different color. Choose from the palette provided by clicking on the color cell. Click the ALL button to set all text to the same color.

**Post Subsea Top** - Use the option when posting formation tops and you want to see subsea values. Subsea values are computed as: SS=Datum-Top.

**Use Top Aliases** - If you have defined formation top aliases, use this option to have the aliases searched for when posting a value.

**Post Quality Code** - Check this option to have the quality code posted following a zone data or top item. Null values will show only the quality code.

**Post Units** - This option causes the units value to be posted following the zone or top value.

**Truncate to 1st Word** - This option truncates the data to only the first word.

**No Commas** - This option removes commas from the line.

**Active** - When the "Active" option is checked, data will be posted by each well. Uncheck the option to disable data posting.
Options Tab

The Options Tab controls a few additional options for data posting.

**Enlarge With Zoom** - By default, the Cross-Section module keeps text the same size regardless of zoom. This option proportionally enlarges text when you zoom in.

**Drop Missing Data Lines** - This option suppresses blank data lines due to missing data. Blank lines added as data lines are not suppressed.

**Opaque Text** - Check this option for posting text with an opaque background. Opaque text is useful when posting over color-filled contours.

**Drop Source Code From Labels** - This option suppresses the display of the source portion of the item name when the Label Style includes the name.

**Always Show SSTVD as SS** - This option forces Petra to always display SSTVD values as SS values.

**Gap Btwn Well And Data** - Enter the number of inches to leave as a gap between the well symbol and the posted data items.

**Line Spacing (inch)** - Enter the number of inches to separate each posted text line.

**Global Scale Factor** - Enter a multiplying scale factor greater than 1.0 to enlarge all text or less than 1.0 but greater than 0.0 to reduce the text.

**Display Dates As** - This dropdown changes how the data posting displays dates.

**Load/Save Settings** - These buttons save and load the settings on the Posting Data tool to an external *.DBW file.
Sample Tab

The Sample Tab displays a sample wellspot with the data fields selected on the Data Tab. This can be useful for quickly determining how Petra will actually print the data posting onto a plotter.

![Sample Tab Image]

6.3.1 Post Data At Depth

Well data can be posted at specific depths next to the log tracks on a cross-section. This option is located under the "Wells>Post Data at Depth..." menu.

This feature allows you to post any data stored in the tops or zone tables at a depth defined by either a top, a zone or constant depth. Figure 1, below, shows an example of two text boxes posted with different data for each box. The yellow box contains a title and 3 data items while the pink box contains one data item and no title. The yellow box has been depth referenced to the DSAND zone while the pink box references formation top 602DKOTJ.
Figure 2a and 2b, below, show the dialog screen settings for the yellow box in the cross-section displayed above.

Figure 2a - Data at Depth Dialog Screen Showing Box Properties
How To Create and Define a Data Box

1) Add New Box

Create a new data box by clicking the small "+" icon located at the top of the "text boxes" list.

2) Set Depth Reference

Set the Depth Reference section to define at what depth you want the text plotted. This can be either a formation top, a zone definition, or a constant measured depth. When a zone is used as a reference, an additional parameter is provided to specify whether the box is placed at the top, mid-point or base of the zone interval. This example uses the mid-point of the DSAND zone. Please note that a box will not be plotted if either the reference top is missing or a referenced zone's top or base is missing. It should also be noted that only zones which are defined based on formation tops should be used as a reference. For example, you should not use a zone similar to the "well" zone as a reference.
3) Set Box Properties

Set the box Title, Style and WSN List properties.

**Title** - This is optional

<table>
<thead>
<tr>
<th>Title</th>
<th>Style</th>
<th>WSN List</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box Title (Leave Blank for No Title)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DSAND</td>
<td>Color</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Size (inches)</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>Font</td>
<td>Arial Italic</td>
</tr>
</tbody>
</table>

**Style** - Choose the box type, colors, and placement. The box vertical placement defines how the box will be connected to the reference depth. The box can be positioned to the left or right of the log tracks.

<table>
<thead>
<tr>
<th>Title</th>
<th>Style</th>
<th>WSN List</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box Type</td>
<td>Outline Color</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fill Color</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Outline Thickness</td>
<td></td>
</tr>
<tr>
<td>Gap Between Track and Box (inches)</td>
<td>0.25</td>
<td></td>
</tr>
</tbody>
</table>

**WSN List** - This option allows you to restrict which wells have this box posted. You must provide a "wsn list" file containing a list of wells. If the cross-section well is in this list, then, and only then, will the data be posted.
4) Choose Text Items

Begin by selecting a data item from the Zone and Zone Item lists. Then click the "+" icon to add the item to the "Data Items in Box" list.

Next, set the data item Options and Style

**Options** - Miscellaneous posting options for a specific data item.

**Style** - How the text appears cosmetically.
Limits -

Maximum Number of Boxes is 64
Maximum Data Items per Box is 32
Maximum Title Length is 40 Characters

6.4 Depth Scale - Cross Section

The Cross-Section Depths window controls how Petra displays well depths. This includes setting cross sections as structural or stratigraphic, setting the vertical depth scale and interval range.

To open the Cross-Section Depths window, select Depths-Depth Scale... from the menu at the top of the Cross-Section Module, or the button on the toolbar.

General Tab

The General Tab sets most of the basics of the Cross-Section's depths.
Cross-Section Type

The cross-section type can be either "Structure" or "Stratigraphic". A structural cross-section has a depth interval defined by upper and lower measured or subdatum depths. A stratigraphic section has depths defined using formation tops. The upper top is treated as the relative datum and appears as a "flattened" surface.

Depth Axis Options

Show Depth Track - This option plots depths and depth ticks inside the depth track.

Label Deviated Borehole - This option labels deviated wellbores.

Depth Track on Deviated Boreholes - This option adds a MD depth track for deviated wellbores.

Round Depth Labels to Whole Nbrs - This option rounds depth labels to the nearest whole number rather than leaving a decimal.

Show Depths on Section Ends - This option displays depth ticks at the left and right edges of the cross section. For structural cross sections, these values will be in the depth range selected on the "Structure Depths" tab. For stratigraphic cross sections, these values will reflect the distance in feet or meters away from the top defining the upper depth limit.

Limit Depths By T.D. - This option prevents well tracks and data from plotting below the well's TD specified on the Main Module's Wells Tab. This can be useful for more...
accurately visualizing the depths penetrated by each well.

Limit Depths By Datum Elev. - This option prevents well tracks and data from plotting above the well's datum elevation specified on the Main Module's Wells Tab. This can be useful for more accurately visualizing the surface elevation for each well.

No Depth Label Ticks - This option prevents depth label ticks inside the depth track.

Single/Dual Label(s) in Depth Track - The "Single Label" option displays only the label specified in the "Depth Grid Lines Multiples of" option in the depth track (MD or SSTVD). The "Dual Labels" option displays both MD and SSTVD labels.

Track Width (inches) - This option sets the width of the depth track.

Track Text Size - This option sets the size of the depth track labels.

Section End Label Size - This option sets the size of the depth labels on the left and right edges of the cross section.

Vertical/Horizontal Text - This option specifies whether the depth labels inside the depth track are vertical or horizontal. Most users will find horizontal text too cluttered.

Label Format - This dropdown specifies how Petra plots depth labels. Options include simple numbers, a comma delimiting units of 1,000, and the addition of a "'" for feet or "m" for meters.

# of Decimals - This dropdown selects the number of decimals in the depth labels.

Log Curve Sample Decimation

This option decimates log curves. A value of 1 plots all log samples in the depth interval, while a "2" plots every other sample and "3" plots every third sample. This can be useful for reducing the jittery character of greatly compressed log curves.

Depth Grid Lines Multiples of

This option changes how Petra displays depth grid lines. With the MD option selected, the "Single Label in Depth Track" will display only MD. With the SSTVD option selected, the "Single Label in Depth Track" will display only SSTVD.

Depth Scale Tab
Depth Scale - This option sets the vertical exaggeration of the cross section. Note that the scale can be set in either imperial or metric units.

Depth Axis Tick & Grid Interval
These options set how Petra draws major and minor grid lines on the track grid or ticks on the depth track.

Compute Optimum Using Depth Scale Above - This option attempts to automatically calculate reasonable major and minor grid lines. This is a good default option for most users.

Use These Settings - This option instead draws major and minor lines based on user settings.

Structure Depths Tab
This tab sets the depth interval when the "Structure" depth type is selected on the General Tab.
The Cross-Section Depths Structure Depths Tab

**Upper Depth** - This option sets the upper depth for the cross section. These values can be in MD, TVD, or SS.

**Lower Depth** - This option sets the lower depth for the cross section. These values can be in MD, TVD, or SS.

**Depth Type** - This option sets the type of the depths in the Upper and Lower Depth fields. MD and TVD will increase from the datum, while SS will be relative to sea level.

**Use These Depths to Position Deviated Wells along the Cross-section** - This option adjusts the position of directional and deviated wells to produce a more accurate portrayal of the wellbore.

**Compute Using Tops** - This option selects a depth range that will display all the currently displayed formation tops.

**Compute Using Logs** - This option selects a depth range that will display all the currently displayed digital logs.

Stratigraphic Depths Tab
This tab sets the depth interval when the "Stratigraphic" depth type is selected on the General Tab.

The Cross-Section Depths Stratigraphic Depths Tab

This tab sets the depth interval when the "Stratigraphic" option is selected on the General Tab. Select the formation tops which define the upper and lower depth. Note that an offset entered in depth units extend the cross section above, or trim the cross section below the selected top. In the example above, the cross section will extend 50' above the A formation, and 250 below the B formation.

Use These Depths to Position Deviated Wells along the Cross-Section - This option adjusts the position of directional and deviated wells to produce a more accurate portrayal of the wellbore.

Correct Section for Fault Cut Gaps - This option will use the fault cuts in the database to attempt to correct for missing section on the stratigraphic cross section.

Grid Lines Tab

The Grid Lines Tab adds vertical lines and horizontal lines across the cross section. These lines can make it easier to visualize depths and the distance between wells.
**Depth Grid**
- This option draws horizontal lines across the cross section using the "Major" settings set on the Depth Scale Tab.

**Include Minor Depth Grid Lines**
- This option draws horizontal lines across the cross section using the "Minor" settings set on the Depth Scale Tab.

**Horizontal Grid**
- This option draws vertical lines between the wells to signify distances between wellbores in XY units. Note that these lines will only make sense with a well spacing that’s relative to XY Location.

**No Grid**
- This option does not draw any vertical lines.

**Grid Ticks Only**
- This option draws only ticks along the bottom of the cross section.

**Grid Lines**
- This option draws full vertical lines extending from the bottom of the cross section to the top.

**Grid Interval**
- This option sets the interval of the horizontal grid lines. Setting this entry to 1000 will draw vertical lines every 1000 XY map units (feet or meters)

**Select Well Used as Origin of Grid**
- This dropdown selects the origin, or 0, of the vertical lines. By default, Petra selects well on the far left as the origin.
Auto Flatten Tab

The Auto Flatten Tab controls how Petra creates stratigraphic cross sections from the "Flatten on..." command when right clicking on a top.

Adjust Depths to Show All Displayed Tops - This option automatically creates a depth range that displays all selected tops.

Adjust Depths Using Offsets From Flattened Top - This option uses the selected offsets above and below the top.

6.5 Digital Log Display Options

The Logs Display Options window controls how log curves are displayed on the cross-section. Options are provided for defining the log scales, color and line style and shading criteria.

For a detailed walkthrough on using these options on a variety of log curve types, see "How To Display Digital Log Curves."
To open the Log Display Options window, select **Logs>Display Options** from the menubar at the top of the Cross Section Module. Alternatively, select the button on the toolbar at the top of the screen.

**Scale Tab**

**Style Tab**

**Cutoff Tab**

**GeoColumn Tab**

**Tracks Tab**

**Misc Tab**

**Cross Over Tab**

**Lith Sum Tab**

![The Scale Tab with logs added to the “Selected Logs” list](image)

**Available Logs List**

The available logs list shows the digital log curves in the project.

**All Wells** - This option lists all curves for all wells in the project.

**Selected Wells Only** - This option lists only the curves for the wells currently selected on the cross section.

**Show Aliased Curves Only** - This option only shows curves that have been aliased. Using log aliases can greatly simplify the process of making a good template that will work for many wells.

**Selected Logs List**
The Cross Section Module only displays the logs on the Selected Logs list.

To add a log to the Selected Logs list, select the desired log on the Available Logs list and left click the "->" button.

To drop a log from the Selected Logs list, select the desired log on the Selected Logs list and left click the "<-" button. To drop all logs from the Selected Logs list, left click the "<<" button.

**Color and Shading Indicators**

Plain Line Color - Curves with no shading have a plain rectangle with the curve’s color. As an example, \(\text{SP}\) indicates that the SP curve is a plain red line.

Cutoff Shading - Curves with cutoff shading have a split rectangle. The left half of the rectangle indicates the color of the line, while the right half indicates the color of the cutoff fill. As an example, \(\text{LD}^*\) indicates that the ILD curve has a black line with blue cutoff fill.

GeoColumn Shading - Curves with GeoColumn shading have an empty white rectangle. As an example, \(\text{GR}^*\) indicates that the GR curve has a GeoColumn Shading pattern.

In the example below, the SP and %_Shale curves are plain lines - the SP curve is red, while the %_Shale is black. The GR curve’s plain box indicates a GeoColumn shading. The ILD and %_Sand’s boxes indicate cutoff shading - the ILD curve has a black line with a blue cutoff fill, and the %_Sand curve has a black line with a yellow cutoff fill.

![The Left Rectangle indicates the color and shading of the log curve.](image)

**Track Indicators**

The rectangle to the right of the curve name indicates the curve’s track, or position relative to the well symbol. In the example below, the GR and SP curves are in track 1, the ILD curve is in track 2, the NPHI and DPHI curves are in track 3, and the %_Sand and %_Shale curves are in track 4.
Every track has a given color (left). The right rectangle on the Selected Logs List indicates the curve's track (right).

6.5.1 Log Display Scale Tab

The scale tab is primarily used to add logs to the cross section, and to set the logs' scales and position around the wellbore. Note that changing the settings only applies to the highlighted log on the Selected Logs list.

The Scale Tab with logs added to the "Selected Logs" list

**Track** - This entry specifies the position of the log relative to the depth axis. Refer to the "Tracks" tab to track details.

**Label** - This entry sets the header for the log curve. By default, Petra will use the curve name.

**Left Scale** - This option sets the log value for the left side of the log scale.

**Right Scale** - This option sets the log value for the right side of the log scale.

**Logarithmic Scale** - This option plots the selected log with using a logarithmic scale. The left and right scales should be entered as powers of 10 when using this option. Note that anything with a "0" scale will disable the logarithmic option.

**Disabled** - This option temporarily hides the log trace from the display. Disabling a curve retains the settings.
Use Alias Logs - This option uses log curve aliases when the selected curve is absent. Disabling this option will force petra to only use the exact curve name.

Suppress Track Header - This option hides the log curve headers at the top of each track.

Default Log Scale - This option will set the left and right scales to the curve’s default log scale. Note that this is set on the Log Maintenance Tool or with the Save Default Scale button below.

Save Default Scale - This option sets the log curve’s default scale to the current settings on the Left and Right scale entries.

Statistical Default Scale - This option automatically fills in the left and right scale values using the statistical average from the logs of the current cross-section wells. Values are computed as 2 standard deviations from the mean. The logarithmic option is set if the minimum value is positive and the different of the maximum and minimum exceeds 500.

6.5.2 Log Display Style Tab

Style Tab

The color and style tab defines the appearance of the log trace highlighted on the "SelectedLots" list. This tab will change slightly with different shading methods.
Shading Method

This section sets how Petra draws log curves.

**No Shading** - This option just draws a plain line using the Line Color selected on the lower right corner of the Style Tab.

**Shade Using Cutoff** - This option fills in the log curve whenever it is above or below a user-specified cutoff value. Selecting this option displays the Cutoff Tab, which sets the cutoff value and color scheme.

**Geocolumn Shading** - This option fills the curve using a colorbar from a log curve. Note that geocolumn shading can color the selected log trace using values from another log curve. This option can be used to plot a litho-column type display. Proceed to the "GeoColumn Tab" to set the geocolumn shading options.

Misc Plotting Style

**Clip Log At Track Edges** - This option truncates the log outside the track boundaries when the log is outside the range defined by the left and right scale.

**Center Log Trace In Track** - This option removes the mean value of the displayed log trace resulting in the log plotting in the center of the log track.

**Discrete Points** - This option displays the log as a series of small x's instead of a continuous line. This is useful for displaying non-wireline data, such as sidewall core porosity values.

**Pay Flag Curve** - This option displays the log curve as a "step" function, which can be very useful when plotting pay flag curves.
Labeled Spikes - This option displays the log curve as a series of horizontal lines with optional value labels at the end of the spikes. Spikes begin at the minimum valued side of the track and extend toward the maximum valued side. The label size can be set on the "Misc" tab screen. A size of zero suppresses the labels.

Line Style - This dropdown sets the log curve’s pattern. This can include solid lines, and various combinations of dashes and dots.

Line Width - This dropdown sets the line width for the log trace. Note that the widths of the user-set lines (User 1, User 2, etc) are set on the Petra Program Options' Font/Graphics Tab

Line Color - This box sets the color of the selected curve. Note that this box is available only when the "No Shading" shading method is selected.

6.5.3 Log Display Cutoff Tab

The Cutoff Tab controls how a log is shaded relative to a cutoff value. This tab sets the color for the log trace as well as the cutoff shading underneath the log trace.

This tab is enabled when the highlighted log on the Selected Logs list is using the "Shade Using Cutoff" option.
Shade

The shade section sets how the cutoff shading works relative to the cutoff value.

Less Than Cutoff - This option shades the area of the curve wherever the log values are below the cutoff value.

Greater Than Cutoff - This option shades the curve wherever the log values are above the cutoff value.

Cutoff

The cutoff section sets the specific cutoff for the selected log curve.
Constant Cutoff - This option sets a specific, constant cutoff value.

Statistical Cutoff - This option sets a option provides a variable cutoff based on the mean log value and standard deviation. The cutoff value is entered as the number of standard deviations above the mean. The equation used is:

\[ \text{CUTOFF} = \text{MEAN} + (\text{SD} \times \text{USERVALUE}) \]

Curve Line Color

Choose the color to use when the log trace is less than the cutoff value. Check the associated color palette to change the color box.

Shading Color

Choose the color to use when the log trace is greater than the cutoff value. Check the associated color palette to change the color box.

Pattern

Petra can draw patterns inside cutoff shading. The left up/down button sets the pattern, while the right up/down button sets the density of the pattern.

Suppress Curve Outline - This option hides the outline of the curve. In practice, this option will leave a curve that only shows the fill and pattern.

6.5.4 Log Display Tracks Tab

Every digital log curve has a "track" that determines the position of the log curve relative to the wellbore. Each log trace is plotted in one of the 11 predefined track positions relative to the well symbol by assigning a track number to each log. As shown in the illustration below, tracks 1 through 7 are single width tracks while tracks 0, 8, 9 and 10 are double width tracks. Tracks are displayed as a series of depth grid lines and one or more vertical subdivisions. Setting the width, number of grid divisions and logarithmic scale option can customize tracks. Each track grid can be visible or hidden from view.
The Tracks Tab

A well with Track 1 (Left), Track 2 (Center), and Track 3 (Right)

Track Definitions
The track definition section contains a list showing each of the 11 tracks.
Select the desired track to modify it. Note that the selected track is indicated by a "<==" symbol to the right of the name.

Show - This option toggle the track between hidden and shown. Hidden tracks are indicated by the symbol in the track list. Note that log curves can still display in hidden tracks. Alternatively, double-click a track to toggle its status.

Width - This option sets the width of the selected track in inches.

Divisions - This entry sets the number of vertical scale lines for the track. When the
Log10 option is selected, this entry sets the number of decades.

**Bold Every** - This option sets the interval for plotting bold division lines. As an example, setting this value to 2 will plot every other vertical division line as bold. Set this value to zero if no bold division lines are to be plotted.

**Log10** - This option plots logarithmic decades on the track, and should be used for logarithmic log curves are plotted in the track. Each track division display an additional 9 intervals.

**Reverse** - Check this option to plot Logarithmic grid lines in reverse order, i.e., 0.9, 0.8, 0.7,...,0.1. Use this option to make the log10 grid lines match a log10 curve plotted with the maximum value on the left and the minimum value on the right.

**Log10 Offset** - This entry sets the starting point for the logarithmic track grid. Normally, logarithmic tracks start at offset 1 representing log scales such as, 0.1,1.0,10.0,100.0,etc. However, increasing the log10 offset to 2 will draw the grid to represent scales such as, 0.2,2.0,20.0,etc. Use an offset of 3 for 0.3,3.0,30.0,etc.

**Suppress Trk Grid** - This option prevents the selected track from displaying horizontal or vertical lines.

**Suppress Outline** - This option prevents the selected track from displaying the outer border of the track and any header labels.

**Append Tracks 8, 9, 10** - By default, Petra displays tracks 8,9, and 10 as a double track over tracks 2 & 3, 4 & 5, and 6 & 7 respectively. This option instead appends tracks 8, 9, and 10 onto the far right of the normal tracks.

**Default Log Widths** - This option sets all track widths to 1.0 and 2.0 inches.

**Sync** - This option sets the digital log track widths to be equal to the raster log track widths. This can be useful when working with mixed digital and raster logs.

**Paper Log Widths** - This option sets all track widths to match standard paper logs of 2.5 and 5.0 inches.

**Track Label Height (inches)** - This option sets the text size for the log curve labels at the top of each track grid.

**Depth Track Pos** - This option changes the location of the depth track. By default, the depth track is set to the left of track 2.

### 6.5.5 Log Display Misc Tab

The Log Display Misc Tab sets some additional options on how Petra draws digital
logs on the Cross Section Module.

### The Misc Tab

**Suppress Log Curve Scale Headers on Tracks** - This option prevents log curve labels from appearing above the log tracks.

**Include Curve Headers On Disabled Tracks** - This option draws the log curve labels on top of tracks even when the tracks are disabled.

**Plot Track Grids After Log Curves** - This option draws track grids on top of the log curves. This can be useful for more easily reading log values.

**Suppress Track Grids If No Curves are Plotted** - This option prevents tracks from being drawn when the well contains no log curves.

**Use Curves From Other Well Completions** - This option uses log curves from the well's completions.

**Plot Shading Btwn Logs After Other Shading** - This option draws the shading between logs last, to ensure that it is on top of other shading.

**Suppress Track Grids on Deviated Wells** - This option prevents track grids on deviated wells. This can be useful for a cleaner, simpler appearance.

**Show Tracks in Zoom Mode Only (Screen)** - This option prevents track grids from appearing on the full cross-section. The vertical and horizontal scale lines only appear when the user is zoomed in on a portion of the cross-section.

**Display Curve Units In Header** - By default, Petra only displays the curve name and left and right values. This option also displays the log curve's units. Note that these units can be changed in the Log Maintenance window available from the Main Module's Logs Tab.

**Show Aliased Curve Name in Track Header Label** - By default, Petra will display the curve name substituted in for an aliased log. This option instead forces Petra to display the aliased log even if another curve name is used. The Legend Label Method
sets how this label is displayed.

**Spike Curve Labels Size** - This option sets the size of the labeled curve spikes. Note that the "Labeled Spikes" option on the Style Tab ust be checked.

**Reset All Curve Labels** - This option resets all curve labels to the default options.

### 6.5.6 Log Display Discrim Tab

The Log Display Discrim Tab sets a discriminator curve that suppresses geocolumn shading for the selected log curve on the Selected Logs list.

This tab is enabled when the "Use Discriminator" option is selected on the GeoColumn Tab.

**Discriminator Curve** - This dropdown sets the discriminator curve for the highlighted curve on the Selected Logs List. When the discriminator curve is 0 or NULL, Petra will not display any geocolumn shading. This can be useful for de-emphasizing anomalous values in the curve.
A gamma curve with geocolumn shading and a discriminator curve. Note that when the discriminator curve is set to 0, the gamma curve has no geocolumn shading.

6.5.7 Log Display Cross Over Tab

The Log Display Cross Over Tab sets some additional options on how Petra draws digital logs on the Cross Section Module.

The Log Display Options Cross Over Tab

Set Color Shading Btwn Curves... - This button opens the Shade Between Logs tool.

Shade Between Logs Tool

This cross section option allows you to color and pattern fill between two adjacent log traces or a log trace and the track edge.
Only those logs which have been selected for plotting on the "Log Scales" screen will be available for shading between logs.

Shaded Curve Pairs List
This list box shows which logs pairs have been selected for shading.

Select Log Pairs To Shade Between
This section is used to select the log pairs and shading options. Choose two logs, one from the Log 1 list and the other from the Log 2 list. Set the When option to indicate the relationship of Log 1 to Log 2 when shading should be done. Choose the Color or Pattern to fill with.

Click the Add button to add a new log pair to the selected list.

The Replace button is used to change the options of an existing log pair. First click the item in the Shaded Log Pairs list box. Change the options then click the replace button.

Use the Drop button to remove a log pair from the selection list.

For example, you might shade between neutron porosity (NPHI) and density porosity (DPHI) to indicate the presence of hydrocarbon. To do this, first select NPHI as Log1 and DPHI as Log2 then choose the option that says "Log 1 LEFT of Log 2". Shading takes place whenever the NPHI log plots to the left of the DPHI log.
Active - This option check box keeps the shading active. Deselecting this option disables log shading, but retains the settings.

6.5.8 Log Display GeoColumn Tab

The GeoColumn tab provides options for displaying a curve using "geocolumn" shading. The GeoColumn feature shades a curve with multiple colors based on curve values. It's like cutoff shading but using many cutoffs.

Shading Direction - This option sets the direction of the shading. The shading can be to the left or right of the log curve.

Log Used For Shading - The values from the curve selected here are used to define the color "cutoff" ranges. This curve can be the same curve as being shaded or can be any other curve.

GeoColumn Base Line Value - Shading occurs from the curve traces back to either the track edge or a specified curve value.

Use Discriminator - A discriminator curve is a "flag" curve containing 1's and 0's. When a discriminator curve is used, the GeoColumn shading will occur only where the discriminator curve is equal to 1.

Use Discriminator - This option enables the Discrim Tab, which establishes a discriminator curve. A discriminator curve suppresses geocolumn shading at depths where the curve has a value of 0 or NULL.

Suppress Curve Outline - The curve trace is not drawn. Only the shading will be drawn.

Transparent When Background Color - When the shading color matches the screen
background color, shading will not occur.

6.5.9 Log Display Lith Sum Tab

The Lith Sum tab sums multiple curves together. This is most commonly used for adding multiple lithologic percentages that normally would plot on top of each other.

![Log Display Lith Sum Tab](image)

**Track** - This option selects the track that contains the logs to sum together.

**Disable This Track** - This option disables the log summation for the currently selected track. With this option selected, logs will plot as usual, but the settings on the Lith Sum tab are retained.

**Disable for All Tracks** - This option disables the log summation for all tracks. With this option selected, logs will plot as usual, but the settings on the Lith Sum tab are retained.

**Available Curves In this Track**

This list displays all curves for the currently selected track.

**Sum Curves in Track in the Following Order**

While in the Lith Sum Tab, select the logs from the “Available Curves in this Track” window, and click the “>” to add them to the “Sum Curves in Track in the Following Order” window. In this example, the sand and shale percentages are moved over into the “Sum Curves…” window.

Next, use the up and down arrows to set the curves in the order they should be summed. The order should be the same as the order the curves appear on the scale from low to high. In this example, “%_Sand” is on the low end of the scale from 0-
100, so it should go first. This will sum the two logs together to reflect a cumulative value.

When combined with the "shade between log" function, you can get the following display where curves AHNY, SAND, LIME, DOLO and SHLE were used:

Sand and shale percentages with Lith Sum enabled (Left) and disabled (Right)

6.6 Raster Log Display Options

The cross-section displays log raster images for a given well by referencing group names. For example, you might display images from the "GR" group in track 1 and images from the "Default" group in track 2.

Petra predefines one group called the "Default" group. You can create as many groups as you have different images for a well. Groups names should normally have something to do with either the log curves they contain or the sample rate of the log, i.e., "5-inch logs".

Each well can have only one image in a group. However, there is no limit on the number of different groups you can define. Therefore, if you have 5 different log images for a well, you must have 5 different image groups defined. The well will have 1 image in each of the 5 groups.

Available Image Groups

This section contains a list of all defined image group names in the project. To display an image group, select the desired log on the Available Image Groups list and left click the "->" button to the right of the Available Image Groups list. To add all logs to the Image Groups To Display list, left click the ">>" button to the right of the Available Image Groups list.

Show Groups For This Cross Section Only - This filters the "Available Image Groups" list to only the groups in the currently selected wells. This can be a very useful way of quickly filtering out irrelevant group names.
Image Groups To Display

This section contains a list of all image groups that will be displayed on the cross section. To drop an image group from the Image Groups To Display list, select the desired log and left click the ">>" button to the right of the Image Groups To Display list. To add all logs to the Image Groups To Display list, left click the ">>" button to the right of the Image Groups To Display list.

Track Tab

Each selected image group has "Group Details" associated with it. Click to highlight one of the groups listed in the "Image Groups To Display" section. Then, set the appropriate detail options.

Log Track # - This defines the image's plotting position relative to the well symbol and digital log depth track. The track positions are illustrated for convenience.

Track Width - The track width is entered in inches and determines the width of the log raster image. Typically, the track width should be set to the actual width of the paper log from which the image was scanned. NOTE - Log images use the same tracks as the digital log curves. Therefore, changing the width will also effect any digital curves displayed in the same track.

Group Options Tab
Show Extra Depths Above/Below Calibrations

Do Not Display Extra Depths - This option limits the raster to only the depth calibration points.

Display Extra Depths Defined in LIC File - This option

Display Extra Depths Using Values Below - This option adds extra footage above and below the top and/or bottom calibration points. Petra simply extrapolates the distance between depth calibration points, so the extra distance can be erroneous or include other information on the scanned image.

Aliases

Plot Only First Aliased Group Found - This option only plots the first aliased image.

Plot All Aliased Groups - This option plots all aliased images for a group. When multiple runs covering different depths are aliased together, this is a great way of displaying a more complete picture of the wellbore data. On the other hand, multiple aliased logs can be a real overplotting mess.

Pay Tab
Show Pay Intervals - With this option checked, any pay intervals that have been defined during the calibration process will be drawn on the cross section.

General Tab

This section applies to all image groups and contains various plotting options and conditions.

Enable Separate Templates Per Well - This option enables different sets of raster log image settings for different wells. With the huge variety of raster names, depths, and quality, individual raster settings can be a great way of creating ideal settings for each well.

Plot Headers at Image Top - This option displays the section of the image defined as the header at the top of the image.

Plot Scale Header at Image Top - This option displays the section of the image defined as the log scale header at the top of the image.

Plot Headers at Image Bottom - This option displays the section of the image defined
as the header at the bottom of the image. It may be necessary to increase the size of the bottom margin if the bottom header becomes clipped.

Scale Header Height (inches) - The amount of space to reserve for plotting the header section, both above and below the curve section. The header section will be "stretched" to fit this height.

Scale Footer Height (inches) - The amount of space to reserve for plotting the header section, both above and below the curve section. The header section will be "stretched" to fit this height.

Float Top Header - Normally, the top header section will appear just below the well symbol at the upper depth of the cross section. This option will cause the top header to float with the top of the image curve section even if the image starts deeper than the upper depth of the cross section.

Draw Calibration Lines - This option will draw lines across the image at the calibration depths. Use this option to compare the image calibration depths with the digital depth track.

Hide Track Grids Containing Images - This option causes digital track grids to be hidden if the track contains a log image to be displayed.

Suppress Depth Track If Image in Track 0 - Petra draws the depth track directly underneath the well symbol in track 0. This option prevents the depth track when there is a raster in track 0.

Show Fill Image Path Name in Status Bar - When you bring the mouse over the raster image, Petra displays the raster's group name and image file name. This option instead displays the full image pathway. This option can be useful for troubleshooting.

Plot Images From Other Completions - By default, Petra will only display raster images from the exact well, and not from other completions. This option enables raster images from other completions.

Use Screen Plot Technique For Printer - This option changes how Petra draws raster logs. Select this option when the Cross-Section Module plots incorrectly.

Memory Tab

The memory tab changes how Petra works with image files. This can affect Petra's redraw speed and system resources.
Reload Images From Disk – With this option, Petra refreshes raster image files from the network or local disk every time the cross section's appearance changes. With a large Layer File and a slow network, this can translate to poor performance.

Keep Images in Memory – This option tells Petra to load the raster image files once and keep them in local memory rather than continually refreshing from the network or local drive. By eliminating waiting on the network, this option accelerates redrawing at the expense of using more RAM.

File Tab

Load Template - This button loads an external Log Image Template (*.LIT) template file. Loading an external file will overwrite the current raster settings.

Save Template - This button saves the current raster log settings to an external Log Image Template (*.LIT) template file.

Misc Tab
Pay Label Text Height - This option sets the text height in inches of the raster log pay labels (set on the Pay Tab).

Opaque Text - This option causes open wells symbols, such as a gas or dry hole symbols, to be plotted using the background color (normally white) to fill the interior of the symbol. Use this option when you wish the well symbols to stand out against a colored background.

Pay Label Position - This option sets the location of the pay label. 1 is outside the pay interval on the left, 2 is left-justified, 3 is centered, 4 is right-justified, and 5 is outside the pay interval on the right.

Use Pay From Calibration Files. Do Not Use DB Pay - Calibration files can store pay intervals. This option forces Petra to use the pay intervals from the calibration file, rather than the project database. This can be useful for temporarily reviewing old pay intervals.

6.7 Displaying Formation Tops

The Formation Tops For Cross-Section Tool defines how the Cross Section Module displays formation tops.

The Select Tab sets the tops to display on the cross section. The General Tab sets options that apply to all displayed tops while the Color Tab and Style Tab customize individual tops.

Select Tab

The Select Tab adds and removes tops from the Cross Section Module’s display.
Available Tops List

The available logs list shows the formation tops in the project.

Restrict By Source - This option restricts the tops on the Available Tops list by the selected source code. Only the tops with the selected source code will appear on the Available Tops List. The "<All Sources>" option displays all tops from all sources (unless restricted by the Reorder Tool on the Main Module's FmTops Tab).

Displayed Tops List

The Cross Section Module only displays the tops on the Selected Logs list.

To add a log to the Selected Logs list, select the desired log on the Available Logs list and left click the ">" button.

To drop a log from the Selected Logs list, select the desired log on the Selected Logs list and left click the "<" button. To drop all logs from the Selected Logs list, left click the "<<" button.

General Tab

The general tab options apply to all selected tops.
The Formation Tops for Cross Section General Tab

Tops Connection Method

Do Not Connect Tops - This option draws small ticks at each well.

Connect Tops To Track Boundaries - This option draws the tops straight across the log tracks and connects the tops from well to well.

Connect Tops to Borehole With Straight Line - This option draws straight lines between wells.

Connect Tops to Borehole With Curved Line - This option draws tops using a spline function fit to the tops, which results in a more realistic structural picture.

Label Method

Although individual tops may be labeled or not labeled, this option disables all top labels at once.

Label Tops - For each top, this option uses the label settings set on the Style Tab. Essentially this option allows top labelling.

Do Not Label Tops - This option disables all formation top labels on the Cross Section Module.

Opaque Label Box - This option uses opaque label boxes around the formation top label. This can be useful for displaying labels over log shading.

Label Position - This option sets

Label with Actual Name of Alias - This option continues to use formation top aliasing, but will plot the actual name of the formation top rather than the aliased name.
Repeat Tops

Ignore Repeat Tops - This option does not plot repeat tops. Only the first top listed will appear on the cross-section.

Indicate Top with Markers - This option draws a small triangle (matching the color of the top) at each top location in the cross-section. This makes it easier to recognize repeat tops along a wellbore. These markers also indicate which tops are repeats by not filling in the triangle for any repeat value.

Settings

Use the "Load" and "Save" options to save the selected tops along with their display options to a disk file for later use.

Color Tab

The color tab sets color and shading options for the selected top on the Displayed Tops List.

The Formation Tops for Cross Section Color Tab

Line Color - This dropdown selects the top's color. The Palette button selects an alternative color that will replace the selected color on the dropdown menu.

Fill Color - This option sets the color of the fill between wells or inside well tracks. The Palette button selects an alternative color that will replace the selected color on the dropdown menu. More detailed options for how Petra draws the color fill below the formation top are on the Fill Options Tab.

Pattern Fill - This window sets a lithologic pattern for the color fill. The scroll bar to the right sets the density of the pattern.
Fill Between Tops - This option turns on the color fill in between formation tops. Note that there are more options on the Fill Options Tab.

Apply Colors To All Tops - This option sets all selected tops to use the currently displayed line and fill color options.

Default Palettes - This option resets the color palettes for the Line and Fill Color dropdown menus.

Save Color Palettes - This option saves the current color palettes for the Line and Fill Color dropdown menus to external files.

Load Color Palettes - This option loads a color palettes for the Line and Fill Color dropdown menus from external files

Style Tab

The style tab contains options for setting the line style and labeling options for individual tops. For each top, first select the top from the "Tops To Display" by clicking on the top names.

Label

Label Between Wells - This option plots the top name between the two wells with the widest spacing.

Label At Wells - This option plots the top name next to the borehole of each well.

Do Not Label This Top - This option suppresses the label for an individual top.

Label Height - This entry sets the size for the individual labels in in inches.
**Draw As Unconformity** - This option draws the top using a wiggly line to indicate an unconformity surface.

**Allow Top Aliases** - This option uses formation top aliases.

**Do Not Connect Top** - This option will draw the selected tops as a series of tick marks at the depth track but will not connect wells with a line.

**Disable Top** - This option temporarily disables a top. All the line and fill options are stored.

**Treat Top as a Contact** - This option draws the selected top after all others. This can be useful for demonstrating fluid contacts that cross formation boundaries and interfere with formation shading.

**Line Width** - This dropdown sets the line width for the top. Note that the user-selected line widths are set on the Petra Program Options' Font/Graphics Tab.

**Line Type** - Select the line type used to draw the line for the top.

**Apply Style To All Tops** - Press this button to set all tops displayed using the current style settings.

**Misc Tab**

![The Formation Tops for Cross Section Misc Tab](image)

**Sorting**

The sorting section controls whether tops are pre-sorted before plotting, which controls how Petra draws fills between tops.
Sort Tops - This option attempts to automatically sort formation tops in increasing depth order before drawing any fills, ensuring that the shading between tops is correct.

Do Not Sort Tops - This option disables automatic sorting. This option is best used where the automatic option incorrectly shades tops because of pinch-outs and missing values. Note that the tops on the Displayed Tops List must be manually sorted from top to bottom.

Fill Options Tab

The Fill Options Tab changes how Petra draws fill between formation tops.

Do Not Fill Between Wells - This option turns off the fill between wells.
Track Fill

Do Not Fill Tracks - This option does not display any formation top fill in the depth tracks.

Fill All Tracks - This option fills all displayed depth tracks.

Fill Depth Track Only - This option fills only the depth track immediately underneath the well symbol.

Fill Track 1 - This option fills only the selected depth track.

Advanced Fill Options

Only fill between tops that occur in all wells - This option will only fill between tops that occur in all wells. Tops that have a null value for any well on the cross section will not have any fill.

Fill between tops that occur in adjacent wells - This option will fill any top that occurs in two adjacent wells. This option is more tolerant of missing tops.

6.7.1 Repeat Tops

Repeat Top Pick Mode

To pick repeat tops, a new picking mode has been added to the cross-section. This mode is available through the Correlation Tool Bar only. To enter this mode select a top from the drop down and click the ‘Repeat Top Mode’ button (clicking the arrow to the right gives you an option to enter auto store mode which is similar to Smart Pick mode). Upon entering this mode a dialog will appear explaining how this mode works. Picking repeat tops is different than other picking methods in the cross-section. This mode is specially designed for handling horizontal wells in complex cross-sections. Here are the keys needed to successfully begin picking repeat tops.
1) CTRL+Click to Select a Well. In order to pick a top along a deviated well path, Petra must know what well you want to pick on. To select a well, simply CTRL+Click anywhere along the desired well path. This will outline the entire bore-path with a lime-green color (can change color through the Display->Colors dialog).

2) *NOTE* Tops indicated by markers. Once a well is selected, if the currently selected top has any picked values on that well they will be marked with an ‘x’ or ‘+’. This shows you what tops are currently on that well and also which tops can be moved or deleted.

3) Click to Pick a New Value. Simply clicking at the desired location will add a top value for the current top on the selected well.

4) SHIFT+CLICK to Pick a Value in Space. If the well is deviated Petra now allows the user to pick tops that are offset vertically from the well path. To add a top in space (must be vertically directly above or below the bore-path) hold down the SHIFT key while you click. A ‘+’ will indicate the new top value.

5) Drag Tops. Simply clicking directly on one of the ‘x’ or ‘+’ markers and dragging (while continuing to hold down the mouse button) lets the user move tops around.

6) ALT+Click to Delete a Pick. To delete a repeat top value, simply hold down ALT while you click on its marker. *NOTE* You cannot delete the original top value with this method, use the ‘Set Null’ option when out of the repeat top picking mode.

7) Right Click to Re-Draw. Right clicking anywhere will re-draw the screen with any changes you’ve made to the top. This does not end picking! If not in ‘Auto Store’ mode then you will be prompted to save changes to the DB.

8) End Picking. When done picking, just press ESC or click on the Repeat Top Mode button again to exit the picking mode. If not in ‘Auto Store’ mode then you will be prompted to save changes to the DB.

Below is a screenshot of the new picking mode in cross-section. Note the far left well is highlighted showing we have selected that well to pick on. Also we are picking the 354BRNT Top. The red triangles are the top markers showing all points that the top has values picked at. The filled-in triangles are the original tops while the empty ones are the repeats. The red ‘x’ and ‘+’ markers show you where the 354BRNT top has values along the selected well. The ‘x’ markers are points that the top actually crosses the well path, while the ‘+’ marker is the top picked ‘in space’ below the well path. Also note how the status bar shows you the actual MD along the well path (at the closest point to the cursor).
6.8 Correlating Formation Tops

There are few different ways to pick tops in the CrossSection Module.

As an alternative, however, the Log Correlation Tool provides a simpler interface for pure formation top picking with fewer plotting and display options. This tool can be particularly handy when working in projects with a large number of unique raster log group names.

Right Click Menu

First, select a well by left clicking on either well symbol or the depth track directly beneath the well symbol. Note that Petra will draw a pink box around the well symbol. Next, hover the cursor directly over the top to correlate and right click the mouse. Here, select the "Correlate Top: " option. Note that the bottom of the Cross Section module turns yellow to signify that there's a top being actively picked. Click the left mouse button on the desired location of the top for multiple wells, and select the right mouse button when finished.
This method is quick, but can only propagate tops already picked in at least one of the wells in the cross section. To pick a top not on any of the wells, you'll need to use either the correlation toolbar or the menu bar.

**Correlation Toolbar**

The Cross Section Module has a special [Correlation Toolbar](#) that picks a single formation top selected from a dropdown, as well as a "Smart Pick" mode that quickly modifies any top displayed on the cross section.

**Tops>Start Correlate**

First, select **Tops>Start Correlate..** from the menu bar at the top of the CrossSection Module. Next, select the desired top to correlate, or select the +New To " button to add a new formation top to the project. Click the left mouse button on the desired location of the top for multiple wells, and select the right mouse button when finished. Alternatively, select **Tops>End Correlate..**

![Select Top To Begin Correlating](Image)

6.8.1 **Fm Top Correlation Toolbar**

To enable or disable the Top Correlation Toolbar, select **Tops>Show Correlation Toolbar** from the menu bar at the top of the CrossSection Module.

**Smart Pick**

This tool is a "drag and drop" method of changing tops. When in Smart Pick mode, you can CTRL+ left click any top and drag it to a new position. Importantly, this method makes immediate changes to the database without any additional dialog boxes. Select the green button to start Smart Pick mode, and the red button to end Smart Pick mode.

**Top Dropdown** - This dropdown selects the top used by the "Start" and "Stop" buttons.
Start - This option starts picking the top selected on the Top Dropdown immediately to the left. Click the left mouse button to pick the top's depth for multiple wells. To stop picking tops, select the right mouse button or select the "Stop" button to the right.

Stop - This button stops picking tops, and provides an opportunity to save the top changes to the project database. Selecting "Yes" will apply the changes to the database, while "No" will ignore any changes made to the tops.

Refresh - This option refreshes the image on the screen with the latest tops from the database. This can be useful when multiple users are working the same tops simultaneously in the project.

New - This option creates a new formation top in the project with the Add New Formation Top Marker tool.

Set Null - This option erases the depths for the top on the top selected on the Top Dropdown. Click the left mouse button to null the top's depth for multiple wells. To stop erasing tops, select the right mouse button or select the "Stop" button to the right.

Type Log - When a From-To pair is set, and a type log selected (Logs>Select Log Curve) this button will create a Type Log Correlation Window.

From-To - This establishes a From-To pair used in many different Cross Section Module functions.

6.9 Pay Data Toolbar

The Pay Data toolbar is primarily used for picking new pay intervals and editing existing pay intervals.

Pay Intervals - This dropdown selects the pay name for adding new pay intervals.
- This button sets the pay name set on the Pay Intervals dropdown with a mouse.

**Source Restriction** - This dropdown limits the pay names displayed on the Pay Intervals dropdown to only those with the selected source code. This can be useful for filtering out irrelevant pay names.

- This button creates a new Pay name

- This button opens the Pay Data Display Options tool.

- This button adds new pay intervals for the selected pay name. Position the mouse over a well near the depth track vertically beneath the well symbol. Make note of the WSN of the well you are near. Pick the top of the pay interval using the left mouse button; click the left mouse button again to set the base of the pay interval. Note that you can continue picking more pay intervals on the same well or any other well. You may zoom or scroll the screen while in picking mode. To stop picking pay intervals, select the right mouse button. You will be prompted to save the pay intervals to the database.

- This button moves existing pay interval boundaries. Position the cursor over a well near the depth track. Click and hold down the left mouse button near the top or base of the pay interval being modified and adjust it up or down in depth. Release the left mouse button positioned at the new depth. You will be prompted to keep the change. Click the Right Mouse button to signal you are done modifying pay intervals.

- This button deletes pay intervals. Position the cursor over a well near the depth track. Click the left mouse button anywhere between the top and base of the pay interval. An X will be drawn where you clicked and you will be prompted to delete the selected pay interval. Click the Right Mouse button to signal you are done deleting pay intervals.

- This button sums the pay intervals from a select pay name to a zone item. The selected pay from all wells in the current cross-section will be summed.

- This button hides the Pay Data Toolbar.

### 6.9.1 Pay Data Display Options

The Pay Display Options tool controls how Petra displays pay intervals on the cross section. Some of the basics of the pay names, including name, color, and display patterns, are set on the Pay Interval Data tool on the Main Module’s Raster Tab.

To open the Pay Data Display Options tool, select the button on the cross section module’s Pay Data Toolbar. Alternatively, select Pay>Pay Data Display Options on the menu bar at the top of the Cross Section Module.
Data Tab

Available Pay List
The available logs list shows the pay names in the project.

For All Wells - This option lists all pay names for all wells in the project.

Selected Wells Only - This option lists only the pay names for the wells currently selected on the cross section.

Selected Pay List
The Cross Section Module only displays the pay names on the Selected Pay list.

To add a log to the Selected Pay list, select the desired pay name on the Available Pay list and left click the ">" button.

To drop a log from the Selected Pay list, select the desired pay name on the Selected Pay list and left click the "<" button. To drop all pay names from the Selected Pay list, left click the "<<" button.

Label Pay - This option adds a label to the side of the pay intervals. The specifics of this pay label are set on the Options Tab.

Options Tab
Pay Label Size - This entry specifies the height of the pay label size in inches.

Label Vertical Position - This dropdown sets the vertical position of the label relative to the top and base of the pay interval. The label can be upper, center, or bottom-justified.

Label Horizontal Position - This dropdown sets the horizontal position of the label relative to the pay interval.

Label Style - This dropdown sets the exact text on the label. This can be a combination of pay name, thickness, and top/base.

Include Source - This option adds the pay name source to each label.

Do Not Play Pay Intervals Unless Well Contains a Raster Log - This option only allows pay intervals for logs displaying a raster log.

Do Not Drop Pay Labels When They Are Too Small - By default, Petra will not display labels for very thin pay intervals. This option forces labels for all pay intervals.

Plot Pay in DEPTH TRACK Only - By default, Petra draws pay intervals across all tracks on the cross section. This option forces Petra to only display the pay intervals in the depth track.

Plot Pay PATTERN Symbols - Though a pay name can have both a pattern and color (both are set on the Pay Interval Data tool), Petra only displays pay interval color by default. This option adds the pay name's pattern to the cross section. This can obscure some of the details on logs.

Defaults - This button restores the defaults for the Pay Data Display Options tool.
6.10 Well Symbol Style - Cross Section

The well location style screen provides options for setting the well symbol size and well labeling style. The well label is a single line of text and can be used as an alternative to using the Posted Data option.

To open the Well Symbol Style tool, select Wells>Symbol Location and Style on the menu bar at the top of the Cross Section Module.

Symbol Tab

The Well Labeling Style's Symbol Tab

Symbol Size - Select the one of the default symbol sizes, small, medium or large or select the Custom button and enter the symbol size in inches.

Opaque Symbols - Check this option to have the well symbol filled with the background color.

Symbol Location - This option sets the location of the location of the

Symbol Color - Choose to draw the well symbol using the default color defined in the system colors or using the well symbol definitions defined in the Well Symbol Descriptions section

Annotation Tab

The Annotation Tab provides a simple alternative to the Data Posted By Well Spot tool. The Annotation Tab becomes available when the "Allow Simple Well Labeling" option on the Options Tab is selected.
Well Label - This dropdown sets the label around the well symbol. Options include:
- No Label (Suppress the well label)
- Unique Well Id (UWI or Api Number)
- Api Series No. (5-digit series number or the UWI)
- Well Short Name
- Well Label
- Well Seq No. (WSN)

Position - This option sets the label position above, below, left or right of the well symbol.

Label Size - Select the one of the default symbol sizes, small, medium or large or select the Custom button and enter the symbol size in inches.

Options Tab
The Options Tab sets a few additional options for well labeling.
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The Well Labeling Style’s Options Tab

Label Distance Between Wells - This option posts the distance between each well symbol at the top of the cross section. The entry to the right sets the height of the text. The "Label Distances As" dropdown sets the label in feet or meters.

Place Well Symbol at Bottom of Deviated Wells - This option posts the well symbol at the bottom of deviated wells instead of at the top of the cross section.

Allow Simple Well Labeling - This option creates the Annotation Tab.

6.11 Cross-Section Overlay

Note: All of the following instructions are based on the use of the Overlay Tool Bar. If your overlay tool bar becomes hidden, click on "Overlay>Show Tool Bar".

Creating Lines

To create lines in Petra, simply click on the pencil icon on the toolbox. Then click where you want the beginning of the line to start. Clicking the left mouse button again will add control points, while clicking the right button will end the line. After you finish adding control points on the line, the Overlay Line Attributes dialogue box will pop up.

Editing Lines

To select and edit pre existing lines, click on the red arrow on the toolbar which brings up a crosshair for your mouse on the map module and then select the line you wish to edit with one click of the left mouse button. This changes the color of your line to blue and shows all the control point points in the line. Occasionally after making many changes to lines, it is necessary to redraw the screen to see the changes or to
continue editing.

Moving individual control points - change the location of any blue boxed "control point" by clicking and dragging it to a new position.

Moving whole lines - To move a whole line unchanged, press ALT and click on the line with the right mouse button.

Copying a line - click on the copy button that looks like 🖋️. To paste the line, click on the button and place the text.

Creating Text

To set text, click on the "abc" icon on the toolbar. Petra first asks you to establish a baseline that shows where you want the text and then builds a rectangle to establish the height of the text.

Editing Text

To edit pre existing text, first click on the red arrow on the toolbar, which brings up a crosshair for your mouse on the map module. Select the text you wish to edit with one click of the left mouse button; this brings up a blue box around your text and allows you to edit the text. Sometimes after manipulating a piece of text multiple times, it may become necessary to refresh the screen to see the blue box that highlights text.

Editing features like the content of the text displayed, the height of the text in map units, angle in degrees, overlay layer, text color and font, and text justification - double click anywhere inside the blue box. This brings up the Overlay Text Attributes dialogue box that allows you precise control over features, including degree of angle and text height.

Changing the location of the text - press ALT and right click somewhere inside the box and drag it to the new location.

Changing the angle of the text manually - press ALT and right click on one of the control points that establish the baseline on the bottom of the blue box.

Copying a text box - click on the copy button. To paste the text, click on the button and place the text.

Importing an Image File

To add an image file, simply click on the "Add Image File" button on the toolbar that looks like 📏. After clicking this, Petra will ask you to establish a rectangle on the map screen where the image file will be placed. Then, Petra will ask you for the location of the file and the layer you want it to go into. Various scaling options are available under the "Options" tab.

Adding a Fault Line
To add an fault line, simply click on the fault line icon on the mapping toolbox that looks like 📐. This will change your mouse to a crosshair. To add the fault, first click on position for the beginning of the fault and then click again to place more nodes on the fault. The right mouse button ends the process of adding nodes to the fault. After this, click to the left and the right of the fault to define throw.

*Note: Fault lines can be moved and edited just like a line. Select it with the red arrow selecting tool - Right clicking it will move the entire fault, while left clicking a single node will stretch the line.*

*Note: Be careful to place the fault lines away from the well lines. Crossing a well with a fault line will generate an erroneous image.*

6.11.1 Overlay Tool Bar - Cross Section

The overlay tool bar contains icons to manipulate overlay lines and text.

- 🕒 Select overlay line or text item.
- 📝 Show attributes of the selected item.
- 🖋 Add a line, polygon, contour, or fault to the map.
- 📜 Add text to the map. Click 3 points. First point is the start of text baseline, second point is the end of text baseline, third point indicates text size.
- 🖼 Add an Image reference to plot a Windows metafile or bitmap file. Click and drag to draw a rectangle to define the position and size of the image.
- 🔁 Add a fault line to the cross section.
- 📦 Add a box or rectangle to the map.
- ✂️ Delete the selected item.
- 📑 Copy the selected item into the overlay clipboard function.
- 📑 Paste the item from the overlay clipboard onto the screen.
- 📑 Display Layer & Preferences screen which provides global editing options.
6.11.2 Overlay Line Attributes - Cross Section

Every overlay line has a series of attributes that define the type of line and its appearance.

To edit a line's attributes, select the red arrow button, and double-click a node on the desired line.

General Tab

The General Tab sets the basics of the line, including its layer and class.

Layer
- This dropdown sets the layer that will contain the line. Since the CrossSection Module can selectively display or hide entire layers, related lines should generally be in the same layer.

Line Class
- Normal lines have no specific attributes beyond a color and fill. Normal lines are useful for display purposes, including lease lines and arrows.
- Unconformity lines illustrate an unconformable surface contact with a squiggly line on the map.

Line Width
- This dropdown sets the line widths for drawing the line. Line widths range from narrow to extra-wide. This dropdown also can select the 4 custom "User-1" through "User 4" line widths. These line widths can be modified on the Petra Program Options' Font/Graphics Tab in the Main Module.
**Line Style** - This dropdown sets the line to use one of the predefined drawing styles to draw a solid or dashed line.

**Smooth Line Points** - By default, Petra draws a straight line between the node points that make up a line. This option instead draws a smoothed line through the line's nod points.

**Closed Polygon** - This option forces the starting and ending points to match when drawing polygons. This switch should be specified when using area fill options.

**Polygon Name** - This entry sets the name of the polygon.

**Label Polygon** - This option plots the volumetric name in the center of the polygon.

### Colors Tab

![The Overlay Line Attributes General Tab](image)

**Do Not Fill** - This option disables color fill for lines that are not polygons. This can also be used to draw a polygon without any color fill.

**Fill Interior** - This option fills the polygon with the color set on the "fill color" dropdown.

**Line Color** - This dropdown sets the color of the line. For closed polygons, this will set the shape's outline. To change the available colors on this dropdown, select the "Palette..." button. To restore the default colors, select the "Default" button.

**Fill Color** - This dropdown sets the color of the fill inside a polygon. To change the available colors on this dropdown, select the "Palette..." button. To restore the default colors, select the "Default" button.

### Drawing Mode
Normal - This option draws the line or polygon element with an opaque color. Lines or polygons with a normal drawing mode will cover elements that are below them.

Transparent - This option draws the line or polygon with a transparent color. With a transparent drawing mode, other elements will be visible through the line or polygon.

Combine Colors - This option will display overlapping lines and polygons with a different color. In practice, this option is a great way to demonstrate regions of overlap on the overlay.

Patterns

Petra can draw patterns inside polygons. The left up/down button sets the pattern, while the right up/down button sets the density of the pattern.

Pattern Color - This dropdown sets the color of the pattern inside a polygon when the "Use Pattern Color" option is selected.

Pattern Line Mode

Use Thin Black - This option draws the selected pattern using thin black lines. This option will override the "Pattern Color" dropdown.

Use Line Color & Width - This option draws the selected pattern using the line color (selected on the Colors Tab) and thickness (selected on the General Tab). This option will override the "Pattern Color" dropdown.

Use Pattern Color - This option uses the color set by the Pattern Color dropdown immediately to the left.
Pattern Filled polygons with "Use Thin Black" (Left), "Use Line Color & Width" (Center), and "Use Pattern Color" (Right)

Contours Tab

This section sets individual contour line values and settings. This section is only available when the "Contour Line" class is selected on the General Tab.

Contour Value - This entry sets the value for the contour line.
Label Contour Line - This option enables or disables contour line labeling.
Label Height - This option sets the height of the contour label in inches.
Hachures - This option adds hachures to inside or outside of a contour line. The "None" option disables hachures for the selected line.

Arrow Tab

This section allows arrow heads to be added to the line end points. Note that Petra can only draw arrows on lines with a "Normal Line" line class selected on the General Tab.
The Overlay Line Attributes Faults Tab

**Arrow Type** - This dropdown sets the appearance of the arrow. Note that the arrows are directional. An arrow pointing to the right will put the arrowhead at the end of the line, while an arrow pointing to the left will put the arrowhead at the beginning of the line.

**Size** - This option sets the size of the arrow in inches.

### 6.11.3 Overlay Layers & Preferences - Cross Section

**Layer Name List**

Visible for both Properties and Preview Tabs, the list box shows all layer names in the open Overlay file.

This list selects the currently active layer - as an example, to change the state outline color to red, you'd need to select the "State" overlay layer here first.

The Layer Name List displays the current status of all the layers in the overlay file. Layers which are not currently visible are indicated by a small symbol. The layer's default color, which is the color assigned to newly added items, is shown on the right edge of the list.
Interpreting a layer name on the Layer Name List

The Layers Tab has two tabs: Properties and Preview. The Properties Tab changes layer visibility, layer names, and update status. The Preview Tab displays a quick preview of the data inside the specified layer. These two tabs are on the upper right corner of the Overlay Layers tool.

Layers Tab

The Layers Tab sets a few of the basics for the layers in the overlay file. This includes changing layer names, visibility, and update status.

Layer Properties

Layer Name - To change the name of a layer, first select the layer in the Layers lists. Type a new layer name and click the "Apply" button.

Layer Default Color - To change the default color of a layer, first select the layer in the Layers list. Select a new color from the drop down color list and click the "Apply" button.

Layer Visibility - Use this section to "Show" or "Hide" individual layers. Double clicking the layers list will toggle a layer's visible state.

Plot This This Layer After other Graphics - This option changes how Petra handles overlaps between overlay objects and other elements on the Cross Section Module. When this option is selected, Petra will draw the selected layer last, on top of other
objects.

- This option can be used to delete all data associated with the selected layer. You will be prompted to verify the clearing process. Data is only removed from memory. It does not effect any saved overlay files unless you overwrite them with the modified overlay.

**Update Layer Data**

![Overlay Preferences](image)

**Line Color** - This dropdown sets the color of the line. For closed polygons, this will set the shape's outline. To change the available colors on this dropdown, select the "Palette..." button. To restore the default colors, select the "Default" button.

**Fill Color** - This dropdown sets the color of the fill inside a polygon.

**Text Color** - This dropdown sets the color of the text. To change the available colors on this dropdown, select the "Palette..." button. To restore the default colors, select the "Default" button.

**Text Size** - This entry sets the height of the text in depth units, or inches. With "relative" inches, the text will enlarge as you zoom in and out of the map.

**Make All Layer Items Use Layer Default Color** - This option changes all layer items to use the default layer color set on the Layers Tab.
Layer Order

This section allows layers to be specified in a plotting preference order. All layer names are shown in the list box in the current plotting order. Layers at the top of the list are plotted before layers coming later in the list. Thus, a layer at the top of the list may be covered up by subsequent layers.

Select a layer from the list and click the small arrows to change the layer’s plotting order.

General Tab

The General Tab has a couple of miscellaneous options for scaling and image path reports.
6.11.4 Overlay Text Attributes - Cross Section

The Overlay Text Attributes tool sets the details for text displayed on the Cross Section Module. This tool will appear immediately after creating a text box.

To reopen this box and change text settings, select the red arrow button on the Overlay Tool Bar on the right side of the CrossSection Module and select the text to change.
Text - This entry sets the actual text on the cross section. This can contain text from 1 to 255 characters.

Layer - This dropdown sets the overlay layer that will contain the text. To rename the selected layer, select the "R" button.

Text Height

Size in Depth Units - This option scales text height to the Cross Section Module’s default depth units (set on the Map Projection Settings Units Tab). With this option, text height will increase and decrease with zoom.

Size in Inches (Absolute) - This option scales text height in inches. This option sets text height at a single size - it will stay the same size regardless of zoom. Be careful with this option when sending large cross sections to a plotter - an absolute text size that looks good on a computer screen may be too small for a large plot.

Size in Inches (Scaled To Section) - This option scales text height in inches relative to the actual size of the cross section (set by the vertical depth scale and the horizontal Cross Section Size Options). Put another way, this draws text at the actual scale that will be sent to the plotter.

Text Angle - This setting sets the text’s rotation in degrees. 0 is horizontal, positive degrees rotate the text counter clockwise, and negative degrees rotate the text clockwise.

Justification - This option sets the text justification within the textbox. This can be set to left, right, or centered.

Color - This option sets the text’s color.

Font - This option sets the text’s font.

Use Opaque Background - Set this option to draw the text using the cross section background color as the background of the text. Opaque text will cover up underlying data.

6.12 Plot Interval Data

The Cross Section Module can display any combination of interval data colors, patterns, markers and text.

To display interval data for a well in the Cross Section Module, select Wells>Plot Interval Data. This box shows a list of the interval data tables on the left along with a
series of tabs on the right that control how interval data (Style, Text, Filters) are shown.

First, select the interval data table or tables to display. Petra can show multiple intervals at the same time, though it’s generally better to keep different interval tables in different tracks. In the example below, only the LITH table is selected.

**Style Tab**

The Style Tab governs how the interval data is displayed on the Cross Section.
The Interval Data Fill’s Style Tab

**Use Interval Fill Color** – This option tells Petra to fill the interval with the interval’s color.

**Use Interval Fill Pattern** - This option tells Petra to fill the interval with the interval’s pattern.

**Use Interval Marker Symbols** - This option tells Petra to fill the interval with the interval’s marker symbols. The Marker Scale factor below changes the size of these symbols. The individual interval’s marker fill can also be overridden with the Marker Fill Mode below.

**Text Positioning** – Text can be positioned at the top, middle, or bottom of an interval. Select the dropdown by default labeled “Text At Top of Depth Interval” to change where text is plotted.

**Combining Text Horizontally or Vertically** – This changes how multiple text fields are displayed. “Combine Text Horizontally” lists additional text fields to the right of the first text box. “Combine Text Vertically” stacks additional text fields on the bottom of the first text field.

**Separate Text with Space** – This option changes how different fields are separated when plotted horizontally. Horizontally combined text boxes can either be separated with a space, slash, a dash, or a comma.

**Text Label Size** – This option sets the size of text (in inches). Keeping this option at 0 is a good default. Remember that an absolute text size probably won’t be appropriate for both computer screens and large paper plots; 1 inch letters will look huge on a computer screen, but will be normally sized on a large wall plot.

**Marker Scale Factor** – This option sets the scale of the interval markers. Setting the scale factor to 0.5, for example, plots all markers at ½ their original size.

**Marker Fill Mode** – Though every interval stores information on how to display markers, this option overrides the fill mode for all displayed markers on the cross section. Note that this does not change the settings stored in the interval.

**Pattern Scale Factor** – This option sets the pattern scale, or density, of the lithologic pattern fill. Higher numbers here generate higher pattern density.

**Text Tab**

The Text Tab sets the specific data fields to be displayed as text.
To add text, select the appropriate Table on the Interval Data to Plot dropdown menu and a data field from the “Data Fields to be Posted By Intervals dropdown menu on the right. Select the button to add the field to the list. Items at the top of the list will be at the top (for vertically combined text) or on the left (for horizontally combined text). Selecting the “Include Text Labels” option adds the field name as a prefix before each data field. Particularly elaborate displays can also be saved as a template in a *.IDF file with the Save/Load Template buttons.

The Filters Tab

Filters provide more control over which intervals are displayed on the Cross Section Module. Intervals that do not meet the filter criteria are not displayed. To create or modify a set of filters, select the “Set Filters...” button on the Filters tab. For more information on filters see Using Interval Filters.
6.13 Interpretive Color Fill

The Interpretive Log Color-Fill feature interpolates the values from a single log curve in between the wells. This can be useful for visualizing stratigraphic change across a field. This tool uses selected formation tops to help guide and constrain the interpolation between one well and the next.

Log Data

The Log Data tab sets the log curve to be interpolated between wells.

Select Log Curve To Interpolate From Well to Well - This dropdown selects which log curve will be interpolated from well to well.

Use Log Aliases for Missing Logs - This option allows the interpretive log fill to use log aliases. Without this option, only the wells with the exact curve name will have a log fill.

User Curves from Other Well Completions - This option allows the interpretive log fill to use log curves from other completions.

Tops Tab

Petra uses FmTops between wells to better constrain the interpolation. This tab sets the boundaries for the interpretive log fill.
Fill Between the Selected Tops

This list displays the tops currently displayed on the Cross Section Module. You can choose the tops used in the interpolation. Color-fill will be generated between each pair of tops chosen. For example, if you have tops A, B, C and D and do not choose C, then you will have color-fill from A down to D. The grid will follow the A-B interval and the B-D interval. Top C will have no influence on the grid. If you chose only A and B then the color-fill when only be generated between tops A and B.

Resolution Tab

The Resolution Tab controls the resolution of the interpretive color fill grid. Generally, smaller grids look better but require more time to generate.

Grid Cell Width

This option sets the width of each grid cell, and can be set to small, medium, large, or to a specified XY map unit width. In general, the default width is sufficient for most cross sections.
Grid Cell Height

The vertical resolution sets the height of each grid cell, and can be set to small, medium, large, or to a specified depth unit.

This usually should be set to the resolution of the curve data on the cross section, as coarse grid heights can obscure thinner beds. As an example, curve data with a half foot resolution should have a grid cell height of 0.5.

Color Range Tab

This tab sets the colorbar for the interpretive log fill.

The Color Range Tab

Minimum - This entry sets the lower value for the color bar.

Maximum - This entry sets the upper value for the color bar.

Interval - This entry sets the interpolation interval for the color bar. Note that the colorbar can have a maximum of 46 intervals, starting with the minimum and counting up towards the maximum.

Set Colors... - This option opens the Color Interval Definition, which can more directly change the intervals and specific colors on the interpretive log fill.

Miscellaneous Tab

This Miscellaneous Tab sets an additional option for optimizing the interpretive log fill.
The Miscellaneous Tab

Faster Display - Larger Plot Files - This option stores the interpretive color fill grid in RAM, which can accelerate cross section plotting at the expense of using system resources.

Slower Display - Smaller Plot Files - This option does not store the interpretive color fill grid in RAM. This decreases the consumption of system resources, but can result in slower plot times and poorer graphics.

Interpretive Color Fill and the Top Connection Method

The Interpretive Color Fill's appearance is controlled by the Top Connection Method Dropdown Method on the Formation Tops' General Tab.
6.14 From-To Pairs

"From-To" pairs establish pairs of depths on a well. These points are useful in a variety of functions, including shifting log curves, pay intervals, and fault gaps.

To create From-To pairs, select the "From-To" button on the Fm Top Correlation Toolbar. Alternatively, select Logs>Start Picking From-To Pairs on the menu bar at the top of the CrossSection Module. Left click once at the top of the interval and again at the base of the interval. Repeat to add more from-to pairs. Right click to stop picking, or select Logs>End From-To Picking.

The From-To pair tools are available from Logs>... menu at the top of the Cross Section Module.

For Digital Logs (uses the log curve indicated under the Logs menu)

Depth Shift Log Curves
Amplitude Shift Log Curves
Set Data Values To NULL
Interpolate Data Values

For Fault Gaps

Create Fault Gaps - This option adds new fault cuts based on the extents of the from-to pairs.

Shift Existing Fault Gaps - The "from" depth is used to identify an existing fault marker and the depth of that fault is set to the "to" depth.
For Pay Data

Pay Intervals (create) - This entry stores the From-To thickness to a selected zone data item. New pay data entries are added to the database for each interval.

For Perfs

Create Perfs - New perf entries are added to the database for each interval.

6.14.1 Depth Shift Log Curves - Cross Section

One or more log curves can be interactively depth shifted. This process involves picking pairs of adjustment points on a selected log curve displayed on the cross section. Each adjustment pair represents the depth to shift "from" and the depth to shift "to". This process allows log curves to be shifted up or down and curve sections to be compressed or expanded.

Once the "from-to" pairs are picked from the displayed log curve, the "Depth Shift" log menu invokes the shifting option. You are prompted with the well and log curve information to verify that you want to apply the shift. You are also given an option to apply the same depth shift to other log curves in the database.

Depth Shifting Other Log Curves

An option is available to apply the depth shift to not only the selected log curve but to any other log curves in the database. A list box displays all available log curve names with the currently selected curve pre-highlighted in the selection list. Click the list box to highlight all log curves for which you want to apply the depth shift. Note: you are not required to apply the shift to the originally selected log curve.

6.14.2 Amplitude Shift Log Curves - Cross Section

Corrections can be made interactively to the log curve values or amplitude. This process involves picking pairs of adjustment points on a selected log curve displayed on the cross section. Each adjustment pair represents the anchor points at which the shift will start ("from") and end ("to"). For example, if two pairs of anchor points are
selected, the log curve values will be shifted using the difference in the "from" and "to" values are the depths represented for each pair. The log curve values between the to pairs will use linear interpolation to determine the amount of shift.

Once the "from-to" pairs are picked from the displayed log curve, the "Amplitude Shift" log menu invokes the shifting option. You are prompted with the well and log curve information to verify that you want to apply the shift.

6.14.3 From-To Set Data Values To NULL

Enter topic text here.

6.14.4 From-To Interpolate Data Values

The log values within each interval are interpolated using the two values at the "from" depth and "to" depth.

6.14.5 Cross-Section "Pay" Intervals

This tool stores a picked From-To pair to a zone data item or to a digital log curve.

Pay Zone Tab

This tool stores the thickness of the From-To pair to a zone data item. Note that Petra can either add the thickness to a preexisting entry, or completely replace the entry with the From-To thickness.

Store Pay Thickness in Zone Table - This option enables the pay thickness to be stored to a zone data item.

Zone Item Update Mode - This option changes how Petra stores the thickness when there is already an entry in the well's zone data item. "Replace Current Value" completely overwrites any preexisting entry, while "Add To Current Value" simply adds
the thickness to the pre-existing value.

**Pay Curve Tab**

This option stores a new curve to the database based on the From-To Pairs.

- **Store "Pay" Intervals as Pay Flag Curve** - This option enables the pay curve to be stored to the database.
- **Store Pay Flag Curve As** - This dropdown sets the name of the pay flag curve. Either select an existing curve name on the dropdown menu, or enter a brand new name.
- **Current Value in "Pay" Intervals** - This option sets the value for the interval between the From-To pairs. By default, this is set to 1
- **Curve Value in "Non-Pay" Intervals** - This option sets the value for the interval outside the From-To pairs. Note that the "Use NULL value" will set the curve value to nulls outside the From-To pairs. By default this entry is set to 0.
- **Curve Update Mode** - This option controls how the tool handles overwriting a pre-existing pay curve. "Add or Replace Existing Curve" will completely overwrite a preexisting curve with the same name, while the "Add or Merge Into Existing Curve" will simply merge the new from-to interval's pay into the preexisting curve.

**6.15 Grid Profile Option**

The Cross-Section grid profile option projects grids created in the Map Module as a profile across structural cross sections. Grid profiles are not plotted on stratigraphic cross sections.

To project a grid onto a Cross Section, select Tops>Contour Grid Profiles on the menu bar at the top of the Map Module.

A maximum of 25 surfaces can be selected and displayed. Note that grids are
identified as subsea structure, measured depth, or datum. Datum grids are not plotted, but are used to convert other grids to match the cross section depth axis scale. If your grids are not showing up on the cross section, check that you have the appropriate grid types set and are including a datum grid.

**Grids Tab**

The Grids Tab adds grids to the Cross Section Module, and controls their general appearance.

**Select Grids For Cross-Section Profiles**

This section contains a list of available grid files located in the project's GRIDS directory.

Choose a grid then click the "Add To List" button to select it for plotting. The grid name will appear Selected Grids List.

**Selected Grids**

This section displays those grids which have been selected to plot on the cross section. Single clicking a grid name in this list will show the current attribute settings in the Grid Attribute section. Double clicking a grid name will show the grid's statistics. You may remove a single grid from the selection list by using the small '>' button located below the list box. To clear the selection list to start over, click the '>>' button.

**Grid Attributes**

Set each of the grid attributes for a selected grid. First, highlight the grid name in the "Selected Grids" list by clicking on the grid name. Set the attributes (see below) and click the "Apply" button. (Note: the Apply button is optional).
**Grid Type** - The grid type determines how the grid depth values are interpreted. A grid must be identified as either "Subsea (Structure)", "Measured Depth", or "Datum". Including a datum grid, such as a contour map of the KB, will ensure that the other grids are correctly drawn when switching between log depths and tvdss depths.

**Color** - Choose the line color for drawing the grid profile.

**Line Style** - Choose from one of the standard line pattern styles.

**Line Width** - Choose from one of the standard line thickness.

**Label** - Enter the descriptive title for the grid. The default comes from the grid file header.

### Options Tab

The option tab controls some of the details of drawing grid profiles.

![Options Tab](image)

**Sample Rate**

The sample rate determines how many samples are interpolated from the surface grid along the length of the cross section. The default value is 100.

**Averaging**

The averaging factor (N = 1..10) determines the distance around each profile data point in Method 1. Larger values result in smoother profiles. All grid node values within a distance of N times the grid spacing will be averaged using an inverse distance weighting function. A value of 1 will sample only the grid nodes within a single grid cell distance. A value of 10 allows all grid nodes that are closer than 10 times the grid size to be included in the average. For Method 2, the averaging factor determines the amount of smoothing applied by a triangular filter function.
Method
Choose one of the two grid sampling methods. Method 1 samples the grid using an inverse distance weighting and results in a smoothed profile. Method 2 interpolates each profile point from the grid cell it is contained in.

6.16 Uassigned Tops Overview

The Cross Section Module and Log Correlation Tool both create and store “unassigned tops.” Unassigned tops are useful for correlating things outside the traditional definition of a formation top. This can include possible faults or other marker "picks" that are considered by the interpreter to be unknown, uncorrelated or otherwise "unassigned". For convenience, picks are grouped by name, color, and interpreter. A single well can store any number of unassigned tops with the same name. Unassigned tops are stored to Petra's database, and are shared among different modules and different users.

Unassigned tops can be easily correlated and converted into formal formation tops. Once the interpreter determines that a set of picks correlates, a "correlation" line can be created to connect the picks on the cross-section. Once you are satisfied that a correlation is valid, it can be converted to a formation top.

To display the CrossSection Module Unassigned Tops Toolbar, select Tops>Unassigned Tops>Toolbar.

(1) List of Pick names
(2) List of Correlation names
(3) Buttons to add and modify pick names and set pick display options
(4) Buttons to add, modify or delete picks
(5) Buttons to add and modify correlation names and set correlation display options
(6) Buttons to connect picks as a correlation and convert a correlation to a top
(7) Eye dropper function lets you click on a pick or correlation and set the item names in (1) and (2)
(8) Maintenance functions for creating, modifying, and deleting picks and correlations
(9) Interpreter list to restrict (1) and (2)

UAT Workflow
The typical workflow for UAT is as follows: (#) indicates toolbar functions used
A. Create one or more pick names (1, 3 & 9)
B. Make picks on one or more cross-sections (4)
C. Create a correlation name (2 & 5)
D. Define a correlation of picks (6)
E. Convert correlation to a Top (6)

Therefore the progression from pick to top is as follows:
PICK ==> CORRELATION ==> FMTOP

UAT Picks
All picks are associated with a pick name and interpreter source. Each pick name has its own color, line thickness and line style. Each user sharing a Petra project should create their own pick group so their picks won't be confused with other users' picks. Picks are drawn on the cross-section as individual and unconnected depth markers.

UAT Correlation
A correlation is a user-defined name for a series of correlated picks. Each correlation name has its own color, line thickness and line style. Eventually, a correlation can be converted to a formation top. Correlations are drawn on the cross-section as connected "picks".

6.17 Cross Section Slip Box
The slip box takes a screenshot of a part of the cross-section and places it into a separate window inside the cross-section. This section of the log can be a great help to correlation between one log and another. The slip box window can be moved around the screen, as well as stretched and squeezed. The slider box on the top of the window changes the box's opacity to make it easier to overlay on top of other
6.18 Type Log Curve Tool - Cross Section

The Type Log Curve Tool provides a floating, re-sizeable window containing a single digital log curve. The tool can be useful for correlating logs.

While this tool is very similar to the Slip Box, there are a few differences. The Type Log Curve Tool can only display a single digital log curve, while the Slip Box can display an image of any combination of digital and raster logs. The Type Log Curve has a few additional display options relative to the Slip Log, including completely flipping the depth and log scales.

Creating a Type Log Curve Window

First, select Logs->Select Log Curve menu to choose the actual log curve for the type log curve window. There are a couple of limitations on the specific curve selected: the tool can only use log curves actively displayed on the cross section (set on the Log Display Options). Additionally, this tool can only use unaliased log curves - a good workaround is to simply disable the "Use Alias Logs" option on the Log Display Option's Scale Tab, create the window, and then re-enable the log aliases.
Next, select Logs>Start Picking From-To Pairs to define the depth range. Left click once at the top of the interval and again at the base of the interval. Right click to stop picking. If you pick multiple from-to pairs, Petra will only use the last pair to establish the depths on the Type Log Curve Window.

Finally, select Logs>Type Log Curve Tool>Set Type Curve menu. The type curve will appear in a floating window.

The Type Log Curve Tool window can be dragged across the screen, as well as resized by clicking and dragging any of the edges of the window.

![Type Log Curve Tool](image)

**Type Log Curve Tool Options**

There are a few additional options for the Type Log Curve Tool available by right clicking the window.

- **Match Depth Scale** - This option sets the height of the tool window so the log curve matches the current depth scale.
- **Match Curve Scale** - This option resets the width of the tool window so the log curve scale matches the current track width.
- **Match Depths and Curve Scale** - This option resets the vertical depth scale and horizontal log scale to match the current cross section depth scale and log curve scale.
- **Flip Scale** - This option reverses the amplitude scales. For example if the curve is plotted from 0 to 100, flipping the scale plots the curve from 100 to 0.
- **Flip Depths** - This option vertically flips the depths on the type log, so that the base of the from-to pair is at the top of the window. This can be useful for working with structurally complex, overturned section.
- **Reload Curve** - This option reloads the curve from the database. This can be useful for updating curves that have been normalized, merged, or otherwise changed.
Pseudo Wells are wells added to the project inside the Cross-Section Module that act as additional control points for drawing tops. Pseudo wells have a wells with a special database flag set to indicate they are not real wells. Pseudo wells can be hidden or shown on both the Cross-Section and Map Module. In the Cross-Section module, pseudo wells sill affect the positioning of formation tops, even when the pseudo wells are hidden. This can be useful for adding additional points to control how tops display on the cross section.

Pseudo wells can only be added to a well-to-well cross-section with at least two wells. Pseudo wells also require the "relative spacing" mode active on the Width and Margins tool.

To add pseudo wells, select Wells>Add Pseudo Well on the menu bar at the top of the Cross-Section Module.

To hide the pseudo wells, select Wells>Add Pseudo Well on the menu bar at the top of the Cross-Section Module.
Adding Vertical Pseudo Wells

Vertical wells are added by clicking once on the position of the well relative to the other wells on the section.

Adding Deviated Pseudo Wells

Deviated wells are added by drawing the path of the borehole, from top to bottom, as it should appear on the section.

When a pseudo wells is added to the cross-section, it will have a datum (KB) value interpolated from it’s two neighboring wells. The symbol code for the well is set to "PSEUDO" and can be used to as data criteria to "find pseudo wells" using the well selection function.

The right-click pop up well menu contains three related menus:
1) "Convert Pseudo Well to Real Well"
2) "Convert Real Well To Pseudo Well"
3) "Redraw Pseudo Well Deviated Track".

Item 3 can be used to redraw the deviated borehole for a previously drawn deviated pseudo well.

Map Module

To hide pseudo wells on the Map Module, select the "Exclude Pseudo Wells When Loading Wells" on the Well Symbol Style’s Options Tab.

Note that the inclusion or exclusion of pseudo wells takes place when the wells are "loaded". This means if you add pseudo wells to a cross-section they will not show
on the map until you re-select the wells. A simple "refresh data" will not do it. However, if you are showing pseudo wells on you map and you wish to exclude them, simply set the "exclude" option and "refresh data".

6.20 Displaying Test Indicators

The Select Test Indicators to Plot window adds perfs, tests, shows, and other information along the wellpaths in the Cross-Section Module.

To open this tool, select the button on the Cross-Section Module's toolbar, or select Wells>Post Test Indicators on the menu bar at the top of the screen.
FootNotes Tab

6.20.1 Test Ind. Tests Tab

To add a test indicator, select the check box next to the desired test indicator. Next, select the track number and position.

Track No
Each trace is plotted in one of the 11 predefined track positions relative to the well symbol. As shown in the illustration below, tracks 1 through 7 are single width tracks while tracks 0, 8, 9 and 10 are double width tracks.

Relative Position
A trace’s relative position sets the position inside the track. Relative position goes from 1 to 5, with 1 at the far left, 3 at the center, and 5 at the far right.

Depth Track Symbols
The depth track symbols sets the a few additional indicators inside the depth track. Options include casing, liners, prod symbols, and cement.

6.20.2 Test Ind. Options Tab

![Select Test Indicators To Plot](image)

**Plot Bridge Plug Symbol At Depth Track** - By default, Petra plots bridge plugs in the same track and relative position as perfs. This option overrides the position of the perfs and instead plots bridge plug symbols at the depth track.

**Taper DST Symbols** - By default, Petra draws DST symbols as rectangles. This option instead tapers the DST symbols.

**Show tests from re-completions which match 10-digit API#** - Generally, Petra treats recompletions as separate wells. Accordingly, Petra only draws the tests from the single well displayed on the cross-section and does not include recompletions. This option instead forces Petra to display tests from all recompletions.

**Do Not Plot values When Equal to 0.0** - This option suppresses plotting values equal to zero. This can be useful for simplifying plots.

**Test Symbol Width Scaling Factor** - This option scales the width of all test symbols, where 1 is the default. Setting this value to 0.5 will

**Prod Symbol Size** - This option sets the size of the production symbols in inches. The default setting is 0.2 inches.

6.20.3 Test Ind. Remarks Tab

The Remarks Tab adds remarks for the selected tests. Note the options for tests not
selected on the Tests Tab will be grayed out.

6.20.4 Test Ind. Dates Tab

The Dates Tab restricts the tests displayed on the cross section to only those falling within a date window.

6.20.5 Test Ind. Text Tab
Text Options

Word Wrap Width - This option sets the number of characters for a single line of a test remarks field. Petra will wrap the text beyond this number of characters. For closely-spaced wells, it might be useful to decrease this entry.

Text Height - This option sets the height of test text.

Opaque Text - This option makes the text and the surrounding text boxes opaque. This can be useful for making text more visible, but can obscure other features on the cross section.

Remarks Position

This option sets the location of the remark text. Text can either start at the top of the test, or centered within the top and base of the test.

6.20.6 Test Ind. IP Tests Tab

The IP Tests Tab controls how IP tests are displayed on the cross section. This tab is only available when the IP Tests option is selected on the Tests Tab.

Plot All Production Tests - This option does not restrict the tests, and will display all of them on the cross section.

Plot IP Tests Only - This option restricts the tests on the cross section to only IP tests.

Plot Non-IP Tests Only - This option restricts the tests on the cross section to only non-IP tests.

Preferred Tests - This option restricts the tests on the cross section to only "preferred tests" established on the Production Tests Detail Window available on the IP Tests Tab.
6.20.7 Test Ind. DSTs Tab

The IP Tests Tab controls how DSTs are displayed on the cross section. This tab is only available when the DSTs option is selected on the Tests Tab.

6.20.8 Test Ind. Cores Tab

The Cores Tab controls how cores are displayed on the cross section. This tab is only available when the Cored Intervals option is selected on the Tests Tab.

Cross Types To Plot - This entry restricts the cores plotted on the cross section to only those with the "core type" specified on the Main Module's Cores Tab. To plot all core types, leave this entry blank.

Hide Core Symbol - This option hides the core symbol. This can be useful for reducing the visual clutter by only displaying the core remarks.
6.20.9 Test Ind. PdCum Tab

The PdCum Tab controls how production cums are displayed on the cross section. This tab is only available when the PD Cum option is selected on the Tests Tab.

Enter Fm Names to Restrict PdCum Data or Blank for All - This option restricts the pd cums on the cross section to only those with one of the specified "Fm Names" set on the Main Modules's Prod Cums Tab.

Post the Following Items

This section sets what will plot along with the production cum symbol. This can include the formation name, dates, oil/gas/water cumvs and more. The entry box to the right plots additional fields loaded by the user.

6.20.10 Test Ind. Perfs Tab

The Perfs Tab controls how perfs are displayed on the cross section. This tab is only available when the Perfs option is selected on the Tests Tab.
Restrict Perfs to Sources - This option restricts the perfs on the cross section to only those with one of the specified source set on the Main Modules’s Perfs Tab.

Plot Other Sources is Above Source Not Present - When the selected perf source specified on the “Restrict Perfs to Sources” isn’t available, this option allows Petra to plot other perf sources. This effectively just makes the entered sources a priority rather than a strict requirement.

Problem Perfs

"Problem" perfs are duplicate or overlapping perf intervals in the database. The Perfs Tab can filter these perfs out without actually deleting them from the database.

Skip "Problem" RED Perfs - This option prevents large overlapping gross interval perfs from appearing on the cross section.

Skip "Problem" BLUE Perfs - This option prevents duplicate perfs from appearing on the cross section.

Include or Exclude Perfs by Type

By default, Petra plots all perf types. This tool selectively displays different perf types on the cross section.

Do Not Restrict Perfs By Type - This option just plots all perf types.

Include the Selected Perf Type - This option will include only the perfs selected on the Perf Type List below. Only the checked perf types will plot.

Exclude the Selected Perf Type - This option will exclude the perfs selected on the Perf Type List below. Perf types checked will not plot.
By default, Petra displays text about test indicators along side the test symbol on the wellbore. This option instead plots the test text as a footnote at the bottom of the wellbore.
7 SpreadSheet Module

The spreadsheet tool allows you to edit data from the database in spreadsheet format. Spreadsheet columns are made up of selected Well Header or Zone data values. Options include copying, sorting, computing statistics, find/replace, among others.

**IMPORTANT:** Petra does not automatically save changes made in the SpreadSheet Module to the project database unless instructed. The values displayed on the SpreadSheet Module are the values at the time the spread sheet was created. Any changes made in the Spreadsheet module must be save to the project. Users must Save the changes to the project by selecting File>Save on the menu bar at the top of the screen or by selecting the "Yes" option when requested to Save.

To open the Spreadsheet Module:

- Select Tools>Spreadsheet on the Main Modules menu bar
- Click the button on the Main Module Toolbar

**Important:** The first time that the the SpreadSheet Module is opened the Spreadsheet Options dialog will open so that the default columns can be selected. Thereafter, the spreadsheet will open populated with the selected well values.

**Read Only** - This check box disables the SpreadSheet Module from writing back to the project database. This is intended as a safeguard to prevent data from accidentally being modified.
- Opens the Spreadsheet Options Tool.

- Manually refreshes the displayed data. Alternatively, select Columns>Reload from the menu bar at the top of the screen.

- Changes back to the project database. Alternatively, select File>Save on the menu bar at the top of the screen.

- Opens the Replace tool that performs a find/replace on the currently selected column.

- Sorts the spreadsheet by the currently selected column in ascending alphabetical order.

- Sorts the spreadsheet by the currently selected column in descending alphabetical order.

- Opens a Data Statistics window. This window will have a list for well header info, and a histogram for numerical data items.

Related Topics

Selecting columns

Working With Columns

7.1 Spreadsheet Options

The Spreadsheet Options dialog box allows you to:

- Select the well header and Z data items which make up the columns of the spreadsheet.

- Select and sort any subset of wells in the Spreadsheet.

- Select Spreadsheet Module start up options.

To select or change Spreadsheet Options:

- Click the button on the top of the Spreadsheet Module or,
- Select Columns>Select... on the Spreadsheet Module menu bar.
Related Items:

Spreadsheet Columns Tab
Spreadsheet Wells Tab
Spreadsheet Options Tab

7.1.1 Spreadsheet Options Columns Tab

The Spreadsheet module can display well header information (like API, well number, elevation datum, etc) and zone data items. Note that formation tops are in the "FMTOPS" zone, and can either be expressed as MD, SSTVD, or TVD tops. Spreadsheet columns are made up of selected Well Header or Zone data values. To select, add, or replace the columns included in the spreadsheet:

- Click the button on the top of the Spreadsheet Module and then the Columns Tab
- Select Columns->Select on the Spreadsheet Module menu bar
Column is Quality Code Field - Selecting this option sets the desired column to use the data item's quality code field rather than the actual value.

Column is Remark Field - Selecting this option sets the desired column to use the data item's remark field rather than the actual value.

Use Aliases - This option uses zone data item aliases to display "equivalent" data items when the selected zone data item is unavailable. Note that Petra can only read aliased data items, and will not overwrite any values.

To add a column:
1. Select the desired header information or zone/data item.
2. Select the "+ Add" button.

To replace a column:
1. Select the item in the Spreadsheet Data Columns list.
2. Select the replacement data item from the Select Data Column Item section.
3. Select the "Replace" button.

To remove a column(s):
1. Select the desired column(s) from the Select Data Column Items list.
2. Click the "<" button.
3. To drop all logs from the Selected Logs list, left click the "<<" button.

Saving Column Lists
Frequently used lists of data items can be saved to disk for future use. The "Save" and "Load" buttons save column settings to an external spreadsheet columns (*.SSC) file.
7.1.2 Spreadsheet Options - Wells Tab

The Spread Sheet Module can display any subset of wells in the project. To select or change the wells shown:

- Click the button on the top of the Spreadsheet Module and then the Wells Tab or,
- Select Wells>... on the Spreadsheet Module menu bar

All Wells - This option selects all wells in the project.

Wells By Data Criteria - This option opens the Wells By Data Criteria tool that selects wells by specific data criteria.

Map Selected Wells - This option selects the wells currently selected in the Map Module.

Main Selected Wells - This option selects the wells currently selected in the Main Module.

Cross-Section Wells - This option selects the wells currently selected in the Cross-Section Module.

Sorting Wells

The Spreadsheet Module can sort wells by the data in a selected column in Ascending, Descending, Original or Multi Column order. To sort the wells, select any data cell in the desired column for the sort and then select the sort method from the Spreadsheet Module menu bar Wells>Sort... or the right-click pop up menu.

When wells are sorted, wells containing a null value in the sort column are positioned to be bottom of the list.
Sort Original Order - ressorts the wells by WSN, or Well Serial Number. A well’s WSN is just the order it was loaded into the project.

Multi Column Sort sorts wells by multiple columns. When Multiple Column Sort is selected the following dialog is displayed to select the relevant columns for sorting in priority from top to bottom.

7.1.3 Spreadsheet Options - Options Tab

Use BH Location Data - This option uses bottom hole locations rather than the default surface locations.

Startup Options - Checking opens Spreadsheet Options dialog box by default rather than the Spreadsheet populated with current column values.
7.2 Working with Columns

Column Statistics

A statistical histogram can be displayed for numeric data columns. Click any data cell of the desired column and choose the "Show Stats" menu of either the "Columns" menu or the pop up menu invoked with the right mouse button.

Find and Replace

The find option can search the current column for a specified value. Values in the current column may be replaced using the same option. Set the current column by clicking any data cell of the desired column. The find and replace functions search downward from the current data cell.

To apply a Find and Replace, select the button on the toolbar or select Search>Find and Replace on the menu bar at the top of the Spreadsheet Module.

Upper Case Option

Columns>Set Column Data To Upper Case - This option converts all lower case characters in the current column to upper case.

Export>Comma Delimited File

This option copies the currently selected data out to a comma delimited file.
Include Column Headings - This option includes column headings at the top of the CSV file. Deselecting this option removes headings, which can make importing the data easier for some software packages.

Include WSN Column - By default, Petra includes the well's Well Series Number in the export. Since this number just reflects the order the well was imported into the project and serves as an internal record keeping for Petra, it may not be useful in all applications.

Put Double-Quotes Around Data - This option adds double quotes around data. This can make imports easier for some software packages.
8 Log Cross Plot Module

The Log Crossplot Module graphically compares two different log curves on an X-Y scatter plot to help identify the log response to lithology. Color-coding the data points can show an additional third variable on the scatter plot.

To open the Log Cross Plot Module, select Tools>Log Data Cross Plot from the menu bar at the top of the Main Module.

This brings up the “Data Definition” screen superimposed over the main Crossplot Module, both of which are blank by default.

Getting Started

Selecting wells
Setting the depth range
Setting the X and Y Axes
Setting Z-Axis color coding

Advanced Tools

Regression Lines
Drawing Polygons
Pickett Plots
8.1 Log Crossplot Selecting Wells

Selecting Wells

The Log Crossplot Module can display any subset of wells in the project. To change the wells shown, select **Wells** from the menu bar at the top of the Log Crossplot Module.

- **All Wells** - This option selects all wells in the project.
- **Wells By Data Criteria** - This option opens the **Wells By Data Criteria** tool that selects wells by specific data criteria.
- **Map Selected Wells** - This option selects the wells currently selected in the **Map Module**.
- **Main Selected Wells** - This option selects the wells currently selected in the **Main Module**.
- **Cross-Section Wells** - This option selects the wells currently selected in the **Cross-Section Module**.

To switch between wells, select either the desired well on the dropdown at the top of the Log Crossplot Module or use the left and right arrows to scroll through the selected wells.

Plot Single/Combine All Wells

Petra can either plot the log crossplot data points from a single well or from multiple wells in aggregate. To switch between these two modes, select **Wells>Plot Single Well** and **Wells>Combine All Wells**. Note that showing multiple wells will remove the curves displayed on the right side of the screen – after all, with data points from multiple wells, which curves would you show?

By default, data points from all wells are shown the same color. To color code different wells by different colors, select the “Use Different Symbol Color When Combining Wells” on the General Tab of the Log Cross Plot Data Definition screen available from **Logs>Axes and Scales** on the menu bar at the top of the screen. Note that this color coding only uses ten distinct colors; plotting more than ten wells will recycle colors.

8.2 Log Crossplot Set Depths

It’s often useful to limit the crossplot’s data points to a specific interval of interest. Data points can be constrained by zone definition, tops, or by a specified depth (MD or TVD).
On the menu bar at the top of the screen, select **Depths>Set Depths…** from the menu bar at the top of the screen. Alternatively, select the button on the toolbar at the top of the Crossplot Module. This opens the Depths Tab on the Log Cross Plot Data Definition screen.

### Zones

To set depths by a zone’s interval definitions, select the “Set Depths From Zones” button. Next, select the desired zone. Note that the WELL zone by default covers -1M MD to +1M MD, so it should cover the entire footage of all wells. If the tops used in the zone interval definition are missing for a well, Petra will not display the log plot.

### Set Depth From Range

To set depths by tops or by a specific depth range, select the “Set Depth From Range” button. Next, select the “Set Range” button. In the Set Depth Range box, select the relevant top, MD, or TV Depth button. For MD and TVD, select the relevant button and enter the adjacent depth in the entry field.

### Tops

For tops, select the desired top from the “Fm Top Name” dropdown box. Notice that an offset can also be added or subtracted to the fm top; this offset will include data points above or below the actual fm top depth.

### 8.3 Log Cross Plot Data Definition

The Log Cross Plot Data Definition tool sets the X and Y axes, establishes Z color shading, saves templates, and sets titles and labeling.

To open the Z Data Cross Plot Data Definition tool, select the button option on
the menu bar at the top of the Log Crossplot module, or select Logs->Axes & Scales.

8.3.1 Log Crossplot Data General Tab

The General Tab controls the presentation of the cross plot, including the title, the cross plot type, and labels. The General Tab also governs the symbol style for individual data points.
Title
This box sets the title for the plot. This title will appear at the top of each cross plot display.

Cross Plot Type
X-Y and X-Y-Z Plot—This option creates a scatter plot with two logs forming the vertical and horizontal axes. Note that this option creates the X – Y Axes Tab next to the General Tab. A third variable (Z) can be shown by color coding the individual data points.

Ternary Diagram - This option displays three log values on an equilateral triangle. Ternary diagrams are most commonly used to display ratios between three variables that add up to a constant, such as the relative percentages of shale, sandstone, and limestone that add up to 100%. In Petra, however, the three scales on the diagram are independent, so they don't necessarily need to add up to a constant. Note that this option creates the Ternary Tab next to the General Tab. A fourth variable (Z) can be shown by color coding the Ternary Tab next to the General Tab.

Label Well Using
This dropdown sets how wells are labeled at the top of the plot. Wells can be labeled by UWI, name, number, well label, UWI and name, or well name and number.

Symbol
These dropdowns set the shape and size of the data points on the plot. By default, data points are red but can be color-coded to reflect an additional curve on the Z Axis Tab.

Show Curves For
This option simply filters the available curves on the Ternary and X – Y Tabs. Selecting “All Wells” shows curves for all wells in the project, while “Selected Wells Only” limits the curve selection only to curves available to the currently selected wells. It’s generally simpler and faster to keep this setting to “Selected Wells Only.”

Use Different Symbol Color When Combining Wells - Petra can show log data points for a single well, or for multiple wells. This option color codes different wells by different colors. Note that this color coding only uses ten distinct colors; plotting more than ten wells will recycle colors. Deselecting this option will plot all log data points a default red.

The examples below show a combination of four wells. The plot on the left shows every data point from every well as red. The plot on the right, however, breaks out the data points from each well in a different color (blue, pink, green, and red).
8.3.2 Log Crossplot Data X-Y Axes Tab

The X-Y Tab is only available when “X-Y and X-Y-Z Plot” is selected on the General Tab. This tab sets the curves and scales for the scatter cross plot. Note that if any of the curves are unavailable, Petra cannot plot the diagram. If using log aliasing, make sure to select “Use Log Aliases” on the bottom part of the tab.

X-Axis and Y-Axis

This section sets the curve and scale for the horizontal X axis and the vertical Y axis. Select the desired curve on the dropdown, and set the scale using the Minimum and Maximum. In the example below, the X axis is a gamma ray log, and the Y axis is a
deep resistivity log. Note that both curves can also be displayed in a logarithmic scale; just be sure to select a minimum above zero. The “Use Depths of Above Curve for X/Y Axis” will instead plot the other axis curve relative to depth.

The example below shows an X – Y log cross plot where gamma ray is on the horizontal X axis and deep resistivity is on the vertical Y axis. Note that the resistivity log is on a log10 scale. The logs for the relevant curves are plotted to the right of the screen since this plot only shows the log cross plot for a single well.

Swap X & Y - This button simply swaps the selected curves, scales, and settings for the X and Y sections.

Connect Points - This option draws a connecting line between data points down MD on the curve. This connecting line is a little smaller than the data points, and is red by default.

The example below shows the cross plot with connected points. Especially with less log footage (and fewer data points), this plot illustrates how the curve cross plot relationship changes with depth.
Plot Histograms - This option adds a histogram along both axes showing the distribution of each curve’s data points. The example below shows histograms arranged for both the horizontal and vertical axes.

8.3.3 Log Crossplot Data Ternary Tab

The Ternary Tab is only available when “Ternary Diagram” is selected on the General Tab. This tab sets the curves and scales for the three logs on the plot. Note that if any of the curves are unavailable, Petra cannot plot the diagram. If using log aliasing,
make sure to select “Use Log Aliases” on the bottom part of the tab.

Axis 1, 2, and 3

These sections set the curve and scale for the three axes on the triangle. Select the desired curve on the dropdown, and set the scale using the Minimum and Maximum. Note that curves can also be displayed in a logarithmic scale; just be sure to select a minimum above zero.

The example below shows a ternary diagram between gamma, neutron porosity, and deep resistivity. The three curves used in the diagram are shown on the right side of the screen. Unlike a traditional phase diagram or lithologic percentage plot, the data points do not add up to a constant value. Instead, this plot represents how the petrologic data clusters together in different facies.
8.3.4 Log Crossplot Data Z Axis Tab

The Z-Axis tab color codes data points by an additional third log curve, giving a third Z dimension to the scatter or ternary diagram.

Use Z Axis log

This option simply toggles the selected Z-axis coloring. When toggled on, data points will use the Z-axis colors. When toggled off, Petra just uses the default color for data points, but retains all the color and curve settings for the Z axis.

Use Z-Axis Colors WhenCombining Wells

This option overrides the “Use different symbol color when combining wells” option on the General Tab.

Z – Axis

This section sets the curve and colorbar for the data points. Select the desired curve on the dropdown, and set the scale using the Color Range button.
Here, set the minimum and maximum values for the contours in the “MIN” and “MAX” boxes. The “Interval” sets the contour interval between colors. There can be up to 47 different intervals. Petra comes with several other color schemes available through the “Default” button on the right side of the screen. The example above uses “rainbow.zpl.” To create a new color scheme, select an individual interval and select a color from the palette for that interval.

The two examples below demonstrate how Z data can add an additional dimension to log cross plots. The first example colors a gamma and deep resistivity cross plot by density porosity values. Cool sandy data points tend to correlate with higher porosity, with the notable exception of an island of high resistivity tight streak in the upper left corner of the plot.

The second example shows a gamma ray, resistivity, and neutron porosity ternary cross plot with data points colored by density porosity. This plot reaches similar conclusions as the first, with the added conclusion that neutron porosity and density porosity are closely related.
8.3.5 Log Crossplot Data Discriminators Tab

The discriminator curve filters data points by log criteria. Select one or more curves on the dropdowns, and set the scale using the Minimum and Maximum. Data points that fall outside of this data criteria are not included on the cross plot. In the example below, only data points where density porosity is between 10% and 30% will be included on the plot.

Include Discriminator Logs When Plotting Curves

This option simply plots the discriminator curve along the other curves on the right side of the screen and at the scale specified by the minimum and maximum cutoff values. In the example below, low density porosity values are filtered out, simplifying the plot.
Notice that the density porosity curve (DPHI) is used twice – as a “Z Axis” color scale, and also as a discriminator curve.

8.3.6 Log Crossplot Data Depths Tab

The Depths Tab sets the depths of the data points for the cross plot. This is most useful for limiting the cross plot to a specific interval of interest. Data points can be constrained by zone definition, tops, or by a specified depth (MD or TVD).

**Zones**

To set depths by zone, select the “Set Depths From Zones” button. Next, select the desired zone. Petra will use the zone interval definitions established in the Main Module. Note that the WELL zone by default covers -1M MD to +1M MD, so it should...
cover the entire footage of all wells. If the tops used in the zone interval definition are missing for a well, Petra will not display the log plot.

**Set Depth From Range**

To set depths by tops or by a specific depth range, select the “Set Depth From Range” button. Next, select the “Set Range” button. In the Set Depth Range box, select the relevant top, MD, or TV Depth button. For MD and TVD, select the relevant button and enter the adjacent depth in the entry field.

For tops, select the desired top from the “Fm Top Name” dropdown box. Notice that an offset can also be added or subtracted to the fm top; this offset will include data points above or below the actual fm top depth. In the example below, data points up to 100 feet above the “2ND_WALL_CREEK” top and 50 feet below the “2ND_WALL_CREEK_BASE” top will be included in the cross plot. Note that the “Set Upper and Lower Depths From Zone” will populate the depths fields on this screen with the selected zone’s interval definitions. This makes it easier to select an existing zone’s definitions and modify them.

![Set Depth Range Dialog](image)

**Sample Decimation**

This option decreases the total number of data points in the cross plot by only including every Nth valid data point. This can be useful when working with large intervals, or with finely sampled curves. As an example, setting N = 3 means that Petra will only include every third data point. To plot every available data point, select N = 1.
8.3.7 Log Crossplot Data Capture Tab

The Log Cross Plot Module can also calculate and capture Kendall’s Tau to a specific data item for each well selected. Kendall’s Tau is a measurement of the association between two measured quantities.

8.3.8 Log Crossplot Data Options Tab

The Options Tabs sets a couple of additional options for the Cross Plot Module.

How to Determine Default Scale Ranges

This option simply governs how Petra populates the scale ranges on the X-Y Axes Tab and Ternary Tab when a curve is added for the first time. By default, Petra uses the user-set default ranges established in the Main Module’s Logs Tab. Alternatively, Petra can conduct a statistical measurement of the curves.

Create Regression Report
This option creates a regression report called “xplot_regression.txt” in the project’s PARMS directory. This report contains statistical measurements of the relationship between the X and Y axes, as well as a regression linear equation. While inside the Log Crossplot Module, select CTRL + R to quickly open this report.

REGRESSION REPORT
Jul 1, 2010  10:10 AM

X = GR
Y = ILD

LINEAR REGRESSION
N = 266
SUM X = 27227.29900
SUM Y = 27227.29900
SUM X^2 = 3078851.23372
SUM Y^2 = 171.41121
ssx = 291912.09524
ssy = 20.44893
r1 = -2082.67644
r2 = 5969289.15957
Corr Coef = -0.85243
Slope = -0.00837
Y-Int = 1.61005
Std Error = 0.15120
Equation: LOG(ILD) = (-0.00836969)*GR + 1.6101

8.3.9 Log Crossplot Data Tops Tab

The Tops Tab sets the display of tops against the curves displayed on the right side of the screen.

Display Tops on Logs - This option simply toggles the selected tops. When toggled on, the curve vs depth plot on the right will display the selected tops. When toggled off, Petra leaves off the tops, but retains all the tops and color settings.
Available and Selected Tops

To add a top highlight the desired top name in the "Available Tops" list and click the add button (">"). This moves the log over to the “Selected Tops” list. To remove a top, highlight the top name in the “Selected Tops” list and click the remove button ("<"). The “>>” and ”<<” buttons add all tops and remove all tops, respectively.

Style

To change the color of a top, select the top on the “Selected Tops” list and select the desired color using the color box on the right. The “All” button applies the selected color to all tops on the “Selected Tops” list. In the example below, the 2ND_WALL_CREEK” top and the “2ND_WALL_CREEK_BASE” tops are both displayed in red.

8.4 Log Cross Plot - Pickett Plot Overlay

A Pickett Plot is a double logarithmic plot of resistivity versus porosity.

To add a Pickett Plot, select Options>Pickett Plot. Here, add the cementation, saturation, tortuosity, and water resistivity coefficients at formation temperature.
The Pickett Plot Overlay displays up to 3 water saturation lines based on the Archie water saturation equation:

\[ \log(R_T) = -M \log(\Phi) + \log(A \cdot R_w) - N \log(S_w) \]

Constants are supplied for \( M \), \( N \), \( A \), and \( R_w \). Up to 3 \( S_w \) values can be specified. Each \( S_w \) value produces a separate line on the cross plot.

The cross plot must have a Resistivity curve as the X axis and a Porosity curve as the Y axis. Both axes must be log 10 scale. Typically the Porosity is scaled from 0.01 to 1.0 and Resistivity is scaled from 0.1 to 1000.

The Pickett Plot can have up to three water lines. By default, the 100% water saturation line is added. To change these water saturation lines, enter in the desired percentage (in decimal values from 0 to 1) and toggle the relevant line’s button to the left.

### 8.5 Log_Crossplot Polygons

Facies polygons outline different areas of the crossplot. Each polygon in the Crossplot Module can have its own name, color, and “facies value.” A facies value is a way of coding a log crossplot polygon into a facies curve.

When creating a facies curve, Petra compares the footage of the relevant curves to the log crossplot polygons. The MD of data points falling inside a polygon’s boundary are given that polygon’s facies value. As such, facies polygons allow for a more nuanced cutoff criteria, since polygons vary the cutoff based on the relationship between logs. Additionally, multiple polygons means that a facies log can code for multiple facies at the same time.

The example below shows a Gamma/Resistivity crossplot with a single “pay” polygon. This polygon covers the data points where gamma is lower than about 90 API units and resistivity is above 10 ohmm – in short, it’s the potentially productive sand. Its facies value is 1. On the curves to the right, the data points inside this polygon are highlighted in red. Footage-wise, it’s from about 2905 to 2940’ MD.
Carrying on the example, the polygon is converted to a facies log. All the data points inside the polygon are coded with the facies polygon’s value of 1. The example below shows how a facies curve actually looks in the Main Module; the depths where the gamma and deep resistivity curve values fall inside the polygon are coded with a facies value of 1. Though this example only shows one well, a single facies polygon file can be applied to any number of wells, making it a powerful way of interpreting crossplots over an entire project.
To establish a facies polygon, right click anywhere on the log plot and select “Add Polygon.” Alternatively, select Polygons>Add from the menu bar at the top of the screen. Drawing a polygon works exactly the same as drawing lines elsewhere in Petra. Pick polygon node points with the left mouse button and select the right mouse button to stop picking points. Petra will automatically close open polygons.

During picking, press ESC picking to cancel the current polygon or DELETE to drop the last picked point. Selecting F1 while picking will snap the cursor to the nearest node point on another polygon, which can be useful for generating polygons with no empty space between them and no overlap.

Once the polygon is picked, Petra brings up the “Polygon Definition” box. Here, simply enter the name of the polygon or facies, pick a color, and add a polygon facies value. The facies name is be the only way of distinguishing the polygons apart when calculating a facies curve, so spending time on descriptive names is a good idea. This facies value is the numerical code used when making facies curves, so make sure every facies has a unique value.

Modifying and Deleting a Facies Polygon
To change the area of a facies polygon, right click anywhere on the log plot, select “Select Polygon”, and then left click on the desired polygon. Make sure to click right on the line. Alternatively, select Polygons>Select from the menu bar at the top of the screen, and then left click on the desired polygon. This highlights the polygon and shows its node points; select a node point and drag it to the desired position to change the outline of the polygon. When finished, right click and select “Redraw” to refresh the screen and show the changes.

Changing a polygon’s name, color, and facies value is similar. Select the polygon with the mouse, as outlined above. Once the polygon is highlighted, right click and select “Modify Polygon.” Alternatively, select Polygons>Modify from the menu bar at the top of the screen with the polygon is highlighted. This opens the Polygon Definition box, which sets name, facies value, and color for the polygon.

To delete a drawn polygon, select the polygon with the mouse as outlined above. Once the polygon is highlighted, right click and select “Modify Polygon.” Alternatively, select Polygons>Modify from the menu bar at the top of the screen with the polygon is highlighted. This opens the Polygon Definition box. Select the “Delete Polygon” button on the bottom of the box.

Loading and Saving Facies Polygons
Closing the Log Crossplot Module erases the polygons from Petra’s memory, so
make sure to save the polygons to a file. Additionally, this file will be used later to create facies curves. Select Polygons>Save from the menu bar at the top of the screen. Create a name and select the save button.

On the Save Polygons to Disk box, the area outside the polygons name and value can be modified. By default this area is named “DEFAULT” and its value is zero. This screen also allows for a comment to better describe the polygons.

Creating Facies Curves from Facies Polygons
To compute a facies curve, select Compute>From Logs>Advanced Transforms from the menu bar at the top of the screen in the Main Module. This opens the “Log Transformations” module.

Setting the Wells and Depths in the Log Transformations Box
First, select the desired wells and depths in the Log Transformations Module with Wells>Select. “Current Well From Main” selects the single well currently selected in the Main Module. “All Wells” selects all wells available in the project. “By Data Criteria” selects wells based on a set of nested criteria including well headers, logs, or zone data. “Wells From Main” selects all wells currently selected in the Main Module.
Next, limit the calculation by depth ranges in the Log Transformations Module by selecting Depths>Depth Range on the menu bar at the top of the screen. The interval calculated can be constrained by zone definition, tops, or by a specified depth (MD or TVD)

**Using the Crossplot Facies Model to Calculate a Facies Curve**

Next, select the “Facies Log” button, or select Transform>X-Plot Facies Model from the menu bar at the top of the Log Transformations Module. Petra will then ask for the location of the saved facies polygon file (*.XPP). Select the desired polygon file. Petra then opens the Facies Log from Cross Plot Polygons tool. This tool is divided into several different tabs.

On the File Tab, the “Facies Polygon File” entry box should be populated with the selected facies polygon file. The File Comments entered when saving will be shown below. To select a different facies polygon, select the “Browse” button.

The Logs tab sets the logs used in the facies curve calculation. To change the logs used in the crossplot calculation, select the desired curves on the X-Axis and Y-Axis dropdown boxes. Note that changing the logs will keep the polygon cutoff values the same. If using log aliases in the project, make sure to select the “Use Log Aliases” checkbox. This window also changes the name of the output facies curve; by default this is set to “FACIES” as in the example below. To change the name, just enter in a new curve name.
The Facies Tab sets the actual values used in the facies curve. The “Default Facies Value” entry box sets the value of any foot where the curve data doesn’t fall inside any of the polygons. In the example below, it’s set to 0.

The “Log Values For Each Facies Polygon” window lists each of the polygon names along with their respective facies values. The values shown are initially populated by each polygon’s “facies value” created in the Log Crossplot Module. To change a polygon, select the polygon name on the list, and change the value on the “Edit Value” box. Select the “Change Value” button to accept the changes. In the example below, depths where the gamma ray and deep resistivity fall into the “PAY” polygon will be coded as 1 on the facies curve, while all other depths will be set to zero.

The Discriminators tab filters data points by log criteria. To set a discriminator curve, select up to 5 curves and set the scale using the minimum and maximum entry boxes. Data points that fall outside of these data criteria are not included in the facies curve and will be given the default facies value entered on the Facies tab.
Chapter 9
9  Z Cross Plot Module

The Z Crossplot Module graphically compares different Zone Data Items on an X-Y scatter plot to help identify the relationship between multiple variables. Color-coding the data points can show an additional third variable on the scatter plot. This module can be used to display petrophysical relationships, production information (when stored in a data item), or any other parameter stored in a zone.

To open the Z Cross Plot Module, select Tools>Z Data Cross Plot from the menu bar at the top of the Main Module.

This brings up the “Data Definition” screen superimposed over the main Crossplot Module, both of which are blank by default.

Getting Started

Selecting Wells
Setting the XY Scales
Setting Z-Axis color coding
Additional Options
Loading and saving Data Definitions

Advanced Tools

Regression Lines
Drawing Polygons

9.1  Z Cross Plot Selecting Wells

By default, The Z Crossplot Module simply uses the wells selected in the Main
Module. All data points for all these wells show up on the scatter plot.

To change the wells selected on the Z Cross-plot, select the Wells option on the menu bar at the top of the screen.

All Wells - This option selects all wells in the project.

Select by Data - This option opens the “Select Wells By Data” option. This tool can refine the wells used in the cross plot based on several different criteria. Additionally, multiple nested searches can combine to make for more precise well lists.

Wells from Main/Map/Cross-Section - These options select the wells currently active in the relevant module. As an example, selecting “Wells from Map” selects only the wells currently selected in the Map Module.

Highlight from Polygon - This option changes the color of the data points inside a given polygon to use the same color as the polygon.

9.2 Z Data Cross Plot Data Definition

The Z Data Cross Plot Data Definition tool sets the X and Y axes, establishes Z color shading, saves templates, and sets titles and labeling.

To open the Z Data Cross Plot Data Definition tool, select the Data option on the menu bar at the top of the Z Crossplot module.

The Z Data Cross Plot Data Definition X-Y Axis Tab
9.2.1 Z Cross Plot Data Definition X-Y Axis

The X-Y tab controls the basic settings for the plot, like the plot title and axes.

![The Z Data Cross Plot Data Definition X-Y Axis Tab]

**Title** - This entry sets the title of the plot.

**X Axis Data**

This section sets the specific zone and data item, for the X axis of the plot. The upper dropdown select the zone, and the lower dropdown selects the data item.

**Minimum (left)** - This entry sets the minimum value for the cross plot.

**Maximum (right)** - This entry sets the maximum value for the cross plot.

**Log Scale** - This button sets the selected axis to a logarithmic scale.

**Stats** - This button displays a histogram of the z data for the selected wells, which can aid in setting a reasonable minimum and maximum scale for the plot.

**Defaults** - This option sets the minimum and maximum scale based on the minimum and maximum data value in the data. If the minimum and maximum values are more than 500 apart (and is not a top or contains negative numbers), Petra will automatically scale the axis to a logarithmic scale. Note that dates can also be used in these fields in the format MM/DD/YY, like 01/01/1910.

**Y Axis Data**

This section sets the specific zone and data item, for the Y axis of the plot. The upper dropdown select the zone, and the lower dropdown selects the data item.

**Minimum (lower)** - This entry sets the minimum value for the cross plot.

**Maximum (upper)** - This entry sets the maximum value for the cross plot.
Log Scale - This button sets the selected axis to a logarithmic scale.

Stats - This button displays a histogram of the z data for the selected wells, which can aid in setting a reasonable minimum and maximum scale for the plot.

Defaults - This option sets the minimum and maximum scale based on the minimum and maximum data value in the data. If the minimum and maximum values are more than 500 apart (and is not a top or contains negative numbers), Petra will automatically scale the axis to a logarithmic scale. Note that dates can also be used in these fields in the format MM/DD/YY, like 01/01/1910.

Misc

View Z Data - This button opens a zone data item viewer. Here, use the "+" button to the left of the desired zone to expand the tree, and then select the desired data item. Note that entries here can be edited as well.

Flip X Y - This option flips the X and Y axis.
9.2.2 Z Cross Plot Data Definition Z-Axis

The Z-Axis tab color codes data points by an additional Z data value, giving an additional dimension to the XY scatter plot.

Data points that do not have a Z value will not be plotted.

Use Z-Axis - This option enables Z-Axis color coding.

Z Axis Data

This section sets the specific zone and data item, for the Z axis color coding. The upper dropdown select the zone, and the lower dropdown selects the data item.

Minimum (left) - This entry sets the minimum value for the cross plot.

Maximum (right) - This entry sets the maximum value for the cross plot.

The normal colorbar is Petra’s default way of selecting the colors for a grid. This system gives greater flexibility in changing colors and irregularly spaced intervals, but tends to be a little more work to set up and has a more limited total number of
intervals.

![Color Interval Definition Window]

**Edit Value**

Each selection of the interval list box displays the interval "z" value in the Edit Value entry field. Use the Apply button to modify the z value. Intervals need not be a constant increment, however, z values must increase from top to bottom.

**Set Interval**

- **Min** - This option sets the maximum contour. Grid values below this minimum won't appear on the contours.
- **Max** - This option sets the maximum contour. Grid values above this maximum won't appear on the contours.
- **Interval** - This option sets the desired contour interval.
- **Apply** - This button creates intervals from the minimum to maximum.

**Number of Intervals**

This option displays and modifies the total number of intervals on the interval list. The normal colorbar can handle a total of 46 different intervals, starting with the minimum and counting up towards the maximum. Decreasing intervals will drop the highest
intervals first. Similarly, adding additional intervals will add intervals above the maximum.

Color Scheme

Load... - This button loads a previously saved set of intervals and colors.

Save... - This button saves the current set of intervals and colorbar to a *.ZPL file.

Default Colors - This button resets the color palette and intervals to the grid defaults.

Palette

Changing An Interval Color - To change the color for a particular interval, select the interval by clicking the left mouse button on the list box in the center of the screen. The interval color will be highlighted in the color palette. Click the left mouse button on any color palette color cell to change the interval's color.

Set Colors... - This button changes the the selected palette’s color. Alternatively, doubleclick the palette color.

The system color selection dialog is activated for changing the cell's color. The system color dialog can also be used to define several additional customized colors.

Use

Interp - This button will interpolate the entire palette starting with the upper left corner and ending with the lower right corner. If you want to interpolate between two specific cells, click the starting cell then hold down the CONTROL KEY and click the ending cell. All intermediate cells will be interpolated.

Load... - This button loads a previously saved customized color palette.

Save... - This button saves the current color palette to a *.ZPL file.

- The "Fill with Pallete" button fills the color scheme with the current palette from top to bottom starting with the upper left corner palette cell. If the number of color intervals is less than the number of palette colors, then only the beginning palette colors will be used. See the "Stretch Fill" option to fill the color scheme with all palette colors.

- The "Flip Colors" button inverts the colors in the internal list box from top to bottom.
The "Stretch Fill With Palette" button will fill the color scheme starting with the upper left-most palette color. The entire palette will be "stretched" over the color interval range.

**Default** - This option selects one of Petra "default" colorbars. By default, these ZPL files are stored in C:\geoplus1\Parms.

**Auto Incr** - This option advances the interval list box item following color selection for a particular interval. Use this feature to quickly set the colors for all items in the interval list box. Simply select the first numeric interval and begin selecting colors from the palette. Each click of the palette sets the color for the current interval and advances to the next interval. Continue until all interval colors are selected.

### Changing Colors on a Normal Colorbar Walkthrough

Changing the palette on the right side of the screen directly changes the colors used on the colorbar. To change a color on the palette, double click inside any color box to bring up a color tool. This screen has a set of basic colors, though you can use any color by selecting the color box on the right, or enter values using Hue/Saturation/Lightness or Red/Blue/Green.
Changing a palette color (Left), selecting red on the color screen (Right)

The palette color changed to red

Filling an entire palette by selecting individual colors is slow and creates blocky color transitions. Interpolating between colors in different palette cells is easier and leads to smoother transitions. Interpolation proceeds from upper left to lower right. To interpolate between two specific cells, click the starting cell then hold down the CTRL key and click the ending cell. All intermediate cells will be interpolated. In the example below, the interpolation is from the white cell in the upper left corner to the red cell created in the example above. Repeat the process with different cells to create a smooth transition between several different colors.

Interpolating between colors with the CTRL key. Before (Left) and after (Right)
For a single color colorbar, set the upper left and lower right colors to the starting and ending colors. Next, select the “Interp..” button to interpolate the entire palette starting with the upper left corner and ending with the lower right corner. In the example below, the upper left color is white, and the lower right color is pink. Using the “Interp…” button interpolates between white and pink, as shown in the example below.

9.2.3 Z Cross Plot Data Definition Options

This option governs a couple of additional settings for the plot, including setting the labels for the axes and the symbol size.
Axis Labeling Mode

This dropdown determines how Petra labels the X and Y axes. The options include:
- Zone Name - Data Item - Item Description
- Zone Name - Data Item
- Zone Name - Item Description
- Item Name - Item Description
- Item Name
- Item Description

Symbol Size (Inches) - This option sets the size of the individual data points on the cross plot.

Do Not Use LOG Scale to Compute Defaults - This option forces Petra to always use linear scales when setting defaults on the X-Y Axis Tab and the Z-Axis Tab.

9.2.4 Z Cross Plot Data Definition File

The file tab saves and loads settings for the “Data Definition” window as a *.ZXS file in the project’s PARMS directory. This only saves the settings for the axes, title, and labeling; it does not save polygons.

![Z Cross Plot Data Definition File](image)

9.3 Z Cross Plot Regression

Petra can also perform variety of regression operations on the cross plot data. To add regression lines to the plot, select Options>Regression from the menu bar at the top of the screen.
Auto Fit Line - This option adds a linear regression line to the log crossplot. The equation for the line, correlation, and standard deviation are all shown at the bottom of the screen.

Auto Fit Quadratic - This option adds a quadratic curve to the log crossplot. Like the linear regression, the equation for the line, correlation, and standard deviation are all shown at the bottom of the screen.

User Fit Line - The User Fit line creates a linear user-drawn line across the log crossplot. Simply draw the line across the data. The equation for the line, correlation, and standard deviation are all shown at the bottom of the screen.

Show Standard Error Bars - This option adds error bars at one standard deviation. The better the line fits the data, the smaller these bars will be. As a reminder, these bars will include about 68% of the data points assuming a normal distribution.

9.4 Z Cross Plot Polygons

Z Crossplot polygons outline different areas of the graph, separating wells that have specific z data relationships. Each polygon in the Z Crossplot Module can have its own name, color, and value. Note that polygon values don't have any effect in the Z Crossplot Module, but exist so that polygons can be shared with the Log Crossplot Module. Polygons allow the user to select wells based on a more nuanced criteria rather than by simple data searches, since polygons can vary the cutoff based on the relationship between zone data.
The example below shows the Net to Gross crossplot with a single “OUTLIER” polygon. This polygon covers the data points the net to gross ratio is outside a single standard deviation. Put another way, the amount of net sand in these wells is significantly lower than what the rest of the data would suggest. This could be due to gamma normalization problems or petrophysical effects.

Making a Polygon

To establish a polygon, right click anywhere on the log plot and select “Add Polygon.” Alternatively, select Polygons>Add from the menu bar at the top of the screen. Drawing a polygon works exactly the same as drawing lines elsewhere in Petra. Pick polygon node points with the left mouse button and select the right mouse button to stop picking points. Petra will automatically close open polygons.

During picking, press ESC picking to cancel the current polygon or DELETE to drop the last picked point. Selecting F1 while picking will snap the cursor to the nearest node point on another polygon, which can be useful for generating polygons with no empty space between them and no overlap.

Once the polygon is picked, Petra brings up the “Polygon Definition” box. Here, simply enter the name of the polygon, pick a color, and add a polygon value. The polygon name is a good way of distinguishing the polygons apart when exporting wells, so spending time on descriptive names is a good idea.
Modifying and Deleting a Polygon

To change the area of a facies polygon, right click anywhere on the log plot, select “Select Polygon”, and then left click on the desired polygon. Make sure to click right on the line. Alternatively, select Polygons>Select from the menu bar at the top of the screen, and then left click on the desired polygon. This highlights the polygon and shows its node points; select a node point and drag it to the desired position to change the outline of the polygon. When finished, right click and select “Redraw” to refresh the screen and show the changes.

Changing a polygon's name, color, and value is similar. Select the polygon with the mouse, as outlined above. Once the polygon is highlighted, right click and select “Modify Polygon.” Alternatively, select Polygons>Modify from the menu bar at the top of the screen with the polygon is highlighted. This opens the Polygon Definition box, which sets name, value, and color for the polygon.

To delete a drawn polygon, select the polygon with the mouse as outlined above. Once the polygon is highlighted, right click and select “Modify Polygon.” Alternatively, select Polygons>Modify from the menu bar at the top of the screen with the polygon is highlighted. This opens the Polygon Definition box. Select the “Delete Polygon” button on the bottom of the box.
Loading and Saving Polygons

Closing the Log Crossplot Module erases the polygons from Petra’s memory, so make sure to save the polygons to a file if you want to use them later. Select Polygons>Save from the menu bar at the top of the screen. Create a name and select the save button.

On the Save Polygons to Disk box, the area outside the polygons name and value can be modified. By default this area is named “DEFAULT” and its value is zero. This screen also allows for a comment to better describe the polygons.

![Creating a new polygon file (left) and setting the value for data not inside the polygons](image)

On the Save Polygons to Disk box, the area outside the polygons name and value can be modified. By default this area is named “DEFAULT” and its value is zero. This screen also allows for a comment to better describe the polygons.

Exporting Wells inside a Polygon

To save a well list select Polygon>Export wells. Here, select the “Browse” button to navigate to a location on the network and name a WSN list. Next, add a comment for the WSN list if desired. Finally, select the polygon containing the wells to be included in the WSN list. Note that the “Output Wells Outside All Polygons” only selects the wells not inside any polygon. The example below shows how the wells inside the “OUTLIER” polygon will be written to a WSN list called “outlier.wsn.”
10 Histogram Module

The Petra histogram module displays histograms for selected log curves. "Picks" can be digitized from the display and stored in the Zone database. Histogram picks are typically used for log normalization.

To open the Histogram Module, select Tools>Log Histogram from the menu bar at the top of the Main Module.

For a detailed walkthrough of the Histogram Module, see “How to Use the Histogram Module.”

Getting Started

Selecting Wells
Selecting a Log Curve

Basic Shortcuts and Key definitions

PageUp - Display previous well
PageDn - Display next well
CrossHair Cursor
Select the "Display>CrossHair Cursor" menu to toggle the large histogram cross...
hair. The histogram crosshair follows the mouse cursor inside the histogram chart. The cross hair value is echoed in the log curve box.

**Advanced Tools**

*Creating “Picks”*

### 10.1 Histogram Selecting Wells

**Selecting Wells**

The Histogram Module can display any subset of wells in the project. To change the wells shown, select **Wells** options from the menu bar at the top of the Histogram Module.

- **All Wells** - This option selects all wells in the project.
- **Wells By Data Criteria** - This option opens the **Wells By Data Criteria** tool that selects wells by specific data criteria.
- **With Selected Curve** - This option selects only the wells with the currently selected curve in the **Log Curve Tab**.
- **Map Selected Wells** - This option selects the wells currently selected in the **Map Module**.
- **Main Selected Wells** - This option selects the wells currently selected in the **Main Module**.
- **Cross-Section Wells** - This option selects the wells currently selected in the **Cross-Section Module**.

To switch between wells, select either the desired well on the dropdown at the top of the Log Crossplot Module or use the left and right arrows to scroll through the selected wells.

**Plot Single/Combine All Wells**

Petra can either plot the log data points from a single well or from multiple wells in aggregate. To switch between these two modes, select **Wells>Plot Single Well** and **Wells>Combine All Wells**. Note that showing multiple wells will remove the curves displayed on the right side of the screen – after all, with data points from multiple wells, which curves would you show?
10.2 **Histogram Data Definition**

The Histogram Data Definition tool sets the basics of the log histogram, including the log curve used, the limits and shape of the histogram, and the depth interval.

**Log Curve Tab**

The Log Curve Tab sets the histogram title, curve, and axis.

![Histogram Data Definition](image)

**Title** - This entry sets the histogram title. This title will appear with the currently selected well information immediately above the histogram.

**Log Curve** - This log dropdown sets the curve used in the histogram, as well as the upper and lower bounds.

**Log10 Scale** - This option draws the histogram in a logarithmic scale instead of a linear scale. This can be useful for representing curves with a very large variation, such as resistivity curves.

**Use Log Aliases** - This option uses **log curve aliasing** to replace missing log curves with an equivalent log curve.

**Default Scale Range** - This option sets the minimum and maximum log curve scales with the defaults set on the Main Module's **Log Maintenance Tool**.

**Statistical Scale Range** - This option attempts to read the log curve values and set an appropriate scale.

**Reverse Curve Display** - By default, Petra scales logs the log curve display from the minimum at the left to the maximum at the right. This option flips the log scaling such that the minimum is on the right, and the maximum on the left.

**Histogram Tab**
Number of Histogram Cells - This entry sets the total number of bins or "cells" used in the histogram. The best number of bins will vary from application to application.

Maximum Samples Per Cell - This entry sets the maximum height of any one bin. The default is 100

Compute Maximum Samples From Data - This option instructs Petra to calculate and scale the vertical axis to the maximum number of samples in any one bin. When this option is deselected, Petra will scale the vertical axis to the "maximum samples per cell."

Show Mean and Std Dev on Histogram - This option calculates and displays the mean and standard deviation for the histogram. The mean will appear as a long-dashed vertical line on the histogram, while the standard deviation will be two short dashed vertical lines.

Color Fill Histogram Cells - This option fills the histogram bins. Deselecting this option will leave empty rectangles for the bins.

Histogram Type

Standard - Standard plots divide the samples into different bins that each represent a discrete interval of values. The height of the rectangle represents the "frequency" or count of samples inside the bin.

Cumulative - This type of plot divides the count for each bin by the total number of samples to create a percentage. Each bin then shows the sum of the previous bins up to 100%.

"Greater Than" Freq Plot - This type of plot divides the count for each bin by the total number of samples to create a percentage. Each bin then shows the sum of the previous bins subtracted from 100%.
Discriminators Tab

This tab establishes a discriminator curve to filter the sampled log curve. At depths where the discriminator curves are outside the minimum and maximum values, the corresponding depth will be left out of the histogram. If this box is checked and the log is absent, the statistics will not be calculated.

Depths Tab

By default, Petra tries to display data over the entire log curve. Especially for log normalization, it's much better to keep the curve histogram limited only to the most relevant section.
Set Depths From Zones - This button sets the interval based on zone interval definitions. Select the desired zone from the "Select Zones(s)" list below. Note that the WELL zone by default covers -1M MD to +1M MD, so it should cover the entire footage of all wells.

Set Depths From Range - This option sets the depth range from any two formation tops, measured depths, or true vertical depths. This button opens the “Set Depth Range” dialog.

To set depths by tops or by a specific depth range, select the button. Next, select the “Set Range” button. In the Set Depth Range box, select the relevant top, MD, or TVD button. For MD and TVD, select the relevant button and enter the adjacent depth in the entry field. For tops, select the desired top from the “Fm Top Name” dropdown box. Notice that an offset can also be added or subtracted to the fm top; this offset will include data points above or below the actual fm top depth.

To set depths by a zone’s interval definition, select the desired zone on the “Set Upper and Lower Depths From Zone” dropdown menu.

Sample Decimation - This option decimates the data to only keep every N'th sample in the histogram. Setting this value to 2, for instance, would only display every other sample. Setting this value to 5 would only load every 5th sample. By default, this option is set at 1 to include every sample in the histogram.
Tops Tab

The Tops Tab draws formation tops on the log curve on the right part of the Histogram Module. Tops can be particularly useful for orienting yourself to the log curve.

Display Tops on Logs - This option enables and disables formation tops on the log curve. Deselecting this option will keep the selected formation tops.

To select the tops that appear on the log curve, add tops to the "Selected Zone Items" list by selecting the "<>" button to add a selected top, or the ">>" button to add all tops. To drop a top from the "Selected Zone Items" list, select the desired top and select the "<" button. To drop all tops from the "Selected Zone Items" list, select the "<<" button.

10.3 Histogram - Select Picks

"Picks" are database-stored curve values. Picks are most commonly used for log curve normalization, such as scaling all gamma ray values in a project to set "sand" and "shale" values. Commonly, picks are first created for the entire project from statistical measurements, and the histogram module is used to visually inspect and QC the pick relative to the actual curve.

When working with picks, it’s usually a good idea make sure the “CrossHair Cursor” option is on. When this option is selected, (Display>CrossHair Cursor on the menu bar at the top of the screen), Petra draws a vertical line on the correlation log that corresponds to the cursor’s location on the histogram. This can make it significantly easier to see the relationship between the histogram value and the log.
Displaying Existing Picks

On the menu bar at the top of the screen, select **Picks>Define Picks** from the menu bar at the top of the screen. Alternatively, select the button from the Picks toolbar at the top of the screen. This opens the Define Histogram Picks window. Here, select an existing zone data item with the zone (top) and data item (bottom) in the “Available Zone Items” box.

The example below shows two picks: “PC10GR” and “PC90GR.” Both of these picks these are log statistics created in the Main Module (**Compute> From Logs>Statistics…**), where “PC10GR” is the curve’s 10th percentile, and “PC90GR” is the curve’s 90th percentile.

The picks for each well will then be displayed on the histogram. The examples below show two different wells. Since wells are logged with different tools at different times, the picks are slightly different. The well on the left has a smaller difference between the 10th percentile sand and the 90th percentile shales than the well on the left.

Creating New Picks

To create a new data item in the selected zone, select the button in the
“Define Histogram Picks” window. Select the ▶ button to add the data item to the “Selected Picks” list in the lower left corner of the window. Note that new zone data items won’t have any data, so no picks will immediately appear.

Modifying Picks

To modify a displayed pick, in the main Histogram Module window select the desired pick from the dropdown on the Picks toolbar, and select the “Start” button.

Select the new location of the pick on the histogram. As mentioned above, the “CrossHair Cursor” draws a vertical line on the log to show the histogram’s value relative to the curve. Left click to set the selected pick. Next, right click to open a set of options. These options include: Next Well, Prev Well, Redraw, End Picking, Delete Picking. Selecting “Next Well” and “Prev Well” saves the pick change and scrolls through the wells selected in the Histogram module. “Redraw” saves the pick change, refreshes the screen to reflect the changes, and leaves the pick tool active. “End Picking” saves the pick change and deactivates the picking tool, but does not refresh the screen. “Delete Pick” erases the pick value entirely, leaving a null value in the database for that well.
Chapter 11
11 Log Correlation Module

The Log Correlation Tool is a straightforward tool for correlating formation tops, unassigned tops/faults, and pay intervals. This tool can display both raster and digital logs.

To open the Log Correlation Tool, select Tools>Log Correlation on the menu bar at the top of the Main Module, or select the button on the Main Module toolbar.

For a more comprehensive set of options, the Cross Section Module provides more advanced options beyond top picking. As another alternative, the Slip Log Module displays and pick tops on up to four horizontal raster logs.

For a detailed walkthrough of the Histogram Module, see “How to Use the Histogram Module.”

The Log Correlation Module

Getting Started

Using the Guide

The guide at the top of the screen shows the suggested workflow for using the Log Correlation Tool. You'll want to select a few wells, set the Log Types for each track, put raster logs inside those Log Types, set the depths, and finally select and pick tops and pay intervals. The Quick Guide on the top of the screen has a set of buttons that link directly to these different tasks in this order.

Step 1 - Select Wells
Step 2 - Set Tracks  
Step 3 - Set Left/Center/Right Track  
Step 4 - Depths  
Step 5 & 6 - Picking Type: Formation Tops, Unassigned Tops, Pay  
Step 7 (Formation Tops Only) - Set Pay Style  
Step 8 (Formation Tops Only) Pick Tops & Step 7 (Unassigned Tops, or Pay)  

Correlation Tools  
Adding a Correlation Slip Box  
Panning & Zooming with the Quick List MiniMap  

Annotations and Data Posting  
Well Symbols and Log Headers  
Posting Well Data around the Well Symbols  
Plotting Perfs  

Basic Shortcuts and Key Definitions  
Highlighting a well - single click on the well's depth track with the left mouse button  
Show the data for a selected well in the main module - double-click on the well's depth track with the left mouse button  
Terminating interactive process such as screen drawing or zooming - hit ESC  
During screen drawing, skip to next graphic element - Space Bar  
Drop the last point picked while drawing an overlay line - Delete  
Drop the last well picked while picking wells for a cross-section - Delete  

11.1 Step 1 - Select Wells  

There are two ways to select wells for the Log Correlation Module: with the Map Module or directly from the Cross Section Module.  

With the Map Module  
The "Select Wells" button on the guide takes you directly to the Map Module. Alternatively, click the map icon at the top of the screen: 🌐. Once in the Map
Module, select Tools>Pick "Log Correlate" Wells... Select individual wells with the left mouse button to add wells to the Log Correlation Tool. Right click to stop and switch back to the Log Correlation Tool.

With the Cross Section

Select Wells>Use Cross Section Wells. This option will plot the wells currently used in the Cross Section Module.

11.2 Step 2 - Set Tracks

The next step is to set tracks with either the "Set Tracks" button on the guide, or the set tracks button on the toolbar. Tracks simply define where raster logs and the depth track will be drawn in relation to the well symbol and data posting.

Defining the Log Type

To define a track, click the drop down box directly under "Log Type" for each column. Under this drop down menu, notice that Petra initially creates a few default Log Types including Density, Gamma Ray, Induction, Neutron, Resistivity, and Sonic. In this example, the Resistivity Log Type will be drawn in the center column, and the Density Log Type will be drawn in the right column. You can also select the "New Log Type" button on the lower right corner of this screen to create a new Log Type.

Notice the text underneath each of the columns (highlighted in red below) initially reads "3 wells have no logs defined." Initially, none of the Log Types have any logs names assigned to them. In other words, Petra doesn't know what raster log names (also known as "group names") should be drawn in either the "Resistivity" or "Density" tracks. The next step is to assign log names to each of these Log Types.
Changing the Depth Track Location

You can also modify the location of the depth track. The depth track plots MD or TVD depths next to the raster logs. This option simply moves the location of the depth track relative to the other tracks and the well symbol. In the example below, notice that the depth track is set to "Right Center" between the center and Right column.

Click OK to go to the Log Correlation Tool main screen. Alternatively, click the "Change Logs" button under one of the Log Types to take you directly to the next step at the Assign Log Type screen.

11.3 Step 3 - Logs In Tracks

Introduction to Log Names and "Log Types"

The fundamental problem with log data is the proliferation of log names created by
different commercial data vendors and individual users. The same general type of curve can have hundreds, if not thousands, of different names in a single project.

The Log Correlation Tool gets around this problem by using "Log Types." A Log Type is just an alias list of equivalent logs. In the example below, the "Resistivity" Log Type we build will contain a list of the resistivity raster logs in a project. To display a resistivity curve on a cross-section, we simply tell Petra to draw the "Resistivity" Log Type. Petra then goes down this list of raster logs for each well on the cross-section and draws the first one it finds. For the interpreter, this means that time invested in setting up Log Types will pay off with quicker, easier cross-sections later.

Assign Log Type Window

The next step is to put raster logs inside the newly defined tracks. Practically, this means that we need to assign raster group names to the Log Types. In the main screen, select one of the defined tracks under Step 3. In this example, the center track with the Resistivity Log Type is selected.

This brings up the Assign Log Type screen. This screen shows the available raster logs and their start and stop depths for each well in the Log Correlation Tool. Shading separates different wells. You can sort by ascending or descending order for each column.

This screen also features a search box at the top of the screen that filters data by WSN, UWI, well name, well label, log name, or start and stop depths. Select "Filter" to return the data meeting the criteria. This filter can also be made sensitive to capitalization by selecting the "Case Sensitive Filter" box. After narrowing your logs and wells by applying one filter, you can select different criteria and select "Filter" again to further limit the results. "Clear Filter" removes all filtering and returns all the available raster logs for all selected wells.
You can select raster logs for the wells either by aliasing default raster groups to a Log Type or by individually assigning raster logs for each well. Using both approaches together will give the best combination of speed and customization. A good Log Type default list is a useful way of making a quick first pass at the proper raster log for each well, while assigning individual logs can ensure that you are displaying the best possible log.

"Default" Log Type Rasters – This method aliases different raster groups to one Log Type. Petra then assigns a "default" raster log to the well based on this list. In this example, different resistivity raster images will be aliased to a single default "Resistivity" Log Type. The first step to setting up a Log Type is to select the Default Maintenance button on the lower left side of the screen (highlighted in red).
This brings up the Add/Edit Log Type Defaults screen. Here you can add, delete, or modify the existing Log Types. In this example, the Resistivity type is selected in the "Defined Log Types" box in the upper left corner. Next, select the raster names to add to the Log Type. To add or remove raster names to the Log Type, select the "<" or ">" buttons (highlighted in red). In the example below, the Resistivity Log Type will bring up the log, Res, and Res1 raster logs as a default. In essence, Petra will try to draw the first available raster log on this list for the Resistivity Log Type in the center track. Click Save Changes and Close to exit.
Back at the Assign Log Type screen, notice that the raster logs selected on the default Log Type list now show checks in the boxes underneath the "Default" column. In addition to showing which logs are selected, these check boxes can also be used to quickly add and drop logs from the selected Log Type. For example, clicking the "Default" check box next to the "ELOG" raster log will drop it off the "Resistivity" Log Type for all wells. Clicking the same "Default" check box again restores it to the list. The Log Type Defaults list (highlighted in red below) shows the order of the default logs for the selected wells. Again, log names higher on the list will be drawn before log names lower on the list. To change the priority of the alias list, select a log name and use the and buttons.
"Assigned" Individual Raster Logs - The other way of selecting raster log names to display is to individually assign raster logs for each well. Though this process takes more time, assigning individual logs allows you to select the best raster log for each well. Petra stores this information for the next time you bring the well into the Log Correlation tool.

The easiest way to assign a specific raster log to a well is to use the Assign Log Type screen. To select a specific raster log, select that raster log's check box in the "Assigned" column.

Additionally, you can also open the well-specific "Log Type Assignments" box by double-clicking an individual well. To assign a raster log to the selected well, select the specific raster log from the "Available Raster Logs" list on the right side of the screen and click the "<" button. In the example below, the "ELOG" raster has been assigned to the selected well. Select OK to save the changes and return to the main "Assign Log Type" screen.
In the example below, notice that the two different wells have "assigned" logs. In one case (highlighted in blue), the log RES_TYPE will be plotted instead of the two default logs, RES and ELOG. In the other case (highlighted in red), ELOG is both a default log and an assigned log. This just means that it will be displayed regardless of its order in the default Type Log list.

The Assigned logs box (highlighted in green below) shows the assigned logs for the selected well. If a well has multiple assigned logs, you can prioritize them with the and buttons. Log names at the top of the assigned logs list will be shown before log names at the bottom of the list.
After setting up one Log Type, this is a good place to go back and repeat the same Step 3 in order to fill the log types established for the columns in step 2. Carrying on with the example, the screenshot shows the results of setting up log types for resistivity and density logs. Notice that the far left well does not have a log. This is because the depth scale is still from 1000-2000’ MD, which is above the start of that well’s raster logs. After setting up log types, the next step is to move our focus down to the interval of interest, the 2nd Wall Creek formation.
11.4 Step 4 - Depths

The next step is to set the depths for the correlation tool. In the main screen, click the "Depths" button on the guide, or click the depths button on the top toolbar.

General Tab

The General Tab sets the type of cross section, as well as the specifics of the depth track.
Depth Type

The depth type can be either "Structure" or "Stratigraphic". A structural cross-section has a depth interval defined by measured or SubSea depths. A stratigraphic section instead has depths defined with formation tops, where the raster logs are hung on the upper fm top. Stratigraphic cross-sections are useful for showing variation in stratigraphy independent of structural change.

Depth Axis Options

Show Depth Track – This option toggles the display of the small track that shows MD, TVD, or SS depths. To hide it, deselect the "Show Depth Track" option. Hiding the depth track will also hide any perf and test information.

Limit Depths By TD – This option limits the drawn raster logs and the depth track down to a well's TD (as stored in Petra’s database) rather than to full extents of the bottom set with the Structure or Stratigraphic Depths Tabs.

Track Width - This governs the width of the depth track. Text inside the depth track is automatically scaled. Expanding the track width of the Depth Track can make the measured depth numbers easier to read.

Structure Depths

This tab to sets depths for structural plots.
Upper Depth/Lower Depth - These entry boxes set the boundaries for the cross section. Depth values can be entered as either measured or subsea depths. Remember that subsea values below sea level (like those on wells drilled on the Gulf Coast) are negative from 0.

Compute Using Tops – Petra can automatically compute a valid structure depth range from the tops selected for the cross-section. If no tops are picked for the selected wells, Petra won't be able to calculate a depth range.

Compute Using Logs - Petra can automatically compute a valid structure depth range from the logs selected for display. Here, Petra will calculate depths that will cover the top of the shallowest and bottom of the deepest logs.

Stratigraphic Depths

This tab sets the depths for stratigraphic plots.
Upper/Lower Depth Limit Defined by (DATUM) - These dropdowns select the formation tops that define the upper and lower boundaries of the stratigraphic plot. Note that Petra will flatten the wells along the upper formation. You can also add an "offset" number, which allow stratigraphic depths to include data a set number of feet or meters above and below the selected tops. It’s also acceptable to use the same formation top for both the upper and lower depth limits with a sufficient offset above and below, as in the example below. Notice that the upper and lower depth limits are set by the same top with offsets 50' above and 200' below.

It’s worth noting that if either of these formation tops are null for a well, Petra doesn’t have anything to flatten on and the well will be blank. For initial correlation work, it is generally best to pick a consistent, widely correlated top to flatten on.

11.5 Step 5 & 6 - Select Type and Display

The next step is to select the pick type. These three buttons on the quick list are an easy way to switch between picking tops, unassigned tops ("U/A Tops"), or pay intervals. Each button under Step 5 changes Steps 6 and 7 to reflect the particular pick type. In all cases step 6 links to that pick type's display options:

- Formation Tops
- Unassigned Tops
- Pay
11.5.1 Formation Tops

To switch to picking fm tops, first select the "Tops" option on the Picking Type box on the Guide at the top of the screen.

This changes the Quick List to Pick Tops mode.

To start picking tops, first select the desired fm top on either the Displayed Tops list at the top or the Pick Tops list at the bottom. Next, select the "Pick Tops" button on the guide: or the green button on the Pick Tops Quick List: .

Remember that the two pick modes work differently. "Pick Across" creates a single top across all wells, while "Pick Down" cycles through the Pick Tops list. To create fm tops, just click the depths on the raster logs where your tops are located. To stop picking, right click the mouse or click the stop button on the Pick Tops Quick
List: [ ]. The example below shows formation tops for the top and base of the 2nd Wall Creek in red. Notice that the currently active fm top, 2nd Wall Creek, is shaded to black.

If working on fm tops, the next step is to select the tops you want to display and pick. First, select the "Tops" option under the Step 5, and then click the "Select Tops" button under Step 6 on the guide (highlighted in red).

This brings up the Formation Tops Display Options window. To display a formation top in the Log Correlation Tool, first select it on the "Available Tops" list and click the "<" button to bring it over into the "Displayed Tops" list. The tops listed in the Available Tops list can be filtered to show only the tops with values for the wells in
Once on the Displayed Tops list, you can change the color of the top as it shows up on the plot. The small check box next to the name on the Displayed Tops list toggles whether the picks are for display only or can be modified. Tops with a green check can be picked and shown up on the Pick Tops list, while those without a green check are display only.

After the tops are selected, the next step is to pick the style of the displayed tops. Under the Style Tab, you can change how the line between tops is drawn. Line width makes the lines between tops thicker and thinner, while the line type determines whether the line is dashed or solid. The "Apply Line Width and Line Type" button will change the width and type for every other displayed top, but will retain each line's color. In the example below, the "2nd Wall Creek" top is selected. The style tab shows that this top is red, solid, and of normal width.
If your project has Top Aliases set up in the Main Module, click the "Allow Top Aliases" to use them.

"Disable Top" temporarily hides the specific formation top on the cross-section while retaining its display settings. Disabled tops will have a ⚫ symbol next to their name.

### 11.5.2 Unassigned Tops

The Log Correlation Tool also allows you to create and store "unassigned tops." Unassigned tops are useful for correlating things outside the traditional definition of a
formation top – i.e. distinct, mapable lithostratigraphic units. This can include faults or other marker "picks" that are considered by the interpreter to be unknown, uncorrelated or otherwise "unassigned". Unassigned tops can be easily correlated and converted into formal formation tops.

Just like regular formation tops, you also need to turn on the display of unassigned tops. First, select the "U/A Tops" option under the Step 5, and then click the "Select Tops" button on the guide (highlighted in red).

This brings up the Unassigned Tops Display Options Screen. This screen shows all the pre-existing unassigned top names in the project. In the example below, there is only the "default" unassigned tops name. Since this will be shared throughout the whole project, it's a good idea to make a new, named set of unassigned tops. To create a new set of unassigned tops, select the button.

On the Unassigned Tops "Pick" Properties box, enter a name under "Pick Name" that reflects the purpose of your unassigned tops. This can be as generic or as specific as you like. In the example below, the picks are all going to be on 2nd Wall Creek resistivity features, so the pick name is "2nd Wl Crk Res." Next, select or enter an interpreter name. It's a good idea for every interpreter to have their own in order to prevent one user from overwriting another user's work. In the example below, the source name is "CTM." Next, select the line style, width and color for the unassigned tops. Select OK to create the correlation and return to the display options screen.
Notice that the unassigned tops name now appears in the Available Unassigned Tops list on the right of the screen. To display a formation top in the Log Correlation Tool, first select it on the Available Tops list and select the "<" button to bring it over into the "Unassigned Tops To Display" list.

Once on this list, you can still change the color of the unassigned tops. Selecting the small check box next to the name on the Unassigned Tops To Display list toggles whether the picks are display only or can be modified. Tops with a green check can be picked and modified in the correlation tool, while those without a green check are display only.

Unassigned Top Correlations Display Options

Unassigned tops by themselves have no relationship to each other. Correlating unassigned tops links them together into a single named unit. These correlations can be flattened to show stratigraphic variation or converted into regular formation tops.
One of the best uses for correlation is to flatten the cross section on localized distinctive log features with no formal name.

Just like regular formation tops an unassigned tops, you also need to turn on the display of unassigned top correlations. First, select the "U/A Tops" option under the Step 5, and then click the "Select Tops" button on the guide (highlighted in red).

This brings up the Unassigned Tops Display Options Screen. To look at correlations, click on the "Unassigned Top Correlations" Tab on the top of the screen. This screen shows all the pre-existing unassigned top and unassigned top correlations in the project. In the example below, there are no available correlations.

To create a new set of unassigned tops, select the button.

On the Unassigned Tops "Correlations" Properties box, enter a name under "Correlation Name" that reflects the purpose of your unassigned picks. This can be generic or specific as you like – in the example below, the correlation is on a single resistivity bump above the 2nd Wall Creek, so the correlation’s name is "Resistivity Bump." Next, select or enter an interpreter name. It’s a good idea for every interpreter to have their own to prevent one user from overwriting another user’s correlations. In the example below, the source name is "CTM." Next, select the line style, width and color for the unassigned top correlation. Select OK to create the correlation and return to the display options screen.
Notice that the correlation now appears in the Available Correlations list on the right side of the screen. To display a correlation in the Log Correlation Tool, first select it on the Available Tops list and click the "<" button to bring it over into the "Unassigned Tops To Display" list.

Clicking the small check box next to the name on the Correlations To Display list toggles whether the correlations are display only or can be modified. Tops with a green check can be picked and modified in the correlation tool, while those without a green check are display only.

Picking Unassigned Picks

To switch to picking unassigned tops, first select the "U/A Tops" option on the Picking type box on the Guide.
This changes the Quick List to show the Unassigned Picks toolbar.

**Unassigned Picks**

*Making Unassigned Tops:* This creates new unassigned tops under the picks name shown in the dropdown menu. Different pick names can be used to keep groups of unassigned picks separate by both purpose and interpreter. In the example above, new unassigned tops will be part of the "2nd WL CRK RES" name created earlier. To pick tops, click on the logs on the main screen. Multiple unassigned tops with the same picks name can be added to the same wellbore. Right click to finish picking tops.

This brings up the option of saving the new pay intervals to Petra's database. Selecting "No" will erase all new, unsaved unassigned picks. In the example below, notice the red lines signifying the resistivity anomaly picked as a unassigned top.
Moving Unassigned Tops: To move unassigned tops, select this button. Left click the unassigned top to move and drag it to the new location. When finished, right click the mouse button. This brings up the option of saving the new pay intervals to Petra's database. Selecting "No" will leave all unsaved pay picks unchanged.

Delete Selected Tops: To delete unassigned tops, select this button. Left click the unassigned top to delete it. The unassigned top interval will be hatched with red to show that the changes haven't been saved to the database. When finished, right click the mouse button. This brings up the option of deleting the unassigned top from Petra's database. Selecting "No" will leave all unsaved pay picks unchanged.

Delete Tops by Name: This button deletes all the unassigned tops with the currently selected unassigned tops name. In this example, the "2nd WI Crk Res" unassigned tops group is selected, so selecting this option will delete all the "2nd WI Crk Res" unassigned tops on the currently selected wells.
Create New Unassigned Tops Name:  

This button provides another quick way to create new unassigned group names. This brings up the New Pay Interval Definition screen. Enter the name, source, description, and color of your pay zone. Unassigned top names created here will automatically show up in the Unassigned Picks dropdown menu on the Quick List.

Unassigned Correlations

Connect Unassigned Tops:  

This button designates selected unassigned tops to a specific correlation. First, select the correct correlation name on the lower dropdown menu (in the example above, the correlation is called "Resistivity Bump"). Next, select the "Connect Unassigned Tops" button and click on unassigned tops on the wells to add them to the correlation. Right click when done. The unassigned tops will now be connected by a line to signify that they are part of a correlation. In the example below, the blue correlation line connects the unassigned tops.
This button converts a correlation into a fm top. As a formal fm top, the surface can be gridded or used in calculations. First select the appropriate correlation from the correlation dropdown menu. Next, select the "Convert correlation to Fm Top" button to bring up the "Convert Correlation To Top" window.

This brings up the Convert Correlation To Top window. Here, select an existing fm top or create a new top for the correlation. In this example, the "Resistivity Bump" correlation will be converted to the "Resistivity Bump Top" Fm top. This newly created fm top will be stored into Petra's database.

This screen also gives you the option to convert the correlation for all wells in the database, only the currently selected wells in the Log Correlation Tool, or only the wells selected in the Main Module.
Flatten on Correlation: This option flattens all wells onto the correlation selected on the correlations dropdown menu. This is useful for quickly seeing changes in stratigraphy or for testing correlations without the formality of a true fm top.

Delete Correlation: This option deletes the correlation selected in the correlation dropdown menu.

Create new unassigned top name: This option is another way to quickly create a new correlation. Select this button, and enter the name, interpreter, color, and line width and style of the correlation line. Correlations created here will automatically be displayed.

Making another Cross-Section.

After you pick your first set of tops and pay, it’s not necessary to go through the entire process again for a new cross-section. Petra saves track settings, default logs, depths, and top information to apply to your next set of wells. To make a new cross section, all you'll have to do is select the new set of wells (Step 1) and make adjustments in the default and/or assigned raster logs (Step 3). Continually making small improvements to your default Log Type list as you make new cross sections is a good use of your time – the better and more comprehensive your default Log Type list, the less time you have to spend individually assigning raster logs to wells.
Other Display Options

Plotting Well Data around Well Symbol – To plot well data around the well symbol at the top of the screen, select Wells > Plot Data around Well Symbol. This brings up the Post Data By Well Symbol screen. Here you can select which well identification data will be plotted around the well symbol. In the example below, the wells’ label is plotted above the well symbol.

Well Symbols - While in the Correlation Tool's main screen, dragging the lower line of the frame containing the well symbols increases and decreases this space. The ✩ and ✫ buttons on the toolbar at the top of the screen toggle the well symbol and well data on and off, respectively.

The example below shows well labels displayed over each well symbol.
Plotting Log Scale Information – The tops of raster images usually have scale information for each track. If this scale information is calibrated, it can be shown on the Log Correlation Tool's main screen. To show and hide this raster scale information, click the ⬅️ and ➤️ buttons on the toolbar at the top of the screen. The next step is to tell Petra how the scale information is stored in the raster calibration. Under Logs/Images>Log Header Display on the menu bar at the top of the screen, select "Header", "Lower Scale", or "Upper Scale." Many older Petra projects store scale information as the "header." Once this data is displayed, dragging the lower line of the frame containing the scales stretches and squeezes the image scales for readability.

Test Indicators - Select Wells>Plot Test Indicators to bring up the Test Indicators screen. Select the display color for perfs, and click "Enable Perfs Display." The Log Correlation Tool will display perfs as a colored box on the depth track. The example below shows perf indicators as a red rectangle on the depth track (highlighted in green).
Zoom and Scroll

For detail work, it's probably advantageous to zoom and scroll on the cross section. There are two ways to zoom in and out on the Log Correlation cross section.

**Toolbar Zoom** – The toolbar has a set of zooming tools: 🔗 - 🔒 🔒 🔒.
"+" and "-" zoom in and out by 1/2 onto the center of the screen. The button allows you draw an area to zoom. The button returns to the last zoom setting, while the magnifying glass removes all zoom to return you to the default scaling.

*The Pan and Scroll Window* - This window on the Quick List log correlation window pans and scrolls around a zoomed cross-section. The "enlarge button" creates an additional window, which is useful for double monitor setups.

Like the toolbar zoom, the "+" and "-" zoom in and out of the center of the screen, while the "X" removes all zoom. The extents of the log correlation main window are shown in red on this window. Dragging this red outline scrolls the extents of the main correlation window at the current zoom level.

*Scrolling with the Arrow Keys Window* – When zoomed in on a section, you can also quickly pan across the section using the arrow keys. By default, the screen will pan by 50% with every key press. To change this number, go to Display>Arrow Keys.

**The Right Mouse Button**

Many common commands and some context-specific commands are available by clicking the right mouse button on the cross section. A familiarity with these commands can ultimately add up to huge savings in time and effort.

The right mouse button accesses several common commands related to tops. Place your mouse over the top right click the mouse flatten on, hide, or null the closest picked fm top. To start picking the selected top under the Pick Tops Quick List, right click and select "Start Picking Top(s)."

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Slip Box

The slip box takes a screenshot of a part of the cross-section and places it into a separate window inside the cross-section. This section of the log can be a great help to correlation between one log and another. The slip box window can be moved around the screen, as well as stretched and squeezed. The slider box on the top of the window changes the box's opacity to make it easier to overlay on top of other logs.
11.5.3 Pay Picking and Display Options

The Log Correlation Tool can show one or more color-filled intervals representing "pay" zones. Though most often used for illustrating zones of productive reservoir, you can use pay zones to show anything that has a top and base. Pay zone intervals and thicknesses can also be stored to a data item in the Zone database. Once stored as a data item, these thicknesses are available for posting or contouring.

To display pay intervals, select the "Pay" option under the Picking Type Option then click the "Select Pay" button on the guide (highlighted in red). This opens the Pay Data Display Options screen.

This screen shows pay zones already in the project, and can be filtered to show either pay intervals for the selected wells in the Log correlation Tool or to show the pay intervals for all wells in the project. These pay intervals can also be filtered by the source.

In the example below, notice that the option for showing pay "For Selected Wells Only" (highlighted in red) is turned on. Since none of the selected wells have any pay selected, nothing appears in the "Available Pay" window.

In this example, a 2nd Wall Creek pay interval already exists in the database. Changing "For Selected Wells Only" to "For All Wells" displays all the pay zones in the project. Notice in the example below that there are pay intervals both for lithology ("LS" and "Sand") as well as for actual reservoir pay ("2WC"). To display a pay interval, select it on the Available Pay list and click the "<" button to bring it over.
to the Selected Pay list on the right. To enable editing on the pay zone, make sure to select the small checkbox to the left of the pay zone’s name. A green check, like that shown in the example below, signifies that the pay interval can be edited.

To create a new pay interval, select the button on the Pay Data Display Options window. This brings up the New Pay Interval Definition box. Enter the name, source, description, and color of your pay zone. Select "Add" to add the pay interval to Petra’s database.

Pay Picking Mode

To switch to picking pay intervals, select the "Pay" option under Step 5 on the Guide.
This changes the Quick List to show the Pay Intervals toolbar.

**Begin Picking:** After selecting the appropriate pay interval, left click once in the appropriate location on the wellbore to create the top of the pay interval, and again to create the bottom. To continue picking wells across your cross-section, simply click on the appropriate depth on other wells. Petra will draw a hatched box covering the interval, as shown in the example below. This hatching indicates that the pay intervals are **not** saved to the database. When finished, right click the mouse button.

This brings up the option of saving the new pay intervals to Petra’s database. Selecting “No” will erase all unsaved pay picks. In other words, if you make 25 correct pay picks in a row followed by a single bad one, make sure to select “Yes” and go back to fix the bad pick. Selecting “No” will erase all the unsaved good picks as well as the single unsaved bad one.
Once saved, the hatched lines on the pay intervals disappear to signify that the pay intervals are stored to Petra’s database, as shown in the example below.

*Move Picks:* To move pay picks, select this button. Left click the top or bottom of a pay interval and drag it to the new location. The pay interval will be hatched to show that the changes haven’t been saved to the database. When finished, right click the mouse button. This brings up the option of saving the new pay intervals to Petra’s database. Selecting “No” will leave all unsaved pay picks unchanged.

*Delete Picks:* To delete picks, select this button and left click inside the pay interval. When finished, right click the mouse button. This brings up the option of saving the new pay intervals to Petra’s database. Selecting “No” will cancel all unsaved pay deletions, leaving the pay picks unchanged.

*Create New Interval Name:* This brings up the New Pay Interval Definition screen. Enter the name, source, description, and color of your pay zone.
11.6  **Step 7 (Fm Tops Pick Style)**

When the "Tops" picking type is selected, Step 7 shows the two options for picking formation tops: across and down. You can change the pick style with the buttons on the Guide, or by using the buttons on the Pick Tops part of the Quick List.

**Pick Across** – This is the standard pick mode in the Cross Section module. In this mode, a single formation top is picked across all wells shown.

**Pick Down** - In this mode, tops are picked in the order they’re shown on the Pick Tops list. Practically, this means that tops can be picked successively down the same wellbore before moving to the next wellbore. It helps to have the tops in a stratigraphically successive order going down the wellbore. Use the buttons to move a selected top up or down in the Pick Tops list.

11.7  **Step 8-(Pick Tops) & Step 7(U/A Tops or Pay)**

The last step is to actually pick your fm tops, unassigned tops, and pay intervals. The most convenient way to pick all three is to use the Quick List on the right of the screen. To toggle the Quick List on and off, click the button in the upper left corner of the screen, or select View>Quick List on the menu bar at the top of the screen.

The quick list has three settings: Pick Tops, Unassigned Tops, and Pay Intervals. The easiest way to select between the three modes is to use the "Picking Type" box on the Guide.

11.8  **Well Symbols and Log Header**

While in the Correlation Tool's main screen, dragging the lower line of the frame containing the well symbols increases and decreases this space. The buttons on the toolbar at the top of the screen toggle the well symbol and well data on and off, respectively.
Plotting Log Scale Information

The tops of raster images usually have scale information for each track. If this scale information is calibrated, it can be shown on the Log Correlation Tool's main screen. To show and hide this raster scale information, click the and buttons on the toolbar at the top of the screen. The next step is to tell Petra how the scale information is stored in the raster calibration. Under Logs/Images>Log Header Display on the menu bar at the top of the screen, select “Header”, “Lower Scale”, or “Upper Scale.” Many older Petra projects store scale information as the “header.” Once this data is displayed, dragging the lower line of the frame containing the scales stretches and squeezes the image scales for readability.

11.9 Pan and Zoom

Zoom and Scroll
For detail work, it's probably advantageous to zoom and scroll on the cross section. There are two ways to zoom in and out on the Log Correlation cross section.

**Toolbar Zoom** – The toolbar has a set of zooming tools: `+ -  Zoom灵敏度`.

“+” and “-” zoom in and out by 1/2 onto the center of the screen. The `Zoom灵敏度` button allows you to draw an area to zoom. The `Zoom灵敏度` button returns to the last zoom setting, while the `Zoom灵敏度` magnifying glass removes all zoom to return you to the default scaling.

**The Pan and Scroll Window** - This window on the Quick List log correlation window pans and scrolls around a zoomed cross-section. The “enlarge button” creates an additional window, which is useful for double monitor setups.

Like the toolbar zoom, the “+” and “-” zoom in and out of the center of the screen, while the “X” removes all zoom. The extents of the log correlation main window are shown in red on this window. Dragging this red outline scrolls the extents of the main correlation window at the current zoom level.

**Scrolling with the Arrow Keys Window** – When zoomed in on a section, you can also quickly pan across the section using the arrow keys. By default, the screen will pan by 50% with every key press. To change this number, go to Display>Arrow Keys.

### 11.10 Slip Box

The slip box takes a screenshot of a part of the cross-section and places it into a separate window inside the cross-section. This section of the log can be a great help to correlation between one log and another. The slip box window can be moved around the screen, as well as stretched and squeezed. The slider box on the top of the window changes the box’s opacity to make it easier to overlay on top of other logs.
11.11 Post Data By Well Symbol

The Log Correlation Module can display header information around each well symbol. To plot well data around the well symbol at the top of the screen, select Wells>Plot Data around Well Symbol.

Top/Bottom/Left/Right - These dropdowns select the desired header information that will be displayed around the well symbol. The "Top" dropdown, for example, sets the information that will be displayed above the well symbol.

Font - This entry displays the font used for the header information. To select a different font, select "Change Font."
Size - This option sets the text size.

Color - This sets the color of the text.

11.12 Plot Test Indicators

The Log Correlation module can perfor intervals along the wellbore.

To add perfs, select Wells>Plot Test Indicators

Perfs Tab

Perf Display Color - This option sets the color for perfs on the Log Correlation Module.

Enable Perfs Display - This option enables perfs on the log correlation module.
Deselecting this option will remove perfs from the display.

Options Tab

Show tests from recompletions which match 10 digit API - By default, Petra treats recompletions as separate wells. This option forces the Log Correlation Module to use all perfs from all recompletions that match the first 10 digits of the API number.
Chapter 12
12 Production Analysis Module

The Decline Curve Analysis Module displays a well’s production data and applies decline curves to forecast a well’s ultimate production. This tool can display the entire production history for a well or display individual production streams that represent sequential or commingled production.

To open the Decline Curve Analysis Module, select Tools>Decline Curve Analysis from the menu bar at the top of the Map Module.

Sequential and Comingled Production

"Sequential" production refers to wells perforated in the lowest productive reservoir and then produced to depletion and plugged. The next deepest reservoir was perforated and so forth. Each reservoir is sequentially produced until all reservoirs are depleted. "Comingled" production refers to wells with simultaneous production from multiple reservoirs, all produced to depletion. This method makes it difficult to calculate the individual contribution of oil, gas, water and/or condensate from any individual reservoir unless production logging methods are used.

Getting Started

Selecting Wells
Setting the Current and Available Production Streams
Changing the X & Y Axes
Fitting a Curve
Decline Curve Forecasting

Production Analysis Toolbar

- This button prints a hard copy.
- This button zooms in on the plot. Simply draw a rectangle around the desired region on the plot.
- This button restores the plot to the default X and Y axis.
- This button fits the available production to the screen.
- These buttons set the decline curve forecast.
- This option adds a plot of the perfs along the horizontal axis. This can be useful for analyzing the effect of perfs on production.

12.1 Selecting Decline Curve Wells

By default, The Decline Curve Analysis Module simply uses the wells selected in the Main Module.

To change the wells selected on the Decline Curve Analysis Module, select the Wells option on the menu bar at the top of the screen.

Select All Wells - This option selects all wells in the project.
Select Wells by Data - This option opens the “Select Wells By Data” option. This tool can refine the wells used in the cross plot based on several different criteria. Additionally, multiple nested searches can combine to make for more precise well lists.
Wells from Main - These options select the wells currently active in the Main Module.
List of WSN, UWI and Well Labels

WSN, UWI and user-created Well Labels can be sorted in Ascending or Descending order using the left mouse button (LMB) and clicking the column title box. Using the LMB, you can select the well of interest by clicking on the particular row.

12.2 Current and Additional Production Streams

The C
Current Production Stream

This dropdown sets the stream that will be forecasted using the forecasting methods. Individual stream forecasting requires the user to select the stream here.

Display Additional Streams

The Additional Streams list represents all production streams in the Petra Project database. Not all streams will be available for all wells. Note that the color boxes to the right of each stream may be changed.

Multiple streams in the DCA module are displayed by clicking the streams you want displayed under Additional Streams.

12.3 X & Y Axis

The Y (Production Rate) and X (Time in Years) axes can be adjusted graphically by holding down the LMB and “dragging” in the clear area next to the axis of interest. Note the dotted lines which denote the axis halfway marks on each axis. Holding down the LMB and dragging in the appropriate area will modify either the minimum or maximum value.
Fit Chart to Data Extents

The Fit Chart to Data Extents expands the production history to full graph extents.

12.4 Fitting a Decline Curve

The DCA module provides the user with a set of graphical tools to fit an exponential or hyperbolic curve to the production data. Manual and automatic curve fits are provided via the buttons below.

Manual Exponential method
For a Manual Exponential Method, click the LMB on the location of the initial decline (Qi) and terminal decline points (Qt). The exponential line is fit and model decline parameters as well as TA, REM and EUR are calculated and displayed on the graph and in the forecast box.

**Manual Hyperbolic method**

After clicking the LMB on the location of the initial decline (Qi) and terminal decline points (Qt), the mouse will be centered on the line at which point you can “bend” the line to match the production decline curve. Once you have a match, click the LMB one more time and the hyperbolic line is displayed with model decline parameters as well as TA, REM and EUR calculated and displayed on the graph and in the forecast box.

**Autofit Exponential and Hyperbolic methods**

After clicking the selection box, move the mouse to the graph and draw a box around the area of the decline curve you want to curve fit. Click the LMB again and the exponential or hyperbolic line is fit and model decline parameters as well as TA, REM and EUR are calculated and displayed on the graph and in the forecast box.

12.5 **Decline Curve Forecasting**

The Forecast Parameters and Results box provides model parameters and forecast results. The Up and Down arrows on the right of each entry modify the input parameters by an incremental amount. Note that the plot is updated in real-time. Clicking LMB on the Up arrow increases the value and clicking the Down arrow decreases the value.

Values can be entered by holding the LMB down and highlighting “swiping” the field. A new value can be entered and the forecast model adjusted accordingly.

The Forecast Parameters and Results box may be moved to the graph area by going to the top of the box. Hold down the LMB when the crosshairs are displayed and drag to the graph area.
Model parameters

Qi, Qt, Qf, Di and b may be modified by either entering values or incrementally changed by clicking the Up / Down arrows in each field.

Rotation about Qt
Rotation of the exponential fit can be accomplished by holding the LMB down on the box representing Qi and rotating the line. Values in the forecast box will change accordingly.

“Parallel” move of forecast line

A “parallel” move of the forecast line (Di constant) is accomplished by holding the LMB down on the box on the center of the forecast line. Values in the forecast box will change accordingly.
12.6 Saving/Loading Forecasts

Load Forecasts From Parms (loads model parameters from PARMSDB)
Save Forecasts To Parms (saves model parameters to PARMSDB)

12.7 Plot Options

The Plot Options tool sets a few additional options for the Production Analysis module.

To open the Plot Options tool, select "Plot Options" at the top of the Decline Curve Analysis menu bar.

General Tab

Plot Text Color - This option sets the text color on the Decline Curve Analysis Module.
Plot Border Color & Thickness - The left button sets the border color around the plot, while the right button sets the line thickness
Minor Gridline Color & Thickness - The left button sets the minor gridline’s color on the plot, while the right button sets the line thickness
Major Gridline Color & Thickness - The left button sets the major gridline’s color on the plot, while the right button sets the line thickness

Rate vs Time Tab
Plot Perfs - This option plots perfs along the bottom horizontal axis of the plot. Note that this option is also available on the toolbar at the top of the Decline Curve Analysis Tool.

p/z Tab

p/z Data Stream - This dropdown selects the data stream containing the p/z stream.

p/Z Economic Limit - This option sets the economic limit in psi.

Projection Line Color - This limit sets the projection line’s color.

Forecast Tab
Minimum Eff. Decline Rate Where Hyperbolic Goes Exponential - Over the course of a well's life, production can switch from hyperbolic production to exponential. This option sets the minimum effective decline rate where this production switches over.
13 Production Group Normalization Module

The Production Group Normalization Tool displays and analyzes monthly production data for a set of wells. With this tool, production data can be easily summed together, averaged, or time-normalized back to a single starting date. This is useful for comparing historical and average production between different populations of wells. For example, this tool can be used to compare production differences based on completion techniques, reservoir properties, or structural setting.

It’s important to remember that this tool only works with wells that have monthly production data. Wells missing monthly production data will not contribute to cumulative or average plots. Production streams where each well in a lease contains a fractional percentage of the total lease production can also generate spurious results.

To open the Production Group Normalization Tool, select Tools>Production Group Plot on the Main Module’s menu bar. (Note - the first time it opens, you will see defaults of oil, gas and wtr for the first 100 wells from your main well list).

To load or save an existing Production Group Plot, select File>Load… or File>Save…. on the menu bar at the top of the screen. This “PGP” file stores the list of wells and all display settings. Remember that the Production Group Normalization Tool still reads and recalculates from Petra’s database, so the data shown on the screen after loading a plot will reflect the most current production stream information in the database.

Getting Started

Selecting Wells

Options Tab
The Options Tab establishes which averaging and time-normalization, if any, will be applied to the data.

Well Grouping Method

Group Plot (Sum Wells) – This sums the selected wells’ production streams together. This data can either be shown as a cumulative or an average plot.

Individual Well Plot – This plots the individual production streams for each selected well.

Time Normalization Method

Production streams record production for a well each calendar month. Time-normalizing this data adjusts all the production streams back to a single starting point. When production is time-normalized and averaged, the plot illustrates “average well” or “type curve” production for the selected wells.

Raw Data – This option shows the production data through time without adjusting to a single starting time. Production is plotted on the Y axis against calendar year along the X axis. Raw data plotted against cumulative values shows historical production for the selected wells.

Normalized to Start Time – This option adjusts each well's production to a single starting point a set number of months and years after the beginning of production. This helps to eliminate partial month production or spurious data at the beginning of a well's production stream. For example, setting this option to 2 months will set the
start time for every well (0 on the X axis) after the first two months of production. A time-normalized plot shows production on the Y axis against the elapsed time along the X axis. Average production plotted against elapsed time after a single starting point gives an “average well” or “type curve” production. The cumulative values on the bottom of the production plot do not include the data truncated by time normalization, and reflect only the sum of the data after the normalized start time.

**Normalize to Max Data Value Within 1st** – This option adjusts all production to a starting time at the maximum value of a selected production stream within a time frame. This is useful to time-normalize wells that take a variable amount of time to reach full production. As an example, if this option is selected with maximum OIL production in one year, Petra will find the month with maximum oil production within the first year and set that as the start time (0 on the X axis). Average production plotted against elapsed time after a single starting point gives an “average well” or “type curve” production. The cumulative production values at the bottom of the screen do not include the data truncated by the normalization, and reflect only the data after the maximum value.

**Auto Redraw** – This option automatically redraws the plot whenever any change is made. If this option is deselected, the manual redraw button is located on the upper right side of the screen.

**Other Plotting Options**

**Chart Axis Cycles** – This sets the number of logarithmic orders of magnitude shown on the plot. The default is 3.

**Show Well Counts** – This enables well count graphs to be plotted at the top of the screen. This graph shows the number of wells with production data for each month. Each production stream has its own well count, which is turned on under the “Plot Well Counts” check box under each production stream tab. When looking at averaged data, this plot helps to show how many wells are being used to calculate average production at any given month. Non-producing wells (those with null values) are not factored into averages. Well counts can also be useful to show the number of producing wells in a field when looking at historical cumulative data.

In the example below, notice that the well count graph is on top of the regular time-normalized average production graph.
Show Daily Rates – This converts monthly production rates into an average daily production rate.

Show Avg Prod/Well – This option divides cumulative production based on the number of producing (non-null) wells. In other words, if a well has a null for a month, it is not used in calculating an average production for that month.

Draw Through Null Values – This option draws a straight line between null production values.

Suppress Yearly Cums in Report – When creating a text file as a data report under the REPORT TAB, Petra normally also includes cumulative values for the end of each year. When this box is checked, the cumulative values are left off the report in order to ease the production data’s import into other applications. For more information, see REPORT TAB.

AutoScale All – Selecting this option sets all Production to AutoScale. Using this option retains any user-set YMax settings for each tab (see below).

BkGnd, Labels, Grid – These options set the colors for the background, X axis labels, and logarithmic grids. By default these are white, black, and grey.

OIL, GAS, WTR, and OTHER(1-5) Tabs
Petra can store multiple production streams for an individual well. Typically these production streams include oil, gas, and water values along with a few reservoir-specific streams. The Production Group Normalization Tool has 8 tabs named Oil, Gas, Wtr, and Other 1-5 for displaying separate production streams on the same plot. Each tab sets the display options for one production stream. Despite the naming convention, you can select any production stream and any color for each tab. To toggle the display of these different streams on the plot, use the first 8 buttons on the toggle bar at the top of the screen:

**Display**... - This check box toggles the display of the currently selected production stream on and off.

The color box immediately to the left allows you to change the color of the production plot on the screen.

**Plot Well Counts** – When “Show Well Counts” is enabled on the OPTIONS TAB, this displays a graph of the well count graph for the production stream as shown in the example. This well count graph shows the total number of wells with production values for each month.

**Hide Y Axis Labels** – By default, every stream shown on the plot has its own production scale added to the Y axis. This option hides the selected production stream’s axis labels. When multiple production streams are shown at the same scale, it’s sometimes helpful to only show one set of values.

**Scale Range** – By default, Petra default automatically sets the Y axis scale for
production, shown by “Auto Scale to Data.” Selecting “Use YMax Below” allows you to select a specific maximum value for the Y axis.

Wells Tab

The Wells Tab shows a list of the wells selected in the Group Production Plot tool. The checked box to the left of each well signifies that the well is used in cumulative or average data shown on the main plot. Unchecking the box temporarily removes the well from both plots and calculations. The “Check All” and “None” buttons respectively select and deselect all wells in the Production Group Normalization Tool.

Well Hilite Active – This shows an individual well's production stream relative to the aggregate data. Clicking on a well name causes the individual well's production to be shown on the main plot. The drop down menu selects the individual production stream to display, while the color box selects the display color. In the example above, the plot is showing the individual well's oil production stream in pink relative to the time normalized average oil production for the field. Highlighting a well also shows its WSN, UWI, and well Label on the top of the plot in the selected color.

Ratios Tab
The Ratios Tab contains a series of ratios that are be automatically calculated and plotted on the graph in addition to the production stream data. To toggle the display of the selected ratios on the plot, use the “X/Y” button on the far right of the buttons at the top of the screen. Available ratios include:

- Wtr/Oil
- Gas/Oil
- Oil/Gas
- Gas/(Oil + Wtr)
- Wtr/(Wtr+Oil)
- Oil(Wtr+Oil)
- Oil/Othr4
- (Oil+Wth)/Othr4
- Othr5/Othr4
- (Othr4 + Othr5)/Othr4
- Other4/(Other 4+Othr5)

To change the color of the ratio as plotted on the chart, click the color box.
immediately to the right of the ratio's description.

Select None – This button deselects all ratios so that they are no longer plotted.

Show Names – This option replaces the Othr4 and Othr5 listed in the ratio listing with Other4&5’s selected production streams. This makes selecting the proper ration easier.

Comment Tab

This adds annotation to the bottom left side of the plot (highlighted in red in the example). The “Plot Comments” button toggles these annotations on and off.

Report Tab
The Report Tab shows and exports detailed information about the monthly production data.

The text on the tab gives a brief report for the production streams for each well. This report gives the name of the production stream, the wsn, and years of first and last production.

Data Report – This button generates a text file containing the data displayed on the screen. In other words, the text file contains the same normalized and averaged data as on the screen, as well as any calculated ratios. Normally, this report also includes cumulative values for the end of each year. To suppress these cumulative values, check the “Suppress Yearly Cums” box on the Options Tab (see above).
Capture Production to a Well... - This stores the displayed production and ratio data to a well. Most often this data should be stored to a fake or “placeholder” well. Once stored to a well, you can use the production analysis tool to fit a decline curve or calculate the average date when an economic limit is reached. These placeholder wells containing aggregate production data can also be re-selected inside the Group Production tool, allowing you to compare different populations of wells to each other.

13.1 Selecting Wells

There are three ways to select wells: with an existing WSN list, by data criteria, or with the map module.

With an existing WSN List

Select Wells>Load WSN File... on the menu bar at the top of the Production Group Normalization screen. Navigate to and select the WSN list, and click the Open button.

By Data Criteria

Select Wells>Select Wells... on the menu bar at the top of the screen. This opens the “Select Wells By Data” box common to other Petra Modules. For more information on selecting wells based on data,

With the Map Module

In the Map Module, select Wells>Select Wells on the menu bar at the top of the screen. You can select a set of geographically contiguous wells with “Inside Rectangle”, “Inside Polygon”, or “Outside Polygon.” You can also select wells individually with the “With Mouse” command. Click to select individual wells with the left mouse button, and right click to stop.

After displaying the number of wells selected from the Map Module, Petra displays the “Selected Wells Options.” Select “Use Wells In Prod Group Plot...”
Module” (highlighted in red below). Click OK to select the wells and open the Group Production Tool.

Once these wells are selected in the group production tool, it’s also possible to individually turn wells on and off by clicking on each well’s check box under the WELLS TAB. Turning a well off removes its contribution to the aggregate cumulative or average production. For more information, see the WELLS TAB below.
Chapter 14
14 Thematic Mapping Module

The Thematic Mapping Module imports, displays, queries, and colors ESRI Shape Files based on attribute data. This tool can send the results to a Map Module’s overlay.

To open the Thematic Mapping Module, select the button on the toolbar at the top of the Main Module. Alternatively, select Tools>Thematic Mapper from the menu bar at the top of the screen.

Getting Started

Creating a Well Theme from Petra Project Data
Adding a New Theme from a Shape File
Copying Themes
Removing a Theme
Changing Theme Order
Working with Multiple Themes
Using Queries to Create Themes
Coloring Theme Properties
Clipping a Theme’s Extents
Sending a theme to a Map Module Overlay Layer
Create and export a "WSN" list file from a well theme

14.1 Create Well Theme

A "well theme" is a shape file that is created and populated with well data from the Petra project database. Like any other shape file, you can run queries on a well themes attributes - a well theme will contain well data pulled from the Petra project.

By default, the shape file for well themes are written to the Petra project’s Overlay folder.

To add a new well theme, select Theme>Create Well Theme... from the menu bar at the top of the Thematic Mapping Module.

Wells Tab
Well List
The well list determines which wells are pulled from the Petra database into the well theme.

All Wells - This option pulls all wells in the project. While in prospect mode, this option will only pull the wells from the currently selected prospect.

Wells In Main - This option pulls the currently selected wells on the Main Module.

WSN List - This option pulls the wells from a user-selected WSN list. Select the “Browse” button to navigate to and select the pre-existing WSN list.

Well Locations
This option determines which well locations are used to display the wells on the map.

Surface Location - This option plots the well theme symbols at each well’s surface location.

Bottom Hole Location - This option plots the well theme symbols at each well’s bottomhole location.

Map Location - This option plots the well theme symbols at the location specified by the directional survey location tool.

Columns Tab
The Columns Tab sets the specific types of data included in the well theme.
Add - This button adds the selected well header or zone data item to the "Well Shape File Data Columns" list. Data on this list will be included in the well shape file.

Replace - This button will replace the selected item on the "Well Shape File Data Columns" list with the well header or zone item data. Data on this list will be included in the well shape file.

Well Header Data - This dropdown selects the specific header info for the well theme.

Zone Data Item - These drop-downs select zone data items for the well theme. The upper drop-down selects the specific zone, and the middle drop-down selects the item. When the zone data item is a formation top, bottom drop-down sets the specific type of top - MD, SSTVD, or TVD.

Column is Quality Code Field - This option sets the selected column as a quality code field, rather than the actual item.

Column is Remark Field - This option sets the column as a remark, rather than the actual item.

File Tab

The "File" tab sets the output filename and reference datum of the created shape file.
Petra well shape filename and folder - By default, this tool creates the well shape file in the Petra project Overlay folder.

What Geographic Coordinate System Best Represents the Lat/Lon Coords In The Petra Project? - This dropdown sets the reference datum of the Petra well locations.

Aux Files

By default, the Create Well Theme tool creates well themes for all wells. This tab creates additional well themes based on specific well types, including straight wells, surface locations, bottom locations, or the wellpaths of deviated wells.

Straight holes only - This tool adds an additional well theme containing only straight holes.

Surface location only - This tool adds an additional well theme containing only the surface locations of wells with different surface and bottom hole locations.

Bottom location only - This tool adds an additional well theme containing only the bottom hole locations of wells with different surface and bottom hole locations.
Deviated well path - This tool draws the well paths for wells with directional surveys.

Misc Tab

Use Aliases For Tops and Zone Items - By default, Petra will only use the actual top and zone items set on the Columns Tab. This entry enables formation top aliases and zone item aliases.

14.2 Adding a New Theme

This tool adds new themes from external ESRI shape files (*.SHP). The new theme will be added to the theme list and will have the same name as the shape filename.

Select the menu option "Theme>Add Theme..."
In the "Select ESRI Shape File" open dialog, browse to find the shape file you wish to open and click the "Open" button.

If the shape file does not have an associated ".prj" file to define the shape file's coordinate system, then you will be prompted to specify the appropriate lat-lon or xy coordinate system. The default for lat-lon data is NAD 1927.
The shape file name is added to the theme list on the left side of the screen and the data is displayed in the map window of the Thematic Mapper. The newly added theme becomes the "current" theme.
14.3 Export WSN Well List

Any theme that contains Petra well data can be exported to a "wsn list" file, thus allowing query results to be used in Petra functions that use wsn lists.

To export a well theme simply right click on the well theme and select the "Export Petra WSN List..." menu as shown below:
You can also save WSN lists from the expression, spatial and distance query screens. This allows a query to be performed, highlight the results, save a WSN list and cancel without actually saving a new theme.

14.4 Copying a Theme

The Copy Theme function allows the "current theme" to be copied to a new shape file. Options are available to copy the entire theme's data or to copy just the elements in the current zoom window. In addition, you can change the coordinate system of the output theme to a different coordinate system from the original theme.
The following screen shows the options to copy "oilpipe" to a new theme called 'oilpipe_1'.

CLIPPING

In this example the entire theme will be copied. You can also zoom prior to copying, and then copy only the visible (zoomed) area to the new theme.

DATUM SHIFTING

Also shown in this example is the ability to change the coordinates, in this case lat-lon coordinates from one datum to another. When the option is checked, there are two additional options provided. The "Predefined Conversions" allow NAD27 and NAD83 transforms in North America. The "Advanced" option is provided for all other datum shifts.
With the "Advanced" option checked, a new tab is displayed.
The "New Coordinate System" tab provides two options. First, you specify the output coordinate system for your new theme. Secondly, it provides the datum shift parameters for converting from one lat-lon coordinate system to another. In this case for datum shifting the lat-lon values of the theme from NAD27 to NAD83.

Datum shifting can be done in one or two steps, depending on the data source and destination. If the combination of old and new datum is listed in the "First Transformation" list, then a "Single Transformation" can be used. If not, then the old coordinate system must be shifted using a "Double Transformation" in which the old coordinates are shifted to an intermediate coordinate system with the "First Transform" and then transformed to the final coordinate system with the "Second Transform". This example illustrates a datum shift from NAD27 to NAD83 using a double transform.

**Note** - Some transforms require the use of external files. For example, NADCON and HARN transforms require additional files which Petra does not deploy. If you have ArcView installed, you may already have the required files. Contact Petra technical support if you require these files and do not have ArcView installed.
14.5 Theme Selection and Activation

Current Theme Selection
The "current" theme is identified by a slightly raised outline in the theme list. The current theme is also identified at the bottom left corner of the screen. The current theme is the theme which is used when "theme properties" is selected.

Theme Activation
A theme is displayed or hidden depending on the "check box" next to the theme name in the theme list.

14.6 Theme Display Order

Themes are displayed in the reverse order they are listed in the Theme List so that the first theme listed (top of list) is plotted last, or "on top of" all other themes.

14.7 Clipping a Theme's Extents

The "Copy Theme" function can clip the output theme to contain only those elements appearing in the current zoom window.

1. Zoom the window to the appropriate areal extent for clipping.
2. Select the "current" theme.
3. Right-click on the theme name to display the popup menu and select "copy theme"
4. Select the "Current Zoom" option under "Theme Items To Copy"

14.8 Thematic Mapping Map Projections

The Thematic Mapping Module can handle multiple shape files with different map projections. Some shape files have a *.PRJ file that contain the shape file's map projection information. For shape files without the PRJ file, however, you'll need to set the file's map projection manually.

When there are two or more themes with different projections, you'll need to pick one. In addition to setting the coordinate system for each shape file or theme, it will be necessary to set the "display coordinate system" if you have different coordinate systems for two or more themes. You will be prompted automatically
when adding a theme that differs from previously loaded themes.

**Theme Coordinate System**

Shape files will be in one of two ESRI coordinate systems:

"Geographical Coordinate System" - The shape file contains latitude-longitude coordinates. Typically, we have either NAD27 or NAD83 lat-lon coordinates.

"Projected Coordinate System" - The shape file contains xy coordinates based on a specific map projection, such as, UTM or State Plane.

**Display Coordinate System**

The Display Coordinate System is the lat-lon "unprojected" or xy projected coordinate system of the displayed map. That is, you may display the map as either unprojected latitude-longitude or as projected xy coordinates using a given map projection. Unprojected lat-lon displays may not look correct due to lat-lon lines being drawn as straight lines. Distance queries require a projected display for accuracy.

The Display Coordinate System can be changed anytime using the "options" menu.

![Select A Coordinate System For Display](image)

14.8.1 Change A Theme's Map Projection

The "Copy Theme" function allows you to change the coordinate system of the copied theme. For example, you might have a shape file in NAD 83 that you want to be NAD 27. The copy function will allow you to set the coordinate system of the output theme (shape file) to be NAD 27.

14.8.2 DatumTransform Constants

- Abidjan1987_To_WGS1984 Cote d'Ivoire
- Accra_To_WGS1972BE Ghana - offshore
<table>
<thead>
<tr>
<th>Source Conversion</th>
<th>Destination Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accra_To_WGS1984</td>
<td>Ghana</td>
</tr>
<tr>
<td>Adindan_To_WGS1984_1</td>
<td>Mean for Ethiopia and Sudan</td>
</tr>
<tr>
<td>Adindan_To_WGS1984_2</td>
<td>Burkina Faso</td>
</tr>
<tr>
<td>Adindan_To_WGS1984_3</td>
<td>Cameroon</td>
</tr>
<tr>
<td>Adindan_To_WGS1984_4</td>
<td>Ethiopia</td>
</tr>
<tr>
<td>Adindan_To_WGS1984_5</td>
<td>Mali</td>
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<tr>
<td>Adindan_To_WGS1984_6</td>
<td>Senegal</td>
</tr>
<tr>
<td>Adindan_To_WGS1984_7</td>
<td>Sudan</td>
</tr>
<tr>
<td>Afgooye_To_WGS1984</td>
<td>Somalia</td>
</tr>
<tr>
<td>AGD1966_To_GDA1994</td>
<td>Australia</td>
</tr>
<tr>
<td>AGD1966_To_GDA1994_2</td>
<td>Australia - ACT</td>
</tr>
<tr>
<td>AGD1966_To_GDA1994_3</td>
<td>Australia - Tasmania</td>
</tr>
<tr>
<td>AGD1966_To_GDA1994_4</td>
<td>Australia - New South Wales &amp; Victoria</td>
</tr>
<tr>
<td>AGD1966_To_GDA1994_8</td>
<td>Australia - Tasmania</td>
</tr>
<tr>
<td>AGD1966_To_GDA1994_9</td>
<td>Australia - Northern Terr</td>
</tr>
<tr>
<td>AGD1966_To_GDA1994NTv2New</td>
<td>New South Wales &amp; Victoria</td>
</tr>
<tr>
<td>AGD1966_To_GDA1994NTv2Nort</td>
<td>Northern Territory</td>
</tr>
<tr>
<td>AGD1966_To_GDA1994NTv2Tas</td>
<td>Tasmania</td>
</tr>
<tr>
<td>AGD1966_To_GDA1994NTv2Vic</td>
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<td>AGD1984_To_GDA1994</td>
<td>Australia</td>
</tr>
<tr>
<td>AGD1984_To_GDA1994_2</td>
<td>Australia</td>
</tr>
<tr>
<td>AGD1984_To_GDA1994_3</td>
<td>Western Australia</td>
</tr>
<tr>
<td>AGD1984_To_GDA1994NTv2Que</td>
<td>Queensland</td>
</tr>
<tr>
<td>AGD1984_To_GDA1994NTv2Wes</td>
<td>Western Australia</td>
</tr>
<tr>
<td>AGD1984_To_WGS1984_1</td>
<td>Australia</td>
</tr>
</tbody>
</table>
Tv2Maritimes

ATS1977_To_NAD1983CSRS98N New Brunswick
Tv2NewBrunswick

ATS1977_To_NAD1983CSRS98N Nova Scotia
Tv2NovaScotia

BabSouth_To_NAD1983 Bablethuap Island - Republic of Palau

Batavia_To_WGS1984 Indonesia (Sumatra)

BataviaJakarta_To_Batavia Batavia (Jakarta) to Batavia

BataviaJakarta_To_WGS1984 Batavia(Jakarta) to WGS84

Belge1950Brussels_To_Belge1950Belge 1950( Brussels) to tBelge 1950

Belge1972_To_WGS1984_1 Belgium

Belge1972_To_WGS1984_2 Belgium

Bermuda1957_To_WGS1984 Bermuda

Bern1898Bern_To_Bern1898 Bern 1898 (Bern) to Bern 1898

Bern1898Bern_To_CH1903 Bern 1898 (Bern) to CH1903 (Greenwich)

Bissau_To_WGS1984 Guinea-Bissau

Bogota_to_WGS1984 Columbia

Bogota_To_WGS1984_2 Colombia Casanare, BP Cusiana/Cupiagua field areas

BogotaBogota_To_Bogota Bogota (Bogota) to Bogota

BogotaBogota_To_WGS1984 Bogota(Bogota) to WGS84

BukitRimpah_To_WGS1984 Indonesia (Bangka and Belitung Islands)

Camacupa_To_WGS1972BE_1 Angola - offshore

Camacupa_To_WGS1984_1 Angola - offshore block 5

Camacupa_To_WGS1984_10 Angola - offshore block 2, 3, & 17

Camacupa_To_WGS1984_2 Angola - offshore block 2

Camacupa_To_WGS1984_3 Angola - offshore block 1 & 16

Camacupa_To_WGS1984_4 Angola - offshore block 7 & 8

Camacupa_To_WGS1984_5 Angola - offshore block 3

Camacupa_To_WGS1984_6 Angola - offshore block 7

Camacupa_To_WGS1984_7 Angola - offshore block 3, 7, 15, & 17
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<th>Thematic Mapping Module</th>
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<td>Angola - offshore block 1 &amp; 16</td>
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<td>Argentina</td>
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<tr>
<td>CampoInchauspe_To_WGS1984_2</td>
<td>Argentina - Neuquen province, Chos Malal area 2</td>
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<td>Cape_To_Hartebeesthoek94</td>
<td>South Africa</td>
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<tr>
<td>Cape_To_WGS1984_1</td>
<td>South Africa</td>
</tr>
<tr>
<td>Cape_To_WGS1984_2</td>
<td>South Africa</td>
</tr>
<tr>
<td>Carthage_To_WGS1984</td>
<td>Tunisia</td>
</tr>
<tr>
<td>Carthage_To_WGS1984_2</td>
<td>Tunisia - offshore</td>
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<tr>
<td>CH1903_To_WGS1984_1</td>
<td>Liechtenstein, Switzerland</td>
</tr>
<tr>
<td>CH1903_To_WGS1984_2</td>
<td>Liechtenstein, Switzerland</td>
</tr>
<tr>
<td>CH1903Plus_To_CHTRF1995</td>
<td>Liechtenstein, Switzerland</td>
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<td>ChosMalal1914_To_CampoInchauspe</td>
<td>Argentina - Neuquen province, Chos Malal area</td>
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<tr>
<td>ChosMalal1914_To_WGS1984</td>
<td>Argentina - Neuquen province, Chos Malal area</td>
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<td>CHTRF1995_To_WGS1984</td>
<td>Liechtenstein, Switzerland</td>
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<td>Chua_To_WGS1984</td>
<td>Paraguay</td>
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<td>Conakry1905_To_WGS1984</td>
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<td>Dabola_To_WGS1984</td>
<td>Guinea</td>
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<tr>
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<td>DatumLisboaBessel_To_WGS1984_2</td>
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<td>DatumLisboaHayford_To_WGS1984_1</td>
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<td>DatumLisboaHayford_To_WGS1984_2</td>
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<td>DeirezZor_To_WGS1972BE</td>
<td>Syrian Arab Republic - Deir area (35 22 N, 40 06 E)</td>
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</table>
DeirezZor_To_WGS1984_2  Syrian Arab Republic
DeirezZor_To_WGS1984_3  Syrian Arab Republic - Al Whaleed area
DeirezZor_To_WGS1984_4  Syrian Arab Republic - Shaddadeh area (36 N, 41 E)
DHDN_To_ETRF1989  Germany - former W Germany
Dominica1945_To_WGS1984  Dominica
ED1950_To_ED1987_2  Norway (offshore north of 65 deg N)
ED1950_To_ETRF1989_1  Norway - offshore N of 65N Svalbard and Jan Mayen Islands
ED1950_To_WGS1984_1  Mean for Austria, Belgium, Denmark, Finland, France, Germany (West), Gibraltar, Greece, Italy, Luxembourg, Netherlands, Norway, Spain, Sweden, Switzerland, and Portugal
ED1950_To_WGS1984_10  Italy (Sardinia)
ED1950_To_WGS1984_11  Italy (Sicily)
ED1950_To_WGS1984_12  Malta
ED1950_To_WGS1984_13  Portugal, Spain
ED1950_To_WGS1984_14  Tunisia
ED1950_To_WGS1984_17  France
ED1950_To_WGS1984_18  UK - offshore E of 6W
ED1950_To_WGS1984_19  Greece
ED1950_To_WGS1984_2  Mean for Austria, Denmark, France, Germany (West), Netherlands, and Switzerland
ED1950_To_WGS1984_23  Norway - offshore N of 62N Svalbard and Jan Mayen Islands
ED1950_To_WGS1984_24  Norway - offshore S of 62N
ED1950_To_WGS1984_3  Mean for Iraq, Israel, Jordan, Kuwait, Lebanon, Saudi Arabia, and Syria
ED1950_To_WGS1984_4  Cyprus
ED1950_To_WGS1984_5  Egypt
ED1950_To_WGS1984_6  Ireland, United Kingdom
ED1950_To_WGS1984_7  Finland, Norway
ED1950_To_WGS1984_8  Greece
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<th>Dataset Code</th>
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<td>ED1950_To_WGS1984_9</td>
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<td>ED1950_To_WGS1984PT3</td>
<td>Portugal</td>
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<tr>
<td>ED1950_To_WGS1984PT7</td>
<td>Portugal</td>
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<tr>
<td>ED1950ED77_To_WGS1984</td>
<td>Iran</td>
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<tr>
<td>ED1987_To_WGS1984_1</td>
<td>North Sea south of 62 deg N (UK, Denmark, Germany, Norway) and Netherlands (offshore)</td>
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<td>Egypt1907_To_WGS1972</td>
<td>Egypt</td>
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<td>Egypt1907_To_WGS1984</td>
<td>Egypt</td>
</tr>
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<td>Egypt1907_To_WGS1984_3</td>
<td>Egypt - Gulf of Suez</td>
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<td>Estonia1992_To_ETRF1989</td>
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<td>Estonia1992_To_WGS1984</td>
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<td>ETRS1989_To_WGS1984</td>
<td>Europe</td>
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<td>Fahud_To_WGS1984</td>
<td>Oman</td>
</tr>
<tr>
<td>Fahud_To_WGS1984_2</td>
<td>Oman</td>
</tr>
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<td>FD1958_To_WGS1984</td>
<td>Iran - Kangan District</td>
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<td>Ferro_To_MGI</td>
<td>MGI (Ferro) to MGI</td>
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<td>GDA1994_To_WGS1984</td>
<td>Australia</td>
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<td>GGRS1987_To_WGS1984</td>
<td>Greek GRS</td>
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<td>GraciosaBaseSW1948_To_WGS1984_1</td>
<td>Faial, Graciosa, Pico, Sao Jorge, &amp; Terceira Islands (Azores)</td>
</tr>
<tr>
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<td>Faial, Graciosa, Pico, Sao Jorge, &amp; Terceira Islands (Azores)</td>
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<td>GreekAthens_To_Greek</td>
<td>Greek(Athens) to Greek</td>
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<td>Grenada1953_To_WGS1984</td>
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<td>Guam1963_To_HARNGuam</td>
<td>Guam 1963 to NAD 1983 HARN Guam</td>
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<td>Rota Island - Northern Mariana Islands</td>
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<td>Saipan Island - Northern Mariana Islands</td>
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<td>Tinian and Aguijan Island Northern Mariana Islands</td>
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<td>Hanoi1972_To_WGS1984</td>
<td>Vietnam - Meekong delta</td>
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<td>Name</td>
<td>Description</td>
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<td>HeratNorth_To_WGS1984</td>
<td>Afghanistan</td>
</tr>
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<td>HitoXVIII1963_To_WGS1984</td>
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<td>Iceland</td>
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<td>Hungarian to ETRF 1989</td>
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<td>HuTzuShan_To_WGS1984</td>
<td>Taiwan</td>
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<td>Indian1954_To_WGS1984</td>
<td>Thailand, Vietnam</td>
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<td>Indian1960_To_WGS1972BE</td>
<td>Vietnam - offshore</td>
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<td>Indian1960_To_WGS1984_1</td>
<td>Vietnam - offshore</td>
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<td>Indian1960_To_WGS1984_2</td>
<td>Vietnam near 16N</td>
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<td>Indian1960_To_WGS1984_3</td>
<td>Vietnam - Con Son island</td>
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<tr>
<td>Indian1975_To_WGS1984</td>
<td>Thailand</td>
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<td>Indian1975_To_WGS1984_2</td>
<td>Thailand</td>
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<tr>
<td>Indian1975_To_WGS1984_3</td>
<td>Thailand - Bongkot field</td>
</tr>
<tr>
<td>Indonesian1974_To_WGS1984</td>
<td>Indonesia</td>
</tr>
<tr>
<td>IRENET95_To_ETRF1989</td>
<td>Northern Ireland</td>
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<td>Jamaica1969_To_WGS1984_1</td>
<td>Jamaica 1969 to WGS 1984_1</td>
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<td>Kalianpur_To_WGS1984_1</td>
<td>Bangladesh</td>
</tr>
<tr>
<td>Kalianpur_To_WGS1984_2</td>
<td>India, Nepal</td>
</tr>
<tr>
<td>Kalianpur_To_WGS1984_3</td>
<td>Pakistan</td>
</tr>
<tr>
<td>Kalianpur1937_To_WGS1984_2</td>
<td>Myanmar - Moattama area</td>
</tr>
<tr>
<td>Kandawala_To_WGS1984</td>
<td>Sri Lanka</td>
</tr>
<tr>
<td>Kertau_To_WGS1984</td>
<td>West Malaysia, Singapore</td>
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<td>Korean1995_To_WGS1984_1</td>
<td>Republic of Korea</td>
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<tr>
<td>LaCanoa_To_WGS1984</td>
<td>Venezuela - Delta Amacuro, Anzoategui, Bolivar, Monagas, Sucre States</td>
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<tr>
<td>Leigon_To_WGS1984</td>
<td>Ghana</td>
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<td>Liberia1964_To_WGS1984</td>
<td>Liberia</td>
</tr>
<tr>
<td>LisbonLisbon_To_Lisbon</td>
<td>Lisbon (Lisbon) to Lisbon</td>
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<td>LKS1994_To_WGS1984</td>
<td>Lithuania</td>
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<td>Locodjo1965_To_WGS1984</td>
<td>Cote d'Ivoire</td>
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<td>Philippines (excluding Mindanao)</td>
</tr>
<tr>
<td>Luzon1911_To_WGS1984_2</td>
<td>Philippines (Mindanao)</td>
</tr>
<tr>
<td>Mahe1971_To_WGS1984</td>
<td>Mahe Island</td>
</tr>
<tr>
<td>Majuro_To_NAD1983</td>
<td>Majuro - Republic of Marshall Islands</td>
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<td>MakassarJakarta_To_Makassar</td>
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OSGB1936_To_ED1950UKOAA UK - England, Scotland, Wales, N Sea
OSGB1936_To_WGS1984_1 Mean for UK (England, Scotland, Wales, and Isle of Man)
OSGB1936_To_WGS1984_2 UK (England)
OSGB1936_To_WGS1984_3 UK (England, Wales, and Isle of Man)
OSGB1936_To_WGS1984_4 UK (Scotland, including Shetland Islands)
OSGB1936_To_WGS1984_5 UK (Wales)
OSGB1936_To_WGS1984Petroleumum UK - England, Scotland, Wales, N Sea
Padang1884Jakarta_To_Padang1 Padang 1884(Jakarta) to to Padang 1884 884
PDO1993_To_WGS1972 Oman
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SAD1969_To_WGS1984_12  Trinidad & Tobago
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Schwarzeck_To_WGS1984  Namibia
Schwarzeck_To_WGS1984_2  Namibia
Segora_To_WGS1984  Indonesia - Kalimantan
SierraLeone1968_To_WGS1984  Sierra Leone
SIRGAS_To_WGS1984_1  South America
SouthYemen_To_YemenNGN1996  South Yemen
StGeorge_To_NAD83  St. George I. to NAD83
StKitts1955_To_WGS1984  St. Kitts and Nevis
StLawrence_To_NAD83  St. Lawrence I. to NAD83
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
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<tr>
<td>StLucia1955_To_WGS1984</td>
<td>St. Lucia</td>
</tr>
<tr>
<td>StPaul_To_NAD83</td>
<td>St. Paul I. to NAD83</td>
</tr>
<tr>
<td>Tananarive1925_To_WGS1984</td>
<td>Madagascar</td>
</tr>
<tr>
<td>Tananarive1925Paris_To_Tananarive1925</td>
<td>Tananarive 1925 (Paris) to Tananarive 1925</td>
</tr>
<tr>
<td>Tananarive1925Paris_To_WGS1984</td>
<td>Tananarive (Paris) to WGS84</td>
</tr>
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<td>Mozambique</td>
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<tr>
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<td>Mozambique - Maputo &amp; S Gaza province, S of approx. 24S</td>
</tr>
<tr>
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</tr>
<tr>
<td>Tete_To_Moznet_5</td>
<td>Mozambique - Nampula, Niassa and Cabo Delgado, N of 16S</td>
</tr>
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<td>Brunei, Malaysia (Sabah, Sarawak)</td>
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<td>Brunei Darussalam offshore</td>
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<td>Tokyo_To_JGD2000_1</td>
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<tr>
<td>Tokyo_To_WGS1984_1</td>
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<td>Algeria - N of 35g (31 30’) N</td>
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<td>Voirol 1875 (Paris) to WGS84</td>
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<td>VoirolUnifie1960_To_WGS1984</td>
<td>Algeria</td>
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Voirol Unifie 1960 (Paris) to Voirol Unifie 1960
Voirol Unifie 1960 (Paris) to WGS84
WGS1972_To_WGS1984_1 World
WGS1972_To_WGS1984_2 World
Yacare_To_WGS1984 Uruguay
YemenNGN1996_To_WGS1984 Yemen
Zanderij_To_WGS1984 Suriname

14.9 Project Files

The current state of the Thematic Mapping Module can be saved as a "project file". A project file contains a list of the selected shape files along with all information to redisplay the themes in the current status. Project files can be saved anywhere on your system, however, the default is to save them under the Petra project's public "parms" folder.

14.10 Changing the Theme Order

You can change the display order for themes by dragging and dropping items within the Theme List. Use the left mouse button to drag a theme to a new position in the list.

14.11 Theme Properties

Every theme has a set of properties, most of which govern how the theme is displayed.

To view a theme's properties, first select it as the "current" theme. Then select the button on the toolbar, or Theme>Theme Properties... on the menu bar at the top of the screen.
14.11.1 Single Symbol

The Single Symbol method applies the same color, line style, marker symbol and fill color to all records in the theme (shape file).
14.11.2 Unique Values

The Unique Values method applies different colors based on values. The example below shows selecting the "operator" field and assigning a different color to each operator name.
Results in the following map display
You may change the color for each unique value entry by "double-clicking" the item under the themes list.
14.11.3 Class Breaks

The Class Breaks method applies a different color to shape file records based on a range of numeric values in a selected data field. The example below shows selecting the "TD" field and assigning a color range to its values.
The Color button can be used to assign a different color scheme.
The resulting map is displayed.
14.12 Queries

Queries can be performed using the attribute data associated with a shape file theme. Queries result in a new shape file (theme) being created with a subset of the records from the original theme. The following queries are available:

Expression Query - These are queries based on SQL statements, such as, TD>10000 or OWNER="Smith"

Spatial Query - These queries perform queries using the "shape" data for two themes, a "source" and "selection" theme. These queries are good for finding wells falling inside leases or pipelines crossing leases.

Distance Query - Distance queries use a "source" and "selection" theme to find all of the "source" records within a distance to the "selection" theme records. This query can be used to find wells within a given distance to a pipeline theme.

14.12.1 Expression Query

Use an expression query to find a subset of records within the current theme that meet certain selection criteria. The query uses standard SQL language for defining
Following example shows finding the subset of wells that have a cumoil value greater than 1000000 and a datum value that is not NULL. The screen displays the Query Results and we clicked the "Highlight Results" button to see the wells meeting our criteria. We then clicked the "Save As Theme" button and saved the results to a new theme called "MyWells".
"LIKE" Operator

Use the LIKE operator (instead of the = operator) with wildcards to build a partial string search.

For example, the following query would select Mississippi and Missouri among the USA state names:

[STATE_NAME] LIKE 'Miss*'  
where * represents any group of characters.

The following query would find Catherine Smith and Katherine Smith:

[OWNER_NAME] LIKE '?atherine smith'  
? represents any single character.
WILDCARDS

Wildcards are used with the LIKE operator to build a partial string search. The following wildcards are available with Shapefiles:

_ indicates one character.
% indicates any number of characters.
If you are querying personal geodatabase data:
? indicates one character.
* indicates any number of characters.

If you use a wildcard character in a string with the = operator, the character is treated as part of the string, not as a wildcard.

The # is also used as a wildcard to match a single digit (numeric value) with the LIKE operator when querying a shapefile.

For example, this query would return parcel numbers A1, A2, etc.:
[PARCEL_NUMBER] LIKE ‘A#’

14.12.2 Spatial Query

Spatial queries use the "shape" data from two themes to find records in the "source" theme that meet conditions from a "selection" theme. For example, spatial queries can be used to find "points" (or wells) contained in leases, two lease files that overlap, and a variety of other conditions based on the interaction of the
geometry of the "shapes".

The following example finds all wells in the "Shape_Leases" theme.

The selected wells were then saved as the "WellsInLeases" theme.
14.12.3 Distance Query

A Distance query uses the "shape" data from two themes to find records in the "source" theme that are within a given distance from the "selection" theme. For example, you might want to find all wells that are within 1000 feet of a pipeline theme.

The following example shows finding all wells within 700 feet of a section line. The original "PetraWells" theme was selected as the "current" theme, thus becoming the "source" theme. The "SECTIONS" theme was used as the "selection" theme.
When you perform a distance query using a dataset (shape file) containing latitude-longitude data, you will receive the following warning that the distance query is only an approximation due to the variation in the number of feet (or meters) per degree at different locations on the earth.

The selected wells were then saved as the "Edge Wells 1" theme (shown in yellow).
14.12.4 Spatial Query Methods

- **moAreaIntersect** - If the search feature is a polygon feature, returns features that are wholly or partially contained within it, but not adjacent to it. Otherwise, the features themselves must be polygon features, and the method returns features that wholly or partially contain the search feature. This method is similar to the moContainedBy search method, with the difference that the feature may contain the shape, OR the shape contain the feature.

- **moAreaIntersect NoEdgeTouch** - Same as moAreaIntersect, but the boundaries of the search feature and the feature may not intersect or touch.

- **moCentroidInPolygon** - Returns polygon features whose centroids are contained by the shape

- **moCommonLine** - Returned features must share at least one identical common line segment with the search feature.

- **moCommonPoint** - Returns features that share at least one identical common point with the search feature.

- **moCommonPointOrLineCross** - Returns features that share a common point with the search feature or intersect it.
• **moContainedBy** - Returns features that wholly contain the search feature. If the feature is a polygon feature, the search feature must be wholly inside it, inclusive of the feature's boundary. If the feature is a line feature, the search feature must lie along the feature's path. If the feature is a point feature, the search feature must be on one of its vertexes.

• **moContainedByNoEdgeTouch** - Returns features that wholly contain the search feature, not inclusive of the search feature’s boundary. The feature must be a polygon feature, the search feature must be wholly inside it, and their boundaries may not intersect or touch.

• **moContaining** - Returns features that are wholly contained within the search feature.

• **moContainingNoEdgeTouch** - Returns features that are wholly within the search feature, not inclusive of the search feature’s boundary. The search feature must be a polygon feature, the feature must be wholly inside it, and their boundaries may not intersect or touch.

• **moEdgeTouchOrArealIntersect** - Returns features that touch the search feature, are wholly or partially within the search feature, or wholly or partially contain the search feature(s).

• **moExtentOverlap** - Returns features whose extents overlap the extent of the search feature. (Can be used with a 3D Rectangle for searching on 3D features).

• **molIdentical** - Returns features that are identical to the search feature. Considers feature type and coordinate description. Typically used to find duplicate data.

• **moLineCross** - Returns features that intersect the search feature.

• **moPointInPolygon** - Returns polygon features that contain the first coordinate of the search feature.

### 14.13 Send Theme To PETRA Overlay

The Send To Petra function sends the current theme to an overlay layer in the Map Module. After making the appropriate theme the "current" theme, click on the small icon. The map module will be notified and respond with a window for you to specify the layer in which to load the thematic data.

The following example sends the "Shape_Leases" to overlay layer "Leases"
15 **3D Visualization Module**

The 3D Visualization Module (or "3DViz") displays many kinds of project data in a project as three dimensional objects in a cube (map X, map Y, and subsea depth). Note: 3DViz can only display sub sea depth data. 3DViz requires no special computer hardware and should run on most PC's.

To start 3DViz, select the icon on the main Petra toolbar. Alternatively, select Tools>3D Visualization on the menu bar at the top of the Main Module.

![3DViz Example Screenshot](image)

**Getting Started**

**Changing the View with the Mouse**

- **Rotate and move scene** - Left Click and Drag
- **Zoom In** - Right Click and Drag Up
- **Zoom Out** - Right Click and Drag Dn
- **Rotate Scene** - Ctrl + Left Click and Drag
- **Pan Scene** - Shift + Left Click and Drag, or Middle Click and Drag

**Adding New Data**

**Set Vertical Exaggeration**

**Setting Default Well KB and TVD Values**

© 2014
Setting the Data Extent
Setting a Frame
Axes Options

Keyboard Shortcuts
F2 Seismic Editing Mode
F5 Refresh Data From Tables
F6 Restore Default View
Ctrl + X Axis Options
Ctrl + E Extent Options
Ctrl + F Frame Options
Ctrl + O Display Options
Ctrl + C Clear All
Ctrl + Alt + C Clear Screen
Ctrl + D Display All
Ctrl + L Set Light Position
Ctrl + W Set Data Limits to Full Extent
+ Zoom In
- Zoom Out
Z Zoom Off
W - Show as wireframe
S - Show as solid

Load Default overlay - Generate and plot a overlay containing well symbols.

15.1 Main Menu

File
Import Custom Bitmap - This option draws an image bitmap in the 3DViz frame by mapping its corners to the world coordinates.
Print To Bitmap - Generates a bitmap from the window image.
Print... - Print the 3DViz image to a printer
Load Settings - Load 3DViz settings.
Save Settings - Save 3DViz Settings.
Reset Parameters - Reset all 3DViz parameters and settings to default value and closes the program.
Exit - Close the 3DViz program

Wells
Select Wells - Select wells to use in the 3DViz module. Well lists may come from various sources or be generated by sorting.
Select Well by WSN - Hilight a particular well based upon WSN.

Display
Refresh Data - Reloads all data from disk and replots all layers.
Set Extent - Extent Dialog to set the X/Y and Z extents of the visualizer.
Set Data Limits to Full Extent - Sets the extents to the min-max of the layers.
Set Vertical Exaggeration - Vertical Exaggeration dialog.
Set Light - Makes globe appear on display allowing the positioning of the light source. This is used in conjunction with the Display Options Light parameter.
Frame - Frame options dialog, allowing the placement of a 3D frame or cube at XYZ extents.
Axes - Axes dialog options to label the X, Y, and Z axis.
Restore Default View - Sets the 3DViz view to the default zoom and rotation.
Save Current View - Save the current view (zoom and position)
Restore Saved View - Restore the saved view (zoom and position)
Default Settings - Resets all custom settings to their default state.
Options - Display Options dialog.

View
Map View
Front View
Zoom In
15.2 Selecting Wells

To change the wells selected on the Decline Curve Analysis Module, select the **Wells>Select Wells** option on the menu bar at the top of the screen.

- **All Wells** - This option selects all wells in the project.
- **By Data Criteria** - This option opens the “Select Wells By Data” option. This tool can refine the wells used in the cross plot based on several different criteria. Additionally, multiple nested searches can combine to make for more precise well lists.
- **Main Selected Wells** - This option selects the wells currently active in the Main Module.
- **Map Selected Wells** - This option selects the wells currently active in the Map Module.
- **Petra Current XSect Wells** - This option selects the wells currently active in the Cross Section Module.
- **Selected Cross Section Image Wells** - This option selects the wells currently active in the Cross Section Module.
- **PetraSeis Selected Wells** - This option selects the wells currently active in the PetraSeis Module.
- **No Wells** - This option selects the wells currently active in the Main Module.

15.3 Toolbars

The 3DViz's main toolbar across the top of the screen controls zoom, rotation, saving and loading views, data and other display options.

Zoom and Rotate

The buttons zoom in on the data displayed on the 3DViz module, and rotate the box.

Working with Views

- This button saves the current "view" or angle of the 3DViz module. This will keep only the rotation of the frame, and not any of the layer elements.
- This button restores the saved view to the 3DViz module. This will rotate the
frame back to the saved angle.

- This button restores the angle to the default module.

- This option clears the screen.

- This tool refreshes the data displayed on the module from the project database. This is useful for reflecting changes made to the database in other modules, such as updated tops.

- This button opens the "Search Well By WSN" tool. This tool finds a well by its well sequence number.

- This button changes the data extents. Wells and grids outside the data extents will not plot on the 3DViz Module.

- This button changes the vertical exaggeration.

- This button opens the Map View tool that graphically resets the 3DViz aerial extents.

- This button opens the Front View tool that graphically resets the 3DViz depth extents.

15.4 Front View

The Front View window displays a cross section through the frame of the project to show wellbores and tops. The tool projects from south to north, so the left side of the Front View tool is west, and the right side is east.

The primary use of this tool is to set the depth boundaries of the 3DViz extents by dragging the red lines to the desired depths. This tool can also change the eastern
and western boundaries of the 3DViz extents.

To open the Front View select the button on the menu bar at the top of the screen. Alternatively, select View>Front View from the menu bar at the top of the 3DViz Module.

- This option refreshes the Map Module to reflect the most current data in the project.
- This option enables or disables wellbores on the Map View Table.
- This option applies the new extents set on the Front View to the 3DViz Module.

15.5 Map View

The Map View displays an aerial view of the area selected in the 3DViz Module. This tool can select wells and highlight wells, and change the limits on the 3DViz Module.

To open the Map View select the button on the menu bar at the top of the screen. Alternatively, select View>Map View from the menu bar at the top of the 3DViz Module.
- This option resets the limits on the Map View to the current limits selected on the 3DViz Module.

- This option refreshes the Map Module to reflect the most current data in the project.

- This option enables or disables wellbores on the Map View Table.

- These buttons zoom in and out of the Map View. Note that this also resets the red lines on the Map View.

**Selecting and Highlighting Wells**

To select a well, simply click it on its location in the Map View. Doubleclicking a single well will take you directly to it in the Main Module. To select multiple wells, hold down the CTRL key and select multiple wells.

- This tool highlights selected wells on the 3DViz Module. This effectively dims all other wells displayed in the project. To disable highlighting, simply doubleclick anywhere inside the frame.

- This option limits the 3dViz Module to only the wells selected on the Map View Tool.

- This tool limits the 3DViz Module to the extents defined by the red rectangle.

**Changing the Area**

The Map View tool can change the extents on the 3DViz Module. The red lines on the edges of the map display the 3DViz Module’s current extents. Selecting and dragging
the lines to the desired location changes the limits on the module.

15.6 Place a Custom Bitmap

This tool places a bitmap image file (*.BMP) in the 3DViz frame. To add a picture file, select File>Import Custom Bitmap from the menu bar at the top of the 3DViz Module.

![Place a Custom Bitmap](image)

**Bitmap** - This entry sets the specific name and location of the bitmap file. Selecting the "Browse" button opens the Windows Explorer. Note that the 3DViz module will only keep a link to the image, rather than importing into the project. As such, the image file needs to remain accessible.

**Opacity** - This option sets the opacity/transparency of the image file. Setting this entry to 1 will make the image completely opaque, or to 0.1 will make the image mostly transparent.

**Bitmap Placement Options**

**Bitmap Place At** - This dropdown sets the location of the image file. This includes the front plane (south), back plane (north), right plane (east), left plane (west), top plane, or bottom plane. Note that changing this dropdown will change the entries on the Extent Section.

**Extent**

This sets the specific extents of the image file. Note that the 3DViz module will plot the lower left hand corner of the image file in the "Origin", the left extent in the X1,Y1, Z1 position, and the upper extent in the X2,Y2, Z2 position.
15.7 Printing

To print out a hard copy, select File>Print... from the menu bar at the top of the 3DViz Module.

Print Options

The Print Options tool sets the options for the hard copy, including the orientation, title block, and resolution.

Orientation

Portrait/Landscape - This option sets the orientation of the hard copy.

Options

Include Title Block - This option adds a title block to the plot. Selecting this option opens the Title Block Print Options below.

Print Preview - This option creates a preview of the plot.

Resolution

This option sets the resolution of the plot. Lower resolution plots are quicker, but of lower quality.

Title Block Print Options

The title block dialog allows loading of saved title blocks and saving of modified title block.

Set and select the desired parameters while viewing a representation of the finished title block on the left. The title block is positioned in the upper left corner of the printed page.
Print Logo

This option adds a logo to the title block. To add a logo, select the "..." button and navigate to the desired image file containing the image of the logo. The small checkbox to the left switches the image on or off.

**Logo Width** - This option sets the width of the logo in inches.

**Logo Height** - This option sets the height of the logo in inches.

**Title**

**Company** - This option adds the company name at the top of the title block.

**Project** - This option adds the project name. By default, Petra adds the project name to this entry.

**Title1/2/3** - These options add text lines to the title block.

**Mapped By** - This option adds a "mapped by" option to the title block. This can be useful to identify the creator.

**Descriptions** - This option adds a description field to the title block. By default, Petra adds the project description set on the Main Module Project Tab.

**Legends**

**Tops** - When tops are displayed on the 3DViz Module, this option adds a legend for the plot.

**Logs** - When logs are displayed on the 3DViz Module, this option adds a legend for the plot.
Others - This option adds legends for other layers on the 3DViz Module.

15.8 3DViz Layers

The Layers List on the left side of the screen shows the elements that have been added to 3dViz Module. This tool is a quick way to hide, modify, remove, and sort different data types.

This tool also has a special list for Tops, Logs, and Seismic data.

The first three toolbar buttons control sorting of the layers. The next buttons remove or change the property of the selected layer. The last portion of the property button shows the Layer popup menu shown below. The property of an entry can also be shown by double clicking on the layer.

Quicklist

These sort the current layers on the 3DViz module by alphabetical order.

- This opens the 3DViz Sort Layers tool.

- This tool remove selected layer, and will clear all the layer settings.

- This tool opens the options on the currently selected layer. As an example, selecting this tool with the "Tops" entry highlighted will open the Tops tool.

Properties

Zoom to Selected Layer - Zooms the image to center the data from the selected layer.

Clear and Clear All - Hides the specified Layers.

Display and Display All - Shows the specified Layers

Remove Selected - Removes the selected layer from the Layers list.

Remove and Remove All Layers - Remove the specified layers from the layer list.

Properties - Display the selected layer property dialog.
The 3D Viz Module can display boreholes as tubes with a specified diameter and color. Note that deviated wells are drawn using the directional survey data loaded on the Main Module's Location Tab.

To modify how boreholes are displayed, select the **Boreholes** button on the Layer Toolbar. Alternatively, select **Wells>Bore Holes** on the menu bar at the top of the 3dViz Module.
Set Color and Size

Size - This option sets the wellbore diameter in map units. As an example, setting this option to "50" will create wellbores with a diameter of 50 meters or feet. This is useful for illustrating borehole location (displaying them at actual diameter would make them very difficult to see), but can be misleading about the proximity of very closely spaced wells (like sidetracks).

Color - This option sets the color for the boreholes on the 3DViz module. Select the rectangle to set a different color.

Opacity - This option sets the opacity of all wellbores on a scale from 0 (transparent) to 1 (completely opaque).

Dim Opacity - This tool dims all wells except the selected well. Dimmed wells can have an opacity anywhere from 0 (transparent) to 1 (completely opaque).

Select Wells to Hilight - This option uses a Select Wells By Data Criteria to highlight selected wells with a different wellbore color.

Hilight Color - This option sets the color for the optional highlight.

Show Secondary Surveys - Petra can store "Primary" and "Secondary" directional surveys, but the 3DViz module only displays the "Primary" survey by default. This option enables both the primary and secondary surveys for all directional wells.

Additional Color Options for Directional Wells

This section controls how the 3DViz module displays directional wells with survey data.

Plot directional wells using color(s) selected above - This option plots directional wells using the color specified on the "Color" box in the "Set Color and Size" section above.

Plot Directional Wells using Survey Definition color - This option instead plots directional wells using the "default color" specified on the Survey Def Maintenance
15.8.2 3DViz Tops

The 3DViz Module displays tops as a thin disk or cylinder on boreholes.

To modify how Tops are displayed, select the button on the Layer Toolbar. Alternatively, select Wells>Tops on the menu bar at the top of the 3dViz Module.

Select Tab

The Select Tab adds and removes formation tops to the 3DViz Module.

Select Source

This section displays the FmTop sources for the project. The Available Tops list will only display tops for checked sources. This can be useful for filtering out only the relevant tops from a large, multi-user project.

Available Tops

This list displays the FmTops in the project with the selected source(s). To add a single top, select it on the Available Tops list, and select the "->" button. To add all the tops on the Available Tops list and select the ">>" button.

Selected Tops

This list displays the tops added from the Available Tops list. To drop a top, select
the desired top from the Selected Tops list and select the "<" button. To drop all tops from the 3DViz Module, select the "<<" button.

**Edit**

This section changes the size and color of the selected top on the Selected Tops List.

**Options Tab**

The Options Tab sets the fm top display style, and adds a filter to exclude fm tops with a specified quality code.

![Options Tab Diagram]

**Style** - This dropdown selects how formation tops display on the 3DViz Module. Options include cylinders, discs, and ticks.

![3D Viz formation tops as cylinders (left), discs (center), and ticks (right)]

**Skip Well if Quality Code contains** - This option excludes formation tops with specified quality codes. This can be useful for excluding questionable, extrapolated, or otherwise lower-quality tops. To use multiple codes, separate different codes with a
15.8.3 3DViz Shows

Petra displays shows as a cylinder around the wellbore. Petra can either shade all shows in the database the same color, or with individual colors and diameters.

To modify how shows are displayed, select the button on the Layer Toolbar. Alternatively, select Wells>Shows on the menu bar at the top of the 3dViz Module.

All Shows with Same Color and Size

This option plots all shows at the same color and size.

Size Factor - This entry sets the size of the show cylinder relative to the borehole. A size factor of "3" will plot shows as three times larger than the borehole.

Color - This entry sets the color of all shows.

Color and Size based on show Types

Size Factor - This entry sets the size of the show cylinder relative to the borehole. A size factor of "3" will plot shows as three times larger than the borehole.

Color - This entry sets the color for the relevant show type.

Opacity - This option sets the opacity of the show cylinders on a scale from 0 (transparent) to 1 (completely opaque).
15.8.4 3DViz Perfs

Petra displays perfs as a cylinder around the wellbore. Petra displays all perfs the same color.

To modify how shows are displayed, select the button on the Layer Toolbar. Alternatively, select Wells>Shows on the menu bar at the top of the 3dViz Module.

Color - This entry sets the color for the relevant show type.

Size Factor - This entry sets the size of the perf cylinder relative to the borehole. A size factor of “3” will plot shows as three times larger than the borehole.

Opacity - This option sets the opacity of the perf cylinders on a scale from 0 (transparent) to 1 (completely opaque).

15.8.5 3DViz Logs

Petra displays logs with "geocolumn" shading, as multi-colored cylinders around the wellbore. The 3DViz Module varies the cylinders size and color based on log values.

To modify how digital logs are displayed, select the button on the Layer Toolbar. Alternatively, select Wells>Curves... on the menu bar at the top of the 3dViz Module.
GeoColumn Tab

The 3DViz module can draw digital logs in two different ways - by varying the diameter of the cylinder and the color. These two are independent and can color the selected log trace using values from another log curve. This option can be useful for plotting a litho-column type display.

Select Log

This dropdown selects the digital log to display around the wellbores. This curve will be used to set the diameter of the log curve cylinders.

Size Scale

Min Scale - This option sets the minimum boundary for the digital logs.
Max Scale - This option sets the maximum boundary for the digital logs.
Size Factor - The size factor sets the scaling for the digital log cylinders. Setting this value to 4 will draw digital log curves at 4 times the wellbore diameter.

Logarithmic Scale - This option displays the selected digital log on a logarithmic scale.

Clip/Shift Logs to Fit Range - This option controls how logs plot when they are outside the minimum and maximum scale. The "Clip Logs at Range" will simply clip the logs beyond the range, while the "Shift Logs to fit Range" option instead scales the logs to fit the range.

Normalize Logs to fit Range -

def - This option populates the min and max scale by the default log scale set on the
Main Module's Log Tab's "Scale" button.

**Stat** - This option populates the min and max scale using a statistical measurement of the log values.

**Data** - This option populates the min and max scale using a statistical measurement of the log values.

**Direction**

This section sets how logs plot diameters on the wellbores.

- **Largest value corresponds to Largest diameter** - This option draws logs as a variable cylinder. Larger log values are fatter than low log values.

- **Largest value corresponds to Smallest diameter** - This option draws logs as a variable cylinder. Larger log values are thinner than low log values.

- **Fixed diameter** - This option draws logs as a fixed cylinder.

**Select Log for Shading**

The Shading log sets the colors of the log curve cylinder. By default Petra uses same log as used for the diameter scaling, but can use any digital log.

- **Select Log for Shading** - This sets the log for the color shading.

- **Min Scale** - This option sets the lower boundary of the color bar.

- **Max Scale** - This option sets the upper boundary of the color bar.

- **Sample Rate** - This option sets the sample rate for the color scale.

**Depths Tab**

The Depths Tab sets the depths of the logs displayed on the 3DViz log. Selecting the "Set Depths..." option opens the Set Depth Range tool.
This tool displays dipmeter data on the 3D Module. This tool displays dip and azimuth as tilted disks along the wellbore.

To display dipmeter data, select the button on the Layer Toolbar. Alternatively, select Wells->Dipmeter on the menu bar at the top of the 3DViz Module.
Select Logs

Dip Log - This dropdown selects the dip log in the project. Petra reads 0 as flat, and 90 as vertical.

Azimuth Log - This dropdown selects the azimuth log in the project.

Use Aliases - This option enables log aliases for the dip and azimuth log.

Sample Rate

Display Depths that are Multiple of - This option restricts the discs to only a set depth interval. Setting this interval to to 50, for example, will only display dipmeter discs every 50’.

No. Of Dip/Azm Samples to Average - This option calculates and displays an average of both dip and azimuth around every displayed disc. This can be useful for displaying data that represents a larger chunk of lithology. As an example, setting this entry to 10 will average 5 data points on either side of the displayed disc. This setting will generally depend on the data sample rate and the desired smoothing.

Size and Color

Size Factor - This entry sets the size of the dipmeter discs. The diameter is a multiple of the wellbore diameter. Setting this entry to 4, for example, will draw dipmeter discs that are 4 times bigger than the wellbores.

Coloring

The 3DViz Module can display dipmeter discs with either a single set color or with a colorbar set by another digital log.
Single Color - This option displays dipmeter discs with a single set color. To change the color, select the button.

Use Color Curve - This option colors dipmeter discs based on another digital log curve value. Select the desired log curve from the dropdown - note that it can be any digital log curve, not just a dipmeter curve. To set a colorbar, select the button. Note that this tool can use either the Normal Colors or Enhanced Colors.

15.8.7 3DViz Grids

Petra displays grids as a surface in the 3DViz Module.

To modify how shows are displayed, select the button on the Layer Toolbar. Alternatively, select Surfaces>Grids on the menu bar at the top of the 3dViz Module.

Grid Tab

The Grids dialog allows the selection of a Petra structure grid (depth) and an attribute grid (color). The attribute grid defaults to the structure grid, although a different attribute grid may be selected. The attribute grid must have identical grid characteristics as the structure (same size and bins).

The colors for the attribute grid may be changed and the opacity may be adjusted.
Grid File

The 3DViz module can display grids both as a surface and as a color. The "Structure" grid sets the grid, while the "Attribute" grid sets the coloring used. This can be useful for displaying both structural and reservoir information, such as a structure and isopach map together on the same.

Structure - This entry sets the structural grid. The 3DViz Module will display the values in the grid relative to the zmin and zmax set on the frame.

Attribute - This entry sets the attribute grid that colors the structure grid using the colorbar set in the Color Range Section below.

Color Range

Min - This sets the lower range for the colorbar.
Max - This sets the upper range for the colorbar
Interval - This sets the color interval for the colorbar
Units - This sets the units for the grid file.

Opacity/Decimation

Opacity - This option sets the opacity for the grid file plotted on the 3DViz Module, ranging from 0 (transparent) to 1 (opaque).

Decimation - This option decimates out the number of grid points plotted on the 3DViz Module. This reduces the amount of memory and increases drawing speed for large grids.

IsoPach Tab
Upper Grid File - This dropdown sets the upper boundary for the isopach. In general, this will be an upper boundary of a grid file.

Lower Grid File - This dropdown selects the lower boundary for the isopach. This can either be a structure grid on the base of the isopach or a grid representing isopach thickness.

Color - This option sets the color of the isopach mass.

Opacity - This option sets the transparency or opacity of the isopach.

15.8.8 3DViz Overlay

This tool adds a Petra Overlay File (*.OVL) at a flat depth inside the 3DViz Module's cube. As an overlay file, various overlay layers can be turned on and off inside the 3dViz module. This tool can be a little more flexible than the Map Images tool, but can't display map data outside of an overlay file (such as attribute maps or data posting).

To modify how an overlay file is displayed, select the button on the Layer Toolbar. Alternatively, select Maps>Load Overlay File on the menu bar at the top of the 3dViz Module.
Overlay - This dropdown selects the overlay to display on the 3DViz module. By default, this tool looks in the project's Parms directory. To change the directory, select the Browse button and navigate to the desired location.

- This button opens the Overlay Layers and Preferences tool. Here, you can enable and disable different overlay layers. Note that the overlay file here is read only - though you can clear layers and change plotting order, these changes will not be saved back to the overlay file.

Opacity - This option sets the opacity of the overlay file between 0 (transparent) and 1 (opaque).

Place Overlay At

Fixed Elevation - This option sets the depth (in SSTVD) to draw the overlay file. The "Top" button sets this depth to the highest datum in the project, while the "Bottom" button sets this depth to the lowest TD in the project.

Well Symbol

Well Symbol - This option adds well symbols to the overlay file.

Browse - This option sets an additional filter for t

Symbol Size Factor - This entry sets the size of the symbols on the overlay.

15.8.9 3DViz Map Images

Map images generated by the Petra map module may be displayed at a specified elevation on the 3D display.

Creating a *.GEO File

The first step is to displaying a map on the 3DViz module is to create a *.JPG and *.GEO file. The JPG is a simple image file, while the *.GEO file sets the specific
location of the image on the 3DViz Module.

In the Map Module, select File>Print To...>3DViz Image from the menu bar at the top of the screen.

The map images contain a well list which may be used with the image by checking the Load Wells from Image check box. Here, select File>Export 3DViz Image and save the file to the desired location. Note that Petra will create 2 files, a *.JPG and a *.GEO file.

Adding the Map Image

To add the image file, select the button on the Layer Toolbar. Alternatively, select Maps>Load Petra Map on the menu bar at the top of the 3DViz Module.
Map - This dropdown selects the *.GEO file created in the Map Module. Select the "Browse" button to navigate to the file.

Opacity - This option sets the opacity of the Map Image. Opacity can be set anywhere from transparent (0) to opaque (1).

Place Map At - This option sets the elevation of the image. The "Top" button sets the entry equal to the very top of the frame, while the "Bottom" entry sets the map to the base of the frame.

15.8.10 3DViz Cross Sections

Petra displays cross sections as a fence diagram inside the 3DViz module. The 3DViz module uses a special *.X3D file to position a cross-section image file inside the 3D volume.

Multiple cross section images may be shown, generating a fence diagram. Multiple cross sections, particularly at high resolution, will require more memory and will render more slowly.

Creating a X3D File

The first step to displaying a cross section on the 3DViz module is to create a X3D file. This process creates both the cross section image and the X3D file, which correctly positions the cross section image file inside the 3DViz volume. In the Cross Section Module, select Print To>3DViz from the menu bar at the top of the screen.
On the Print Preview Tool, select File>Export 3DViz File or File>Export 3DViz File (Clipped) on the menu bar at the top of the screen.

Adding a Cross Section

Petra displays cross sections as a fence diagram inside the 3DViz module.

To modify how shows are displayed, select the Layer button on the Layer...
Toolbar. Alternatively, select **Surfaces>Grids** on the menu bar at the top of the 3dViz Module.

![Cross Section](image)

**Cross Section** - This dropdown selects the cross section to display on the 3D module. Note that Petra will look for *.X3D files created by the Print Preview tool. By default, this tool will look in the project directory.

**Color** - This option sets the background color of the cross section. By default, this is white.

**Opacity** - This option sets the opacity of the cross-section in the 3D module.

**Rendering Resolution** - This slider bar sets the resolution of the cross section on the 3D module.

**15.8.11 3DViz Depth Plane**

Petra displays a single plane as a surface inside the 3DViz Module.

To add a plane, select the button on the **Layer Toolbar**. Alternatively, select **Surfaces>Depth Plane** on the menu bar at the top of the 3DViz Module.

![Add Depth Plane](image)
15.9 **Well Options (Default KB & TD)**

The 3DViz module uses a KB (or other well datum) and TD (Total Depth) to position wells inside the module. The 3DViz module cannot plot wells that do not have these values.

This tool assigns a default KB and TD for wells missing these values. A Deviated well will use the deviation survey to calculate a TD.

Select **Wells>Set KB and TD** from the menu bar at the top of the 3DViz module.

![Well Options dialog box](image)

- **Set KB and TD for Missing Records** - This entry enables the default KB and TD for wells that are missing them.

- **KB** - This entry sets the default KB for the wells missing an active datum. By default, this is set to 0.
TD - This sets the default TD for the wells missing an active TD. By default, this is set to 10000.

Calculate Means and TD - This button calculates the average values for KB and TD for the wells currently loaded in the project.

15.10 Vertical Exaggeration

Set the vertical (depth) exaggeration for the viewer by entering the desired value in the edit box.

To change the vertical exaggeration, select Display>Set Vertical Exaggeration on the menu bar at the top of the screen.

There is also an entry for Vertical Exaggeration in the Set Extents dialog.

15.11 Frame Options

Frame Options are used to draw lines at the corners of the cube bound by the extents. It can also be used to position semi transparent planes on the sides of the cube.
Frame Color - This option sets the color for the frame.

Draw Planes - This option toggles the frame around the data on the 3DViz Module.

Opacity - This option sets the opacity of the frame.

North - This option sets the northern color and opacity of the frame's surface. By default, the northern frame is yellow to distinguish it from other frames.

South - This option sets the southern color and opacity of the frame's surface.

East - This option sets the eastern color and opacity of the frame's surface.

West - This option sets the western color and opacity of the frame's surface.

Top - This option sets the color and opacity of the bottom of the frame's surface.

Bottom - This option sets the color and opacity of the bottom of the frame's surface.

Frame Extents

The frame extents set the boundaries of the frame.

Set Extent From - This dropdown sets the extents of the frame from either the currently selected well limits, or by the limits of the data currently displayed.

xmin - This entry sets the east boundary of the frame.

xmax - This entry sets the west boundary of the frame.

ymin - This entry sets the north boundary of the frame.

ymax - This entry sets the south boundary of the frame.

zmin - This entry sets the upper boundary of the frame.

zmax - This entry sets the lower boundary of the frame.

15.12 Extents

The Set Extent dialog sets the X, Y, and Z extents of the module. The 3DViz module will not plot project data, like wellbores or grids outside the extents.

To change the extents of the display, select the button on the toolbar. Alternatively, select Display>Set Extent on the menu bar on the top of the 3DViz Module.
XY Extent

This section sets the aerial or map extent of the 3DViz module.

Set XY Extent By - Selecting this dropdown populates the X and Y min and max extents.

Z Extent

The Z Extent sets the upper and lower boundaries of the 3DModule.

Set Z Extent By - Selecting this dropdown populates the "Upper Depth" and "Lower Depth" entries below.

Set VE - This entry sets the vertical exaggeration for the module.

Edit

X Min - This entry sets the east boundary of the 3DViz Module.
X Max - This entry sets the west boundary of the 3DViz Module.
Y Min - This entry sets the north boundary of the 3DViz Module.
Y Max - This entry sets the south boundary of the 3DViz Module.
Upper Depth - This entry sets the upper boundary of the module in SSTVD.
Lower Depth - This entry sets the lower boundary of the module in SSTVD.
15.13 Display Options

The Display Options tool sets some of the general display options for the 3DViz tool. To open the display options tab, select Display>Options on the menu bar at the top of the module.

General

Display Warnings - This tool displays warnings and errors encountered while plotting the display. This can include bad data like missing well information, such as missing location, TD, or reference datum data.

Display Light Option when Setting Light - This option turns on the Switch for displaying Light Option Dialog when setting Light.

Display Help At Start - This tool adds Switch for making the Layer side panel hide or show.

Background

Background Color - Change to modify the background color of the visualizer.

Light

Fixed Light Source - This option fixes the light in space, or relative to the user. Rotating data in the 3DViz Module will not affect the light source.

Light Move with Object - This option fixes the light relative to the data displayed in the 3DViz Module. Rotating the data around will also rotate the light.

Transformation
Rotation Angle - This option sets the number of degrees the image rotates with each button or key press.

Zoom Factor - This option controls the multiplier for the zoom button on the toolbar.

15.14 Axes Options

The Axes Property tool adds labels to the X, Y, and Z axis.

To open the Axes Property tool, select Axes>Display on the menu bar at the top of the 3DViz Module.

X/Y/Z Axis Visible - These checkboxes control which of axes labels appear on the module. Deselected axes do not display.

Color - This option sets the colors of the axes labels.

Corner Offset - This entry determines the distance the axis line is from the cube corner. Zero is on the corner.
Size Factor - This option sets the size factor of the axes labels. 1 is the default text size, while 2 will double the text size.

Title

X/Y/Z Axis Title - These entries set the the text plotted along the relevant axis.

Ticks and Labels

Number of Intervals - This entry sets the number of labeled points along each axis. The lowest number, 2, labels only the furthest extents of the axis and the center. Increasing this number adds more labels along the axis.
Chapter 16
16 Slip Log Module

The Slip Log Module displays up to four (4) raster log images horizontally across the screen - similar to laying out logs along your desk. Each raster logs can scroll independently, or multiple logs can lock and scroll together. This tool is mostly used for picking formation tops.

The Slip Log Module can only display raster logs, while the Cross Section Module and Log Correlation Tool can handle both digital and raster logs. The Cross Section Module provides more advanced options, while the Log Correlation Tool provides a streamlined interface with fewer plotting and display options. Both tools display logs vertically in a cross-section.

To open the Slip Log Module, select the button on the Main Module toolbar.

Getting Started

Basics

Selecting Wells
Setting a Depth Scale
Displaying Raster Logs
Aligning Raster Logs

Logs and Tops

Displaying and Correlating Formation Tops
Applying Fault Gaps to Raster Logs

16.1 Selecting Slip Log Wells

The Slip Log Module uses the Map Module to select wells.

From inside the Cross-Section module, select Wells>Select From Map from the menu bar at the top of the Cross-Section Module. This will switch to the Map Module.
From inside the Map Module, select Tools>Pick Slip Log Wells from the menu bar at the top of the screen. Next, left click on 2 to 4 wells on the map to select them for the Slip Log Module. Right click to stop picking wells.

Next, simply left-click on the first wellspot on the map to add it to the Slip Log Module. Left-click on one to three more wells to add them to the Slip Log Display. After selecting the desired wells, right-click to finish and jump back to the Slip Log Module.

16.2 Slip Log Depth Scale

Raster logs are displayed using a specified depth scale in units/inch.

To change the depth scale on the Slip Logs Module, select on the toolbar or select Depths>Depth Scale on the menu bar on the top of the Slip Log Module.

16.3 Select Slip Log Raster Images

Each well in the display has associated with it one raster log group. The first time a well is chosen for display, you will be prompted to select the log from a list of available logs for that well. The selected log reference is retained and used whenever the well is chosen for display. You can change the log reference for a given well at any time.

Setting an initial Slip Log Image

The Slip Log Tool will select images sequentially for the wells selected. This log reference will be retained and used whenever the well is displayed, but can be changed at any time.
Changing a Slip Log Image

To change a well's slip log image, select the button above and select Select Different Image for This well. This reopens the "Select Raster Image" tool.

16.4 Aliging Slip Logs Raster Images

Aligned raster logs move together to aid in raster or fault correlation. The Slip Log Module can align two or more raster logs with a couple of different methods.

Line Up at Depth

The Line Up at Depth tool aligns raster logs at a single depth.

To use this tool, select Depths>Line Up on the menu bar at the top of the Slip Log Module, or select the icon on the toolbar.

Here, enter the start depth for the logs. This will align all raster logs at a common depth, and automaticaly lock the scrolling so that the logs will scroll up and down together.
Alignment Cursor

The Alignment Cursor lines up raster logs based on depths picked by the user. These depths are picked graphically and can reflect any feature seen on the log, including tops, flooding surfaces, or unconformities.

To use this tool, select View>Alignment Cursor, or select the button on the toolbar.

This tool activates a horizontal red cursor drawn on each image that can visually inspect features on the different images. To align images to a similar feature, first left click on each image to lock the alignment cursor for that image. Repeat left clicking to lock the cursor for the remaining images. Finally, right mouse click to align the images to the common feature.

Align By Fm Tops.

This tool aligns images to a selected formation top.

To use this tool, open the Edit Fm Tops tool by selecting Tops>Show Edit Tool or by selecting the button on the toolbar.

Highlight the desired top, and select the button to hang all raster logs on the top.

16.5 Displaying and Picking Slip Log FmTops

The first step to working with tops in the Slip Logs Module is to select the tops to display. A project can contain hundreds of tops, so this tool can be useful for filtering the list down to only the most relevant formation tops.

To select the tops to display on the Slip Log Module, select Tops>Select Tops to open the Select Zone Item List tool.
Select the desired tops on the by selecting formation top names from the "Available Items" list and adding them to the rightmost "Selected Items" list. To add one or more selected item names, highlight the names and click the "->" button. You may add all items from the "available" list by clicking the ">>" button. Items may also be added by double clicking the name in "available" list.

To remove a top from the the "selected" list, highlight the desired top and select the "<" button. To clear all tops from the list, select the "<<" button.

**Editing Tops**

Once tops are displayed on the Slip Log Module, select Tops>Show Tops on the menu bar at the top of the screen or select the button on the toolbar to edit tops.

[Diagram]

```
//  / - These two buttons enable (green) and disable (red) formation top editing.
```
While in edit mode, you can use the left mouse button to drag or move existing tops and click to pick new top values.

- This button changes the color of the selected top.
- This option manually sets the MD of the selected top.
- This option aligns the logs on the selected top. This can be useful for quickly picking tops relative to a common, easily correlated top across a field.

### 16.5.1 Repeat Tops

Repeat Tops occur when the same lithologic interval is encountered multiple times in the same wellbore. This is most common in directional wells, though is also possible with structurally complex areas with overturned beds and folds.

To add repeat tops in the Raster Image Calibration tool, select **Tops>Show Repeat Tops**.

When editing formation tops, you can now pick, move, or delete repeat values as well. First ensure that under the Tops menu, ‘Show Repeat Tops’ is checked. This should display any tops along with their repeat values if any exist in the visible range. When in editing mode, there is a new check box and button on the Edit Fm Tops dialog. If the ‘Pick Repeat Tops’ dialog is checked then holding down the CTRL key while clicking adds a repeat of the selected top at that depth. ALT clicking deletes a repeat top. You can also click and drag any top to adjust its position. The ‘Set Repeats’ button opens a grid showing you the value of all repeats for the given top. From here you can edit, add, or delete values.

### 16.6 Applying Faults to Slip Log Images

The Slip Logs Module can add fault gaps in the project database to the raster logs. The Slip Log tool will add a blank space for the gap and shift the image down in
depth.

To add fault gaps, select Depths>Apply Fault Gaps on the menu bar at the top of the Slip Log Module.
Chapter 17
17  Directional Well Module

The Directional Well Module displays and interprets horizontal and directional wells, and is a great way of visualizing digital logs, tops, events, and surfaces along well paths for analysis and interpretation. This tool is also a great compliment to the 3D Visualization tool to view directional wells in more detail.

To open the Directional Well Module, select Tools>Directional Well on the menu bar at the top of the Main Module. Alternatively, select the button on the toolbar at the top of the Main Module.

Getting Started
Using the Map Window
Using the Profile View
Using the Spreadsheet
Quick Reference Guide (PDF Version)
Planning a Well
Instructional Videos

17.1  Map View

The Directional Well Module's Map View works a lot like a simplified version of the Map Module. It displays wells and well paths, overlay data, and grids. Note that the Directional Well Module opens the Map View window automatically. The Map View window cannot
close, and can only be minimized.

To re-open this window select the button on the toolbar at the top of the Directional Well Module.

Map View Toolbar

- These buttons zoom in, zoom out, and zoom to full extents

- This button redraws the Map View using the data loaded in memory.

- This button refreshes the Map View with the latest data in the project. This can be useful for updating the map view to reflect changes made by other users or in another module.

- This button opens the "Line and Wells" tool that selects wells for the Profile View tool.

- This button opens the "Vertical Section" tool that displays a single well down it's vertical section plane.

- This button opens the directional well planning tool
- These buttons create grids, display contours, hide contours, or regrids the last set of contours.

**Overlay**

To load an overlay file, choose the menu option Overlay>Open. You can then select any overlay that you have previously created in the Map Module. Note that overlay files in the Map View tool are read-only, and cannot change here. To make edits to your overlays, use the overlay editing and management functionality in the Map Module.

**Display Options**

The Display Options changes a few additional settings on the Map View. To open the display options tool, select Display>Display Options on the menu bar at the top of the Map View window.

Show Current Profile - This option enables or disables the Profile View outline on the Map View.

Show Secondary Surveys - Petra can store multiple directional surveys in the project database. This is commonly used for proposed well plans and actual directional surveys. When this option is enabled, both primary and secondary directional surveys are displayed on the map. When this option is disabled, the Map View will only show "active" surveys.

**Data Border Gap**

The Data Border Gap establishes a blank space around the outline of the wells selected. To open the data border gap options, select Display>Data Border Gap on the menu bar at the top of the Map View window.
17.1.1 Contour Grids

The Grid Contouring options in the Directional Well Module are a subset of the options available in Petra's Map Module. All grid files (.GRD) created in the Directional Well Module are stored in the same grid folder in your Petra directory as the Map Module, and grid files can be opened in either module.

Before you can make a contour map you must first direct Petra to construct a gridded surface from formation tops or zone data. A grid contains regularly spaced values which have been interpolated from the original data by locally fitting various mathematical functions to the data.

Getting Started

Creating Contour Grids
Displaying Contour Grids

17.1.1.1 Create Contour Grids (Directional Well Module)

To create a contour grid, open the Contours>Create Contour Grid menu item or click on the Create Contour Grid button on the icon bar.

Data Tab
Grid Folder - This box shows the currently selected grid folder, where any created grids will be stored. Selecting the “…” button on the right of this box changes the grid folder’s path. By default, Petra looks in the active project’s GRIDS directory.

Grid Title - This option sets the title for the grid. This title will be placed in the grid file header and displayed as the map title whenever a contour map is generated from the grid. A default title is created whenever well data items or seismic z values is selected.

Output Grid File Name - This is the external file name for the computed grid file. Petra creates a default file name when well data items or seismic z values are selected. The file extension for grid files is .GRD.

Zone Data To Grid

Zone Data – This option selects well data visible from the Zones Tab on the Main Module. Simply select the zone and the appropriate zone data item. The “FMTOPS” zone includes all created fm top data. The adjacent drop down selects whether the fm top will be gridded as a MD, SS, SSTVD (if directional surveys are loaded and enabled), or Seis Time (if velocity functions are loaded). A grid using this data will use well data from for every selected well on the Map Module. Wells that have been dropped from the map will not be used in the grid.

Disabled wells, on the other hand are still honored when gridding, even though they don’t appear on the map. To disable a well, first select the well in the Map Module with the left mouse button. Then, right click and select “Disable (Do Not Plot”). If disabled wells contain bad data points, Petra will still try to grid using that data, which may result in bulls eyes or other anomalies.

View Data - This option opens the View/Edit Zone Data tool.

Well Dist – This option calculates some basic statistics about well spacing, which can be particularly useful when establishing grid spacing. This tool will calculate distance statistics between all wells displayed on a map without discerning if they have data or not. In other words, if you have a large number of closely spaced wells but only a few
of those wells have data, this well distribution box will give you an average distance that is too small.

Method Tab

The Method Tab controls the grid size and surface style of the gridding. The grid size of a grid largely controls how many points are in a calculated grid, which has a direct bearing on contour line smoothness and how well the computer-generated contour lines “honor the data.” The grid method, on the other hand controls how Petra interpolates the grid from one data point to another.

Grid Size

On a rectangular grid, the grid size determines the spacing between horizontal and vertical interpolated grid node values, as shown in the example below where the blue grid nodes are evenly spaced between a set of wells. A grid spacing of 900’ translates to grid nodes 900’ apart both north-south and east-west. Small spacing leads to more grid nodes, which generally “honor the data” better but require much more computer time. Large spacing, on the other hand, tends to generate smoother contours with less computer time but at the cost of a less rigorous tie to data points. The grid size section offers several methods for setting the grid size.
Use Grid Size of (XY units) – This option sets grid spacing to a user-input X and X grid size in map units (feet or meters). A good rule of thumb here is to use ½ the average well spacing.

To calculate average well spacing, select the “Well Dist…” button on the Data Tab (highlighted below on the left). The Well Dist… button on the gridding screen (on the right) gives statistical information on distances between wells, including average distances. This tool will calculate distance statistics between all wells displayed on a map without discerning if they have data or not. In other words, if you have a large number of closely spaced wells but only a few of those wells have data, this well distribution box will give you an average distance that is too small.

Compute Optimum Size From Z Data - During gridding, Petra will compute a grid size based on the well data distribution.

Set Rows and Columns Slider Bar – Instead of setting a specific grid size, this option instead sets the total number of horizontal and vertical rows for the grid. Sliding the “Coarse to Fine” slider bar changes the number of rows and columns used in the grid. Notice that as these are changed, the x and y grid spacing sizes change accordingly.

Match Grid Size of Grid – This option sets the grid size of the new grid to exactly match the grid size of an old grid. Select this option, and use the drop down menu to select the grid file to be matched. Note that the X and Y sizes are updated to show
the grid sized used.

Mathematical calculations between two or more different grids require the size and spacing of each grid to match exactly. As an example, creating a hydrocarbon pore volume grid (where HPV = thickness * porosity * hydrocarbon saturation) would require the isopach, porosity, and water saturation maps to all have the same grid spacing. Using this option to match the porosity and hydrocarbon saturation grid size to the initial isopach grid will save considerable time later.

**Surface Style**

This option determines the shape and characteristics of the gridded surface by applying different mathematical functions to the original data. Surface styles interpolate the data between data points on both rectangular and triangular grids.

**Highly Connected Features** - This is Petra’s default gridding style. It uses a least squares gridding algorithm that tends to preserve trends in the data and works well for most data, particularly structure maps and gently changing petrophysical data. The Highly Connected Features surface style works well with faulted reservoirs. This surface style tends to not do well with rapidly changing or large contrasts between data points such as production in a closely-drilled field.

This method tends to avoid geologically unrealistic contours (or “artifacts”) on the edges of the grid, though contours can to be somewhat jagged and uneven with small grid sizes. The application of surface flexing (“Smooth Contours Using Grid Flexing” immediately below the Surface Style drop down menu) works well with this surface style, as it tends to smooth and even out the spacing between contour lines.

**Disconnected Features** – This surface style uses a linear projection algorithm that tends to produce closed-off features. This surface style can useful for mapping patch reefs or isolated channels. The Disconnected Features surface style can be used with faults. Contours generated from this surface style can be uneven and jagged, but this is easily remedied by adding surface flexing (“Smooth Contours Using Grid Flexing” immediately below the Surface Style drop down menu).

Since this method calculates grid values from a projected linear slope between one data point to the next, the Disconnected Features surface style is susceptible to a couple of different types of gridding artifacts. At the edge of a map this surface style extends the nearest linear projection when calculating Z values, making it particularly prone to “runaway grid values” on the edge of the map. The disconnected nature of the surface style also tends to make “bumpy” maps where two adjacent wells form an adjacent dome and a bowl instead of a more generalized trend.

**Simple Weighting With Slopes** – This surface style calculates a grid using three steps. Petra first calculates a slope for each data point based on surrounding data points. These slopes are then used to project the data points’ Z values out to each individual grid node. Finally, this surface style takes the weighted average of the projected Z values.
The Distance Weighting Damping Factor on the Advanced Tab can greatly affect this surface style. This option uses any value from 1 to 8, with a recommended default setting of 2. With a small factor, more distant data points have more influence on an individual data point which tends to average the grid node; this usually results in a smoother grid. With a larger factor, close data points influence the individual grid much more than more distant data points. The recommended value for this factor is 2. For more information, see the help file on the Advanced Tab.

**Simple Weighting Without Slopes** – This surface style applies a weighted average to the data points around each grid node. In contrast to the Simple Weighting With Slopes surface style, no slope information is used. This option is useful for very dense control such as 3D seismic bin locations.

The Distance Weighting Damping Factor on the Advanced Tab can greatly affect this surface style. This option uses any value from 1 to 8, with a recommended default setting of 2. With a small factor, more distant data points have more influence on an individual data point which tends to average the grid node; this usually results in a smoother grid. With a larger factor, close data points influence the individual grid much more than more distant data points. The recommended value for this factor is 2. For more information, see the help file on the Advanced Tab.

**Distance Grid** - This surface style calculates the distance to the nearest data point for every grid point. Put another way, the grid right next to a data point will have a low Z value, while a grid a great distance from any data point will have a high Z value. Contouring this distance grid can be a useful way of visualizing drainage and bypassed parts of the reservoir. Parts of the grid with a high distance to the nearest well are less likely to be drained than parts of the grid with a low distance.

Again, this method only calculates distance to the nearest selected data point, which can include contour lines and control points in addition to wells. If “Use Overlay Contour Lines” is selected on the Data Tab, the surface style will calculate the distance from the nearest well or the nearest contour line. This renders any
visualization of drainage useless, so be sure to only select “Zone Data” for this surface style.

Closest Point - This option simply sets each grid node to the value of the closest data point. It doesn't interpolate between data points, and is really more useful for resampling existing grids. It is best used with very dense data such as 3D seismic coverage or with legacy XYZ grids.

Minimum Curvature Tension - This surface style attempts to create a very smooth, gradual surface. Contour lines with this method are smooth and evenly spaced, which makes this style a good choice for gently changing petrophysical properties and simple structural settings.

This method cannot be used with faults. Since the minimum curvature algorithm is also available under the “Smooth Contours Using Grid Flexing” option (immediately below the Surface Style drop down menu), so you can use the Highly Connected surface style (which works well with faults) along with the grid flexing option. Since this method strives to have as simple a surface as possible (one with a “minimum curvature”), this surface style tends to smooth over some of the variation in data points. In short, this method has the potential to “not honor the data” as well as other methods. Edge effects with “runaway Z values” are also common with this method.

The "Min Curvature Tension" setting below can greatly affect this surface style. Practically, high tension grids – particularly above 5 - have smoother and more even contours but may not honor the original data as well as lower tension grids.

Flex Grid Factor – Flex Grid Factor adds an additional step after gridding to generate smoother, more even contour lines. When this option is selected, Petra first uses the selected surface style to interpolate between the data points to create grid nodes. Next, Petra applies the minimum curvature surface style to both the original data points and to a decimated sample of the newly-interpolated grid values. This option can be set anywhere between 0 and 12. Setting a low grid factor will keep a relatively strong primary surface style, while a high grid factor will increase the relative strength of the minimum curvature surface style.

Grid flexing is also influenced by the “Min Curvature Tension” option on the Advanced Tab. Practically, high tension grids – particularly above 5 - have smoother and more even contours but may not honor the original data as well as lower tension grids. This option changes the relative strength of the “Smooth Contours using Grid Flexing” option. Low Grid Flex Factor create final grids that look like the original surface style, while higher Grid Flex Factors will create a grid that looks more like a Minimum Curvature grid.

Min Curvature Tension - Setting this option Petra first interpolates the data points with the selected surface style, then adds an additional step to interpolate both the original data points and the newly created grid values with the minimum curvature gridding algorithm.
Mathematically, this option controls the decimation of the initial grid, and can be set from 2 to 12. When this option is set to 2, every other original grid point will be used in the Minimum Curvature step. In this case, a large number of initial grid points remain which constrains much further interpolation from the second minimum curvature interpolation. When this option is set to 12, only every 12th original grid point will remain. The relative low number of initial grid points allows for more interpolation from the Minimum Curvature step. In short, the lower the Grid Flex Factor, the more the final grid will look like the original surface style. Higher Grid Flex Factors will create a grid that looks more like a Minimum Curvature grid.

Advanced Tab

Max Pts Per Octant – Petra interpolates the value of each grid node from surrounding data points. This option sets the maximum number of data points in each octant used for each grid node, and can be anywhere from 1 to 8. For example, with a value of 2 the gridding process will use a maximum of 16 data points (2 for each octant) distributed around the grid node.

When determining which data points will be used for each grid node, Petra first divides the area around the grid node into eight wedges, or “octants.” Petra then uses the closest data points (up to the maximum set by this option) in each octant for calculating an individual grid node’s value. Dividing the surrounding data into octants helps avoid grid nodes that are too heavily biased by data points in one direction.
Use **Natural Neighbors** — This option causes most surface styles to use a “natural neighbors” triangulation search instead of the normal octant search when selecting data points to interpolate for each grid node. This tends to provide a more localized interpolation, which can benefit grids with dense data point coverage. Since this adds an additional pre-gridding triangulation stop, this option can increase gridding time.

When deciding which data points to use for each grid node, most rectangular grids styles (Highly Connected Features, Disconnected features, Simple Weighting With/Without Slopes) use an octant search where the area around a grid node is divided into eight wedges, or “octants.” This octant search ensures that data points used for the grid point interpolation are evenly geographically distributed. A natural neighbors search, in contrast, selects surrounding data points that can be connected by a triangular network. This option just changes how Petra selects the data points for interpolation, so the output will be a normal rectangular grid.

**Skip Well if Quality Code Contains** — This option skips data points from wells that have specified quality codes. Here, enter one or more values separated by a semicolon to indicate wells that are NOT to be used for gridding.
Tops Tab

Skip Well if Quality Code Contains – This option skips repeat formation tops from wells that have specified quality codes. Here, enter one or more values separated by a semicolon to indicate repeat tops that are NOT to be used for gridding.

Triangulation Tab

The Triangulation Tab sets changes the gridding from rectangular to triangular gridding. Triangular grids always “honor the data” at the cost of sometimes unrealistic changes in slope or dip. Refinement adds more interpolation inside these triangles, which smooths these grids. Interior angle clipping reduces grid artifacts caused by widely separated wells on the edge of the map.

Instead of interpolating values for nodes at regularly spaced X and Y intervals, triangulation instead constructs a network of nearest neighbors using the data points. Essentially, Petra calculates node values along lines (shown with lines) between data points. These nodes form triangles known as “Delaunay triangles.” Notice also that
there is a node value directly on top of each well. The resulting contours “honor the data” better because they are drawn using the actual values as opposed to interpolated data in rectangular gridding. Triangular grids are better suited to closely spaced, or highly-variable data rather than widely separated data.

Check the Triangulate box to perform triangulation instead of rectangular gridding.

Triangle Refinement — In a simple triangular grid, each Delaunay triangle is independent from every other triangle so calculated gradients on one triangle can differ significantly from an adjacent triangle. This can lead to rapidly changing, geologically unrealistic dips and angular contour lines. Contours from these simple triangular grids can look strange and can even cross. 

Petra smoothes these triangular contours with a process called “triangle refinement.” Refinement adds more points inside a Delaunay triangle to smooth the grid’s surface and contour lines. These points inside the triangle are interpolated using Petra’s surface style (such as “Highly Connected Features”), selected on the Method Tab and surrounding data points. The refinement value selected here determines the number of additional points, which in turn governs the smoothness of the contours. A refinement of 1 simply uses the existing data points with no interpolation, while a refinement of 16 adds a great deal of interpolated points inside each triangle. Practically, a highly refined grid will have smoother contour lines than a grid with lower or no refinement.
Interior Angle – Triangular grids attempt to connect all data points together regardless of how far apart they are. The part of the grid based on an interpolation between distant data points often shows geologically unrealistic contours – especially on the edge of the map. On the right side of the example below, two highlighted triangles have high interior angles of 172 and 160 degrees. The area of the grid represented by these two triangles probably interpolates the data too far and should be removed. The triangular grid between these distant wells has one corner with a large angle. Filtering out triangles with this high interior angle helps to trim out overly-interpolated or geologically unrealistic parts of the grid on the edge of the map. Setting the value here to 150, as in the example below, will eliminate all triangles with an internal angle above 150 degrees. The smaller the angle, more edge triangles are removed. Suggested values are 120 to 160 degrees.

Fast Local Slope Interpolation Method – Normal refinement uses the selected surface style to interpolate data points inside each Delaunay triangle based on the surrounding “neighborhood” of data points. The “Fast Local Slope” method instead uses partial derivatives to interpolate inside each triangle. In other words, while the normal refinement method attempts to make a more coherent regional picture based on
outside data, this method simply uses only the data points in the Delaunay triangle. Consequently, this method is quick, but is prone to geologically unreasonable dip changes and other artifacts.

17.1.1.2 Display Contour Grids

Contour maps can be generated from grid files produced by the "Create Grid" function. Both contour lines and color-filled contours can be produced.

To create a contour grid, open the Contours>Display Contour Grid menu item or click on the Display Contour Grid button on the icon bar.

Grid Tab

The Grid Tab sets the specific grid displayed on the Directional Well Module's Map View.

Grid File

This section sets the specific grid file for the contours on the Map View.

**Grid File Directory** - This entry sets the location of the available grid files (*.GRD). By default, this tool will look in the project's GRIDS directory.

**Grid Dropdown** - This drop down sets the grid file that will produce the contours. Note that this list contains only the grid files stored inside the Grid File Directory selected above. The files are listed from newest to oldest date created.

**Grid Info** - This button shows information about the selected grid file. This includes the title, dimensions, and grid spacing. For a histogram and more detailed statistics on the grid's Z values, select the "Stats" button.
Contour Range

This section sets the minimum, maximum, and contour interval for the contours. This tool will automatically calculate default values, and will apply a rainbow colorbar.

Colors - This button opens the Enhanced Color Interval Definition tool, which allows for much greater control over the contour colorbar. This tool can apply a preset color bar, or set individual colors for each interval.

Options Tab

Color Filled Contours - This option uses the colorbar set on the Grid Tab color-fill the gridded surface. Deselecting this option will turn off the color fill.

Draw Color Scale Bar - This option draws a small color scale showing the color associated with each contour interval. The adjacent dropdown selects the location of the scale bar, which can be either on the upper left or upper right side of the map.

Draw Contour Lines - This option draws contour lines on the grid. These lines will start at the "Min" contour range on the Grid Tab and proceed up to the "Max" contour range using the contour "Interval" value.

Label Contours - This option control whether any contours are labeled. Refer to the
style tab for labeling options.

**Draw Lines In Default Color** - By default, Petra draws contours using the colors from the colorbar. This option instead draws all contour lines using the default color (which is usually black). To change the default color, select Display>Colors on the menu bar at the top of the Map Module.

**Smooth Contour Lines** - This option smooths contour lines. For jagged or triangular grids, this may force grids to not "honor the data."

**Quick Grid Cell Fill** - This option will color fill each grid cell with a single color. Color contour bands are not drawn.

**Draw Grid Cell Outlines** - This option causes grid lines to be drawn along each grid row and column. This can be useful for demonstrating the resolution of the grid relative to the actual data points.

### Style Tab

This section provides control over line thickness, line style, and labeling interval. Contour lines are drawn as either "normal" or "both" state.

- **Normal Line Width** - Select the line width for drawing contour lines in the normal state.
- **Normal Line Style** - Select the line style for drawing contour lines in the normal state.
- **Bold Line Width** - Select the line width for drawing contour lines in the bold state.
- **Bold Line Style** - Select the line style for drawing contour lines in the bold state.
- **Bold Every Nth Contour Where N** - Set the interval at which bold contours are drawn.
- **Label Every Nth Contour Where N** - Set the interval at which contour lines are labeled.
- **Label Size (XY Map Units)** - The height of the contour labels in XY map units. Set the
size to zero for the default of 0.1 inches.

Label Distance (XY Map Units) - The distance between contour labels in map XY units. Set the distance to zero for default value.

17.1.2 Selecting Wells

The Directional Well Module includes two methods for selecting wells for the Profile View: Line and Wells, and Vertical Section Plane.

Line And Wells

The Directional Well Module’s Line And Wells tool works identically to the Line and Wells Cross-Section in the Map Module.

1. Zoom in to the wells you are interested in on the Map
2. Click the “Line and Wells” button on the menu bar
3. Click twice on the map to draw the line of projection
4. Click to select the desired wells. The first well you click will be your “Active” well.
5. Right-click to end and open the Profile View

Vertical Section Plane View

The Directional Well Module’s Vertical Section Plane View tool simplifies setting up a Profile View with horizontal wells.

1. Zoom in to the wells you are interested in on the Map
2. Click the “Vertical Section Plane View” button on the menu bar
3. Click on the well you would like to display in the Profile View

4. Petra automatically draws the Profile View parallel to the wellbore and projects the well you have chosen onto the plane.

Adding Additional Wells to the Profile View

Once the Profile View has been created, you may wish to add or drop wells from it. In the Map Window, simply right-click on a well:
In the Profile View, right-click on a well symbol to drop the well:

17.2 Profile View

The Profile View displays a cross section through the area selected on the Directional Well Module’s Map View.

To open the Profile View, use the "Line and Wells" or "Vertical Section" tool on the Map View or select the button on the Directional Well Module’s toolbar.

Getting Started

Posting Digital Logs
Posting and Picking Formation Tops
Creating and posting Events
Correlation Window
Post gridded surfaces
Jump quickly to 3D Visualization to view directional wells in 3D
On the top menu bar, the following functions are available:

1. Zoom in / out / off
2. Redraw / Refresh Data
3. Depth Scale Dialog
4. Digital Logs and Tracks Dialog
5. Formation Tops Display Options
6. Draw Order
7. Measure Tool (for measuring apparent dip and distance between two points)
8. 3D Visualization
9. Enable/Disable Offset vs. TVD Mode

Log Values at Cursor

The Directional Well Module has the ability to display the actual value of a specified Digital
Log at the cursors location on the fly. Before using this feature, there has to be a Digital Log displayed in either the Side or Bottom tracks. If a Digital Log is available in one of these tracks, this is activated by simply clicking on a single Log header in any of the tracks.

**Measure Tool**

The measure tool is used for measuring apparent dip and distance between two points along the profile plane. After selecting the measure tool you can now click any two points along the profile view and see the apparent dip and distance between those points automatically calculate.

*NOTE* Please be aware that these are two points along the plane that has been selected for projecting the profile into. To get a better sense of what two points in space are being used for this calculation, watch the cursor on the Map View as you select your points on the Profile View.

**Using the Apparent Dip Line**

Under the Tops menu there is an option to either "Place" or "Edit" an Apparent Dip Line. This is simply an reference line that can be placed along the Profile View at a given Apparent Dip Angle. This is calculated along the plane like the Measure Tool (see above). The end points of this line can be "dragged" up and down by Left Clicking and dragging with the mouse. Also the depth of the line can be adjusted by Shift + Left Click and dragging with the mouse.
Double clicking one of the end points opens the Edit dialog (also accessible through Tops menu) which allows you to manually set an angle, depth, and label/line attributes.

(Apparent Dip Line is in Blue)

17.2.1 Depth Scale

The Profile View Depth Scale tool changes both the vertical and horizontal scale on the Directional Well Module’s Profile View. This tool also changes the upper and lower depth range and adds depth ticks to the active well.

This tool is a more precise alternative to the "Fit Depths To Screen" tool (F4) and the Auto-Set Depths tool (F5). Both of these tools are available under the Depths menu on the menu bar at the top of the Profile View window.

To open the Depth Scale tool, select the button on the toolbar at the top of of the Profile View window, or select Depths>Depth Scale on the menu bar at the top of the Profile View Window.

Depth Scale Tab
Horizontal Scale/Width/Vertical Exaggeration - This dropdown controls how Petra draws the horizontal axis on the Profile View. Petra can draw the profile in a set horizontal scale, width, or vertical exaggeration.

Depth Scale/Horizontal Scale/Width/Height - This dropdown controls how Petra draws the vertical axis on the Profile View. Petra can set this to a depth scale, a set height, or vertical exaggeration.

Depth Scale Measured In: - This dropdown sets the depth scale on the profile view. Depths can either be in feet or meters.

Horizontal Scale Measured In: - This entry displays the horizontal scale for the Profile View.

Width and Height Measured In: - This dropdown sets the units of measurement used for the Profile View.

 Depths Tab
**Upper Depth** - This entry sets the upper boundary of the Profile view. These numbers can reflect TVD or SubSea depths.

**Lower Depth** - This entry sets the lower boundary of the Profile view. These numbers can reflect TVD or SubSea depths.

**Depth Type**

- **Depths Entered as TVD Depths** - This option sets the upper and lower depths of the profile view as true vertical depths. This will work for relatively flat areas, but will misrepresent the depths and tops of areas with any topography.

- **Depths Entered as SubSea Depth (True Structure Section)** - This option sets the upper and lower depths of the profile view as subsea depths. This sets the logs and tops relative to the reference datum, which more accurately reflects the true position in depth.

**Depth Scale**

The Depth Ticks tab displays depth ticks at points along the Active well's wellpath.
Show Depth Ticks - This option enables or disables the depth ticks on the profile view.

Tick Width (Inches) - This entry sets the width of the depth ticks in inches.

Tick Label Size (Inches) - This entry sets the size of the depth track in inches.

Depth Tick Intervals

Compute Optimum Using Depth Scale - This option attempt to automatically calculate a reasonable depth tick schedule over the Profile View window.

Use These Settings - This option manually sets the depth ticks and labels for the profile view.

Depth Scale Drag Handles

The left side of the Profile View has two small drag handles that adjust the depths visible in the window. Simply click, drag, and release to change the depths. After changing the depths using the drag handles, press F4 to redraw the window with the new depth interval.
17.2.2 Formation Tops

The Tops Display Options Tool controls how the Profile View displays formation tops.

Select Tab

The Select Tab adds and removes tops from the Cross Section Module’s display.
Available Tops List

The available logs list shows the formation tops in the project.

Restrict By Source - This option restricts the tops on the Available Tops list by the selected source code. Only the tops with the selected source code will appear on the Available Tops List. The "<All Sources>" option displays all tops from all sources (unless restricted by the Reorder Tool on the Main Module's FmTops Tab).

Displayed Tops List

The Cross Section Module only displays the tops on the Selected Logs list.

To add a log to the Selected Logs list, select the desired log on the Available Logs list and left click the ">" button.

To drop a log from the Selected Logs list, select the desired log on the Selected Logs list and left click the "<" button. To drop all logs from the Selected Logs list, left click the "<<" button.

Style Tab

The style tab contains options for setting the line style and labeling options for individual tops. For each top, first highlight the top from the "Display Tops" list.
Line Color - This dropdown selects the top's color.

Line Width - This dropdown sets the line width for the top. Note that the user-selected line widths are set on the Petra Program Options' Font/Graphics Tab.

Misc Tab

Label Tops - For each top, this option uses the label settings set on the Style Tab. Essentially this option allows top labelling.

Opaque Label Box - This option uses opaque label boxes around the formation top label. This can be useful for displaying labels over log shading.
Label Text Size - This entry sets the size of the text in inches.

Label Relation - This entry sets the formation tops label's location. This can either be located above or below the line.

Apply to All - Press this button to set all tops displayed using the current style settings.

Markers Tab

Indicate Top With Marker - This option controls how the top displays on the Profile View. Deselecting this option will remove the top.

Marker Size - This dropdown sets the size of the marker on the formation top.

Top Marker - This dropdown sets the specific shape of the top marker.

Apply to All - This option sets the marker size and shape to all formation tops on the Displayed Tops list.

17.2.3 Events

"Events" store depth-related information and annotations about directional wells. This can include casing information, gas kicks or fluid losses, drilling or rig events, lithological data from cuttings, or sidetrack annotation.

Events are stored in Petra's Main Module in the Interval Tab in the DirWellEvents Table. Here, the well events can be edited or deleted.
There are three different kinds of events: Text boxes, point events, and range events. Text boxes just contain an entry for text. Point events save information about a single depth on a directional well. Range events save data about a part of the directional well between a top and base.

Event Toolbar

The easiest way to create or modify To enable or disable the Event Toolbar, select Toolbars>Events from the menu bar at the top of the

- This button adds a new **Text Box**.
- This button opens a **Point Event**.
- This button adds a **Range Event**
- This button edits an existing event.

Directional Survey Drop down – Events can be stored against any of the well’s directional surveys. To view the events for a different survey, select it from the drop down box.
Editing Events

To move the location of the text box for an event, shift-click on the box and drag it to the new location.

To edit the settings for an event, shift-double-click on the box.

To change the depths of a point or range event, turn on the editing mode (Event Editing Mode button on the icon bar).

Click and drag the depth marker to change the depth of an event.

Alt-click to delete an event.

Click and drag on the text box to move.

17.2.3.1 Text Box Events

Text boxes are the only event type that are not associated with a depth along the well.

To create a text box event, select the button on the events toolbar. Next, select the desired location on the Profile View. After setting the location, the Edit Event tool will open:

Data Tab

Text Box - This box sets the text that will be displayed in the event.

Date and Time - These two entries set the date and time of the event. By default, this is set to the time the event is created. It’s probably a good idea to change these to reflect the date and time of the drilling event.
Display Options Tab

Show Date  - This option displays the date (set on the Data Tab) on the text box.
Show Time  - This option displays the time (set on the Data Tab) on the text box.
Text Size   - This option sets the size of the text on the text box in inches.

17.2.3.2 Point Events

Point events are a special kind of event that reflect a point or depth along the well.

To create a point event, select the button on the events toolbar. Next, click on the well at the depth where you would like to place your event. After setting the location, the Edit Event tool will open:

Data Tab
Select Survey Definition - Petra can handle multiple sets of directional surveys. This dropdown sets which set of surveys the point event will be associated with.

Top - This entry sets the depth of the point event.

Text Box - This box sets the text that will be displayed in the event.

Date and Time - These two entries set the date and time of the event. By default, this is set to the time the event is created. It's probably a good idea to change these to reflect the date and time of the drilling event.

Display Options Tab
Show Text Box - This entry enables or disables the point event’s text box.

Show Date - This option displays the date (set on the Data Tab) on the point event.

Show Time - This option displays the time (set on the Data Tab) on the point event.

Show MD - This option displays the MD (set on the "Top" entry on the Data Tab) of the point event.

Text Size - This option sets the size of the text on the point event label in inches.

Line Color - This entry sets the line color of the border around the point event text box.

Line Width - This entry sets the line color of the border around the point event text box.

Reset Text Box Location - If the text box is not visible at your current zoom level, click this button to reset its location.

17.2.3.3 Range Events

Range events are tied to two depths along the well. Range events are tied to two depths along the well. To create a range event, simply click the icon on the Events toolbar and click on the well at the depths over which you would like to place your event. The Edit Event dialog will open:

Data Tab

Select Survey Definition - Petra can handle multiple sets of directional surveys. This dropdown sets which set of surveys the point event will be associated with.
**Top** - This entry sets the upper depth of the range event.

**Base** - This entry sets the lower depth of the range event.

**Text Box** - This box sets the text that will be displayed in the event.

**View Range Event As** - This entry sets the graphical style for the range event.

**Markers Only** - This option displays only the start and end depth markers for the range.

**Borehole** - This option highlights the borehole of the well in the line color selected on Display Options Tab.

**Cylinder** - This option draws a cylinder around the borehole with the selected color and width.

**Date and Time** - These two entries set the date and time of the event. By default, this is set to the time the event is created. It's probably a good idea to change these to reflect the date and time of the drilling event.

### Display Options Tab

![Edit Event Window](image)

**Show Text Box** - This entry enables or disables the text box.

**Show Date** - This option displays the date (set on the Data Tab) on the text box.

**Show Time** - This option displays the time (set on the Data Tab) on the text box.

**Show MD** - This option displays the MD (set on the "Top" entry on the Data Tab) of the point event.

**Text Size** - This option sets the size of the text on the text box in inches.
17.2.4 Correlation Window

The Profile View's Correlate tool correlates specific markers and formation tops between horizontal and vertical wells. Note that this tool only works on digital logs - raster logs will need to be digitized.

To open the correlation window, select Logs>Correlate on the menu bar at the top of the Profile View, or select F2.

Getting Ready

Some things must be setup in the Profile View before using this tool:

1) Add two or more wells to the profile view

2) Select an 'Active' Well (by right clicking on well symbol). This is normally your horizontal well.

3) Select an 'Offset' Well (by right clicking on well symbol). This may be a pilot hole or any other well in the region.

4) Setup the Digital Logs for these wells through the "Logs and Tracks" Dialog. (This is somewhat optional as these can be changed within the correlation tool, but it is easier if it matches what is in the profile view)

Correlation Tool

Here is an example of the Correlate Windows with Gamma Ray curves of both a vertical and horizontal Well when first opened. You will notice that the track on the left is for the 'Offset' Well and the right track contains the 'Active' Well. Before launching I had setup the GR curves with geocolumn shading for these two wells and all of those attributes were pulled into this window. You can also click on the Logs tool button to add, remove, and modify attributes of the displayed Logs. At the bottom of each track there is a depth indicator. This shows you the MD your cursor is within each track/log. Also, there are two tabs on the right side, Tops and Logs. The options in these are similar to similar options in other parts of Petra. The different parts of this window are explained in detail below.
Manipulating the Logs

Zooming

You can "zoom" in on certain depths within a well by clicking the Zoom button and then left click a depth (on either well), and while holding the mouse button down, drag to another depth and release. If you want to see the entire log(s), click the Zoom Off button and then single click the desired well.

To invert a well, simply click the Invert button on that well.

Stretch/Squeeze

In order to correlate a horizontal well to a vertical, there is the need to manipulate the log by stretching and squeezing it. This is easily done in this window. When you
first enter this dialog, there will be two green dashed lines (top and bottom) of each well. We will call these scaling points. You can simply left click and drag any of these around and watch the log react. To add additional points, just double click at the desired location. Here are some shortcut keys to help with this process along with a screen shot demonstrating this functionality.

<table>
<thead>
<tr>
<th>Action</th>
<th>Keyboard Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale Section of Log (stretch/squeeze)</td>
<td>Ctrl + Left Click + Drag Up/Down</td>
</tr>
<tr>
<td>Slide Log Up/Down</td>
<td>Shift + Left Click + Drag Up/Down</td>
</tr>
<tr>
<td>'Slip' Log Within Region</td>
<td>Middle Click + Drag Up/Down</td>
</tr>
<tr>
<td>Add Scaling Point to Log</td>
<td>Double Left Click</td>
</tr>
<tr>
<td>Delete Scaling Point</td>
<td>Alt + Left Click</td>
</tr>
</tbody>
</table>

**Formation Tops**
To display/hide certain tops, just check/uncheck it in the Tops tab. The Line Style/Width and Color options apply to whatever top you have selected (if it is checked).

**Picking Tops**

To enter Top Picking Mode, simply select a displayed top from the drop down (shown above) and hit the green button. You can now left click on either well to add a top pick at that depth pick or alt + left click an existing pick to remove one. When done picking, simply hit the red button (next to green button).

*NOTE* Top picks done in the Correlate Window are always MD/TVD Linked Tops. Also, you can still access all functionality within the profile view while the Correlate Window is open. If you choose to still pick tops in the profile view you can do so and use the Correlate Window to help as a reference.

**Calculate Apparent Dip**

Clicking this button enables a mode where one can calculate the apparent dip between any points on the two wells. Once in this mode, simply click (or click and drag) a point on each well; and the apparent dip will be calculated and displayed below the tracks. This calculation uses the well locations, datums, and the directional survey data (if available) and finds the XYZ location in 3d space between the two points. Then the apparent dip is calculated from horizontal.

*NOTE* This Apparent Dip is always shown as positive.
Reset to Default

Clicking this button defaults all Top and Log settings to match what is being displayed in the Profile View.

17.2.5 Gridded Surfaces

Petra can draw one or more gridded surfaces on the Directional Well Module’s Profile View. You can create grids in the Map Module or with a simplified tool inside the Directional Well Module’s Map View. The Gridded Surfaces

To post a gridded surface, select Tops>Contour Grid Profiles on the menu bar at the top of the Profile View.
Grids Tab

Select Grids For Cross-Section Profiles

This section contains a list of available grid files located in the project's GRIDS directory.

Choose a grid then click the "Add To List" button to select it for plotting. The grid name will appear Selected Grids List. Selected Grids

This section displays those grids which have been selected to plot on the cross section. Single clicking a grid name in this list will show the current attribute settings in the Grid Attribute section. Double clicking a grid name will show the grid's statistics. You may remove a single grid from the selection list by using the small '>' button located below the list box. To clear the selection list to start over, click the '>>' button.

Grid Attributes

Set each of the grid attributes for a selected grid. First, highlight the grid name in the "Selected Grids" list by clicking on the grid name. Set the attributes (see below) and click the "Apply" button. (Note: the Apply button is optional).

Grid Type - The grid type determines how Petra interprets the grid's Z values. A grid must be identified as either "Subsea (Structure)", "Measured Depth", or "Datum". Including a datum grid, such as a contour map of the KB, will insure that the other grids are correctly drawn when switching between log depths and tvdss depths.
Color - Choose the line color for drawing the grid profile.

Line Style - Choose from one of the standard line pattern styles.

Line Width - Choose from one of the standard line thickness.

Label - Enter the descriptive title for the grid. The default comes from the grid file header.

Options Tab

Sample Rate

The sample rate determines how many samples are interpolated from the surface grid along the length of the cross section. The default value is 100.

Averaging

The averaging factor \( (N = 1..10) \) determines the distance around each profile data point in Method 1. Larger values result in smoother profiles. All grid node values within a distance of \( N \) times the grid spacing will be averaged using an inverse distance weighting function. A value of 1 will sample only the grid nodes within a single grid cell distance. A value of 10 allows all grid nodes that are closer than 10 times the grid size to be included in the average. For Method 2, the averaging factor determines the amount of smoothing applied by a triangular filter function.

Method

Choose one of the two grid sampling methods. Method 1 samples the grid using an
inverse distance weighting and results in a smoothed profile. Method 2 interpolates each profile point from the grid cell it is contained in.

Label Text Size

This option sets the size of the labels displayed on the Profile View.

Color Fill Between Grids

This tab adds a color fill between two grids displayed on the Profile View.

To add a color fill, select the "+" button to add a new line. In the left column under "Grid 1" select the upper grid from the dropdown. In the right column, under "Grid 2" select the lower grid from the dropdown. Finally, select the desired color from the third column.

17.2.6 3D Visualization

The Profile View can send the current view to the 3D Visualization Module. The 3D Visualization Module is automatically adjusted to the same depth ranges and scales as your Profile View, and any gridded surfaces and tops posted in the Profile View will also be displayed in the 3D Visualization Module.

To change the 3dViz Module to use the extents and grids on the Profile View, select the button on the toolbar at the top of the Profile View.
To reset the 3dViz Module to use the original extents and grids, select the button on the toolbar at the top of the Profile View.

The Active well in the Profile View will be highlighted and the other displayed wells will be semi-transparent.
17.2.7 Displaying Digital Logs Workflow

In the Profile View, there are a number of tracks in which digital logs can be displayed:

- Side Track (on the left side of the window) – 5 sub-tracks for digital log data
- Bottom Track – 5 sub-tracks for digital log data
- Along wellbores (either vertical or horizontal) – 1 track on each side of each wellbore

To open the Log Display Options Dialog, from the Profile View, click the Digital Logs and Tracks Dialog button on the icon bar, or in the menu bar, choose Logs > Select Logs and Tracks:

Log Display Options Dialog
When the Log Display Options dialog opens, it will automatically display all wells selected in the Profile view and the digital logs loaded into the Petra database for those wells.

In the top bar (#2 in the image above), you can select various grouping and filtering options to quickly locate the wells and logs of interest to you:

Group by Well:
Group by Log:

Apply Filter:

Apply Filter opens the filtering dialog. In this dialog you can create filters to only show the logs of interest:
To create a filter:

1. At the bottom of the dialog, enter the condition you would like to filter on, for example “Log Contains GR”, and press the “Add” button.

2. Multiple conditions can be added, and filtering can be performed on Depths and Well Names in addition to Log names. Multiple conditions are applied using the “and” operator.
3. To view the filtered logs in the main dialog, press “Ok”:

4. To remove the filter, simply uncheck the “Apply Filter” checkbox.

**Track Settings**

To change the widths of the tracks, use the lower right portion of the dialog. There are 5 tracks available in the side track and bottom track.
To activate a track, click its “Active” checkbox. You can also adjust the width (in inches).

Changes to the number and widths of tracks activated will be shown in the track previews:

Changing Digital Log Settings

To activate a digital log, click the checkbox next to its row in the table.
The blue highlight on the row selected indicates that you are working with that log curve in the settings panel on the right. To change the style and track settings of a different curve, simply click on its row to move the blue highlight color.

To change the style and track settings of multiple curves at the same time, simply control-click or shift-click on multiple rows. Settings will apply to all selected wells when you press “Apply”.

To uncheck all digital logs that have been enabled, press the Clear All button.

Log Curve Settings

In the settings panel on the top right, the following tabs are available. Again, these settings all apply only to the well or wells highlighted in blue in the well and curve list.

The Scale Tab is primarily used to select the log track and log scale limits. Scaling
options apply to the highlighted log name in the wells and logs portion of the dialog (blue highlight).

- **Active checkbox**: Activates/deactivates the selected log. This has the same functionality as the checkbox discussed above.

- **Label**: Change the log's label.

- **Disabled**: Check this option to temporarily hide a log trace from the display but retain its settings.

- **Draw Along the Borepath**: Draws the log along the borepath of the well.

- **Draw on Side of Borepath**: Specify which side of the borepath the log should be drawn upon.

- **Borepath Track Width**: Set the width, in inches, of the track along the borepath.

- **Use Alias Logs**: Check this option if you want aliased curves to be plotted whenever the selected curve is absent.

- **Logarithmic Scale**: Check this option to plot a log using log 10 value. The left and right scales should be entered as powers of 10 when using this option and the scale min/max must be >0.

- **Scale**: Left/Right scale for selected log curve.

- **Side Track / Bot Track drop down**: Select whether you would like this curve to appear in the Side Track or Bottom Track, and if so, in which sub-track.
The Style Tab defines the appearance of each log trace. Color, line width, line style and shading options are provided. Color and style options apply to the highlighted log name in the wells and logs portion of the dialog (blue highlight).

- **Shading Method**: The display style for a log is controlled by the selected shading method.

  - **No Shading**: Displays a log using a single color selected from the "Line Color" palette provided.

  - **Shade Using Cutoff**: Displays the log in 2 colors and allows the log trace to be shaded based on a user-defined cutoff value. Proceed to the "Cutoff Tab" to set the cutoff shading options.

  - **GeoColumn Shading**: Shades the selected log trace using values from another log curve. This option can be used to plot a litho-column type display. Proceed to the "GeoColumn Tab" to set the GeoColumn shading options.

- **Line Style**: Choose the line pattern for drawing the log trace.

- **Line Width**: Choose the line width for drawing the log trace.

The Cutoff Tab provides options relating to how a log is shaded based on a user-defined cutoff value. Two colors are used to plot the log trace - one for values below the cutoff and another for values above the cutoff. Shading can occur below or above
the cutoff value.

- Shade:
  - Less than Cutoff: Draws the log curve using the two color scheme according to the cutoff value and shades values less than (below) the cutoff.
  - Greater Than Cutoff: Draws the log curve using the two color scheme according to the cutoff value and shades values greater than (above) the cutoff.

- Cutoff:
  - Constant Cutoff: Enter the log value which defines the boundary at which color change and shading is to occur.
  - Statistical Cutoff: Provides a variable cutoff based on the average or mean log value and standard deviation. The cutoff value is entered as the number of standard deviations above the mean. The equation used is:

\[
CUTOFF = \text{MEAN} + (SD \times \text{USERVALUE})
\]

- Shading Color: Choose the color to use when the log trace is less than the cutoff value. Check the associated color palette to change the color box.

- Curve Line Color: Choose the color to use for the curve line.

- Suppress Curve Outline: Suppresses the curve line
- Use Discriminator: A discriminator curve is a "flag" curve containing 1's and 0's. When a discriminator curve is used, the GeoColumn shading will occur only where the discriminator curve is equal to 1. When this option is selected, the Discrim tab will appear where the discriminator curve can be selected:

The GeoColumn tab provides options for displaying a curve using "GeoColumn" shading. The GeoColumn feature shades a curve with multiple colors based on curve values.

- Shading Direction: Specify which side of the curve should be shaded.

- Log Used for Shading: The values from the curve selected here are used to define the color "cutoff" ranges. This curve can be the same curve as being shaded or can be any other curve.

- GeoColumn Base Line Value: Shading occurs from the curve traces back to either
the track edge or a specified curve value.

- Use Discriminator: A discriminator curve is a "flag" curve containing 1's and 0's. When a discriminator curve is used, the GeoColumn shading will occur only where the discriminator curve is equal to 1. When this option is selected, the Discrim tab will appear where the discriminator curve can be selected:

- Suppress Curve Outline: The curve trace is not drawn. Only the shading will be drawn.

- Transparent When Background Color: When the shading color matches the screen background color, shading will not occur.

The Misc tab provides options for configuring the header for each curve in the track.
Pressing the Apply button will update the “Profile View” with all of the changes you have made. You may need to move the dialog to the side to see the Profile View. The changes are not permanent until the OK button is pressed, which closes the dialog.

Advanced Options for Digital Log Curves

Traditionally, when drawing digital logs along a horizontal borepath, the logs may “loop” back onto themselves when the borepath has a high degree of curvature:

Petra uses advanced functionality to ensure the digital log curve maintains a useful appearance by drawing a tangent line along the borepath and using that line as the track edge for the log curve:
The settings for this advanced functionality can be found in the Track settings “Advanced” tab.

17.3 Spreadsheet View

The Directional Well Module can view and modify directional survey data. This tool
can be used to compare multiple directional surveys in a single well, which are commonly Actual and Proposed directional surveys.

To open the Spreadsheet tool, select the button on the top of the Directional Well Module.
The Directional Module's spreadsheet tool with a single survey (left) and with two surveys (right)

**View Survey** - This dropdown selects between multiple directional surveys. This dropdown selects the left set of surveys, and is set to "Actual" by default.

**View Survey Right** - This dropdown selects the directional survey set to display on the right.

**Show XY's/Show Lat Lon's** - These two options enable the XY and LatLon surface location of each survey point.

**Show Vertical Section** - This option enables the vertical section column, which is a horizontal measurement away from the surface location calculated along a compass azimuth.

**Allow Editing of XY Offsets** - This option allows the XY offsets in the project to change.

**Dir. Survey** - This button opens the directional survey data tool.

### 17.4 Hot Keys
### General

<table>
<thead>
<tr>
<th>Action</th>
<th>Command/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panning while zoomed</td>
<td>Hold down the Middle Mouse Button while dragging the mouse</td>
</tr>
<tr>
<td>Re-Draw Screen</td>
<td>F5</td>
</tr>
<tr>
<td>Refresh Data</td>
<td>Shift + F5</td>
</tr>
<tr>
<td>Select All Wells</td>
<td>Ctrl+A</td>
</tr>
<tr>
<td>Select Wells by Data Criteria</td>
<td>Ctrl+S</td>
</tr>
<tr>
<td>Open Help</td>
<td>F1</td>
</tr>
</tbody>
</table>

### Profile View

#### General

<table>
<thead>
<tr>
<th>Action</th>
<th>Command/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print</td>
<td>Ctrl+P</td>
</tr>
<tr>
<td>Auto-Set Depths to Fit Well</td>
<td>F3</td>
</tr>
<tr>
<td>Fit Depths to Screen</td>
<td>F4</td>
</tr>
</tbody>
</table>

#### Top Picking (once in Picking mode)

<table>
<thead>
<tr>
<th>Action</th>
<th>Command/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pick FM Top on the well-bore</td>
<td>Left Click on the Well-Bore at desired MD depth</td>
</tr>
<tr>
<td>Pick FM Top above/below the well-bore</td>
<td>Shift + Left Click at the desired location</td>
</tr>
<tr>
<td>Move FM Top Pick</td>
<td>Left Click and drag to new location</td>
</tr>
<tr>
<td>Delete FM Top Pick</td>
<td>Alt + Left Click on the pick to delete</td>
</tr>
</tbody>
</table>

#### Events (while NOT in edit mode)

<table>
<thead>
<tr>
<th>Action</th>
<th>Command/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Move Event Text Box</td>
<td>Shift + Left Click and Drag</td>
</tr>
</tbody>
</table>
17.5 Planning A Well

Before you plan a well, it is recommended that you load an overlay into the Directional Well Module’s Map window. From the menu, choose Overlay > Open and select an overlay that you have saved in your Map module. This will let you easily quality check the coordinates that you will be entering for surface, landing, and bottom hole locations.

Using the Zoom functionality, zoom in to the area in which you would like to plan a well:
In the Map menu bar, select Plan > Plan A Well

An option dialog box will pop up with the following options:

- Create New Well – adds a new well to the Petra database with a proposed survey.
- Add Borepath to Existing Well – Allows you to add a new directional survey to an existing well in the Petra database.
To plan a new well in your database, select Create A New Well and press “Continue”.

Enter in:

- **UWI/API**: This can either be UWI/API you will use for licensing the well or any name for the well

- **Symbol**: For use on the map display

- **Select Survey Definition For Survey**: We recommend that you put the proposed survey into the proposed survey category for clarity. This enables you to add the actual as-drilled survey into the actual category later on.

- **Well Name**: Optional

- **Well Label**: Optional

Press “Continue”.

Plan Locations and Path:
1. Datum: Enter your datum, typically a GL (Ground Level) or KB (Kelly Bushing).
   
   a. Auto Calc Datum: After you have picked a surface location, Petra can automatically calculate the datum based on the datum of the closest well.

2. Depth Options: Set the dialog to use either Sub-Sea TVD (elevation) or TVD (depth from datum).

3. Surface, Landing, and Bottom Hole locations
   
   a. These three groups down the left side of the dialog let you set the location and depth of each of the three points of the planned well. The radio buttons along the side (indicated with arrows on the dialog) are used to select which point you are currently working with.

   b. You can also simply type in a value in either XY or Lat Long for these three points, if you have them on a survey plan.

4. Set Location of Selected
a. This box is used to set the location of whichever of the three planning points (#3 on the dialog) you have selected.

i. From Map – Allows you to set the location by clicking on the map

ii. From Well – Allows you to set the location based on another well on your map

iii. Surface – Sets the location to be the same as the Surface location

iv. Landing – Sets the location to be the same as the Landing location

v. Bottom – Sets the location to be the same as the Bottom location

b. Apply Offset – In addition to being able to set the location based on any of the above 5 options, you can also apply an offset (for example if you knew you wanted the surface location of your new well to be a certain distance away from surface location of a previous well). Please note that all offsets are applied in Grid North, not True North.

5. Set Depth of Selected

a. Used to set the depth of whichever of the three planning points (#3 on the dialog) you have selected.

i. Offset from a Single Grid – Allows you to set the depth based on a gridded surface. Select the surface from the drop-down list below. You can also enter a depth offset (positive for shallower, and negative for deeper) to set the point above or below a target.

ii. Between Two Grids – Allows you to set the depth based on two grids. Petra will place the point halfway between the two gridded surfaces in depth.

b. Press the “Apply” button to apply the changes to your selected planning point.

Press Apply to see your changes in a profile view.

A more detailed workflow sequence example is:

Pick a Surface Location from a map:

1. Make sure the radio button next to “Surface Location” is checked, and click the “From Map” button:
2. Petra will show you the map. Click on the surface location for your well. Petra will automatically place a well symbol at the surface location and populate the dialog box with the XY or Lat Long of the location.

a. If you would like to apply an offset or a Kick Off Depth, you can make those changes now in the dialog.
Create a Landing Location from offsets:

1. Check the “Active” checkbox under Landing Location, make sure the radio button next to “Landing Location” is checked, and click the “Surface” button to set the Landing Location from the Surface location of the well:

2. Now apply an offset to that Landing Location of X=0m and Y=400m (0ft and 1200ft respectively). The map will change to reflect your new landing location directly north of your surface location.
3. Apply a depth for your Landing Location by either entering a depth in the “Depth” box, or by setting an offset to a grid.

Pick a Bottom Location from the map.

1. Make sure the radio button next to “Bottom Location” is checked, and click the “From Map” button.
2. Petra will show you the map. Click on the bottom location for your well. Petra will automatically place a well symbol at the bottom location and populate the dialog box with the XY or Lat Long of the location.

3. Apply a depth for your Bottom Location by either entering a depth in the “Depth” box, or by setting an offset to a grid.
If you simply add a depth point for the Landing Location and another depth point for the Bottom Location, Petra will plan the well in a straight line between those two points. If you have significant topographical changes along the well path, you may wish to sample the well to a surface (or between two surfaces) along the wellbore.

To do this, check the “Use Settings Above To Determine Survey from Landing to Bottom Hole” checkbox, ensure your settings are correct (sampling to one or two grids, offset) and press “Apply”.

The difference is shown below.

With two points along the wellbore (Landing Location and Bottom Location):
Sampling to the Top of Coal Seam surface:

Press “Apply” to add your newly planned well to the Petra database. To make changes to your well, simply change the desired values in the dialog and press Apply. When you are satisfied with your planned well, you can press Done to exit the planning screen.
Note About Projected View:

When working with a horizontal well with an offset (or offplane) landing location and a lateral bend, Petra projects the well path onto a straight line drawn between the surface and bottom hole locations. The difference in the projection of grids and borehole path may cause an apparent depth issue in the projected view with respect to the landing location:
To resolve this apparent discrepancy, you can view your profile “un-projected”, or along the actual well path. To toggle this setting, press the “Enable/Disable TVD vs Offset Mode” button on the menu bar:

The un-projected view will show the actual landing location in relation to the surface in question:
Chapter 18
18 "How To" Workflows

18.1 How to make a contour map

Contour maps represent a three dimensional structure where X, Y, and Z displays how a quality like depth, isopach thickness, or porosity varies by location.

There are a few different methods for creating a contour map in Petra. Contour maps can be drawn by hand, by having the computer calculate and contour grids, or by a combination of hand contours and computer grids. Both methods have their strengths and weaknesses. Directly drawing contour lines allows more control over the map, while creating computer-calculated grids is fast and flexible. Using both hand contours and computer-calculated grids is a good way to harness the strengths of both methods.

Hand-drawn Contour Lines

Hand-drawn maps are best. An interpreter making a contour map knows the geology of an area and is able to incorporate this interpretation in a contour map, while a computer cannot. This method can be time consuming, however, especially with large data sets.

To create a contour line, first click on the pencil icon on the toolbox on the right side of the map module: 🖌️ The mouse cursor will turn to a crosshair. Click the left mouse button where you want the beginning of the line to start, and continue clicking the left mouse button for more control points on the line. Clicking the right mouse button will end the line and bring up the Overlay Line Attributes dialogue box.

The “Line Stream” method can be significantly faster than creating each line node individually. To enable Line Streaming, select Overlay>Line Stream Mode Active or select SHIFT + CTRL + S on your keyboard. The normal pencil icon on the toolbar changes to 📊. After selecting this button, mouse cursor turns to a crosshair. Click the left mouse button where you want the beginning of the line to start, and drag the mouse to draw the line. Note that Petra places line nodes automatically. The line stream method creates a large number of nodes, which may be time-consuming to move individually. To end the line, click the right mouse button. Clicking the right mouse button will end the line and bring up the Overlay Line Attributes dialogue box.
In addition to selecting line color and width, you can establish a line as a contour line. Contour lines draw like normal lines, but store and display a contour value. To designate a line as a contour line, click the “Line Class” dropdown box and select contour line. Designating a line as a contour line creates the “Contours” tab.

The Contours Tab gives further control over the contour line.

**Contour Value** – This is where you establish the individual line’s value. In the example
above, the value of the line is 80.

Label Contour Line – Checking this box will tell Petra to label the contour line. Text size is chosen immediately below.

Hatchures – This tells Petra to draw hachures on contour lines. Draw contour lines **clockwise** for IN and OUT to respectively be inside and outside a closed polygon. From a line’s start to finish, Petra will draw an IN hachure on the right and an OUT hachure on the left.

**Gridding**

In creating a computer-drawn contour map, Petra first extrapolates data between data points into a grid. Petra then draws a set of contour lines from this grid. The process of creating computer-drawn contour lines is generally faster than drawing contours by hand. Computer-created grids can also be used for more advanced calculations, such as volumetric and isopach summations. However, purely computer-created grids do not incorporate any form of geological experience or interpretation.

**Creating a grid**

The first step of creating a set of computer-drawn contour lines is to create a grid. A grid contains the mathematical extrapolation of your data points over an area. Grids can be calculated on any combination of the following data types:

- zone data items (such as fm tops and reservoir data)
- repeat tops from horizontal and deviated wells
- contour lines and faults displayed on the map module
- control points loaded into Petra’s memory or from an external file
- interval data

To create a grid, in the map module either go to **Contours>Create Grid**, or click on the “Create a Grid” icon: 📊. This brings up the create Contour Grid box.

**Selecting Data**
First, select the type(s) of data you want to grid under the “Zone Data To Grid.”

**Zone Data** - Most grids will be on zone data from each well, such as reservoir thickness or formation tops. In the example above, the net pay thickness for the 2nd Wall Creek reservoir is being gridded. This value is stored under the “2WALLCREEK” zone under the “NET” data item. Petra automatically creates both a grid title and grid file name based on this zone data, though these names can be changed.

In deviated and horizontal wells, a data point (such as a formation top) can be at a distance away from the surface location. Selecting the “Calc XY for Dev Wells At Top:” button will calculate the correct XY location along the wellbore for the data point at the selected formation top. This feature needs survey data to be loaded into deviated wells.

**Repeat Tops** – Petra can store repeated tops from horizontal and deviated wells in a special format available on the Repeats Tab on the Main Module. To use repeat tops while gridding, select the Tops Tab on the Create Contour Grid dialogue box.

**Contour lines** – Contour lines are one of the most powerful ways to directly modify a grid. This option tells Petra to use all displayed contour lines as additional data points in the gridding process. Hand drawing a contour line can be useful for making a more realistic grid. Petra will use all contour lines from all displayed layers, so be sure to turn off the display of irrelevant contour lines. For a more detailed discussion of contour lines, see “Hybrid Method” below.

**Fault Polygons** – This tells Petra to use lines and polygons designated as faults in the gridding process. Petra will use all faults from all displayed layers, so be sure to turn off layers containing irrelevant faults.

**Control Points** – Control points are XYZ data that are not tied to wellbores. This is
often seismic data.

Interval Data – Interval data can be particularly useful for storing data outside of Petra’s normal zone/data item database – particularly for gridding petrophysical data along deviated and horizontal wells. To grid with interval data, select the Interval Tab on the Create Contour Grid dialogue box.

After you've selected the data type, click on the “Well Dist…” button. This tells you statistical information on distances between wells. This information on well spacing is useful in determining the grid size.

![Well Spacing Statistics](image)

Generally, it’s best to make your grid size ½ the average distance between nearest neighbors. It’s worth noting that this tool will calculate distance statistics between all wells displayed on a map without discerning if they have data or not. In other words, if you have a large number of closely spaced wells but only a few of those wells have data, this well distribution box will give you an average distance that is too small. When making a grid, it is generally best to select only the wells that have the right data and exclude wells with null values. In the example above, average distance is 806, so a grid size of 400 xy units is appropriate.

Selecting a Grid Size and Surface Style
The next step is to select grid size and surface style in the Method Tab. Grid size simply governs the spacing of grid points, which can influence the “smoothness” of a grid. Small grid spacing generally better honor data points but are prone to “bullseyes.” Large spaced grids with fewer points are smoother but usually don’t honor the data as well.

Though there are 4 ways to select a grid size, the best way for a new grid is to use $\frac{1}{2}$ the average well spacing (see above). In the above example, average well spacing is 860’, so grid size is 400’ by 400’.

Next, select a Surface Style. The surface style determines how Petra interpolates the data to create a “surface” for contouring. For most data, “Highly Connected Features” works best and handles faults well. For isopach maps, select “Adjust Zero Contour for Isopach Surface.” This option moves the zero line midway between a zero point and the closest non-zero data points. In effect, this option creates a grid with the more reasonable assumption that the interval pinches out before the wellbore penetration.

Other Advanced Features
One of the best options is “Adjust Grid To Better Fit Control Points”, which adds an additional processing step to force rectangular grids to “honor the data” better. It’s worth noting that this feature still depends on a reasonable grid size. More specifically, a large grid size will break this feature.

There are many more options for manipulating the grid file available on the other tabs, but ultimately the best way to do that is to use contour lines. See “Hybrid Method” below.

Contouring a Grid

Now that the data has been extrapolated into a grid, Petra can draw a set of contours on that grid surface.

To contour a grid, in the map module either go to **Contours>Display Contours**, or click on the “Contour a Grid” icon: ![Contour a Grid Icon]. This brings up the create Contour Grid box.
First, select the grid you wish to display. The grid’s title and a color range will be selected automatically. At the bottom of the Contour Range section, you have the option of selecting “Normal colors” and “Enhanced Colors.” Both of these options select colors for display, but Normal Colors is a little simpler for new users. Select “Normal Colors”, and select the “Colors” button.

Here, set the minimum and maximum values for the contours in the “MIN” and “MAX” boxes. The “Interval” sets the contour interval between colors. Note that normal
colors can have up to 47 different intervals, while “Enhanced” colors can have many more intervals. The default color scheme is a rainbow from purple to red, but Petra comes with several other color schemes available through the “Default” button on the right side of the screen. You can also set your own color scheme by clicking on each individual interval and then clicking on a color from the palette for that interval. Click OK when the color bar is set, and OK again to contour the grid. The contour map should now show up on your map.

Hybrid Method

A hybrid method of contouring takes advantage of a computer’s speed and a human interpreter’s knowledge. It is fairly easy to modify a computer-calculated grid with overlay contour lines, as well as convert a grid’s contours to overlay contour lines. This allows for iterative improvement of a contour map.
Modifying a Grid with Contour Lines

Using hand-drawn overlay contour lines to modify a computer-calculated grid is a great way to add a more geologic interpretation to a contour map.

In the map below, a net pay map is discontinuous at the thickest part of the reservoir, and is only limited to the area immediately around the wells. A better interpretation of this data would smooth the contours and extend the northwest-southeast trend of the map.

The first step is to draw contour lines, as discussed above. Petra will incorporate these lines during regridding, and will modify the grid to fit them. This set of contour lines can be comprehensive (as shown below) or can be only a couple of short lines over a problem area. Make sure that these lines are designated as contour lines and have the correct contour value.
Once the contour lines are drawn, the next step is to recreate the grid using the contour lines. In the map module either go to *Contours* → *Create Grid*, or click on the “Create a Grid” icon: ![Create Grid icon](image). This brings up the create Contour Grid box. Just like calculating a regular grid, put in the zone data to be contoured. This time, also add “Use Overlay Contour Lines.” Petra will use these drawn overlay contour lines.
The newly contoured grid now reflects the drawn contour lines to have a more realistic geological interpretation, as shown below. Hand-drawn overlay contour lines are easy to change, so this grid can be iteratively modified to create better and better maps.
Creating Contour Lines from a Grid

You can capture gridded contours to contour lines in an overlay layer. Once these lines are overlay contour lines, you can edit them just like any other line. This can be useful for letting Petra build a quick first pass at contour lines, and then using your skills as an interpreter to modify them into a more reasonable geological interpretation. Depending on the complexity of your contours, this can be very labor and time-intensive. For most contour maps, it’s probably faster and better to hand-draw overlay contour lines from scratch and use them to modify your grid as discussed above.

After creating a grid file, open the “Contour a Grid” dialogue box. Go to the Options Tab, and turn on “Draw Contour Lines” and “Draw Lines in Default Color Only.” This will tell Petra to draw black contour lines.
Next, go to the Advanced Tab. Select “Capture Contours Directly Into Layer”, and then select the Overlay layer you want to contain these contours. The “R” button allows you to rename the layer. In this example, the overlay layer has been renamed to “CONTOURS.”

This draws the gridded contours (in colors) and stores the computer-generated
contour lines as overlay contour lines in the designated layer.

Turn off the grid, by either going to **Contours>Hide Contours**, or by clicking on the “Hide a Grid” icon: 

![](image)
The grid is off, and now you are left with a set of fully editable contour lines stored in the designated layer. In the example above, one contour line has been selected and all the line points are highlighted in blue.

Notice that the computer-generated contour lines have a lot of points, and editing them one-by-one will take a long time. It’s generally easier to reduce the number of points on the line by using the “Simplify” tool on the tool box. It’s icon looks like this: . When you’ve completed modifying these contour lines, you can use them again in recalculating your grid (see “Modifying a Grid with Contour Lines” above).

18.2 How to Display Digital Logs

Introduction

Digital logs record wellbore information as it changes with depth. Unlike paper logs, however, digital logs store the actual log values in a form that is directly readable by a
computer. Though digital logs typically consist of wireline information, they can also include core data, petrophysical model outputs, or anything that has a numerical value associated with a depth. Digital logs are easily stored in Petra’s database, can be calibrated and used in calculations, and look great in a cross section.

This guide uses a standard set of logs to illustrate a wide variety of Petra’s display styles and features in the cross section module. This guide covers:

- SP – Centering & simple colored lines
- Resistivity – Logarithmic scaling & cutoff shading
- Neutron and Density Porosity – crossover shading
- Gamma Ray – GeoColumn shading
- Mudlog – Lith summation

Adding a New Digital Curve to a Cross Section

All digital log curves are added and modified in the Log Display Options window. To open this window, in the cross-section module click the Log Display Options button: 

A blank Log Display Options window

The “Available Logs” list on the left side of the screen gives a list of all digital logs that can be added to a cross section. This list can be filtered to include the digital logs from all wells in the project, or just the wells currently selected in the Cross Section Module. To add a log, highlight the name in the "Available Logs" list and click the add button (“>”). This moves the log over to the “Selected Logs” list. To remove a log, highlight the log name in the “Selected Logs” list and click the remove button (“<”).

Once a log is added to the “Selected Logs” list and is highlighted, the track and
display options for that log can be set on the various tab screens.

**SP – Simple Line and Color**

On the Scale Tab of the Log Display Options window, highlight the SP curve on the "Available Logs” list and click the add button (”>”). Once the log name is on the “Selected Logs” list, click the curve to highlight it. In this example, the SP curve has been added to “Selected Logs” list.

The next step is to select a depth track, which sets the position of the curve relative to the depth track. Select the depth track for each log by clicking the track up and down arrows (highlighted in red). SP curves usually go to the left of the depth track, so in this example the SP curve goes into Track 1. Next, set the left and right scale (outlined in blue). In this example, the left side of the track will be -40 and the right is -10.

Click “Use Alias Logs” if your project has digital log aliasing.

Go to the Style Tag. SP curves show relative deflection, so select “Center in Track” (highlighted in red). This puts the curve in the center of the track using the scaling set by the left and right scale. In this example, the left and right scale are 50Mv apart, so the SP curve will be centered with 25 mV on either side. This is great for SP curves, but will cause other logs to plot incorrectly.

Here, you can also select color, style, and thickness of the curve's line. To set line color, click the “Line Color” box and select a color. To change line style (dashed or solid) or the width, click the appropriate dropdown box. In this example, the SP curve is red with a “wide” line width.
The “Center Log In Track” option only uses the log scales to set the relative amplitude of the curve. This can be useful for SP curves, but is misleading for almost everything else.

Finally, set up the log track under the Tracks Tab. Hidden tracks don’t show a horizontal or vertical grid and are denoted by the ☹️ symbol to the left. Double clicking each track name under the Track Definitions box toggles the depth track on and off. Click inside the “Width” box to set each track’s width. In this example, the track is 2 inches wide.

Next, set the number of vertical divisions for the track as well as how often these lines will be bold. The track has 10 divisions, and every 5th line will be bold. In other words, the track has 10 vertical scale lines with a bold one in the middle. Since the SP scale is set to represent 50 mV, each vertical line represents 5 mV of SP deflection. After everything is set, click OK at the bottom of the screen to save the settings and display the cross section.

Notice that the log curve header for the SP curve reads “SP(CTR).” This signifies that the SP curve is centered inside the track. The CTR suffix reminds the reader that the scales only show relative, rather than absolute, changes. Consequently, the curve scales on the header only show the relative scale of deflection.
Resistivity Curve - Cutoff-based Filling & Log 10 Scales

Filling in a log based on a cutoff criteria is useful for showing when a curve passes a critical threshold. Since resistivity below a certain threshold indicates a wet reservoir, it’s useful to highlight the curve when it’s above a certain cutoff line. In this example, resistivity will be highlighted above 10 ohmm.

When curves have a large range of values, linear scales tend to show the changes at one magnitude at the expense of displaying changes at another magnitude. Since resistivity curves can cover two or three orders of magnitude, this example will also show how to display these large ranges on a logarithmic scale.

First, add the resistivity curve to the “Selected Logs” list. In this example, it’s named “ILD.” Once it’s on the list, click the curve in the “Selected Logs” list to highlight it and select the track number. Resistivity curves are usually to the immediate right of the depth track, so set the track to 2. Since these values can vary so greatly, it’s useful to show resistivity curves on a logarithmic scale. Set the left and right scales and check the “Logarithmic Scale” box (highlighted in red) below the scale settings. In this example, the scales are set from 0.2 to 200, Click “Use Alias Logs” if your project uses digital log aliasing.
Adding the deep resistivity curve, and setting it to use logarithmic scaling

Go to the Style Tab. You can set the line style and width here, but for this example the resistivity curve is left as a solid line with normal width. Click on “Shade Using Cutoff” under the Shading Method box. This creates and immediately opens the Cutoff Tab.

Adding a cutoff-based shading

Under the Cutoff Tab, you can set the specific parameters of how the curve will be shaded. In this example, the resistivity curve will be shaded whenever resistivity is above 10 ohmm. This helps to quickly distinguish productive intervals from wet intervals. Click on “Greater Than Cutoff” and set the cutoff value, which in this example is 10.

The curve line and curve shading colors are independent and are set by clicking in each color box. In this example, the curve line is black, and the shading underneath that curve will be blue.
Setting the cutoff, line color, and shading. Where the ILD curve is above 10, it will have blue shading.

Go to the Tracks Tab. Turn on and set up the track by double clicking the symbol next to Track 2 under Track Definitions. Also establish the width of the track. In the example below, the width is 2 inches.

Normally the number of divisions sets the number of vertical scale lines in the track. When drawing a logarithmic log, however, the number of divisions needs to be the same as the number of orders of magnitude. In this example, the plot needs to contain 3 divisions (2, 20, 200). To draw the logarithmic scale between the divisions, click the “Log10” button (highlighted in red). Finally, set the Log 10 Offset (highlighted in blue). The Log 10 Offset scales the logs correctly inside the track. Logarithmic scales from 0.1 to 100 use a Log10 Offset of 1, and scales from 0.2 to 200 use an offset of 2. After everything is set, hit OK at the bottom of the screen to draw the cross section.

Turning on track 2. Since the resistivity curve uses logarithmic scales, the “Log10” option is on. Since the scale is from 0.2 to 200, the “Log10 Offset” option is set to 2.

Logarithmic scales require the left and right track scales, the divisions, and the Log10 offset to all agree. With the number of settings, these scales can be tricky and it is not immediately obvious when something is wrong. Even if you don’t plan on using
cutoff shading for interpretation or presentations, it’s usually a good idea to use it in the beginning as an easy way to check the scaling and display of logarithmic logs. If the cutoff shading starts at the correct division on the plot, everything is set up properly. If not, then the divisions, scaling, or Log10 offset need to be adjusted. In the example below, the shading starts at 10 ohmm, so the settings are correct.

Neutron and Density Curves - Crossover Shading

Crossover shading is useful for coloring the space between two log curves. In some reservoirs, the “gas effect” on porosity logs causes neutron porosity to read too tight and density porosity to calculate too porous. Shading the area between the two porosity logs is useful for discerning the total footage of crossover, as well as the relative magnitude.

In this example, the neutron porosity and density porosity are named NPHI and DPHI, respectively. Add the two curves to the “Selected Logs” list and put them into Track 3 to the right of the resistivity curve. Remember that Petra handles each log independently, so you’ll have to set the track for each well. Set each log’s scale, as well. In this example, both the left and right track edges are set to 0.3 and 0 to cover 30% to 0% porosity.

Percentages can be stored as both 0-100 and 0-1. Be sure to set the scales here according to your log’s scaling convention.
Click “Use Alias Logs” if your project has digital log aliasing.

Adding the NPHI and DPHI curves

Next, go to the Style Tab. Since Petra handles each curve individually, we’ll look at the Style tab for the neutron and density porosity logs one at a time. First, click the neutron porosity log in the Selected Logs window. In this example, the neutron porosity log’s line color is set to red in order to distinguish it from the density porosity.

Setting the NPHI curve to use a red line color

Next, click on the density porosity log on the Selected Logs window. Hole washouts cause the density tool to read anomalously low density, which results in high calculated porosity values reading well above 30%. To clip these bad values, under the “Misc Plotting Style” box, select “Clip at Track Edges” (highlighted in red).
Trimming bad density porosity values with the “Clip At Track Edges” option

Next, go to the Tracks Tab. Turn on Track 3 by double clicking the ☰ symbol under Track Definitions and set the width. In this example, the width is 2 inches. Set the divisions to show a useful number of vertical scale lines. In this example, there are 30 divisions with 3 bold lines.

Track settings are independent of logs. Since both the neutron and density logs are in the same track, these changes just need to be made once.

Setting the divisions for the NPHI and DPHI log track

To set up crossover shading between the neutron and density porosity curves, go to the Cross Over Tab. Click the button reading “Set Color Shading Btwn Curves…”
Setting up Color Shading

This brings up the “Shade Between Logs” window. You can also get to this window anytime through Logs>Shade Crossover (Btwn Log Curves)... on the menu bar at the top of the Cross Section Module.

To fill in the space between two logs, first select the two curves for crossover shading in the Curve 1 and Curve 2 dropdown boxes. In this example, Curve 1 and 2 are NPHI and DPHI, respectively. Next, select the proper shading method. In this case, the area where neutron porosity reads to the RIGHT of density porosity should be shaded. Click “+Add” to bring the curves to the “Shaded Curve Pairs” list on the far left side of the screen and hit the OK button on the bottom of the screen. If you make changes be sure to click “Replace” to update a specific log pair.

Crossover shading does not require the two curves to be at the same scale. Crossover shading simply fills in the area between the two curves as drawn on the track.
The two porosity curves should now appear on the cross section. The area between the two porosity curves is shaded red. Notice that the washouts on the density curve are clipped at the edge of the track.

Gamma Ray - GeoColumn Shading

GeoColumn shading colors the area between a curve and the track edge with variable color based on log curve values. The color shading under the curve can either be from the same curve or from an entirely different log. Shading a gamma ray log with the same gamma ray values better displays the finer variations between sandy and shaly sections.

First, add the curve to the selected logs list, put it in the appropriate track, and set the scales. In this example, the GR curve will go in track 1 with the scales set from 0 to 200.

GeoColumn shading can cover up a fair amount of the track, so it’s a good idea to use the “Up” arrow (highlighted in red) to move the GeoColumn curve to the top of the list. When Petra draws multiple things in the same space, items at the top of the list are drawn first - and consequently underneath – the rest of the items on the list. In this case, the SP curve and the GeoColumn shaded GR curve will be in the same track. Plotting GR first will prevent the SP curve from being covered up. Click “Use Alias Logs” if your project has digital log aliasing.
Adding the GR curve, and moving it to the top of the Selected Logs List (Red)

Next, go to the Style Tab. Under the Shading Method box, select “GeoColumn Shading” (highlighted in red). This creates a new tab for GeoColumn shading (highlighted in blue).

Turning on GeoColumn shading for the GR curve

Go to the GeoColumn tab. First, select the log used for shading from the dropdown menu (highlighted in red). This is the curve that determines the color fill underneath the GR log. In this example, the gamma ray curve will have shading that reflects the same gamma ray values. Varying the color underneath the GR curve will better show small variations in sand and shale content. As mentioned above, it’s also possible to shade a curve using a different log – for instance, it might be useful to shade the GR curve with PE values to show differences in lithology.

The next step is to set the color scheme for the shading underneath the curve. Petra has a default rainbow color scheme, but a different color scheme will represent the data better. Click the Colors button (highlighted in blue).
The geocolumn shading will use the GR curve for the coloring underneath the curve.

Set the minimum and maximum values for the colorbar in the “MIN” and “MAX” boxes, with the interval between the bars set at “INTERVAL.” Press the “Apply” button to make the changes to the definition. In this example, the colorbar scale is set to a MIN of 0 and MAX of 200, with an interval of 10.

Next, set the color scale. In this example, the difference between high and low gamma reflects sand content. It’s useful to represent this variation with a color bar showing sand as yellow and shale as black. To set the color bar with a yellow to black scale, in the color palette double click on the upper-left color box (highlighted in red) and set the color to yellow. Double click the lower right color box (highlighted in red) and set the color to black. These two boxes set the colors for the upper and lower values of the colorbar. Next, click “Interp…” (highlighted in blue) to interpolate between these two colors and fill the colorbar.

The Interp button (blue) interpolates colors between the upper left and lower right corners (Red) of the color palette.
The colorbar now scales from 0 as a pale yellow to 200 as black, which approximates the difference between a low gamma ray count for a sand and a high count for a hot shale. Click OK to accept the colorbar settings.

Once the colorbar is set, the GeoColumn Tab should reflect the changes. There is no need to change any settings under the Tracks Tab since the settings will be the same as those established with the SP curve. Click OK to finish and draw the log.

The GeoColumn shading now shows subtle variations in gamma ray character. Notice how it is plotted below the SP curve.
Mudlogs - Lith Summation

Lith summaries are useful for displaying cumulative data. Most often, this is lithology percentages measured from mudlog samples. If a sample has 70% shale and 30% sandstone, it’s generally more useful to represent these two numbers as a cumulative plot adding up to 100 instead of two separate curves at 30 and 70.

This same technique can be used to represent any combined values that represent a percentage of a whole. This includes flow data from production logs, mineralogical breakdowns from spectral gamma ray logs, or fluid-filled porosities from MRI logs.

In this example, mudlog sand and shale percentages are recorded as “%_Shale” and “%_Sand” logs. To create a LithSum, place the logs into a track and set the scale. In this example, the sand and shale percentages are set to track 4, which is to the right of the porosity logs. Additionally, the left and right scales of are set to 100 and 0%. Click “Use Alias Logs” if your project has digital log aliasing.
Adding sand and shale percentage curves. Note that both are in the 4th track.

In this example, the sand percentage will be on the far right. It's easiest to fill the first curve in with cutoff shading. In this example, the first curve on the right is the "% _Sand" curve. Click on the curve to highlight it, and select the "Shade Using Cutoff" option. This creates and brings up the Cutoff Tab.

Turning on Cutoff shading for the %_Sand curve

Shading the first curve of a LithSum set is very similar to setting the shading on the resistivity curve discussed above. In this example, the shading is set to yellow whenever the curve is greater than 0. This will fill in all the area covered by the sandstone percentage. It's also possible to add a sandstone pattern to the fill by using the scroll windows next to the pattern box (highlighted in red). The left set of up and down arrows changes the pattern, while the right set of arrows changes the scaling or "density" of the pattern.
Adding a sandy color and pattern for the % Sand curve

Next, set up and turn on the track by double-clicking the symbol to the left of the name in the “Track Definitions” box. The mudlog in the example is set to track 4, and is 2 inches wide.

Turning on the 4th track, and setting the divisions to reflect 10% increments

If we click “OK” and plot now, the sand percentage is filled in but the shale percentage is displayed as a regular log. In other words, 70% shale content is displayed as 70 on the scale bar (highlighted in red in the example below). This is misleading since it suggests 30% sand and 40% shale instead of the two parts adding up to 100%. The shale fraction and the sand fraction need to be summed in order to accurately reflect the data.
Displaying the %_Sand and %_Shale curves as regular curves without LithSum.

To set up Lith Sum, go back to the Log Display Options screen. Select one of the curves to be added together in a track and go to the Lith Sum tab.

While in the Lith Sum Tab, select the logs from the “Available Curves in this Track” window, and click the “>” to add them to the “Sum Curves in Track in the Following Order” window. In this example, the sand and shale percentages are moved over into the “Sum Curves…” window.

Next, use the up and down arrows to set the curves in the order they should be summed. The order should be the same as the order the curves appear on the scale from low to high. In this example, “%_Sand” is on the low end of the scale from 0-100, so it should go first. This will sum the two logs together to reflect a cumulative value.
The last step is to shade between the shale and sand lines. Go to the Cross Over Tab and select “Set Color Shading Btwn Curves…”

Select the two curves for crossover shading in the dropdown boxes for Curve 1 and Curve 2. In this example “%_Sand” is curve 1, and “%_Shale” is curve 2.

Next, select the proper shading method. In this case, the area where “Sand_%” reads to the RIGHT (below) of “Shale_%” should be selected.

Finally, select a color and a pattern. In this example the area between the sand and shale percentages should reflect shale, so grey with a standard shale pattern is selected. Click “+Add” to bring the curves to the “Shaded Curve Pairs” list on the far left side of the screen and hit the OK button on the bottom of the screen. Click OK again on the Log Display Options window to keep your changes and draw the cross section.
Setting the crossover shading

Mudlog data is now displayed on the cross-section in a meaningful way. At a glance, it’s easy to determine the relative percentages of shale and sand relative to the openhole logs.

The completed Lith Sum shading for the sand and shale percentage curves

18.3 How to Alias Digital Logs

Different naming conventions between wireline companies and tools mean that one type of digital log curve can have a variety of different names. As an example, within the same project a gamma ray curve can be named GR, GRD, GRN, GRR, GRS, GAMMA, and so on.

Generally, we want Petra to treat all these curves as the same. Rearranging a dozen log curve names for display on a cross section can be tedious, and performing a calculation with multiple logs with different names can be almost impossible. Digital log aliasing is a great way to get around these naming problems by establishing a list of curve names that are equivalent. In other words, if the curve name isn't present, Petra will look down the list to find another curve name as a substitute.
To establish digital log aliasing, in the main module under the Logs Tab, click the “Aliases…” button (highlighted in red in the example below). Alternatively, in the main module drop-down menu, go to **Logs>Define Aliases…**

This brings up the Define Log Curve Aliases box. First, click the drop down box next to “Chose Log to be Aliased” and select the digital log curve name that will store the aliasing. In the example below, the GR log will store the alias list for all gamma ray curves. Since Petra will always start at this curve name, the selected name should be your top choice for the curve in question.

Next, select other curves to add to the list, and hit the “>” arrow to bring them over. You can reorder the list by using the up and down arrow keys. Since Petra goes down this list from top to bottom, the order here should reflect the relative priority or quality of the logs with the best logs at the top.

When you've completed the aliasing, click the “Store Aliases” button to save the changes to the database. Click “Done” to leave the aliasing screen and return to the Main Module. If you click “Done” before storing the aliases, Petra will not save your alias list.
As a final note, the Society of Petrophysicists and Well Log Analysts has an excellent searchable curve name dictionary. This can be very useful in deciphering unknown digital log and curve names:

http://www.spwla.org/cgi-bin/mnemonics_data_search.cgi

### 18.4 How to use Raster Logs

**Introduction**

Raster logs are scanned copies of paper logs saved as image files. In order to plot the correct part of the picture at the right depth on a cross section, Petra requires computer-recognizable depths to be assigned to depths printed on the original log. This process is called depth calibration. In the example below, a scanned resistivity log is depth calibrated (shown in red lines) at 2000’ and 3000’ MD.
For details on calibrating a raster log, see Raster Image Calibration.

This guide assumes you’re starting with a set of raster logs already scanned and depth registered, which is typical of commercial data vendors. For more information on calibrating your own logs from scanned images, see here.

**Group Names**

Raster images are assigned "group names", which typically are used to describe and group one type of log curve. In the example below, the "Resistivity" group
(highlighted in red) contains resistivity curves and a correlation gamma ray curve.

Double-clicking on the raster group name brings up the actual image. In the example, double-clicking the "Resistivity" group name brings up the resistivity log assigned to that group. Notice the red depth calibration line starting at 5400' MD.
Displaying Raster Logs on a Cross-Section

To display a set of raster logs, in the cross section module first go to \texttt{RasterLogs>Log Images Display Options}. 
This brings up the "Select Log Images to Display" box. To display a raster image on the cross section, you need to select the groups for display and then place them inside tracks.
To select a group for display, first select the raster group and click the ">" button (highlighted in red in the example above). This brings the group name into the "Image Groups to Display" window on the bottom of the screen.

In general, it's best to display your highest resolution raster logs when you have a choice. When placed on cross section, Petra scales all logs to same size. Squeezing a 5" raster log to fit a 1" space retains much more detail than stretching a 1" log to fit a 5" space.

Next, click on the group name in the "Image Groups to Display" box, and select a track with the "Log Track #" box (highlighted in blue in the example above). This track number sets the raster log's position relative to each well's depth track. For reference, track locations are given on the far right side of the box. Track 1 is immediately to the left of the depth track, while track 2 is to the right of the depth track. The widths of these tracks can be modified by clicking on the width and typing the desired number. In the example above, the "Resistivity" group is in track 1, and the Density/Neutron group is in track 2. These tracks have been modified to be 3 inches wide.

While still in the "Select Log Images to Display" box, click on the General Tab. There are a few options that can tweak the appearance of your cross section.
In this case, we can elect to plot the scale header at the top of the raster log. Scale headers are set during depth registration. Commercial vendors rarely set up a Petra-recognizable scale header, so you'll likely have to establish this yourself – for more information on this and other depth calibration, see here.

Additionally, track grids are useful for showing digital data, but get in the way of raster data. Click "hide track grids that contain raster images." Click OK.

Following the example, the resistivity log is plotted to the left of the depth track, and the porosity logs are plotted to the right.
Dealing with Runaway Raster Group Names

In a simple case with only a few consistently-named raster groups, placing rasters inside a cross section is fairly straightforward. In larger projects, however, there are some significant practical hurdles to using raster logs.

One of the biggest challenges to working with raster images is the inconsistency of group names assigned by commercial sources. This inconsistency means that even a relatively small Petra project can contain hundreds of raster group names. For instance, "Comp Resistivity Neutron Density 2.5IN" and "Comp Neutron Density CAL 2.5" are almost certainly the same type of log, but they have two different group names. Additionally, multiple logging runs for the same well can put different depth intervals in different group names. The quality of the scanned images can vary as well, where the same group name in different wells can be of very different quality. With hundreds of names, multiple runs, and wildly differing quality of scans, selecting a standard set of raster logs suitable for all cross sections in a project can be very difficult.
Petra has two major ways of dealing with this problem: aliasing and individual raster templates.

**Aliasing**

Much like aliasing of digital logs or tops, aliasing of raster groups establishes a list of raster group names that are equivalent. In the event that the selected raster group is not found, Petra moves down a list of other raster groups.

Aliasing is fairly quick and easy, but a single master alias list might not provide the best results for every well for the reasons outlined above. For example, in one well group A is the highest quality log. In another well, log group B is the highest quality log. A single aliasing list won't be able to make this distinction between the two wells, and will simply plot the first log on the aliasing list regardless of quality.

To set up an aliasing list, in the Rasters Tab in the Main Module, click on "Group Maintenance" on the bottom of the screen (highlighted in red).

This brings up the Log Image Group Maintenance box. Go to the Aliases Tab.

Select the raster group you want to alias. This should be your best single log group or a group with a large number of images. Next, click the checkbox for "Edit Aliases
For This Group." This enables you to click on and add other groups to this alias list. It’s possible to rearrange groups inside this list using the blue up and down arrows on the right side of the screen. Once completed, click "Save." In the example below, the "Resistivity" group is aliased with "Resistivity_2in" and "Resistivity_1." In other words, when the "Resistivity" group isn’t present, Petra will attempt to draw the other two raster logs instead.

To turn on aliasing in the cross section module, go to **RasterLogs>Log Images Display.** After a group is selected, click on the "Use Aliases" box (outlined in red).
Individual Raster Templates

In addition to setting raster logs for an entire cross section, it is also possible to set raster logs for an individual well in a cross section. Using an individual well template allows you to select the best logs for each well irrespective of the global raster settings. This is a great solution, but it requires individual attention for each well modified. Generally, a good approach with individual templates is to establish a decent aliasing scheme, and then create individual templates for wells that do not fit the aliasing suitably.

To change an individual well's raster template, first select the well by left clicking on the well symbol or the depth track. Notice how the well symbol is highlighted with a pink box when selected. Next, right click to bring up the menu. Select "Set Raster Template for This Well Only…"
This brings up the "Select Log Images to Display" box. It is exactly the same as the "Select Log Images to Display" for the entire cross section, but only pertains to one well. Here, you can add or change the settings of the raster groups for the selected well. Following the example, we've added the "Computed" curve, a computer-calculated effective porosity and water saturation log for the middle well. This raster group will go in track 3 on the far right.
Turning off individual well templates is just as easy. Just select the well by left
clicking on the well symbol or the depth track as before. Next, right click to bring up the menu and select "Disable Raster Template for This Well..." This turns off the individual template and defaults to the regular cross section raster log template.
18.5 How to fix "Problem Perfs"

Petra projects often contain duplicate or redundant perf intervals. These “problem” perfs can be divided into two major sets: gross interval perfs, or duplicate perfs. Petra automatically recognizes these perf intervals and color-codes them. Gross interval perfs are coded as red, while duplicate perfs are classified as blue.

**Gross Interval Perfs (RED)**

Commercial data vendors originally copied perf information from reported IP tests. Additionally, Petra also has an option to import IP tests as gross perfs. When one IP test covers multiple perfs, this method records one large “perf” that covers the entire gross interval. These gross intervals obscure the actual perfs in a well and invalidate most perf footage calculations.

**Duplicate Perfs (BLUE)**

Duplicate perfs occur when the same perf interval is repeated in the database. Just like gross intervals, this can come from commercial data sources, or from reimporting data into a Petra project.
In the example below, you can see that there are only four actual perfed intervals: 1150-1158, 1164-1169, 1229-1236, and 1240-1245. The remaining perfs are either gross intervals or duplicates. Notice that Petra color codes these intervals both on the list and the graphical diagram of the perfs.
You can deal with “problem” perfs in two ways – permanently deleting them, or by keeping them in the database and filtering them out of displays and calculations.

**Permanently Deleting Problem Perfs**

Deleting “problem” perfs permanently changes the database. *Be sure to have a backup and to check the perfs that will be deleted.* Petra stores information like start and end date for each perf, so make sure this data is captured in the remaining perfs.

First, select all wells containing problem perfs in the Main Module. Next, go to Compute> From Tests>Remove “Problem” Perfs on the menu bar in the Main Module. This brings up the Delete “Problem” Perfs dialogue box. You have the option of deleting gross interval (RED) and/or duplicate (BLUE) perfs. A report option is also available on this screen.
Filtering Problem Perfs

If you choose not to erase these perfs from the database, it is very easy to simply filter them out.

Cross Sections

In the cross section module, redundant and duplicate perfs can obscure the details of what intervals are actually perfed. As you can see in the example below, the redundant 95’ gross interval perf completely covers the 4 intervals actually perfed.

To filter out these redundant perf intervals, first click on the Test Indicators button: at the top of the screen. Alternatively, go to Wells>Plot Test Indicators... This brings up the “Select Test Indicators to Plot” box.

Next, under the Perfs Tab click the check boxes to “Skip ‘Problem’ Red Perfs” and “Skip ‘Problem’ Blue Perfs” as highlighted in the red box below.
On future cross sections, Petra will automatically filter out these redundant perfs. In the example below, the large gross perf intervals are gone and only the actual perf intervals are left.
Perf Flagging

Bad perf intervals can also cause problems when performing the perf-based calculations available at Compute>From Tests>Flag Wells With Tests... in the Main Module. Invalid perfs will cause false positive "perf in zone" flags and wrong total perf footages. Selecting “Skip ‘Problem’ Red Perfs” and “Skip ‘Problem’ Blue Perfs” ensures that Petra only counts true, non-redundant perf intervals.
18.6 How to use Log Correlation Module

The Log Correlation Tool is an easy way to correlate formation and unassigned tops as well as faults and pick pay intervals. To open the Log Correlation Tool, click the Log Correlation icon on the toolbar in the Main Module:

Introduction to Log Names and “Log Types”

The fundamental problem with log data is the proliferation of log names created by different commercial data vendors and individual users. The same general type of curve (such as a gamma ray curve) can have hundreds, if not thousands, of different names in a single project.

The Log Correlation Tool gets around this problem by using “Log Types.” A Log Type is just an alias list of equivalent logs. In the example below, the “Resistivity” Log Type we build will contain a list of the resistivity raster logs in a project. To display a resistivity curve on a cross-section, we simply tell Petra to draw the “Resistivity” Log Type. Petra then goes down this list of raster logs for each well on the cross-section and draws the first one it finds. For the interpreter, this means that
time invested in setting up Log Types will pay off with quicker, easier cross-sections later.

Guide

The guide at the top of the screen shows the suggested workflow for using the Log Correlation Tool. You’ll want to select a few wells, set the Log Types for each column, put raster and digital logs inside those Log Types, set the depths, and finally select and pick tops and pay intervals. The Quick Guide on the top of the screen has a set of buttons that link directly to these different tasks in this order.

Step 1 - Select Wells

There are two ways to select wells: with the Map Module or directly from the Cross Section Module

With the Map Module - The “Select Wells” button on the guide takes you directly to the Map Module. Alternatively, click the map icon at the top of the screen: . Once in the Map Module, select individual wells with the left mouse button to add wells to the Log Correlation Tool. Right click to stop and switch back to the Log Correlation Tool.

With the Cross Section - Select Wells>Use Cross Section Wells. This option selects the wells used in the Cross Section Module.

In the example below, there are three wells with no log types selected. The default depths for the module are from 1,000’ to 2,000’ MD.
Step 2 – Set Columns

The next step is to set the columns with either the “Set Columns” button on the guide, or the “Set Columns” button on the toolbar. Columns simply define where raster and digital logs will be drawn in relation to the well symbol and data posting.

To define a column, first define whether the column will contain digital or raster log data. Next, click the drop down box directly under “Log Type” for each column. Under this drop down menu, notice that Petra initially creates a few default Log Types including Density, Gamma Ray, Induction, Neutron, Resistivity, and Sonic. In this example, the Resistivity Log Type will be drawn in the center column, and the Density Log Type will be drawn in the right column. You can also select the “New Log Type” button on the lower right corner of this screen to create a new Log Type.

You can also modify the location of the depth track. The depth track plots MD or TVD depths next to the raster logs. This option simply moves the location of the depth track relative to the other columns and the well symbol. In the example below, notice that the depth track is set to “Left Center” between the center and left column.

Notice the text underneath each of the raster columns initially reads “3 wells have no logs defined.” Initially, none of the Log Types have any logs names assigned to them. In other words, Petra doesn't know what raster log names (also known as “group names”) should be drawn in either the “Resistivity” or “Density” columns. The next step is to assign specific logs to the Log Types.
Click OK to go to the Log Correlation Tool main screen. Alternatively, click the “Change Logs” button under one of the Log Types to take you directly to the next step at the Assign Log Type screen.

Step 3 - Putting Logs Inside Columns

The Log Correlation Tool can display both digital and raster logs.

**Raster Logs**

The next step is to put raster logs inside the newly defined columns. Practically, this means that we need to assign raster group names to the Log Types. In the main screen, select one of the defined columns under Step 3. In this example, the center column with the Resistivity Log Type is selected.

This brings up the Assign Log Type screen. This screen shows the available raster logs and their start and stop depths for each selected well, with shading separating different wells. You can sort by ascending or descending order for each column.

This screen also features a search box at the top of the screen that filters data by WSN, UWI, well name, well label, log name, or start and stop depths. Select “Filter” to return the data meeting the criteria. This filter can also be made sensitive to capitalization by selecting the “Case Sensitive Filter” box. After narrowing your logs
and wells by applying one filter, you can select different criteria and select “Filter” again to further limit the results. “Clear Filter” removes all filtering and returns all the available raster logs for all selected wells.

You can select raster logs for the wells either by aliasing default raster groups to a Log Type or by individually assigning raster logs for each well. Using both approaches together will give the best combination of speed and customization. A good Log Type “default” list is a useful “top-down” way of making a quick first pass at the proper raster log for each well, while assigning individual logs ensures (in a “bottom-up” way) that you are displaying the best possible log.

“Default” Log Type Rasters – This method aliases different raster groups to one Log Type. Petra then assigns a “default” raster log to the well based on this list. In this example, different resistivity raster images will be aliased to a single default “Resistivity” Log Type. The first step to setting up a Log Type is to select the Default Maintenance button on the lower left side of the screen (highlighted in red).
This brings up the Add/Edit Log Type Defaults screen. Here you can add, delete, or modify the existing Log Types. In this example, the Resistivity type is selected in the “Defined Log Types” box in the upper left corner. Next, select the raster names to add to the Log Type. To add or remove raster names to the Log Type, select the “<” or “>” buttons (highlighted in red). In the example below, the Resistivity Log Type will bring up the Elog, Res, and Res1 raster logs as a default. In essence, Petra will try to draw the first available raster log on this list for the Resistivity Log Type in the center column. Click Save Changes and Close to exit.
Back at the Assign Log Type screen, notice that the raster logs selected on the default Log Type list now show checks in the boxes underneath the “Default” column. In addition to showing which logs are selected, these check boxes can also be used to quickly add and drop logs from the selected Log Type. For example, clicking the “Default” check box next to the “ELOG” raster log will drop it off the “Resistivity” Log Type for all wells. Clicking the same “Default” check box again restores it to the list. The Log Type Defaults list (highlighted in red below) shows the order of the default logs for the selected wells. Again, log names higher on the list will be drawn before log names lower on the list. To change the priority of the alias list, select a log name and use the and buttons.
“Assigned” Individual Raster Logs - The other way of selecting raster log names to display is to individually assign raster logs for each well. Though this process takes more time, assigning individual logs allows you to select the best raster log for each well. Petra stores this information for the next time you bring the well into the Log Correlation tool.

The easiest way to assign a specific raster log to a well is to use the Assign Log Type screen. To select a specific raster log, select that raster log’s check box in the “Assigned” column.

Additionally, you can also open the well-specific “Log Type Assignments” box by double-clicking an individual well. To assign a raster log to the selected well, select the specific raster log from the “Available Raster Logs” list on the right side of the screen and click the “<” button. In the example below, the “ELOG” raster has been assigned to the selected well. Select OK to save the changes and return to the main “Assign Log Type” screen.
In the example below, notice that the two different wells have “assigned” logs. In one case (highlighted in blue), the log RES_TYPE will be plotted instead of the two default logs, RES and ELOG. In the other case (highlighted in red), ELOG is both a default log and an assigned log. This just means that it will be displayed regardless of its order in the default Type Log list.

The Assigned logs box (highlighted in green below) shows the assigned logs for the selected well. If a well has multiple assigned logs, you can prioritize them with the and buttons. Log names at the top of the assigned logs list will be shown before log names at the bottom of the list.
After setting up one Log Type, this is a good place to go back and repeat the same Step 3 in order to fill the log types established for the columns in step 2. Carrying on with the example, the screenshot shows the results of setting up log types for resistivity and density logs. Notice that the far left well does not have a log. This is because the depth scale is still from 1000-2000' MD, which is above the start of that well’s raster logs.
**Digital Logs**

In addition to raster logs, Petra can display digital logs inside the Log Correlation Module. While raster logs are simply images with fixed scales and curves, digital logs actually contain the actual numerical values recorded by the tool in the wellbore. Digital logs are much more flexible and can be displayed at any curve scale and in any combination.

To change the display of digital logs, select one of the digitally-defined columns on the guide under Step 3. In this example, the left column with the “Digital Logs” log type is selected. This brings up the LAS to Raster screen.
Petra uses a digital log “template” containing scales, colors, and position information to draw the digital log curves on the main Log Correlation Tool window. A template is established for each Log Type. In this example, the “Digital Logs” Log Type is selected, and is shown on the digital Log Template dropdown menu (highlighted in red).

You can select digital logs for the wells either by creating a default template for a Log Type or by individually assigning log templates for each well with the “Well” dropdown menu (highlighted in blue), which switches between the Default digital log template and the templates for the wells selected in the Log Correlation tool. This works similarly to the “Default” and “Assigned” raster logs discussed earlier. Though you can create digital log templates for each well, it’s probably much faster to use a single default log template with aliased digital logs.

“Default” Digital Log Template – This method uses a single template of digital logs and display options for all wells. This method works particularly well with digital log aliasing, which establishes a list of curve names that are equivalent. In the example project, gamma ray curves are stored as GR, GRN, GRR, and GRS. Once those curve names are aliased to the single curve name “GR”, the digital log template treats them all as equivalent. For most projects, there’s no need to use individually assigned digital log templates to deal with different curve naming conventions. Once the curves and display options are set, make sure the “Default” option is selected on the Well dropdown menu (highlighted in blue) and select “Save Log Template.

“Assigned” Individual Templates – With a robust digital log aliasing scheme, the only
The real reason to use individual digital log templates is to use different scales or other display features (such as color or shading) for different wells. Once the curves and display options are set for the individual well, make sure the well’s API/UWI is selected on the Well dropdown menu (highlighted in blue) and select “Save Log Template.”

The “Available Logs” list on the left side of the screen gives a list of all digital logs that can be added to a well. Note that aliased curves are annotated with an *. This list can be filtered to include the digital logs from all wells in the project, or just the wells currently selected in the Log Correlation Module. To add a log, highlight the name in the "Available Logs" list and click the add button (">"). This moves the log over to the “Selected Logs” list. To remove a log, highlight the log name in the “Selected Logs” list and click the remove button ("<").

Once a log is added to the “Selected Logs” list and is highlighted, the track and display options for that log can be set on the various tab screens. Each displayed log has its own scale and color settings established by the Scale through Raster/ Calibration tabs on the bottom of the Las to Raster Image box. For a more detailed walkthrough of displaying digital logs, see “How to Display Digital Log Data.”

Scale Tab - The Scale Tab governs a few basic settings for each log. The Scale Tab also sets the left and right scale for the selected log, as well as if the log will use the alias list.
Style Tab – The Style Tab changes how the selected log is displayed. This tab sets the color and thickness of the curve, as well as any shading. Shading can highlight log values above or below a cutoff value, or change color as a function of another log (GeoColumn shading).

GeoColumn Shading – When the GeoColumn option is set on the Style Tab, the GeoColumn Tab appears. GeoColumn shading colors the area between a curve and the track edge with variable color based on log curve values. The color shading under the curve can either be based on the same curve or from an entirely different curve. This shading can either fill to the left or right edge of the track.

Tracks Tab – The Tracks Tab controls how the background grids are drawn for the digital logs. This tab sets the width of the tracks and configuration of vertical scale lines. Double clicking each track name under the Track Definitions box toggles the depth track on and off. Hidden tracks (denoted by the symbol) don't show grids or any curves.

Misc Tab – The Misc Tab sets a few additional options regarding digital log display. Plotting track grids after log curves layers the track grids over the log curves for additional visibility. Using curves from other well completions will use curves from wells with a similar API/UWI number (ending in 00001, 00002, etc). Plotting the shading between logs after other shading will plot this shading on top of any other curves for visibility. Display Curve units in header will show the curve units stored in Petra’s database (on the Logs Tab in the Main Module) on the curve header. Show aliased curve name in track header label will show the curve’s actual name instead of the aliased name.

Crossover – The Crossover Tab shades the space between two log curves or between a curve and a track edge. Crossover shading is commonly used for illustrating the “gas effect” on porosity logs. Simply select curve 1 and 2, and when the shading should appear. It’s worth noting that crossover shading simply fills in the area between the two curves as drawn on the track, and does not require the two curves to be at the same scale.

LithSum – Lith summaries are useful for displaying cumulative data. As an example, if a sample has 70% shale and 30% sandstone, it’s generally more useful to represent these two numbers as a cumulative plot adding up to 100 instead of two separate curves at 30 and 70.
Raster/Calibration – The Log Correlation Module actually creates a temporary raster image of the digital log for display. This tab governs how this temporary file is created. The Raster Image section sets the overall resolution of these raster images. If images are blurry, try adjusting the log scale to be more in line with the scale on the main Log Correlation Module. Adjusting the DPI can also sharpen the image, but at the cost of slower drawing.

Normally, the Log Correlation module draws logs with a linear scale between the top and bottom of the digital data. Deviated logs, however, don't have a perfectly linear relationship between MD and TVD. Adding additional calibration points helps to stretch and squeeze the temporary raster image to better represent a TVD log. Note that adding additional calibration points requires more drawing time.

Step 4 - Depths

The next step is to set the depths for the correlation tool. In the main screen, click the “Depths” button on the guide, or click the depths button on the top toolbar:
**Depth Type**

The depth type can be either "Structure" or "Stratigraphic". A structural cross-section has a depth interval defined by measured or SubSea depths. A stratigraphic section instead has depths defined with formation tops, where the raster logs are hung on the upper fm top. Stratigraphic cross-sections are useful for showing variation in stratigraphy independent of structural change.

**Depth Axis Options**

Show Depth Track – This option toggles the display of the small track that shows MD, TVD, or SS depths. To hide it, deselect the “Show Depth Track” option. Hiding the depth track will also hide any perf and test information.

Limit Depths By TD – This option limits the drawn raster logs and the depth track down to a well's TD (as stored in Petra's database) rather than to full extents of the bottom set with the Structure or Stratigraphic Depths Tabs.

Track Width - This governs the width of the depth track. Text inside the depth track is automatically scaled. Expanding the width of the Depth Track can make the measured depth numbers easier to read.

![Depth Track Options](image)

**Structure Depths**

If the plot is structural, use this tab to set the depths. Enter the "Upper Depth" and "Lower Depth" values to define the desired section to display. Depth values can be entered as either measured or SubSea depths. Remember that SubSea values below sea level (like those on wells drilled on the Gulf Coast) are negative numbers.
Compute Using Tops – Petra can automatically compute a valid structure depth range from the tops selected for the cross-section. If no tops are picked for the selected wells, Petra won't be able to calculate a depth range.

Compute Using Logs - Petra can automatically compute a valid structure depth range from the logs selected for display. Here, PERA will calculate depths that will cover the top of the shallowest and bottom of the deepest logs.

Stratigraphic Depths

If you've selected stratigraphic depths, use this tab to set the scaling. Select the formation tops which define the upper and lower depth. Petra will flatten the wells along the upper formation. You can also add an "offset" number, which allow stratigraphic depths to include data a set number of feet or meters above and below the selected tops. It’s also acceptable to use the same formation top for both the upper and lower depth limits with a sufficient offset above and below, as in the example below. Notice that the upper and lower depth limits are set by the same top with offsets 50’ above and 200’ below.

It’s worth noting that if either of these formation tops are null for a well, Petra doesn't have anything to flatten on and the well will be blank. For initial correlation work, it is generally best to pick a consistent, widely correlated top to flatten on.
At this point, the cross section shows the raster logs at the specified depths. In the example shown below, the cross-section shows the resistivity logs in the first column and density logs in the second column. The depth scale is from 2500’ MD to 3500’ MD.

**Step 5 – Select Picking Type**

The previous steps simply create a cross-section to interpret. The next step is to select the pick type. These three buttons on the quick list are an easy way to switch between picking tops, unassigned tops (“U/A Tops”), pay intervals, or faults. Each
“picking type” button under Step 5 changes Steps 6, 7, and 8 to reflect the particular pick type.

Each pick type changes the Quick List on the right of the screen, as well. The Quick List is the most convenient way to pick tops, pay, and faults. To toggle the Quick List on and off, click the button in the upper left corner of the screen, or select View>Quick List on the menu bar at the top of the screen.

**Picking Fm Tops**

The Log Correlation Tool allows you to create and store formation tops. Formation tops reflect distinct, mapable lithostratigraphic units that are equivalent from well to well. Formation tops are stored to Petra’s database, and are shared among different modules and different users.

**Step 6 - Formation Tops Display Options**

The next step is to select the tops you want to display and pick. First, select the “Tops” option under the Step 5, and then click the “Select Tops” button under Step 6 on the guide (highlighted in red).
This brings up the Formation Tops Display Options window. To display a formation top in the Log Correlation Tool, first select it on the “Available Tops” list and click the “<” button to bring it over into the “Displayed Tops” list. The tops listed in the Available Tops list can be filtered to show only the tops with values for the wells in the Log Correlation tool or by source.

Once on the Displayed Tops list, you can change the color of the top as it shows up on the plot. The small check box next to the name on the Displayed Tops list toggles whether the picks are for display only or can be modified. Tops with a green check can be picked and shown up on the Pick Tops list, while those without a green check are display only.

After the tops are selected, the next step is to pick the style of the displayed tops. Under the Style Tab, you can change how the line between tops is drawn. Line width makes the lines between tops thicker and thinner, while the line type determines whether the line is dashed or solid. The “Apply Line Width and Line Type” button will change the width and type for every other displayed top, but will retain each line’s color. In the example below, the “2nd Wall Creek” top is selected. The style tab shows that this top is red, solid, and of normal width.
If your project has Top Aliases set up in the Main Module, click the “Allow Top Aliases” to use them.

“Disable Top” temporarily hides the specific formation top on the cross-section while retaining its display settings. Disabled tops will have a ⊘ symbol next to their name.

**Step 7 – Pick Fm Top Style**

When the “Tops” picking type is selected, Step 7 shows the two options for picking formation tops: across and down. You can change the pick style with the buttons on the Guide, or by using the ▶️ and ◀️ buttons on the Pick Tops part of the Quick List.

Pick Across – This is the standard pick mode in the Cross Section module. In this mode, a single formation top is picked across all wells shown.

Pick Down - In this mode, tops are picked in the order they’re shown on the Pick Tops list. Practically, this means that tops can be picked successively down the same wellbore before moving to the next wellbore. It helps to have the tops in a stratigraphically successive order going down the wellbore on the Pick Tops list.
Use the buttons to move a selected top up or down in the Pick Tops list.

**Step 8 - Picking Fm Tops**

Selecting “Tops” on step 5 changes the Quick List to Pick Tops mode.

To start picking tops, first select the desired fm top on either the Displayed Tops list at the top or the Pick Tops list at the bottom. Next, select the “Pick Tops” button on the guide or the green button on the Pick Tops Quick List.

Remember that the two pick modes work differently. “Pick Across” creates a single top across all wells, while “Pick Down” cycles through the Pick Tops list. To create fm tops, just click the depths on the raster logs where your tops are located. To stop picking, right click the mouse or click the stop button on the Pick Tops Quick List. The example below shows formation tops for the top and base of the 2nd Wall Creek in red. Notice that the currently active fm top, 2nd Wall Creek, is shaded to black.
You can also create “Auto-named” fm tops using the Create New Fm Top button: on the Quick List. Just like regular tops, auto-named tops correlate across logs and can be used in cross-sections and the map module. The only real difference is that the normal fm top setup is bypassed, so auto-named tops are named on the current date and time - DDMMYYYYHHMMSS. In the example below, the auto-named top “10082008143211” just means it was created 8 October, 2008, at 14:32:11 (2:32:11PM). Auto-named tops are great for quickly correlating an unknown surface, and setting the name and source later. Additionally, auto-named tops can easily be merged into existing fm tops.

**Renaming and Merging Tops**

Merging tops takes essentially takes the values of one named set of tops and moves them to another named set. Instead of dealing with two tops representing the same surface, it’s more convenient to merge them into one. To merge the two together, first select the top to merge into another and select the “Rename/Merge Selected Top.” In the example below, the “10082008143211” auto-named top is selected.
This brings up the Rename/Merge Top screen. Notice that the Source Top is listed at the top of the screen. This is the top that will be renamed or merged into the top selected on the list at the right of the screen. In this example, the “10082008143211” auto-named top will be merged with the 2nd Wall Creek.

The Data Merge Rules settings at the bottom of the window set how the two tops will be merged together

*Update Values* – In wells where both tops exist, the source top (in the example below, 10082008143211) will remain and the selected top (2nd Wall Creek) will be erased.

*Add New Values Only* – In wells where both tops exist, the selected top (in the example below, 2nd Wall Creek) will remain and the source top (10082008143211) will be erased.
Picking Unassigned Tops

The Log Correlation Tool also allows you to create and store “unassigned tops.” There can be multiple unassigned tops with the same name on the same well. Because of this, unassigned tops are useful for correlating things outside the traditional definition of a formation top. This can include possible faults or other marker "picks" that are considered by the interpreter to be unknown, uncorrelated or otherwise "unassigned". Unassigned tops can be easily correlated and converted into formal formation tops. Unassigned tops are stored to Petra's database, and are shared among different modules and different users.

Step 6 - Formation Tops Display Options

Just like regular formation tops, you also need to turn on the display of unassigned tops. First, select the “U/A Tops” option under the Step 5, and then click the “Select Tops” button on the guide (highlighted in red).

This brings up the Unassigned Tops Display Options Screen. This screen shows all the pre-existing unassigned top names in the project. In the example below, there is only the “default” unassigned tops name.
Since this will be shared throughout the whole project, it’s a good idea to make a new, named set of unassigned tops. To create a new set of unassigned tops, select the button. On the Unassigned Tops “Pick” Properties box, enter a name under “Pick Name” that reflects the purpose of your unassigned tops. This can be as generic or as specific as you like. In the example below, the picks are all going to be on 2nd Wall Creek resistivity features, so the pick name is “2nd Wl Crk Res.” Next, select or enter an interpreter name. It’s a good idea for every interpreter to have their own in order to prevent one user from overwriting another user’s work. In the example below, the source name is “CTM.” Next, select the line style, width and color for the unassigned tops. Select OK to create the correlation and return to the display options screen.

Notice that the unassigned tops name now appears in the Available Unassigned Tops list on the right of the screen. To display a formation top in the Log Correlation Tool, first select it on the Available Tops list and select the “<” button to bring it over into the “Unassigned Tops To Display” list.
Once on this list, you can still change the color of the unassigned tops. Selecting the small check box next to the name on the Unassigned Tops To Display list toggles whether the picks are display only or can be modified. Tops with a green check can be picked and modified in the correlation tool, while those without a green check are display only.

![Unassigned Tops Display Options](image)

**Step 6 Cont. - Unassigned Top Correlations Display Options**

Unassigned tops by themselves have no relationship to each other. Correlating unassigned tops links them together across wells into a single named unit. These correlations can be flattened to show stratigraphic variation or converted into regular formation tops. One of the best uses for correlation is to flatten the cross section on localized distinctive log features with no formal name.

Just like regular formation tops and unassigned tops, you also need to turn on the display of unassigned top correlations. First, select the “U/A Tops” option under the Step 5, and then click the “Select Tops” button on the guide (highlighted in red).

![Step 5 and 6](image)

This brings up the Unassigned Tops Display Options Screen. To look at correlations, click on the “Unassigned Top Correlations” Tab on the top of the screen. This screen shows all the pre-existing unassigned top and unassigned top correlations in the project. In the example below, there are no available correlations. To create a
new set of unassigned tops, select the button.

On the Unassigned Tops “Correlations” Properties box, enter a name under “Correlation Name” that reflects the purpose of your unassigned picks. This can be generic or specific as you like – in the example below, the correlation is on a single resistivity bump above the 2nd Wall Creek, so the correlation’s name is “Resistivity Bump.” Next, select or enter an interpreter name. It’s a good idea for every interpreter to have their own to prevent one user from overwriting another user’s correlations. In the example below, the source name is “CTM.” Next, select the line style, width and color for the unassigned top correlation. Select OK to create the correlation and return to the display options screen.

Notice that the correlation now appears in the Available Correlations list on the right side of the screen. To display a correlation in the Log Correlation Tool, first select it on the Available Tops list and click the “<” button to bring it over into the “Unassigned Tops To Display” list.
Clicking the small check box next to the name on the Correlations To Display list toggles whether the correlations are display only or can be modified. Tops with a green check can be picked and modified in the correlation tool, while those without a green check are display only.

![Correlation Tool Screenshot](image)

**Step 7 - Picking Unassigned Tops and Correlations**

Selecting U/A tops on step 5 changes the Quick List to show the Unassigned Picks toolbar.

![Unassigned Picks Toolbar Screenshot](image)

**Unassigned Picks**

*Making Unassigned Tops:* This creates new unassigned tops under the picks name shown in the dropdown menu. Different pick names can be used to keep groups of unassigned picks separate by both purpose and interpreter. In the
example above, new unassigned tops will be part of the “2nd WL CRK RES” name created earlier. To pick tops, click on the logs on the main screen. Multiple unassigned tops with the same picks name can be added to the same wellbore. Right click to finish picking tops.

This brings up the option of saving the new pay intervals to Petra’s database. Selecting “No” will erase all new, unsaved unassigned picks. In the example below, notice the red lines signifying the resistivity anomaly picked as a unassigned top.

*Moving Unassigned Tops:* To move unassigned tops, select this button. Left click the unassigned top to move and drag it to the new location. When finished, right click the mouse button. This brings up the option of saving the new unassigned tops to Petra’s database. Selecting “No” will leave all unassigned tops unchanged.
Delete Selected Tops: To delete unassigned tops, select this button. Left click the unassigned top to delete it. The unassigned top interval will be hatched with red to show that the changes haven’t been saved to the database. When finished, right click the mouse button. This brings up the option of deleting the unassigned top from Petra’s database. Selecting “No” will leave all unassigned top picks unchanged.

Delete Tops by Name: This button deletes all the unassigned tops with the currently selected unassigned tops name. In this example, the “2nd WI Crk Res” unassigned tops group is selected, so selecting this option will delete all the “2nd WI Crk Res” unassigned tops on the currently selected wells.

Create New Unassigned Tops Name: This button provides another quick way to create new unassigned group names. This brings up the New Pay Interval Definition screen. Enter the name, source, description, and color of your pay zone. Unassigned top names created here will automatically show up in the Unassigned Picks dropdown menu on the Quick List.

Unassigned Correlations

Connect Unassigned Tops: This button designates selected unassigned tops to a specific correlation. First, select the correct correlation name on the lower dropdown menu (in the example above, the correlation is called “Resistivity Bump”). Next, select the “Connect Unassigned Tops” button and click on unassigned tops on the wells to add them to the correlation. Right click when done. The unassigned
tops will now be connected by a line to signify that they are part of a correlation. In the example below, the blue correlation line connects the unassigned tops.

*Convert Correlation to Fm Top:* This button converts a correlation into a fm top. As a formal fm top, the surface can be gridded or used in calculations. First select the appropriate correlation from the correlation dropdown menu. Next, select the “Convert correlation to Fm Top” button to bring up the “Convert Correlation To Top” window.

This brings up the Convert Correlation To Top window. Here, select an existing fm top or create a new top for the correlation. In this example, the “Resistivity Bump” correlation will be converted to the “Resistivity Bump Top” Fm top. This newly created fm top will be stored into Petra’s database.

This screen also gives you the option to convert the correlation for all wells in the database, only the currently selected wells in the Log Correlation Tool, or only the wells selected in the Main Module.
**Flatten on Correlation:** This option flattens all wells onto the correlation selected on the correlations dropdown menu. This is useful for quickly seeing changes in stratigraphy or for testing correlations without the formality of a true fm top.

**Delete Correlation:** This option deletes the correlation selected in the correlation dropdown menu.

Create new unassigned top name: This option is another way to quickly create a new correlation. Select this button, and enter the name, interpreter, color, and line width and style of the correlation line. Correlations created here will automatically be displayed.

**Picking Pay Intervals**

The Log Correlation Tool can show one or more color-filled intervals representing “pay” zones. Though most often used for illustrating zones of productive reservoir, you can use pay zones to show anything that has a top and base. Pay zone intervals and thicknesses can also be stored to a data item in the Zone database. Once stored as a data item, these thicknesses are available for posting or contouring. Pay intervals are stored to Petra’s database, and are shared among different modules and different users.

**Step 6 – Pay Interval Display Options**
To display pay intervals, select the “Pay” option under the Picking Type Option then click the “Select Pay” button on the guide (highlighted in red). This opens the Pay Data Display Options screen.

This screen shows pay zones already in the project, and can be filtered to show either pay intervals for the selected wells in the Log correlation Tool or to show the pay intervals for all wells in the project. These pay intervals can also be filtered by the source.

In the example below, notice that the option for showing pay “For Selected Wells Only” (highlighted in red) is turned on. Since none of the selected wells have any pay selected, nothing appears in the “Available Pay” window.

In this example, a 2nd Wall Creek pay interval already exists in the database. Changing “For Selected Wells Only” to “For All Wells” displays all the pay zones in the project. Notice in the example below that there are pay intervals both for lithology (“LS” and “Sand”) as well as for actual reservoir pay (“2WC”). To display a pay interval, select it on the Available Pay list and click the “<” button to bring it over to the Selected Pay list on the right. To enable editing on the pay zone, make sure to select the small checkbox to the left of the pay zone’s name. A green check, like that shown in the example below, signifies that the pay interval can be edited.
To create a new pay interval, select the button on the Pay Data Display Options window. This brings up the New Pay Interval Definition box. Enter the name, source, description, and color of your pay zone. Select “Add” to add the pay interval to Petra’s database.

**Step 7 – Picking Pay Intervals**

Selecting “Pay” on step 5 changes the Quick List to show the Pay Intervals toolbar.
Begin Picking: After selecting the appropriate pay interval, left click once in the appropriate location on the wellbore to create the top of the pay interval, and again to create the bottom. To continue picking wells across your cross-section, simply click on the appropriate depth on other wells. Petra will draw a hatched box covering the interval, as shown in the example below. This hatching indicates that the pay intervals are not saved to the database. When finished, right click the mouse button.

This brings up the option of saving the new pay intervals to Petra’s database. Selecting “No” will erase all unsaved pay picks. In other words, if you make 25 correct pay picks in a row followed by a single bad one, make sure to select “Yes” and go back to fix the bad pick. Selecting “No” will erase all the unsaved good picks as well as the single unsaved bad one.

Once saved, the hatched lines on the pay intervals disappear to signify that the pay intervals are stored to Petra’s database, as shown in the example below.
Move Picks: To move pay picks, select this button. Left click the top or bottom of a pay interval and drag it to the new location. The pay interval will be hatched to show that the changes haven't been saved to the database. When finished, right click the mouse button. This brings up the option of saving the new pay intervals to Petra's database. Selecting “No” will leave all unsaved pay picks unchanged.

Delete Picks: To delete picks, select this button and left click inside the pay interval. When finished, right click the mouse button. This brings up the option of saving the new pay intervals to Petra's database. Selecting “No” will cancel all unsaved pay deletions, leaving the pay picks unchanged.

Create New Interval Name: This brings up the New Pay Interval Definition screen. Enter the name, source, description, and color of your pay zone.

Picking Faults
The Log Correlation Tool can show faults and fault gaps that represent missing section. Fault intervals are stored to Petra’s database, and are shared among different modules and different users.
**Step 6 – Picking Faults**

To display pay intervals, select the “Fault” option under the Picking Type Option then click the “Pick Fault” button on the guide (highlighted in red).

This changes the cursor to a crosshair. To create a new fault, click on the intersection of the fault with the depth track. A single click brings up the “Add Fault Gap” screen. Note that clicking and dragging the cursor up and down will calculate and automatically calculate the missing section for the fault. It’s not necessary to fill in a name, source, or comment for every fault, but doing so can help distinguish between different interpreters’ work.

Fault gaps can be shown in a stratigraphic cross section and help to account for missing section. To add fault gaps, select Faults>Display Options and select “Fill Fault Intervals.” Note that you can limit faults by a source name, which can be useful in large multi-user projects.
To delete a fault, select the “Delete Fault” button and select the fault to delete. This will delete the fault throughout the entire project, so be careful not to erase another interpreter’s work. On a stratigraphic cross-section with fault gaps, make sure to click on the top of a fault gap to delete it.

**Making another Cross-Section.**

After you pick your first set of tops and pay, it’s not necessary to go through the entire process again for a new cross-section. Petra saves column settings, default logs, depths, and top information to apply to your next set of wells. To make a new cross section, all you’ll have to do is select the new set of wells (Step 1) and make adjustments in the default and/or assigned raster logs (Step 3). Continually making small improvements to your default Log Type list as you make new cross sections is a good use of your time – the better and more comprehensive your default Log Type list, the less time you have to spend individually assigning raster logs to wells.

**Other Display Options**

Plotting Well Data around Well Symbol – To plot well data around the well symbol at the top of the screen, select Wells>Plot Data around Well Symbol. This brings up the Post Data By Well Symbol screen. Here you can select which well identification data will be plotted around the well symbol. In the example below, the wells’ label is plotted above the well symbol.
Well Symbols - While in the Correlation Tool's main screen, dragging the lower line of the frame containing the well symbols increases and decreases this space. The and buttons on the toolbar at the top of the screen toggle the well symbol and well data on and off, respectively.

The example below shows well labels displayed over each well symbol.

Plotting Log Scale Information – The tops of raster images usually have scale information for each column. If this scale information is calibrated, it can be shown on the Log Correlation Tool's main screen. To show and hide this raster scale
information, click the and buttons on the toolbar at the top of the screen. The next step is to tell Petra how the scale information is stored in the raster calibration. Under Logs/Images>Log Header Display on the menu bar at the top of the screen, select “Header”, “Lower Scale”, or “Upper Scale.” Many older Petra projects store scale information as the “header.” Once this data is displayed, dragging the lower line of the frame containing the scales stretches and squeezes the image scales for readability.

*Test Indicators* - Select Wells>Plot Test Indicators to bring up the Test Indicators screen. Select the display color for perfs, and click “Enable Perfs Display.” The Log Correlation Tool will display perfs as a colored box on the depth track. The example below shows perf indicators as a red rectangle on the depth track (highlighted in green).
Zoom and Scroll

For detail work, it’s probably advantageous to zoom and scroll on the cross section. There are two ways to zoom in and out on the Log Correlation cross section.

Toolbar Zoom – The toolbar has a set of zooming tools: + and - zoom in and out by 1/2 onto the center of the screen. The button allows you draw an area to zoom. The button returns to the last zoom setting, while the magnifying glass removes all zoom to return you to the default scaling.

The Pan and Scroll Window - This window on the Quick List log correlation window pans and scrolls around a zoomed cross-section. The “enlarge button” creates an additional window, which is useful for double monitor setups.

Like the toolbar zoom, the “+” and “-” zoom in and out of the center of the screen, while the “X” removes all zoom. The extents of the log correlation main window are shown in red on this window. Dragging this red outline scrolls the extents of the main correlation window at the current zoom level.

Scrolling with the Arrow Keys Window – When zoomed in on a section, you can also quickly pan across the section using the arrow keys. By default, the screen will pan by 50% of the currently displayed screen with every key press. To change this scrolling percentage, go to Display>Arrow Keys.

Smooth Scrolling with the Alt Key – When zoomed in on a section, you can smoothly move the section by pressing and holding the Alt key. Clicking and dragging any point on the zoomed in screen will then move the shown part of the cross-section.

The Right Mouse Button
Many common commands and some context-specific commands are available by clicking the right mouse button on the cross section. A familiarity with these commands can ultimately add up to huge savings in time and effort.

The right mouse button accesses several common commands related to tops. Place your mouse over the top right click the mouse flatten on, hide, or null the closest picked fm top. To start picking the selected top under the Pick Tops Quick List, right click and select “Start Picking Top(s).”

### Slip Box

The slip box takes a screenshot of a part of the cross-section and places it into a separate window inside the cross-section. This section of the log can be a great help to correlation between one log and another. The slip box window can be moved around the screen, as well as stretched and squeezed. The slider box on the top of the window changes the box’s opacity to make it easier to overlay on top of other logs.
Shifting Wells Up and Down

Logs can be shifted up and down to facilitate correlation. Press Shift and click the well to move the entire log up and down relative to the other logs. To undo any shifting, select the “Refresh Data” button on the toolbar at the top of the screen.

18.7 How to use Interval Data

Interval data stores data to a specific depth interval that doesn't fit well with the traditional zone concept, such as data that is too fine (such as core descriptions) or too coarse (such as mud weights or biostratigraphic information) to fit inside two formation tops.

The difference between Zones and Intervals

Petra defines a “Zone” as a specific interval defined by a discrete top and a base. Usually a zone’s top and base are defined by specific formation tops so that the zone covers a consistent lithostratigraphic unit. Inside each zone, Petra stores a “Data Item” such as isopach, net pays, or log measurements that relate to that zone. Since zones and their data items are shared across all wells in a project, this method of
organizing data makes storing and mapping single-value data for a specific formation much easier. As an example, mapping all the isopach values for a specific formation is much easier when the values are all stored in one common zone data item for each well.

Zones are limited, however. Cuttings or core data may actually subdivide a specific zone into several different units based on lithology, color, porosity, or other petrophysical characteristics. Similarly, data such as a mudweight or a biostratigraphic presence can be larger than a single zone’s definition. Capturing all this information with the traditional zone model is cumbersome as it leads to a proliferation of new, well-specific zones.

Intervals, on the other hand, are designed to store information about the wellbore without using zones. The interval concept stores data too fine for the zone concept (such as core and lithologic descriptions) as well as data that exists completely outside the normal stacked strata concept (such as logging runs or mud weights). Interval data also handles data overlapping different formations, such as paleostratigraphic data.

Interval Data Basics

Petra stores interval data in tables and fields similar to a spreadsheet. The “table” stores related interval data in a spreadsheet, where each interval is stored as a separated row. In the example below, the project has the default tables LITH, CORE, and PALEO.

Inside the table, each interval is stored as its own row, and information about that interval is stored in “fields”, or columns in that row. All tables come with a few fields, TOP, BASE, DATE1, DATE2, QUALITY, and FMNAME, but you can add user-defined fields containing numbers, dates, or text. In addition to the standard fields, the LITH table in the example below contains the field “Desc” which stores lithologic descriptions.
Creating, Modifying, and Deleting Tables

An interval data “table” stores interval data in a spreadsheet, where each interval is stored as a separated row. Since every interval row in the table shares the same fields (as columns), it’s a good idea to keep different types of data in different tables. To create, modify, or delete tables in a Petra project, select the “Maintenance” button on the bottom of the Interval Tab on the Main Module.

- This option adds a new interval data table. Selecting this option brings up a dialogue box to add the new table’s name and description. A newly created table contains no new fields.

- This option edits just the name and description of an existing interval data table. To edit the fields inside the interval, select the “Data Fields” option on the Maintenance screen.

- This option deletes the entire interval data table, along with all the fields and data contained within the table.

Creating, Modifying, and Deleting New Fields

In an interval table, each interval is stored as its own row, and information about that interval is stored in “fields”, or columns, in that row. To create, modify, or delete fields in a Petra project, select the “Maintenance” button on the bottom of the Interval
Tab on the Main Module.

- This option adds a new interval field to the selected interval data table. Selecting this option brings up a dialogue box to add the new field’s name, description, and attributes. The Kind dropdown box sets the kind of data the interval field stores: a Real Field, Date Field, or String Field. Real Fields simply store numbers, such as porosity or permeability. Dates store calendar days as MM/DD/YYYY. String values store text like core descriptions. For Real fields, the Units box sets the displayed units of measurement, while the Decimal Places for Display option sets the displayed trailing decimals.

- This option modifies the name, description and attributes of the selected field.

- This option deletes the selected field.

Reordering Tables

By default, interval tables show up in the order they’re created. Especially in large multi-discipline, multi-user projects with many different kinds of data, it’s often useful for a user to reorder and filter the interval tables to only show relevant data. To
reorder the Interval tables, select the “Order...” button on the Interval Tab on the Main Module. This brings up the “Filter Interval Data Table Names” box. Here, use the “>” button to bring a single selected table from the Available Internal Table List on the left to the Filtered Interval Table List on the right. The “>>” button brings over all available tables. Once on the Filtered Interval Table List, use the up and down arrows to change the order of the shown tables. Tables at the top of the list will be shown before tables on the bottom of the list. To drop a selected table from the Filtered list, select the “<” button, and to drop all tables from the filtered list, select the “<<” button. If there are any tables on the Filtered Interval Table List, only those tables will be shown.

Reordering and Hiding Fields

By default, interval fields show up in the order they are created. To reorder the Interval fields, select the desired table and select the “Columns...” button on the Interval Tab on the Main Module (highlighted on the left figure below). This brings up the “Interval Data Column Display Properties” window. This screen shows the list of the table’s available fields on the left, the displayed fields on the upper right, and the selected field’s properties are shown in the lower right. This window changes the order of the displayed fields, hide and show specific fields, and changes field properties.
Reorder the specific fields

To reorder a field, select the column at the top of the screen and drag it to the desired position. In the example below, the “TOP” column has been dragged to be before the “QUALITY” column.

Hide and show specific fields

To drop a specific field, select the column at the top of the screen and select the “-” button. To add a specific field, select the field name from the list on the left side of the window and select the “+” button.

Change the field properties

The “Column Properties” on the lower right shows name, justification, shown decimals, the label style (Name or Name and Units), and the data property (Value or Quality). Changing these settings changes how the selected field will be shown.
Adding Interval Data

New interval data can be brought into Petra either manually or by a tabular data import.

Adding New Data Manually

To add new intervals manually, first select the correct well in the Main Module. On the Interval Tab, select the right interval table. In the example below, the “LITH” table is selected. Finally, select the “Edit details” button in the upper right on the Interval Tab. This brings up the Edit Interval Data window for the selected interval table. Continuing with the example, the Edit Interval Data window below shows the fields for only the LITH table.

To add a new interval, enter in the Top and Base. Next, select the button to add the interval.

With the interval now added, enter in the remaining interval details and select the button to save the changes to the interval. In the example below, the Quality, Formation, and LITH Table specific fields are filled in.
To save the changes to the database, select OK. Here, Petra gives the option to save or discard ALL changes made to the selected well’s interval table. All the edits to all intervals will be ignored if you select CANCEL.

**Importing Tabular Interval Data**

Digital data where each row contains information about a discrete interval can be easily imported into Petra. Before attempting to import interval data, check to see if the data has a column dedicated to the UWI/API. Since Petra assigns interval data to specific wells by comparing UW/API numbers, interval data without an identifying API/UWI column can’t be imported. The easiest way to remedy this is to simply open the interval data in a spreadsheet program, and add a new column for well UWI/API.

To import new digital interval data, select Project>Import>Import Tabular Interval Data… on the menu bar at the top of the Main Module. This opens the “Import Interval Data from Tabular File Format” box. Here, select the “Open File” button and navigate to the interval data’s location.

Once the file containing the interval data is opened, Petra switches to the Data Format Tab. This tab essentially links the entries in the file to specific kinds of data.
The first step is to select the interval data file’s formatting under File Format. Files can be imported into Petra in one of three formats: “Columnar”, “Comma Delimited”, or “~ Delimited.” Columnar data organizes data into fixed columns, where Petra imports data based purely on the number of characters from the left. The left screenshot, on the other hand, shows the API number as defined by columns 1 through 14.

Comma and ~ delimited data, on the other hand have no fixed column size and are instead separated by a comma or a tilde. With delimited data, Petra imports data based on the “Field” defined by the delimiter. The example below shows the same UWI/API field defined in two different ways. The right screenshot shows the API number defined as “Field (1)”, i.e. it is separated by the first comma.

Be careful when importing text as a comma delimited file. If the text has a comma in it, Petra will read that as the end of the field. The interval data stored as UWI, Top, Base, Description such as:

05123187700000, 6295, 6998, Calcareous, micaceous, clay-rich siltstone

Would only be imported as:

API: 05123187700000
Top: 6295
Base: 6998
Description: Calcareous

In other words, all the description past the first comma is cut off. This can also cause bad imports when data is beyond the comma-filled text.

The next step is to establish field definitions. Essentially this step defines which part of the file is which kind of interval data. The easiest way is to select and highlight the specific data field in the “Data Record” part of the screen, then select the type of interval data on the left. Petra can import fields for any interval table. In order to put
interval data with the correct well, the UWI or API # field must be defined.

When loading the TOP and BASE of the interval, Petra assumes that the depths are in MD. To import other depths, such as SS or TVD, select the appropriate depth on the “Field is not a Depth or is MD” dropdown when establishing a field definition.

For user-defined fields (Not the TOP, BASE, DATE1, DATE2, QUALITY, FM NAME, UNITS fields), Petra can store a quality code. To import the quality code, select the “Store Field Value” dropdown menu and set it to “Store Field Quality Code.”

To add the field definition, select the “+” button. The “-“ button drops the selected field definition. To modify an existing field, make the appropriate changes and select the button.

The example below shows field definitions for the data file, which include the well API, interval top, interval base, formation name, and description.

To save the field definitions and options, select the “Save” button. This option saves a *.FMI file. Selecting the "Load" button restores all the saved settings.

Most data files have some header or comments at the top. The “Records to Skip Before 1st Well” option tells Petra to skip a set number of lines before importing any well data. Click the "Set Skip" button to set the number of skipped records based on the record currently in the data record window,

Changing Interval Attributes, Markers, and Patterns

Every interval stores a set of colors, markers, and patterns that can be displayed on the cross-section module. It’s possible to change these settings for every interval individually, or with multiple intervals at a time.
Setting a Single Interval’s Attributes, Markers, and Patterns

First, select the desired interval by clicking on the graphical representation of the
interval on the right side of the screen. The selected interval will be marked with a
black triangle on the right side of the interval (highlighted in the example below). Next,
select the Attributes Tab. Here, select the interval’s line and fill color. In the example
below, the first interval (a calcareous siltstone interbedded with sandstone) will be
drawn with a light blue fill. Notice that the selected color appears on the list of
intervals on the far left as well as on the graphical representation of the intervals on
the far right.

Next, select the Markers Tab. Select the marker from the list of available markers,
set the style and color, and select the button to post the marker symbol. In the
example below, the “X” signifies a lack of porosity from the core description.

**Single** - A single symbol is plotted

**Tiled** - Multiple symbols are plotted like wallpaper.

**Column** - Multiple symbols are stacked vertically in a column

**Row** - Multiple symbols are aligned horizontally in a row

**Stretch X** - A single symbol is plotted with its width stretched to fit the interval width

**Stretch Y** - A single symbol is plotted with its height stretched to fit the interval height

**Stretch XY** - A single symbol is plotted with its width and height stretched to fit the interval rectangle
Finally, select the Patterns Tab. This sets a wide variety of lithologic patterns. Select one of the available patterns and a size from the list and select the button. Note that the “size” of the pattern governs the density of the pattern’s display. The example below shows the interbedded sands and shales from the core description.

Setting Multiple Intervals’ Attributes, Markers, and Patterns in a Single Well

First set a single interval to the desired attributes, markers, and patterns. Next, select the button on the “Defaults” section on the Attributes Tab (highlighted below). This stores the current scheme of colors and patterns as a “default” attribute so it can be used later on different intervals.
The next step is to select the multiple intervals that will have this default attribute scheme. To select multiple intervals, select the “Set Tabs” button: \(\text{Set Tabs}\) or hold down the CTRL key. Next, select the desired intervals on the graphical representation of the intervals on the right side of the screen. Note that the selected or “tagged” intervals have a small black triangle on the far right (highlighted in the example below). In the example below, all the very fine grained sandstones have been tagged.

To tag all intervals in the well, select the \(\text{SetAll}\) button. To drop all tags, select the \(\text{ClearAll}\) button.

Finally, select the \(\text{Tag...}\) button on the Defaults section of the Attribute Tab. This applies the current “Default” scheme of colors, markers, and patterns to all tagged intervals.

The \(\text{Apply}\) button only applies the default scheme to the currently selected interval, while the \(\text{ApplyAll}\) button applies the default scheme to all intervals in the well.
To add another “default” scheme, simply set a single interval to the desired colors, markers, and patterns and select the the button on the “Defaults” section on the Attributes Tab. In the example below, there are three default schemes based on lithology: the blue interbedded siltstone/sandstone, the pale yellow very fine grained sandstone, and the bright yellow fine grained sandstone.

Even after adding default schemes, it’s easy to go back and modify individual intervals to display different information. In the previous example, three different default schemes reflected lithology and grainsize from core descriptions. To carry this example one step further, markers can also be added to signify porosity. Recall that for the sandstone/siltstone, an X marked low porosity. To add markers for an individual interval, select the interval and go to the Markers Tab. Select the marker and the marker’s color, and select the button. In the example below, red stars have been added for all intervals with porosity above 10%, and a black X for all intervals with porosity below 10%.
To save the changes to the database, select OK. Here, Petra gives the option to save or discard ALL changes made to the selected well’s interval table. All the edits to all intervals will be ignored if you select CANCEL.

Setting Multiple Intervals’ Attributes, Markers, and Patterns in Multiple Wells

The previous methods change the display of intervals for one well at a time. This can work well for a small number of intervals in a few wells. Even a modest Petra project can contain a large amount of intervals spread out over many wells; changing intervals one well at a time would be very tedious and time-consuming.

Petra’s Find and Replace Interval Data can apply one of the “Default” attribute color and pattern schemes to all intervals in the selected wells that meet a set of search criteria. For more information see the Find/Change Data section.

Find/Change Data…

The Find and Change Data function searches intervals by data criteria and either changes the intervals’ color and pattern fills, or changes field data entries.

To perform a search on interval data, select the “Maintenance” button on the bottom of the Interval Tab on the Main Module. Next, under the Data tab (highlighted in blue) select the “Find/Change Data…”
Setting Basic Interval Search Criteria

Select the interval data table to search under the TABLE dropdown. Next, select the interval field that will be searched under the FIND DATA IN dropdown menu. On the WHERE dropdown, select the style of the search. Petra can search inside data fields in a few different ways; select the condition (such as Data is Equal to value) and the appropriate value, range, or text string to find. The example below shows a search for intervals containing the phrase “very fine grain.”

Limiting the Interval Search to a Zone

This search can be further limited by zones on the Options Tab. Since a zone can be defined by a set of formation tops or depths, this can be a powerful way of limiting the search to intervals that have footage inside a specific stratigraphic interval. In the example below, only intervals intersecting the DSAND zone will be used.
Using a Filter in the Interval Search

With a Find and Replace operation, filters provide a finer control over which intervals are changed. Intervals that do not meet the filter criteria are not changed. To create or modify a set of filters, select the “Set Filters…” button on the Options tab.

Filter criteria are shared between different functions, making it easier to use the same subset of interval data for different applications. Deselecting this box in any part of Petra does not erase the filter criteria; it simply inactivates the filters. For more information on filters see the “Using Filters” section of this document.

Setting the Color and Patterns for the Interval Search

Using the Find and Replace Data method to change color and patterns applies a “default” attribute scheme to intervals meeting search criteria. This method’s key advantage is that it can be applied to multiple wells in a project. As a reminder, a “default” attribute is created in the Edit Interval Data window. For more information on creating a default attribute scheme, see the above section on “Setting Multiple Intervals’ Attributes, Markers, and Patterns in a Single Well.”

Once the search criteria are set, select “Set Interval Attributes.” This tells Petra to change the color and pattern attributes of the intervals that meet the search. On the CHANGE INTERVAL ATTRIBUTES TO dropdown menu, select the appropriate default attribute scheme. The example below shows that the lithologic description field “Desc” in the LITH table will be searched. Recall that in earlier examples, very fine grained sandstones were given a pale yellow color fill with a sandstone lithologic pattern. In the search shown below, intervals containing the phrase “very fine grain” in
the lithologic description will be given this same color and fill pattern.

![Image of Petra workflow interface]

**Setting the Data Change for the Interval Search**

Using the Find and Change Data function changes field data entries in intervals meeting search criteria. This method changes a selected field value for every interval meeting search criteria. This method’s key advantage is that it can be applied to multiple wells a project.

Once the search criteria is set, select “Change Data Values.” This tells Petra to change a specific field on the intervals that meet the search. On the CHANGE DATA IN dropdown menu, select the appropriate field and data value. The example below shows that the lithologic description field “Desc” in the LITH table will be searched. In the search shown below, intervals containing the phrase “very fine grain” will have their Qual field changed to “B.”
Using Filters

Filters limit the intervals used in a particular process. Filters give more control over which intervals are displayed on map and cross sections, which intervals are used in calculations to create zone and log curves, and which intervals are used in Find/Replace operations.

In all these cases, filters add an additional set of search criteria. Intervals that do not meet the filter criteria are not used for that particular task. For example, intervals that don’t pass the filter criteria in the Map Module are not plotted on the map. Filter criteria are shared between different functions, making it easier to use the same subset of interval data for different applications. Unchecking this box in any part of Petra does not erase the filter criteria; it simply inactivates the filters. To create a new set of filters, select the “Set Filters…” button. The examples below show the “Set Filters…” for displaying intervals in the Map Module and for calculations in the Main Module.
The Interval Data Selection filters can be divided into two parts. The upper half of the screen builds and modifies filters, while the lower half shows the active filters and the “pass” relationship between different filters.

To create a new filter, select the table and field for the filter from appropriate dropdown menus. The example below filters intervals in the LITH table by data in the DESC data field.

Next, select the filter’s “Search Type.” With one exception (“Interval Thickness In Range”) the search type tells Petra what the filter should look for inside a field:

- Not Equal to Value
- Equal to NULL
- Not Equal to NULL
- Value in Range
- Field Contains String

“Interval Thickness in Range” eliminates intervals that are thicker or thinner than a given range. Finally, select the “Add” button to add the filter to the “Current Filters” list at the bottom of the box. In the example below, the filter is set to include only intervals that contain the words, “very fine grain”
Up to 10 filters can be active at once. There are two options for how to combine multiple filters: “Pass Filter when ANY conditions are met” and “Pass Filter when ALL conditions are met.” The choice of these two options can have a significant influence on which intervals are plotted on the cross-section. For more on combining multiple filters, see Appendix 2.

Pass Filter when ANY conditions are met – this will pass any interval where at least one of the conditions is met. This is the more permissive option, since only one of the filter criteria needs to be met to pass.

Pass Filter when ALL conditions are met – this will pass any interval only when all conditions are met. This is the more restrictive option, since all filter criteria need to be met to pass.

Plotting Interval Data in the Cross Section Module

The Cross Section Module can display any combination of interval data colors, patterns, markers and text. To display interval data for a well in the Cross Section Module, select Wells>Plot Interval Data. This box shows a list of the interval data tables on the left along with a series of tabs on the right that control how interval data (Style, Text, Filters) are shown.

First, select the interval data table or tables to display. Petra can show multiple intervals at the same time, though it’s generally better to keep different interval tables in different tracks. In the example below, only the LITH table is selected.

The Style Tab

The Style Tab governs how the interval data is displayed on the Cross Section.
Use Interval Fill Color – This option tells Petra to fill the interval with the interval’s color.

Use Interval Fill Pattern - This option tells Petra to fill the interval with the interval’s pattern.

Use Interval Marker Symbols - This option tells Petra to fill the interval with the interval's marker symbols. The Marker Scale factor below changes the size of these symbols. The individual interval’s marker fill can also be overridden with the Marker Fill Mode below.

Text Positioning – Text can be positioned at the top, middle, or bottom of an interval. Select the dropdown by default labeled “Text At Top of Depth Interval” to change where text is plotted.

Combining Text Horizontally or Vertically – This changes how multiple text fields are displayed. “Combine Text Horizontally” lists additional text fields to the right of the first text box. “Combine Text Vertically” stacks additional text fields on the bottom of the first text field.

Separate Text with Space – This option changes how different fields are separated when plotted horizontally. Horizontally combined text boxes can either be separated with a space, slash, a dash, or a comma.

Text Label Size – This option sets the size of text (in inches). Keeping this option at 0 is a good default. Remember that an absolute text size probably won’t be appropriate for both computer screens and large paper plots; 1 inch letters will look huge on a computer screen, but will be normally sized on a large wall plot.

Marker Scale Factor – This option sets the scale of the interval markers. Setting the scale factor to 0.5, for example, plots all markers at ½ their original size.

Marker Fill Mode – Though every interval stores information on how to display markers, this option overrides the fill mode for all displayed markers on the cross section. Note that this does not change the settings stored in the interval.

Pattern Scale Factor – This option sets the pattern scale, or density, of the lithologic
pattern fill. Higher numbers here generate higher pattern density.

The Text Tab

The Text Tab sets the specific data fields to be displayed as text.

To add text, select the appropriate Table on the Interval Data to Plot dropdown menu and a data field from the “Data Fields to be Posted By Intervals dropdown menu on the right. Select the + button to adds the field to the list. Items at the top of the list will be at the top (for vertically combined text) or on the left (for horizontally combined text). Selecting the “Include Text Labels” option adds the field name as a prefix before each data field. Particularly elaborate displays can also be saved as a template in a *.IDF file with the Save/Load Template buttons.
The Filters Tab

Filters provide more control over which intervals are displayed on the Cross Section Module. Intervals that do not meet the filter criteria are not displayed. To create or modify a set of filters, select the “Set Filters…” button on the Filters tab. For more information on filters see the “Using Filters” section of this document.

Interval Data in the Map Module

The Map Module can show and grid interval data on deviated and horizontal wells. Petra can show a rectangular area with the interval’s pattern and color along the wellbore, each interval’s marker symbol, or both. Intervals are a good way of showing the encountered lithology, or for quickly showing the wellbore’s footage spent
in, above, or below a target stratigraphic unit.

Gridding with Interval data

Deviated and horizontal wells can generate data spread along the wellbore’s path. Interval data is a good way of displaying and incorporating multiple data points along a wellpath into a grid. Petra can grid any numerical interval field designated as a “real value.” Date and text interval fields can't be used in gridding.

In the Map Module select Contours>Create Grid… from the menu bar at the top of the screen. Here, select the relevant data, grid size, and surface style; Petra can integrate interval data into a grid using zone data, tops, overlay contour lines, or other XYZ data. On the Interval Data Tab, select the “Active” option to use the selected interval table and numerical interval field in gridding.

Note that there are a couple of ways to modify which intervals are used in gridding: intervals can be pared down by quality codes, zones, or interval filters. The “Skip Well if Quality Code Contains” option allows the user to skip wells that have specified quality codes. Here, enter one or more values separated by a semicolon to indicate intervals that are NOT to be used for gridding.

**Intervals must Fall within Depths of Zone** - This option limits which intervals are used in gridding to only the intervals inside the specified zone definitions. The “WELL” zone covers all depths, and consequently all intervals. Be careful when using zones and horizontal wells. Note that this zone criteria works uses the zone interval definitions, which are often defined by tops. Horizontal wells that stay entirely within a zone and never reach the base will not have a base top picked, and will consequently be excluded from gridding.

**Apply Interval data Filters** - This option provides more direct control over which over which intervals are used in gridding. Intervals that do not meet the filter criteria are not gridded. To create or modify a set of filters, select the “Set Filters…” button on the Filters tab. For more information on filters see the “Using Filters” section of this
**Use Interval Top/Middle/Base Depth** - This option sets where numerical “real value” interval fields are contoured. Especially with longer intervals in horizontal wells, this difference can significantly change where a data point is plotted. Note that this option is grayed out when gridding interval tops and bases.

In the example below, a single interval in the wellbore is outlined in with a box on the cross section on the left. While the top and base of the interval have a specific XY location on the map, other data (such as an average porosity value) can grid that value at the XY position at top of the interval, at the middle of the interval, and at the base of the interval.

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**Apply Subsea TVD Correction to Interval Field Value** - This option instead corrects to SSTVD by subtracting the KB elevation. By default, Petra uses the survey’s TVD when contouring the top and base of intervals. This option is essential when incorporating interval data into SS structure maps.

**XYZ File Containing Int Data Used in Gridding** - This option creates a text file containing the X and Y coordinates (using the project’s map projection) along with the interval value used in gridding. Specifically, Petra creates a *.XYZ file in the project’s GRIDS folder. This file will be named after output grid file name with a “_INTDATA.XYZ” suffix.

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**Plotting Interval Colors**

Interval colors are plotted in a filled rectangle along the wellpath. This is useful for aerially representing continuous information in a wellbore, such as changes in lithology, biostratigraphic assemblages, or even gas shows.

In the Map Module, select **Options>Interval Data on Well Path...** Select the appropriate interval table to display from the dropdown, and select the “Plot Filled Rectangle” option under the Interval Indicator dropdown. With this option, Petra fills the rectangle with each interval’s color.

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Filters provide more control over which intervals are displayed on the Map Module. Intervals that do not meet the filter criteria are not displayed. To create or modify a set of filters, select the “Set Filters…” button on the Filters tab. For more information on filters see the “Using Filters” section of this document.

Plotting Interval Data Markers

Interval markers are along the wellpath at the top, middle, or base of the interval. Unlike the filled rectangle, interval markers can be plotted at a user-defined orientation. Interval markers are useful for representing discrete markers, such as fractures or MWD tool changes.

In the Map Module, select Options>Interval Data on Well Path… Select the appropriate interval table to display from the dropdown, and select the “Plot Marker Symbol” option under the Interval Indicator dropdown. Next, select the position of each interval’s marker relative to the wellbore (middle, left, or right of the wellbore) and the position of the marker along the interval (top, base, midpoint). Note that filters can also be applied to the interval data; only intervals meeting the filter criteria are shown. In the example below, the “Fractures” interval table stores a horizontal line marker for every interval.
To set the direction of each marker, select the Orientation Tab. Markers can be perpendicular to the borehole, parallel to the borehole, or have a user-defined orientation, or azimuth. This user-defined azimuth can either be a constant azimuth for all interval markers in all wells, set for all intervals markers for each well by a zone data item, or for each individual interval in each well by an interval data field. When storing individual fractures in a wellbore, storing azimuth data in each interval captures the most information and allows for each marker to have its own orientation. In the example below, the AZI data field gives the compass azimuth for each fracture.

To set the size of each marker, select the Size Tab. The size of each marker can either be a constant for all interval markers in all wells, set for each well by a zone, or for each individual interval in each well by an interval data field. Note that the marker size can either be set to use map XY units, feet, or meters. Selecting a constant size of 0 sets a default marker size, as shown in the example below. The Marker Scale Factor can scale the size of a zone- or interval field-defined marker by anything between 0 and 100.
Storing Interval Data to a Zone

It’s sometimes useful to extract data from intervals to a zone. Zones are easily used in calculations and mapping. In the Main Module, select **Compute>From Interval Data>Extract Interval Data To Zone**

Under the Extract Interval Data from dropdown menus, select the appropriate interval table and field. In the example below, the “RW from SP” interval data is selected from the “Petrophysics” table.

Petra can either extract the interval field data or the interval thicknesses. In the example below Petra will calculate an average of the “RW from SP” interval data.

Since a single zone can contain multiple or overlapping intervals, there are a few different ways to extract this field or interval thickness data:

- First/Last value
- Min/Max of values
Average of values (weighted or unweighted by thickness on the Options Tab)
Sum of values
Count of values
Sum of interval thicknesses
Average of Thicknesses
Count of intervals

Next, select the zone and data item where the interval data will be stored. Note that this tool uses the selected zone’s definitions (where fm tops or depths define the top and base of the zone) to limit the extraction only to intervals intersecting the zone. A default zone definition of -99999' to 99999' will include every interval in the wellbore.

Next, select when the field value should be stored to the zone data item. Petra can store the interval data meets the following criteria:

When the item is present – This option stores the interval field value to the zone data item when the interval data contains a value. This is useful for most applications, such as storing a petrophysical value to a zone.

Item is absent – This option stores the value when the interval data field is null. Practically, this option is only useful when extracting the sum/average of interval thicknesses or interval counts. As an example, extracting a count of intervals when the porosity interval data is absent generates a well-by-well count of intervals missing porosity values.

Range – This option stores the interval field value when the field value falls between a minimum and maximum value.

Contains text – This option stores the interval field data when the interval field contains specified text.

Matches text - This option stores the interval field data when the interval field exactly matches the specified text.

The Options Tab contains further options for limiting the intervals used in the extraction.
Restrict Intervals By Selected Zone - By default, Petra only uses intervals that intersect the selected zone’s definitions (where fm tops or depths define the top and base of the zone). Note that undefined zones extend from -99999' to 99999' MD, which includes every interval in the wellbore. Deselecting this option will not limit intervals by zone definitions. Alternatively, intervals can also be limited by interval quality codes or FmName fields.

Method To Compute Average Values - When computing an average value for the interval, Petra normally uses weighted averages, where thicker intervals contribute more to the average than thin intervals. Selecting “Compute UnWeighted Average” gives equal weight to all values regardless of interval thickness.

Set Computed values of zero to null - Remember that a null is not equal to zero. Mistaking the two can generate spurious maps and calculations. The option sets extracted values of zero to a null value.

Use Filters To Restrict Intervals - Filters provide more control over which intervals are used in the zone extraction. Intervals that do not meet the filter criteria do not contribute to a zone data item. To create or modify a set of filters, select the “Set Filters…” button on the Filters tab. For more information on filters see the “Using Filters” section of this document.

Storing Interval Data to a Log Curve

It’s sometimes useful to extract numerical data from intervals to a log curve. Logs curves are easily displayed on cross sections and can be used in petrophysical calculations to create new composite curves. In the Main Module, select Compute>From Interval Data>Extract Interval Data To Curve

Under the Extract Interval Data from dropdown menus, select the appropriate interval table and field. In the example below, the “RW from SP” interval data is selected from the “Petrophysics” table.
Petra extracts an interval field data value and applies it to that interval's corresponding footage on a log curve. As an example, an interval from 1500 to 2000' with a RW of 0.06 will translate into a log curve with a repeating RW of 0.06 from 1500 to 2000', as shown in the example below.

Intervals often have gaps and overlaps between intervals. Gaps between intervals are simply stored as null values on the curve. Where log intervals overlap, the bottom interval overprints the upper interval. To resolve these gaps and overlaps in the data, see Resolving Gaps and Overlaps in this document.

Under the Extract Interval Data from dropdown menus, select the appropriate interval table and field. Next, select the name of the log curve. In the example below, the "RW from SP" from the "Petrophysics" table will be stored as a new "RW" curve. These curves can be stored at any sample rate, though 1 foot- and ½ foot-spacing are the most common.
The Options Tab contains further options for limiting the intervals used in the extraction. Filters provide more control over which intervals are used in the zone extraction. Intervals that do not meet the filter criteria do not contribute to the log curve. To create or modify a set of filters, select the “Set Filters…” button on the Options Tab. For more information on filters see the “Using Filters” section of this document.

Storing Log Curve Statistics to an Interval

It’s sometimes useful to extract numerical data from log curves to an interval. More specifically, this tool calculates statistics over a selected log curve between the top and base of each interval and stores the result as an interval data field. This statistical measurement is stored to a data field in a selected interval table. When stored as interval data, log curve statistics can be easily used in petrophysical calculations or compared with other interval data fields. In the Main Module, select Compute>From Logs>Extract Log Stats to Int Data…

First, select the desired log curve from the dropdown menu at the top of the screen. In the example below, the GR curve is selected. Note that this tool will calculate log statistics on aliased curves, as well.

Next, select the desired interval table from the “Interval Data Table” on the lower left side of the screen. In the example below, the LITH table is selected, so the statistics measured will be stored in interval data fields in the LITH table.

Finally, select the desired statistics and the desired location. In the example below, a mean (or average) will be calculated for the GR log. The calculated average will be stored in an interval data field called “GammaStat.” Petra stores statistics out to 7 decimal places, even though the interval data field may only show fewer trailing decimals.
Storing Interval Thickness to an Interval Field

This operation stores each interval's thickness to a specified field in that interval. Select the “Maintenance” button on the bottom of the Interval Tab on the Main Module. On the Table tab, select the interval field that will store the interval thickness. In the example below on the left, the “Recov” field on the CORE table is selected. Next, under the Data tab (highlighted in blue on the example to the right) select “Store Interval Thickness” (highlighted in red).

The example below shows that the sidewall core thicknesses (in this case given a thicker interval) all store thicknesses of 2 feet in the “Recov” field.
Gaps, Overlapping Interval Data, and Bulk Shifts

Interval data is often at the wrong depths, or contains overlapping intervals or gaps. Though interval data is designed precisely to handle this incomplete and contradictory data, it’s often useful to convert interval data into one continuous chain for display or calculations. Interval data can also become out of sync with other well data; moving interval data up or down with a bulk shift easily remedies the discrepancy.

To perform these operations on a single well, select the “Edit Details” button on the upper right corner of the Interval Tab on the Main Module. Next, Edit dropdown on the menu bar at the top of the window, select “Make Intervals Continuous” button or “Resolve Internal Overlaps”, or “Bulk Shift.”

Make Intervals Continuous

This option eliminates overlaps where two different intervals cover the same footage. With this option, Petra moves the base of the upper interval to match the top of the lower interval, as shown in the example below.
Resolve Internal Overlaps

This option eliminates gaps between intervals. With this option, Petra moves the base of the upper interval to match the top of the lower interval to cover the gap, as shown in the example below.

Bulk Shift

This option adds or subtracts a specific number to all interval depths. A negative number moves all intervals up, while a positive number moves all intervals down.
Calculations with Interval Data

Petra can perform basic calculations on interval data columns, zone data items, or constants. This operation is performed on all intervals in selected interval table in either the current well or for all wells selected in the Main Module. To calculate a new interval data column from another, select the appropriate interval table on the appropriate well, then select the “Calculate Column…” on the Interval Tab.

First, establish where the output will be stored. Petra can store data to a new or preexisting column in the selected data table. To store data to a new column, select “Create New Column” and enter in the new column’s name. To use a column that’s already in the data table, select “Use Existing Column”, and select the column from the underlying dropdown menu. Be careful when using an existing column, as this operation can overwrite any data already entered.

Next, enter an equation using variables and mathematical operators. For a list of available operators and sample equations, see appendix 3. The variable on the left side of the equal sign is the result variable. Note that the variables here are just text and will be assigned later, so they can be either specific (“porosity”) or general (“A”). Note that equations can be saved and loaded again at a later date with the “Save” and “Load” buttons on the right side of the screen. In the example below, porosity data is being used to calculate a permeability value.

Now that the equation is entered, select “Assign Vars.” This populates the Variable List in the bottom left corner of the window with the variables written in the equation. Select a variable from the Variable List, and select a column, zone data item, or constant from the relevant dropdown menus on the right. Select the “Assign” button. This will change the entry in the Variable List box to reflect the correct variable.

The Options Tab has a few more controls over the calculation. The calculation can be performed on only the currently selected well in the Main Module, or on all wells selected in the main module. Petra stores a null value whenever there’s a missing variable in the calculation, but the “Save ZERO value to Database” can overwrite this.
null value with a zero. By default, Petra overwrites all interval data fields during the calculation. Deselecting the “Overwrite Existing Database Values with Calculation Result” forces Petra to leave existing database numbers alone, limiting the calculation to only filling in null values. To perform the calculation, select the OK button.

Graphing Interval Data

Petra can plot any numerical interval “real value” versus depth or another real value. This can be particularly useful for quickly seeing how a quantity such as mud weight changes with depth, or understanding the relationship between two different kinds of data like porosity and permeability.

To view an interval graph, first select the correct well in the Main Module. On the Interval Tab, select the right interval table. In the example below, the “CORE” table is selected. Finally, select the “Edit details” button in the upper right on the Interval Tab.
On the Graph Tab, select “Depth vs Z” or “X vs Z” on the first dropdown menu. “Depth vs Z” shows the selected values for the interval fields selected on the Z1, Z2, and Z3 dropdown menus on the vertical axis relative to depth on the horizontal axis. The example below shows how porosity varies with depth.

“X vs Y” shows a scatter plot for the two interval fields selected on the X and Y dropdown menus. The X value is plotted on the horizontal axis, and the Y value is plotted on the vertical axis. The example below shows how permeability varies with porosity.

APPENDIX 1: Setting Default Tables and Fields

Changing these default interval tables can be useful from an administrative perspective. Changing these tables ensures that all new projects will be created with the same interval tables and fields, though these can always be changed inside Petra.
When creating a new project, Petra looks at a file called INTDATA.DEF located in the program’s Parms directory. On most standalone installations, this will be located in C: \geoplus1\Parms. This file contains the default tables and fields that will be created in a new project.

It’s important to not edit the default interval table file (INTDATA.DEF). Instead, copy the INTDATA.DEF file to a new file called INTDATA.USR. Make all new changes to the new file called INTDATA.USR. Petra first looks for INTDATA.USR before it looks for INTDATA.DEF.

The default version of this file contains three tables: LITH, CORE, and PALEO.

Table: LITH - Lithology
Field: Desc - Description

Table: CORE - Core Interval Data
Field: Poros - Core Porosity
Field: Perm - Core Permeability
Field: Recov - Amt of Core Recovered

Table: PALEO - Paleo Data
Field: FmName - Formation Name
Field: Bug - Fossil Name
Field: Age - Age of Zone
PETRA reads the INTDATA file and builds interval data based on comma-delimited values.

**TABLE, TABLE NAME, “Table Description”**

**FIELD, KIND, NAME, SRC, “Field Description”, UNITS, DECIMALS**

**TABLE** – This signifies that the entry is for a new table.

**Table Name** – This is the name of the table. It's a good idea to separate tables based on genetically related data, such as mudlogs, core descriptions. Remember that tables, unlike zones, are completely independent of stratigraphy, so it is probably easier to lump all related data together rather than break out intervals based on specific formations.

“Table Description” - This sets a brief description of the Table. In the example, the “LITH” field's description is “Lithology Data.” Remember to put quotation marks around the description.

**FIELD** – This just signifies that the entry is for a new field. Make sure all new field entries are prefaced by “FIELD.”

**Kind** – Fields can store three kinds of data: Real Values, Date Values, or String Values. The letter here tells PETRA what kind of data this field will store – “R” for Real values, “D” for Date values, and “S” for String values. Real values simply store numbers, such as porosity or permeability. Dates store calendar days as MM/DD/
“Field Description” – This sets a brief description of the field. In the example, the “Reov” field’s description is “amt of core recovered.” Remember to put quotation marks around the description.

UNITS – This sets the units of the field.

DECIMALS – This sets the number of decimals shown for real value (numerical) data. Though it’s a good idea to set this value to 0 for string and date fields, it’s not necessary.

APPENDIX 2: ANY and ALL with multiple Interval Data Filters

There are two options when combining multiple filter combinations. Data can either pass ALL conditions, or ANY of the conditions. The difference between the two is significant, and is best illustrated by an example with two data filters:

“Object is yellow”
“Object is smaller than a breadbox”

We’ll apply those filters to three objects: a Banana, an Apple, and a Schoolbus.

When ALL conditions need to be met, only the banana passes the filter because it is both yellow and smaller than a breadbox.

When the filter just requires ANY condition to be met, each object only needs to pass one of the filters. In this example, all three objects pass the filter. The apple is smaller than a breadbox, the schoolbus is yellow, and the banana is both smaller than a breadbox and yellow.

APPENDIX 3: Equations and Mathematical Operators

Petra recognizes a wide variety of mathematical operators:
+ Addition
- Subtraction
* Multiplication
/ Division
** Exponent

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS(x)</td>
<td>Absolute value of x</td>
</tr>
<tr>
<td>ACOS(x)</td>
<td>Arccosine of x (in radians)</td>
</tr>
<tr>
<td>ASIN(x)</td>
<td>Arcsine of x (in radians)</td>
</tr>
<tr>
<td>ATAN(x)</td>
<td>Arctangent of x (in radians)</td>
</tr>
<tr>
<td>COS(x)</td>
<td>Cosine of x in radians</td>
</tr>
<tr>
<td>COSH(x)</td>
<td>Hyperbolic cosine of x (radians)</td>
</tr>
<tr>
<td>EXP(x)</td>
<td>e to power of x</td>
</tr>
<tr>
<td>INT(x)</td>
<td>Truncated value of x</td>
</tr>
<tr>
<td>LOG(x), LN(x)</td>
<td>Natural Log of x</td>
</tr>
<tr>
<td>LOG10(x)</td>
<td>Log based 10 of x</td>
</tr>
<tr>
<td>MAX(x,y)</td>
<td>Maximum of x and y</td>
</tr>
<tr>
<td>MIN(x,y)</td>
<td>Minimum of x and y</td>
</tr>
<tr>
<td>ROUND(x)</td>
<td>Rounded value of x</td>
</tr>
<tr>
<td>SIN(x)</td>
<td>Sine of x in radians</td>
</tr>
<tr>
<td>SQRT(x)</td>
<td>Square root of x</td>
</tr>
<tr>
<td>SQR(x)</td>
<td>x squared</td>
</tr>
<tr>
<td>SINH(x)</td>
<td>Hyperbolic sine of x (radians)</td>
</tr>
<tr>
<td>TAN(x)</td>
<td>Tangent of x in radians</td>
</tr>
<tr>
<td>TANH(x)</td>
<td>Hyperbolic tangent of x (radians)</td>
</tr>
</tbody>
</table>

Operators are performed in the following precedence:

1 Exponent
2 Multiplication and division
3 Addition and subtraction
Use of parentheses can change the order of precedence.

Example Equations:

\[ \text{GRN} = \text{GR} - \frac{\text{MEAN}_\text{GR}}{\text{MEAN}} \]
\[ \text{LOGNRM} = \text{LONORM} + \frac{(\text{LOG} - \text{PICKLO})(\text{HINORM} - \text{LONORM})}{(\text{PICKHI} - \text{PICKLO})} \]
\[ \text{LOGNRM} = \text{LOG} + \frac{\text{LOGPICK} - \text{GOODPICK}}{\text{LOGPICK}} \]
\[ SW = \left( \frac{\text{RW}}{(\text{RT} \times (\Phi^M))} \right)^{1/N} \]
\[ R = \left( \frac{(\text{A} + \text{B}(\text{C} - 1.0))}{100} \right) \]
\[ R = \text{X} \times \sin(A) + \text{Y} \times \cos(B) \]
\[ R = \log_{10}(\text{X}) \]
\[ R = \text{X} \times \text{X} \text{ or } R = \sqrt{\text{X}} \]
\[ R = \text{X}^{\text{Y}} \text{ (x raised to the y power)} \]

18.8 How to use Petra Standard 2014 Repair Tools

Petra Standard 2014 has split the PetraDBIRepair tool from one application into two separate applications:

- **DBIRepair**: a command-line tool used to verify, repair, reindex, or optimize a single table in a Petra project.
- **PetraRepair**: allows you to select multiple tables in a project to run DBIRepair on simultaneously.
- **PetraPack**:

18.8.1 DBIRepair

DBIRepair.exe is a command-line tool for scripting Petra database verification, repair, reindexing, and optimization.

DBIRepair.exe is able to accept a full path filename to a single Petra table (with automatic VERIFY and REPAIR, if necessary) with parameter switches for FORCEREPAIR, REINDEX and/or OPTIMIZE (for scripting). DBIRepair.exe requires exclusive access to the table (all users must be out of the project). There is a separate report .txt file created with the same name as the table in the same folder.
as the table for each table processed containing any exceptions during the process.

The format for the command line is:

```
DBIRepair.exe fully_qualified_path_and_table_file_name \FORCEREPAIR\REINDEX \OPTIMIZE

Fully_qualified_path_and_table_file_name        Specifies the full path to the Petra database table (see note 1)
\FORCEREPAIR                                    Forces a full repair of the table
(optional, see note 2)
\REINDEX                                         Reindexes the table
(optional - see note 3)
\OPTIMIZE                                        Optimizes the table
(optional - see note 4)
```

Notes:

1. DBIRepair.exe with just the fully qualified path and table file name on the command line will automatically perform a Verify. It will automatically perform a Repair, if it is found necessary by the Verify. This is the safest and fastest option, since a Verify only reads the data and doesn't have to write any data to a new table.

2. \FORCEREPAIR is optional and will bypass the Verify and force a Repair even if it is not necessary. This is a longer process as it has to create a new table to write the data into.

3. \REINDEX is optional and will delete the existing index(es) on a table and create them again from scratch.

4. \OPTIMIZE is optional. It will create a new table and write the existing data in the order of the primary key index, effectively shrinking the file size by eliminating any deleted data. It will speed up data access somewhat as the data will now be stored on disk in the actual index order.

5. All users must be out of the project before any repair processes are started.

6. Backup (copy and zip) your Petra project folder before any repairs are undertaken.
PetraRepair is a graphical interface for the DBIRepair command-line application that makes it easy to verify, reindex, repair, and optimize an entire Petra project.

**Note:** Do not be alarmed by the number of individual DBIRepair.exe screens that pop up on the monitor and then one by one disappear! PetraRepair launches separate DBIRepair processes to work in parallel on each table in the Petra project.

**Notes:**

1. All users must be out of the project before any repair processes are started.
2. Backup (copy and zip) your Petra project folder before any repairs are undertaken.

To start PetraRepair, simply double-click on the file (PetraRepair.exe) in your Petra installation directory:
Click the “Open” button to choose the .ini file for the project you would like to repair (in the PARMS folder):

By default all the tables are checked. If you would like to only repair some of the tables, select them now:
The default for PetraRepair (no check boxes selected at the bottom) is to verify the tables and “automatically” repair only tables with a problem.

Click “Start” to launch DBI Repair for each table with the appropriate switches:

**Do not be alarmed by the number of individual DBIRepair.exe screens that pop up on the monitor and then one by one disappear!**
18.8.3 PetraPack

PetraPack.exe can be run at any time without having to kick anyone out of the project. It will accept a command line full path to a Petra project .ini file (for scripting) or an open dialog will appear for .ini selection, if the command line is left blank.

PetraPack can be launched once for different Petra projects and the operating system will assign each process to separate cores and memory space. This allows packing of more than one Petra project at a time, making use of the available cores and memory. A report .txt file with the same name as the .ini file will be created in the folder with the .ini file containing information about the pack (before and after record counts or any exceptions during the process).

Notes:

1. Backup (copy and zip) your Petra project folder before any repairs are undertaken.

2. It is recommended but not required that you Verify, Repair and Reindex your tables before packing them with PetraPack.exe, since PetraPack.exe relies on a table and index that is not corrupt to correctly determine what records are orphaned and need to be deleted. Otherwise, you might delete records that appear orphaned because of an error in the table or index when the records are really not orphaned, but rather their parent just cannot be properly located.

3. Launching PetraPack simply opens a dialog for you to choose the project:

PetraPack then runs the Pack function on all that project’s tables as below
18.9 How to Use the Z Cross Plot Module

Opening the Z Cross Plot Module

On the Main Module, select Tools>Z Data Cross Plot from the menu bar at the top of the screen. This brings up the “Data Definition” screen superimposed over the main Crossplot Module, both of which are blank by default.

Setting the Axes

The first step is to set the axes for the two variables on the scatter plot. Petra brings up the “Data Definition” screen by default after opening the module for the first time. Otherwise, select Data from the menu bar at the top of the screen.

X-Y Axis Tab

This tab controls the basic settings for the plot, like the plot title and axes. Here, set the set the specific zone and data item, as well as the scale for X and Y axes. The “Log Scale” button sets the selected axis to a logarithmic scale. The “Stats” button displays a histogram of the z data for the selected wells, which can aid in setting a reasonable minimum and maximum scale for the plot. The “Defaults” button sets the
minimum and maximum scale based on the minimum and maximum data value in the data. If the minimum and maximum values are more than 500 apart (and is not a top or contains negative numbers), Petra will automatically scale the axis to a logarithmic scale. Note that dates can also be used in these fields in the format MM/DD/YY, like 01/01/1910.

The example below plots a calculated Net to Gross plot, where the NET is on the X axis, and GROSS is on the Y axis. In this example, GROSS is a simple interval thickness between two tops and NET is a thickness based on a gamma ray cutoff. Both scales are set to 30-100'. The “Stats” button for the GROSS interval shows a histogram of these values.

When graphed, the cross plot shows the relationship between net and gross in the 2nd Wall Creek Formation.
Z Axis Tab

The Z-Axis tab color codes data points by an additional Z data value, giving an additional dimension to the XY scatter plot. Note that data points that do not have a Z value will not be plotted. Select the desired zone and data item and set the scale using the minimum, maximum, and scale. Select the “Colors…” button to set the color bar.

Carrying on the example, the plot now adds a statistical average of the density porosity from 10% to 20%.

Options Tab

This option governs a couple of additional settings for the plot, including setting the labels for the axes and the symbol size. The “Do Not Use LOG Scale to Compute Defaults” button forces Petra to always use linear scales when setting defaults on the X-Y Axis Tab and the Z-Axis Tab.
File Tab

The file tab saves and loads settings for the “Data Definition” window as a *.ZXS file in the project’s PARMS directory. This only saves the settings for the axes, title, and labeling; it does not save polygons.

Selecting Wells

By default, The Z Crossplot Module simply uses the wells selected in the Main Module. All data points for all these wells show up on the scatter plot. To increase or decrease the number of wells selected on the Z Cross-plot, select Wells on the menu bar at the top of the screen.

All Wells

This option selects all wells in the project.

Select by Data

This option opens the “Select Wells By Data” option. This tool can refine the wells used in the cross plot based on several different criteria. Additionally, multiple nested searches can combine to make for more precise well lists.

Wells from Main/Map/Cross-Section

These options select the wells currently active in the relevant module. As an example, selecting “Wells from Map” selects only the wells currently selected in the Map.
Highlight from Polygon

This option changes the color of the data points inside a given polygon to use the same color as the polygon.

Drawing a Regression Line

Petra can also perform variety of regression operations on the cross plot data. To add regression lines to the plot, select Options>Regression from the menu bar at the top of the screen.

Auto Fit Line

This option adds a linear regression line to the log crossplot. The equation for the line, correlation, and standard deviation are all shown at the bottom of the screen.

Auto Fit Quadratic

This option adds a quadratic curve to the log crossplot. Like the linear regression, the equation for the line, correlation, and standard deviation are all shown at the bottom of the screen.

User Fit Line

The User Fit line creates a linear user-drawn line across the log crossplot. The equation for the line, correlation, and standard deviation are all shown at the bottom of the screen.

Show Standard Error Bars

This option adds error bars at one standard deviation. The better the line fits the data, the smaller these bars will be. As a reminder, these bars will include about 68% of the data points assuming a normal distribution.

The example below shows an auto-fit line with standard deviation error bars.
Creating and Modifying Polygons

Z Crossplot polygons outline different areas of the graph, separating wells that have specific z data relationships. Each polygon in the Z Crossplot Module can have its own name, color, and value. Note that polygon values don't have any effect in the Z Crossplot Module, but exist so that polygons can be shared with the Log Crossplot Module. Polygons allow the user to select wells based on a more nuanced criteria rather than by simple data searches, since polygons can vary the cutoff based on the relationship between zone data.

The example below shows the Net to Gross crossplot with a single “OUTLIER” polygon. This polygon covers the data points the net to gross ratio is outside a single standard deviation. Put another way, the amount of net sand in these wells is significantly lower than what the rest of the data would suggest. This could be due to gamma normalization problems or petrophysical effects.

Making a Polygon

To establish a polygon, right click anywhere on the log plot and select “Add Polygon.” Alternatively, select Polygons>Add from the menu bar at the top of the screen. Drawing a polygon works exactly the same as drawing lines elsewhere in Petra. Pick polygon node points with the left mouse button and select the right mouse button to stop picking points. Petra will automatically close open polygons.

During picking, press ESC picking to cancel the current polygon or DELETE to drop the last picked point. Selecting F1 while picking will snap the cursor to the nearest node point on another polygon, which can be useful for generating polygons with no empty space between them and no overlap.
Once the polygon is picked, Petra brings up the “Polygon Definition” box. Here, simply enter the name of the polygon, pick a color, and add a polygon value. The polygon name is a good way of distinguishing the polygons apart when exporting wells, so spending time on descriptive names is a good idea. 

**Modifying and Deleting a Polygon**

To change the area of a facies polygon, right click anywhere on the log plot, select “Select Polygon”, and then left click on the desired polygon. Make sure to click right on the line. Alternatively, select Polygons>Selected from the menu bar at the top of the screen, and then left click on the desired polygon. This highlights the polygon and shows its node points; select a node point and drag it to the desired position to change the outline of the polygon. When finished, right click and select “Redraw” to refresh the screen and show the changes.
Changing a polygon's name, color, and value is similar. Select the polygon with the mouse, as outlined above. Once the polygon is highlighted, right click and select “Modify Polygon.” Alternatively, select Polygons>Modify from the menu bar at the top of the screen with the polygon is highlighted. This opens the Polygon Definition box, which sets name, value, and color for the polygon.

To delete a drawn polygon, select the polygon with the mouse as outlined above. Once the polygon is highlighted, right click and select “Modify Polygon.” Alternatively, select Polygons>Modify from the menu bar at the top of the screen with the polygon is highlighted. This opens the Polygon Definition box. Select the “Delete Polygon” button on the bottom of the box.

**Loading and Saving Polygons**

Closing the Log Crossplot Module erases the polygons from Petra’s memory, so make sure to save the polygons to a file if you want to use them later. Select Polygons>Save from the menu bar at the top of the screen. Create a name and select the save button.

On the Save Polygons to Disk box, the area outside the polygons name and value can be modified. By default this area is named “DEFAULT” and its value is zero. This screen also allows for a comment to better describe the polygons.

On the Save Polygons to Disk box, the area outside the polygons name and value can be modified. By default this area is named “DEFAULT” and its value is zero. This screen also allows for a comment to better describe the polygons.

**Exporting Wells inside a Polygon**

To save a well list select Polygon>Export wells. Here, select the “Browse” button to navigate to a location on the network and name a WSN list. Next, add a comment for the WSN list if desired. Finally, select the polygon containing the wells to be included.
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in the WSN list. Note that the “Output Wells Outside All Polygons” only selects the wells not inside any polygon. The example below shows how the wells inside the “OUTLIER” polygon will be written to a WSN list called “outlier.wsn.”

18.10 How To Calculate Volumetrics With Grids

The Map Module’s “Compute Volume from a Grid” tool calculates volumetrics from a single grid. With a good quality isopach, pore volume, or hydrocarbon pore volume grid, this method can generate accurate estimations of the area occupied by hydrocarbons, and can divide these volumetrics into different lease polygons.

When to use a Grid-Based Approach

Petra can calculate reservoir volumetrics in two different ways: a deterministic approach and a grid-based approach. The Advanced Volumetrics Module (available in the Main Module under Tools>Volumetrics on the menu bar at the top of the screen) calculates reservoir volumetrics based on a single set of averaged reservoir and fluid properties inside a perfectly homogenous cube with a defined volume. This method is best suited for exploratory fields with little hard data.

Well-drilled fields with large amounts of petrophysical data are better served by a grid-based volumetrics calculation. This method calculates volumetrics using the mapped thickness, water saturation, and porosity at each grid node, which better accounts for heterogeneous reservoirs.

How Grid-Based Volumetrics Works

When Petra calculates a grid from a data set (such as pay thickness or porosity measured at each well), it creates a surface that interpolates the values across the empty spaces between data points. In the simplest case, an isopach grid of net pay thickness reflects the thickness of pay (the Z value) at every point on a map (X and Y for Lat and Long). The example below is an isopach grid projected into three-dimensional space. The volume underneath the surface of the isopach grid (down to zero feet thick) equals the volume of the reservoir. Given a good grid that accurately maps the subsurface, this method can generate much more precise measurements of the volume of a reservoir than conventional estimation.
This same grid-based volumetrics can also increase accuracy in heterogeneous reservoirs. Both porosity and water saturations often vary significantly across an entire reservoir. Deterministic calculations force a single average porosity and water saturation, which can easily ignore these effects. In contrast, multiplying individually mapped grids of reservoir thickness, porosity, and hydrocarbon saturation together can generate a more accurate picture of the total volume occupied by hydrocarbons.

The diagram below shows how different kinds of grids can be used to calculate volumetrics in an oil and gas context. The red arrow on each line shows when the volumetrics calculation is performed, and which assumptions are made during the calculation. The first example shows a simple isopach grid; calculating a total volume of oil or gas requires an assumed average porosity and gas saturation. The second example shows an isopach and porosity grid. Multiplying these together generates a pore volume grid, which gives the distribution of pore space footage. Calculating volumetrics here requires an average gas saturation. The final example multiplies an isopach, porosity, and gas saturation grid together to form a hydrocarbon pore volume (HPV) grid. Since this HPV grid already calculates the distribution of hydrocarbons in the system, it needs no further assumed reservoir variables.
Initial Polygon Setup

Volumetrics can be calculated for the grid as a whole, or only for the grid underneath active overlay polygons on the Map Module. While this is most used for assessing volumetrics in individual leases, volumetric polygons can also be used to outline a specific area of interest or to eliminate the effect of large but unproductive areas. To use polygons, select the overlay line in the map module and double-click to bring up the line’s attributes. On the General Tab, make sure that the line is a closed polygon. Note that the “Arrows” tab changes to “Volm.”

Next, select the Volm Tab to edit the polygon’s name and working interest. The calculations made inside this polygon will be referenced by this name. While this is
most used for assessing volumetrics in individual leases, volumetric polygons can also be used to outline a specific area of interest or to eliminate the effect of large but unproductive areas. In the example below, the selected polygon’s volumetrics name is “AOI” and its WI is 100%. You can also designate a specific well’s WSN to store the specific polygon’s calculated volume. Remember that a well’s WSN number is the number Petra assigns to the well when it is created in the project; it is not the API or UWI number. This volume is stored in the well’s zone data, and is set up during the volumetrics process. In the example below, volumetric data for this “AOI” polygon will be stored in the well with a WSN of 178.

Petra will calculate volumetrics for all visible polygons with a volumetric name, so be sure to turn off all irrelevant named polygons before proceeding.

Calculating Volumetrics - Data Tab

Once the overlay volumetric polygons are set-up, select Contours>Volumetrics>Compute Volume From a Grid… on the menu bar at the top of the Map Module to open the volumetrics tool. Here, select the grid and grid type to be used in the calculation from the dropdown labeled “Grid File Used For Volumes.” In the example below the “HPV” grid is selected. To change the grid directory, select a different file path on the Dir Tab. Note that grids on this dropdown menu can be sorted alphabetically by selecting the button. The button selects the most recently created grid in the directory.
Grid Units

When calculating volumetrics, it’s important to make sure the units are correct. Petra stores the default XY and depth units of measurement (feet or meters) in the Map Projections Settings. When Petra calculates a grid, it uses these XY coordinate units. The units used to create the selected grid are shown under Grid XY Units.

By default, Petra assumes that the Z units for the grid are the “Default Depths Units” selected on the Map Projection Settings. Make sure the units selected here reflect the units of the grid.

Grid Type - “Iso”

The “Grid Type” dropdown tells Petra what the numerical values in the grid actually mean. A grid used in volumetrics can be one of three types: “Iso” type data with values from zero to positive numbers, structure data with structural highs as larger numbers, or structural data with structural highs as smaller numbers. In the example below, the SCMR ISOPACH grid is selected as an isopach.

With “Iso” grids (including isopach grids, pore volume grids, and hydrocarbon pore volume grids), Petra uses the thickness to calculate the volume underneath the grid nodes. This is the most common and easiest way to calculate volumetrics with a grid. Note that Petra will ignore the effect of negative numbers in “Iso” type grids.

Grid Type - Structure

Though Petra can use a structure grid in a volumetric calculation, it is almost always better to use an isopach grid. In practice, using a structure grid really only works with small, simple structures with a thick, homogenous reservoir and a discrete water contact.

The numerical representation of a structural high or low is dependent on the reference
datum (Measured Depth/MD or SubSea/SS). SS grids store structural highs as larger numbers (e.g. +2,000 SS is higher than +1,000 SS and -1,000' SS is higher than -2,000' SS). MD grids store structural highs as smaller numbers (e.g. 1,000' MD is higher than 2,000' MD). Practically, grids referenced to SS use the “Structural Highs as Larger Numbers” option, while grids referenced to MD use “Structural Highs as Smaller Numbers” option.

A single structure map only represents the elevations of a surface and doesn’t inherently have any measurement of thickness. When using a structure map, Petra calculates thickness by using the volume of the grid between the minimum and maximum Z values set on the Data Tab. In the example below, Petra will calculate a thickness between -1200' SS and -2200' SS. It’s important to note that setting a limit below the bottom of the grid will add a large extra bulk to the volumetric calculation. The example below will have an additional 200’ of section added to the volumetric calculation.

Calculating volumetrics with a structure map can also lead to problems if the thickness of the reservoir rock is thinner than the difference between the grid and the bounding lower z value. With a sufficiently thick reservoir, the bounds are completely covered
by reservoir rock. With thinner reservoirs, the volumetric calculation can include a volume that doesn't actually include reservoir rock, thus overestimating the volume.

**Compute Volume for Following Area(s)**

This section tells Petra whether the volume underneath a grid will be broken out by different volumetric polygons. The “Generate Volumes for Each Visible Overlay Volumetric Polygon” option will calculate the volume of the grid covered by every visible overlay polygon. Recall that a line defining these polygons need to be closed on the line’s General Tab and named on the line’s Volm Tab. If these polygons overlap, Petra will count the volume of the shared area twice. Setting this option to “Generate Volume For Entire Grid Only” will instead ignore visible polygons and calculate the volume over the entire grid.

**Compute Volumes Between**

The Minimum and Maximum Z values set limits on the overall volumetric calculation. Though these settings are critical when using a structure grid, the limits can also be useful when calculating volumetrics on thickness or “iso” maps. In particular, setting the limits can help to reduce the effect of a large, thin uneconomic area on the calculation.

**Horizontal Slice Volumes**

It’s also possible to calculate volumetrics for horizontal slices from the minimum z value to the maximum z value through the reservoir. In the example below, horizontal slices will be calculated for 0-10’ of thickness, 10-20’, 20-30’, and so on through the entire section. With large grids and small increments, this additional step can be fairly time-consuming.
Options Tab

The Options tab provides a few more options for the volumetrics calculation.

**Ignore Volume if Thickness is Less Than** - This option sets the minimum thickness necessary for Petra to consider in the volumetric calculation; anything below this thickness isn’t included. By default, this thickness cutoff is set at zero, which means that all the entire positive volume of the grid is used. Setting this thickness higher can help to reduce the influence of a large thin or uneconomic area. Note that the cutoff thickness is relative to the selected grid units – a 10’ cutoff applied to an isopach grid is very different than a 10’ cutoff applied to a HPV grid.

**Grid Refinement** - The Grid Refinement option breaks larger grid cells into smaller triangular areas. This slightly increases the accuracy of the volumetrics calculation at the cost of more computing time.

**Also Output Volumes to CSV File** - The "Also Output Volumes to CSV File" option writes a CSV file containing the name, area (both a total area of the polygon and the total area of the grid underneath the polygon), relevant calculated volume, an average grid thickness (if selected), the working interest, and the WSN of the polygon’s “designated well.” Petra creates a CSV file using the volumetric grid name in the project’s GRIDS directory. Using the example above, Petra creates a file named HPV.CSV. Leaving this CSV file open while trying to calculate a new volume (and thus export data to the same CSV file) can create an IO error.

**Print Average Value for each Polygon in Report** - This option simply calculates the average grid thickness for each visible named polygon. What this thickness actually
represents depends on the type of the grid used. The average Z value for a structure grid will be an average elevation rather than an average thickness.

Apply Working Interests Associated with Overlay Polygons - This option scales each volume inside a volumetrics polygon by the working interest.

Write Volumes to SHAPE FILE - This option saves currently visible volumetric polygons and data to a shape file. Select the option and navigate to the desired shape file. This copies all currently visible volumetric polygons to a single shape file.

Reserves Tab
The Reserves Tab selects the type of reserves calculation and specifies the type of input grid. The reserves types include basic volumes, recoverable oil in place, recoverable gas in place, coal bed methane, and coal tonnage. The map type tells Petra whether the input grid is an isopach, a pore volume map, or a hydrocarbon pore volume map. The Map Type only affects oil and gas reserve calculations. The options on the Reserves tab changes depending on the selected reservoir and map type. Similarly, the area and volume dropdowns at the bottom of the window show the relevant units for the specific reserves calculation.

Basic Volumes (No Scaling)
The simplest form of a volumetric calculation is the first option, “Basic Volumes (No Scaling).” This option simply calculates the volume occupied by the grid without any additional reservoir calculations. Note that the “Map Type” option has no effect on this calculation.

The “Basic Volume” calculation can display results in a variety of areas and formats. For area, the available units include raw units (as defined on the Units Tab), square feet, square meters, and acreage. For volume, the available units include raw units (as defined on the Units Tab), cubic feet, acre-feet, acre-meters, MBO, MMCF, and cubic meters.
Oil in Place with Recovery

Petra’s oil reserves calculations multiplies the total area of pore space occupied by hydrocarbons by a recovery factor. This volume is then divided by Bo to correct for differences in volume between hydrocarbons in the reservoir and the same hydrocarbon at surface conditions.

\[
\text{Recoverable Oil In Place: ROIP} = \frac{\text{Volume} \times \text{Por} \times (1 - \text{Sw}) \times \text{Rf}}{\text{Bo}}
\]

The three options for “Map Type” (isopach, pore volume, and hydrocarbon pore volume) simply tell Petra what the selected grid represents. Practically, the map type grays out irrelevant options.

An isopach grid just contains thickness and will need an average water saturation and porosity. A pore volume grid already contains the thickness and porosity information and just needs average water saturation. A hydrocarbon pore volume grids already contains all this information, and therefore needs no averaged porosity and saturation information.

The “Oil In Place with Recovery” calculation can display results in a variety of areas and formats. For area, the available units include raw units (as defined on the Units Tab), square feet, square meters, and acreage. For volume, the available units include raw units (as defined on the Units Tab), cubic feet, acre-feet, acre-meters, or MBO.
Petra’s oil reserves calculations multiplies the total area of pore space occupied by hydrocarbons by a recovery factor. This volume is then divided by Bg to correct for differences in volume between hydrocarbons in the reservoir and the same hydrocarbon at surface conditions.

\[
\text{Gas In Place: } \text{GIP} = \text{Volume} \times \text{Por} \times (1 - \text{Sw}) \times \text{Rf} / Bg
\]

Where \( Bg = \frac{\text{Patm}}{P} \times \left(\frac{460}{T} + 60\right) \times Z; \) \( \text{Patm} = 1 \)

The three options here for “Map Type” (isopach, pore volume, and hydrocarbon pore volume) simply tell Petra what the selected grid represents. Practically, the map type grays irrelevant options out.

An isopach grid just contains thickness and will need an average water saturation and porosity. A pore volume grid already contains the thickness and porosity information and just needs average water saturation. A hydrocarbon pore volume grids already contain all this information, and therefore needs no averaged porosity and saturation information.

The recoverable gas in place calculation also requires a compressibility factor, reservoir pressure, and reservoir temperature. **The calculation only uses the numbers on the imperial units side; SI units must be converted to imperial units.** Using imperial units is fairly simple – simply enter the reservoir pressure and temperature in PSI and °F into the boxes on the left (highlighted in yellow) To use SI units, enter in the pressure and temperature in kPAA and °C into the boxes on the right (not highlighted) and select the arrow buttons for bth pressure and temperature to convert to imperial units. After the SI pressure and temperature are converted, then compute the volumetrics normally.

The “Gas In Place with Recovery” calculation can display results in a variety of areas
and formats. For area, the available units include raw units (as defined on the Units Tab), square feet, square meters, and acreage. For volume, the calculation is limited to MMCF.

Coal Bed Methane (CBM) in Place with Recovery

The “CBM Gas in Place with Recovery” option calculates reserves for a coal bed methane field. Note that the “Map Type” option has no effect on these calculations, and the grid is always assumed to be an isopach grid.

CBM Gas In Place: CBMGIP = Volume*Cf*Gc*Sg*Rf

where Cf converts bulk density in g/cc to tons/acre-ft

The “Coal Gas In Place with Recovery” calculation displays results in a variety of areas and formats. For area, the available units include raw units (as defined on the Units Tab), square feet, square meters, and acreage. For volume, the calculation is limited to MMCF.
Coal Tonnage

Coal tonnage simply calculates the volumetrics of an isopach grid and multiplies this value by an average coal density.

Coal (Tons) = Volume*CoalDensity*62.42796061/2000 when density is in gm/cc
Coal (Tons) = Volume*CoalDensity/1000 when density is in kg/m3

The “Coal Tonnage” calculation displays results in a variety of areas and formats. For area, the available units include raw units (as defined on the Units Tab), square feet, square meters, and acreage. For volume, the calculation is limited to Tons (2,000 lbs).

Wells Tab
Petra can copy the volumetric data for each named polygon to a specific well’s designated zone and data item. Recall that each polygon’s designated well is established by double-clicking the polygon in the map module to open its Overlay Line Attributes screen (see Initial Polygon Setup above). The “Store Polygon Volume in Each Polygon’s Designated Well” option stores the calculated volume to the designated well.

The “Zone To Store Polygon Volume” dropdown simply sets the zone where the relevant volumetric data will be stored. By default, volumetric data is saved in the WELL zone. In the example below, data will be stored in the “VOLUMETRICS” zone.

The “Item to Store Polygon Volume” selects the specific data item where the relevant volume is stored. In the example below, data will be stored in the “GIP” zone.

The “Item to Store AVG Z” selects the specific pre-existing data item where the average grid thickness for each visible named polygon is stored. What this thickness actually represents depends on the type of the grid used. Note that the “Print Average Value for each Polygon in Report” option on the Options Tab needs to be selected for this option to work. In the example below, data will be stored in the “GIP” data item in the VOLUMETRICS zone.
Dir Tab

This tab simply sets the directory of available grids. By default, this option is set to the project’s GRIDS folder.

18.11 How to use the Histogram Module

The Histogram Module displays a histogram of log curve values. Put another way, the histogram visually shows the distribution of log curve values without respect to depth. These values can be limited to a specific depth or zone, or filtered by up to three separate “discriminator” log curves.
Opening the Histogram Module

On the Main Module, select Tools>Log Histogram from the menu bar at the top of the screen. Alternatively, select the button on the toolbar at the top of the Main Module. This opens the Histogram module. The first time this module is opened, the “Histogram Data Definition” screen superimposed over the main Histogram Module, which are both blank by default.

![Histogram Module](image)

Loading/Saving settings

To load or save histogram settings, select File>Load Settings... or File>Save Settings... on the menu bar at the top of the screen. Saving these settings creates a *.HS file that retains the selected curves, scales, and histogram settings.

The Histogram Module looks at the log data stored inside the project’s database, so the data is always live. Changing the curve data will change the appearance of the histogram, even after loading old settings.

Selecting Wells

It’s often useful to only work with a small subset of wells in a project. The Histogram Module can select wells in a few different ways available from Wells>Select on the menu bar at the top of the screen.

“All Wells” selects all wells available in the project. “By Data Criteria” selects wells based on a set of nested criteria including well header information, logs, or zone data.

“All Wells” selects all wells available in the project. “By Data Criteria” selects wells based on a set of nested criteria including well header information, logs, or zone data. “With Selected Curve” selects only the wells that have the currently selected log curve on the Log Curve Tab. “Cross Section Wells” selects the wells currently selected in the Cross Section Module. “Well From Main” selects the single well currently selected in the Main Module. “All Wells From Main” selects all wells currently selected in the Main Module.
To switch between wells, select either the desired well on the dropdown at the top of the Histogram Module or use the left and right arrows to scroll through the selected wells. PageUp and PageDwn also cycle through the set of wells.

Plot Single/Combine All Wells

Petra can either plot the log data points from a single well or from multiple wells in aggregate. To switch between these two modes, select Wells>Plot Single Well and Wells>Combine All Wells. Note that showing multiple wells will remove the curves displayed on the right side of the screen – after all, with log curve data from multiple wells, which well’s curve would you show?

Setting the Log Curve and Scale

On the menu bar at the top of the screen, select Logs>Axes and Scales... from the menu bar at the top of the screen. Alternatively, select the button on the top toolbar. This opens the Log Curve Tab on the Histogram Data Definition window.

The Log Curve tab controls the basic settings for the histogram plot. Here, add a title for the plot. Next, set the specific curve and scale. The “Log Scale” button sets the selected axis to a logarithmic scale. By default, Petra displays the curve scale increasing from left to right; the “Reverse Curve Display.”

The “Default Scale Range” button sets the minimum and maximum scale for the log based on the curve’s established minimum and maximum scale. The “Statistical Scale Range” button sets the minimum and maximum scale based on the minimum and maximum data value in the data.

The example below plots a histogram of gamma ray curve values, where the GR displayed from 0 to 150 API units. Note that the “Use Log Aliases” button is selected, so Petra will use the GR curve’s alias list.
Setting Depths

It’s often useful to limit the histogram’s data points to a specific interval of interest. Data points can be constrained by zone definition, tops, or by a specified depth (MD or TVD). On the menu bar at the top of the screen, select Depths>Set Depths… from the menu bar at the top of the screen. Alternatively, select the button on the toolbar at the top of the Histogram Module. This opens the Depths Tab on the Histogram Data Definition screen.

To set depths by a zone’s interval definitions, select the desired zone on the “Select Zone(s)” list. Next, select the desired zone. Note that the WELL zone by default covers -1M MD to +1M MD, so it should cover the entire footage of all wells. If the tops used in the zone interval definition are missing for a well, Petra will not display the histogram for that well.
To set depths by tops or by a specific depth range, select the “Set Depth From Range” button. Next, select the “Set Range” button. In the Set Depth Range box, select the relevant top, MD, or TV Depth button. For MD and TVD, select the relevant button and enter the adjacent depth in the entry field. For tops, select the desired top from the “Fm Top Name” dropdown box. Notice that an offset can also be added or subtracted to the fm top; this offset will include data points above or below the actual fm top depth.

The histogram below is limited only to the area defined by two tops – it’s 20’ above the 2ND_WALL_CREEK and 20’ below the 2ND_WALL_CREEK_BASE. The histogram is limited to a sand bracketed by shale, so the histogram shows a bimodal distribution of the two distinct lithologies’ gamma values.

Modifying the Histogram

Histogram Cells
The “Number of Histogram Cells” varies the number of “cells” (otherwise known as “bins”) on Petra’s histogram. In the example on the left, the histogram uses 25 cells (from 0-150 API units, so each contains a spread of 6 API units). The example on the left, on the other hand, uses 75 cells where each cell is only 2 API units wide. It’s worth noting that there’s no “best” number of cells for a histogram; different numbers of cells can reveal different things about the data.

Other Options

The “Maximum Samples Per Cell” and “Compute Maximum Samples from Data” options on the Histogram Tab set the scaling for the vertical frequency axis. The “Compute Maximum Samples from Data” option automatically sets the vertical frequency scale to the largest frequency value. To change this scaling, deselect the “Compute Maximum Samples from Data.” The “Maximum Samples Per Cell” manually sets the upper limit of the frequency plot.

The “Show Mean and Std Dev on Histogram” option calculates the arithmetic mean (or average) plus and minus one standard deviation of the log values. These three lines are displayed as vertical dashed lines on the plot. The actual values for the mean, standard deviation (labeled as “SD”), and mode are listed on the bottom of the graph. The example on the left has no statistics, while the example below on the right has the mean and standard deviation added.
The “Color Fill Histogram Cells” option simply fills in the histogram cells; removing this option just leaves outlines for each cell.

Histogram Types

The “Histogram Types” box sets the histogram’s general plot type: Standard, Cumulative, or “Greater Than” Freq Plot. The Standard plot displays the total number of values (or “frequency”) for each cell. The Cumulative plot shows the total number of values for each bin plus all preceding bins. Similar to a Cumulative plot, the “Greater Than” Freq Plot shows the percentage of values greater than any one bin.
Filtering the Histogram by other Log Curves

Discriminator curves filter data points by log criteria. To use a discriminator curve, select the desired curve on the dropdowns, and set the scale using the Minimum and Maximum. Data points with values that fall outside of this data criteria are not included on the cross plot. In the example below, only gamma values with an associated resistivity log of 10 to 100 will be included on the histogram.

The “Include Discriminators Logs When Plotting Log Curves” shows the discriminator curve or curves against the log curve on the right.

With a discriminator curve, the histogram shows a much tighter spread of gamma values since these resistivity cutoff excludes the shales above and below the sand. Note how the “RILD” discriminator curve is displayed to the right of the log curve. Discriminator curve values outside the minimum and maximum scale values will show up as a straight line on the edge of the log window.
Adding Tops to the Offset

The log curves on the right side of the screen can also show tops, which can help orient the user. First, open the Histogram data Data Definition screen by selecting Logs>Axes and Scales… from the menu bar at the top of the screen or the button on the toolbar. Select the Tops Tab.

To add a top, highlight the desired top name in the "Available Tops" list and click the add button (">"). This moves the log over to the “Selected Tops” list. To remove a top, highlight the top name in the “Selected Tops” list and click the remove button ("<"). The “>>” and “<<” buttons add all tops and remove all tops, respectively. To change the color of a top, select the top on the “Selected Tops” list and select the desired color using the color box on the right.

The example below adds the “2ND_WALL_CREEK” and “2ND_WALL_CREEK_BASE” tops to the display.
Picks

“Picks” are database-stored curve values. Picks are most commonly used for log curve normalization, such as scaling all gamma ray values in a project to set “sand” and “shale” values. Commonly, picks are first created for the entire project from statistical measurements, and the histogram module is used to visually inspect and QC the pick relative to the actual curve.

When working with picks, it’s usually a good idea make sure the “CrossHair Cursor” option is on. When this option is selected, (Display>CrossHair Cursor on the menu bar at the top of the screen), Petra draws a vertical line on the correlation log that corresponds to the cursor’s location on the histogram. This can make it significantly easier to see the relationship between the histogram value and the log.

Displaying Existing Picks

On the menu bar at the top of the screen, select Picks>Define Picks from the menu bar at the top of the screen. Alternatively, select the button from the Picks toolbar at the top of the screen. This opens the Define Histogram Picks window. Here, select an existing zone data item with the zone (top) and data item (bottom) in the “Available Zone Items” box.

The example below shows two picks: “PC10GR” and “PC90GR.” Both of these picks are log statistics created in the Main Module (Compute>From Logs>Statistics…), where “PC10GR” is the curve’s 10th percentile, and “PC90GR” is
the curve’s 90th percentile.

The picks for each well will then be displayed on the histogram. The examples below show two different wells. Since wells are logged with different tools at different times, the picks are slightly different. The well on the left has a smaller difference between the 10th percentile sand and the 90th percentile shales than the well on the left.

Creating New Picks

To create a new data item in the selected zone, select the button in the “Define Histogram Picks” window. Select the button to add the data item to the “Selected Picks” list in the lower left corner of the window. Note that new zone data items won’t have any data, so no picks will immediately appear.

Modifying Picks

To modify a displayed pick, in the main Histogram Module window select the desired pick from the dropdown on the Picks toolbar, and select the “Start” button.
Select the new location of the pick on the histogram. As mentioned above, the “CrossHair Cursor” draws a vertical line on the log to show the histogram’s value relative to the curve. Left click to set the selected pick. Next, right click to open a set of options. These options include: Next Well, Prev Well, Redraw, End Picking, Delete Picking. Selecting “Next Well” and “Prev Well” saves the pick change and scrolls through the wells selected in the Histogram module. “Redraw” saves the pick change, refreshes the screen to reflect the changes, and leaves the pick tool active. “End Picking” saves the pick change and deactivates the picking tool, but does not refresh the screen. “Delete Pick” erases the pick value entirely, leaving a null value in the database for that well.

18.12 How to Digitize a Raster Log

Raster logs are scanned copies of paper logs saved as image files. Digital logs, on the other hand, store log values in a form that is directly readable by a computer. Digital logs have several advantages over raster logs: they’re more easily stored in Petra’s database, look great in a cross section, and can be calibrated and used in calculations. Converting a raster log into a digital log is called “digitizing.”

Going from a simple image file to a digital log involves two major steps: depth calibrating the raster image, and tracing the desired log curve. This guide walks through depth calibrating and digitizing the GR curve on the D-122 well in the TUTORIAL project.

Depth-Calibrating the Raster Image

Raster logs are scanned copies of paper logs saved as image files. Petra needs to know what part of the image corresponds to which depth in order to assign values during digitizing. Most commercial data vendors depth register their data, but images directly from scanners and state providers are not depth calibrated.

The first step to calibrating a raster is to select the correct well in the Main Module. For this example, select the D-122 well in the Main Module.
The Raster Calibration Screen

To start calibrating a raster log, open the raster calibration screen. In the Main Module, click on the “Assign/Calibrate” button on the Rasters Tab. This opens the “Calibrate Log Image” screen. Notice that the selected well’s UWI and name appear on the screen.

NEEDS New Image
Next, open an image file by going to File>Open Image on the menu bar. Navigate to the specific image file and select it. By default, the D-122’s raster log will be located here C:\geoplus1\Projects\TUTORIAL\IMAGES\D-122.TIF. It might be useful to use the zoom buttons (Zoom →↑↓) on the upper right corner of the window to make the image larger or smaller.
Group Names

All raster images are assigned “group names.” A group name usually describes the log type (like “Resistivity”) and/or scaling (1”, 2”, or “5”) of a log image. Select the appropriate image group from the "Image Group Name" drop-down list. To add a new group, click the “+” button next to the group names dropdown box (highlighted in red in the example below) or to Group>Add or Delete Groups... on the menu bar. Since the raster image is a resistivity log, add a “Resistivity” group.

When selecting or creating group names, it’s generally better to aim for fewer, more general group names rather than create many precise group names. The more group names in a project, the tougher it will be to display cross-sections later.

The Depth Calibration Toolbar

Though most of the tools to calibrate logs are available from the menu bar at the top
of the screen, the quickest and easiest way to calibrate a raster log is to use the Depth Calibration Toolbar (highlighted in blue in the example above). To turn on this toolbar, go to View>Depth Calibration Toolbar on the menu bar.

Define the Calibration Depths
As mentioned above, Petra needs computer-recognizable depths to be assigned to depths printed on the log. This process involves picking 2 or more depth calibration points from the image. Only the log between the top and bottom depth calibration point can be digitized or shown on a cross-section.

To create a new calibration depth, click the “Add” button on the Calibration Tool Bar. Alternatively, go to Edit>Add Depth Point on the menu bar. Next, position the horizontal cursor at the depth you wish to pick and click the left mouse button. You will be prompted for the depth value. After entering the depth value, the screen will redraw showing the new calibration depth point. Repeat the process for each new depth calibration point.

To change the location of the depth, click and drag the depth calibration point using the left mouse button. To edit the value of an existing depth, click on the depth calibration point with the right mouse button and enter a new value.

The better the quality of the raster log, the fewer points necessary to depth calibrate the image. Most raster logs only really need a handful of points. Petra also automatically scales and places reference black lines every 100’. Unlike normal red calibration lines, these cannot be moved – they just show Petra’s scaling between
your calibration lines. If these black lines look close to the actual image, your calibration points are sufficient. If the thin black calibration lines are off of the depths printed on the raster log, add new points or adjust your existing depth calibration points.

Deleting Calibration Depths
To delete an individual depth calibration point, click the “Drop” button on the Calibration Tool Bar. Alternatively, go to Edit>Delete Depth on the menu bar. After selecting this tool, click the left mouse button on the depth marker to be deleted. The screen will redraw once the marker is deleted.

You can also delete all depth calibration points by going to Edit>Delete All Depths... on the menu bar.

Interpolating Depths
Petra can interpolate and create calibration depth points between the uppermost and lowermost calibrated depths. Since Petra already scales between registered depths, adding a lot of new points generally does not aid in the overall calibration of the raster log.

After creating two or more depth calibration points, click the “Interp…” button on the Depth Calibration Toolbar or go to Edit>Interpolate Depths on the menu bar. Select the interpolation increment, and Petra will compute depths at your specified interval between the top and bottom depth calibration point.

Saving Calibrations
Though it’s not strictly necessary for digitizing, this is a good point to save the calibration. A calibration file stores information like depth calibration points and edges, raster image file name, and group name. Saving a calibration file also updates the Petra database to link the image and group name with the currently selected well.

Click the “Save Calibration As…” button at the top of the screen:  
Alternatively, go to File>Save Calibration As... on the menu bar. This brings up the “Save File As” box. It’s generally best to use the default name and to store the calibration file in the same folder as the image.

After saving the file, the group name will now show up on the Rasters Tab in the Main Module, and you will be able to plot the raster in a cross section.
Digitizing the Curve

Turn On the Curve Digitizing Toolbar

Once the raster image is open, select View>Curve Digitizing Toolbar on the menu bar at the top of the screen to toggle the toolbar on and off. It will appear on the right side of the screen.

Select the Digital Log Curve and Scale

The next step is to tell Petra the curve name and the scale for the log to digitize. Select the red “Set Curve” button at the top of the digitizing tool bar.

This button opens up the “Log Digitization Details” window. In the “Log Curve to Digitize” dropdown box, select an existing curve or enter a new curve name. This curve name will be the name of your digital log, so be careful about replacing an existing digital log for the selected well. Next, specify the curve values for the left and right sides of the track boundary. For curves on a logarithmic scale, such as resistivity, make sure to select the “Use Log10 Scale” button.
For this example, we'll digitize the gamma ray curve. Notice that the footer of the D-122 log states that the GR curve is has a micrograms radium-equivalent/ton scale from 0.8 to 8.8. In order to distinguish it from a more traditional gamma curve, it is named “GR_RAEQ.” The track boundaries are set below – just like on the footer, the scales go from 0.8 to 8.8. The actual raster log wraps when the count exceeds that 8.8, but that's easy to deal with later.

Notice that the same scale box on the digitizing toolbar now shows the name of the curve to be digitized and the scale.

Set the Left and Right Track Edge

The next step is to set the left and right edges of the track containing the curve to be digitized. Petra uses these lines to calculate a numerical value for the digital log. Notice that the footer of the log states that the curve's scale is from 0.8 to 8.8. The left and right digitizing track edges will tell Petra where 0.8 and 8.8 are, with digitized points in the middle scaled accordingly. As an example, a digitized point halfway between the left and right track edges will be stored as 4.8.

To set digitizing tracks, select the “Left” and “Right” buttons in the Tracks box on the digitizing toolbar and then click on the respective track boundary. Remember that digitizing tracks (in the blue box on the left side of the screen) are different than track...
edges.

In the example below, the left and right digitizing track edges (in red) are around the first track containing the gamma ray curve.

Raster logs are often curved due to paper stretching or slipping during scanning. Crooked logs mean inaccurate digital logs. To handle crooked rasters, you can either straighten the whole image, or adjust the left and right track boundaries.

Straightening the whole image has two advantages. You only have to adjust one track straight edge instead of two separate track boundaries, and you can save your work as a new copy of the straightened raster image. If you’re digitizing multiple tracks on the same raster log or a fairly long section, straightening the whole image will ultimately save time. For information on how to straighten a raster log, see here.

The other way of dealing with crooked raster logs is to adjust the left and right digitizing track lines. Both the left and right track edges have control nodes at every calibration depth. You can move these control points with the left mouse button to align track edges with the image. The advantage to this method is that it saves a step and eliminates the need to store multiple copies of the raster image. Simply adjusting track boundaries is easier for short digitizing runs on straight raster images.
Draw the Digitizing Line

The next step is to actually trace the log curve with a digitizing line. As mentioned above, Petra reads these lines and compares them to the track boundaries in order to calculate a digital log value for each depth.

There are two major ways to draw these lines: Manual and Automatic.

Draw the Digitizing Line - Manual

To manually digitize log curves, first click the “Start” button on the Digitize section of the digitizing toolbar.

The Log Digitization Details box will reappear to confirm the settings on the log and scale. Here, you can also select the digitizing style. The default drawing style is that every left click creates one control point on a digitizing line. You can also select “Stylus Mode”, which continually records points at the specified increment when you hold down the left mouse button. In the example below, the stylus mode will create a point every half foot. Select OK to keep the log settings and the pick mode and return to the raster image.
The next step is to draw the digitizing line. In stylus mode, click and hold the left mouse button to continually record points. If using point and click mode, simply click on top of the curve to create points and draw a line. If in point and click mode, you can temporarily activate the stylus mode by holding down the ALT key.

Notice that on the bottom of the screen Petra shows the depth and the value of the curve at the mouse position. These are the values going into the digital log, so it’s a good idea to check this in the beginning to make sure the curve and depth values are reasonable.

To stop tracing the digitizing line, click the “Stop” button on the Digitize section of the toolbar or right click the mouse. Digitizing lines are divided into independent segments. Each time you select “Start” during manual digitizing, Petra brings up the Log Digitization screen and you create a new curve segment with its own scale. Selecting “Continue”, on the other hand, just adds more points to the existing curve segment at the same scale. You can have as many or as few curve segments as you want. For more on curve segments, see “Editing Curve Segments” below.

IF YOU MAKE A MISTAKE, you can either immediately stop and fix the mistake or wait until the end. To fix a mistake you can either individually select and move control points (see “Editing Curve Segments” below), or simply select “Continue” and draw over the mistake.

Draw the Digitizing Line - Automatic
Petra can also automatically follow and trace simple, bold, well-defined curves.

First, select the "Start" button under the "Auto" section, then click on the uppermost point on the curve to be digitized. The auto tracer will attempt to follow the densest portion of the log beginning at the selected point. You can press the ESC key or click the left mouse button to stop the auto tracer. The "Manual" button allows you to manually re-digitize over section not properly handled by the auto tracer.

The "Set" button displays a screen for setting properties controlling the auto tracer.

**Pick Aperture** - When automatically digitizing a curve, Petra looks for the darkest adjacent point within a window or aperture. The pick aperture sets the size of this window, which is by default 10 pixels wide by 5 pixels tall.

**Sample Increment** – This determines how many nodes will be created for a given foot of log. In the example below, the increment is set for 0.5, so one point will be created at every half foot. Note that this increment just determines the how smooth the traced line will be. The sample rate of the digital curve is independent of this number.

**Maximum Feet (Mtrs) To Digitize per Pick** - This option sets the maximum distance Petra will digitize a line. Limiting line length prevents Petra from getting stuck on the wrong line and creating a large mess.

**Maximum Duplicate X or Y before Stopping** - If Petra starts tracing a straight line, odds are good that Petra is following either a horizontal or vertical grid line. This sets the maximum number of duplicate pixels Petra will allow before stopping.

**Image Filtering**

There are a few tricks that can help with auto digitizing. Since the tracing algorithm looks for adjacent dark pixels, it can easily get confused by vertical scale lines and horizontal depth lines. Petra can filter out straight horizontal and vertical lines. This process modifies your image file, so be sure not to save over the original image file.
and have a backup. Both of these filters can reduce the clarity of the curves as well, especially where the curves intersect the filtered horizontal or vertical lines. To restore the filtered lines select File>Reload Original Image.

**Edit>Filter>Remove Vertical Lines**

**Edit>Filter>Remove Horizontal Lines**
Changing the Track Scales (Curve Wrapping)

Whenever the curve on the raster image reaches a track edge, the scale will "wrap" and the curve will reappear on the opposite side of the track. At this point, you will need to stop digitizing and change the scale. The left and right side track scale is displayed near the top of the Digitize Toolbar.

Each curve scale range is displayed in a different color beginning with red for the base scale. There are 6 colors defined above and below the base scale. To increase the scale range and wrap the curve, click on either the button or on the right side scale value. To decrease the scale range and shift the scale to the left, click on either the button or on the left side scale value.

In the example below, the GR curve has started reading above 8.8, and has “wrapped” around the scale. At this point, right-click or select “Stop.”
Next, click the arrow to wrap the digitizing scale to the right from 0.8-8.8 to 8.8-16.8 and select “Continue” to digitize the wrapped section of the curve. Note that the digitizing line skips a saddle in between the two hot highs; it’s perfectly reasonable to skip a section and come back to it later. Notice in the example below that the digitizing scale and the digitizing line are pink to show that they are on a 8.8-16.8 scale.
Right click or select “Stop” to stop digitizing. Click the button to wrap the scale back to 0.8-8.8 scale and select “Continue.” Notice that the digitizing line color has returned to red. Make sure to fill in the saddle in between the two high gamma count spikes.
Scale wrapping also works for the automatic tracer. When it detects that the curve has run into the track edge, it will ask if you want it to automatically adjust the curve scale. In the example below, the automatic digitizer has spotted the track edge. Selecting “Yes” will stop the digitizer and automatically wrap the scale for you. The next step is to click on the uppermost part of the wrapped curve.

Editing a Curve Segment
As mentioned above, digitizing lines are divided into segments. Every time you press “Start” for either manual or automatic digitizing, you create a new line segment. Each segment has its own scale and can be shifted left and right or up and down independently of any other segment.
Selecting a Curve Segment - To edit a curve segment, first click the “Select” button on the red “Edit” toolbar. Alternatively, double-click on the curve segment. Selecting a line segment shows each of the control points as small rectangles. To deselect a segment, click the right mouse button. In the example below, there are two curve segments. The top segment is selected, which shows all the control points for that line.

Moving Curve Segment Points - Once a curve segment is selected, you can individually move any control point. Simply left click and drag the control point to its new position. Right clicking deselects the curve segment to show the newly edited curve.

Deleting a Curve Segment - To delete the selected curve section, either click on the "Delete" toolbar button or press the Delete key on the keyboard. Remember that this deletes the entire curve segment. If you accidentally delete something, use the Undo Button on the Edit toolbar.
Changing Curve Scale Range - To change a curve segment’s scale range, first set the correct scale range at the top of the digitizing toolbar. Next, select the segment and click the "Scale" button. The curve section will then be set to the scale shown on the top of the scale bar.

Breaking a Curve Segment - You can break a segment into two segments. First, select the segment. Then, hold down the CTRL-key and click on a segment control point. All points ABOVE the picked point will become unselected. They are now part of a different segment.

Breaking and Deleting Part of a Segment - You can also break a segment into two segments then delete the bottom portion. First, select the segment. Then, hold down the CTRL and ALT-keys together and click on a segment control point. All points BELOW the picked point will be deleted.

Using the Delete Rectangle - You can draw a rectangle to delete intermediate points of the selected curve segment. First, select a curve segment. Next, hold down the SHIFT-key and click and drag to form a rectangle. All points within the depth range of the rectangle will be deleted. The segment will be de-selected and two new segments will be formed.

Deleting ALL Curve Segments - Click on the "Clear" tool bar button in the Edit section to delete all curve segments.

Merging of Curve Segments - Normally, when a curve segment is digitized over the same depth interval as a previous curve segment, the new segment is automatically merged into the earlier segment. Merging prevents having multiple segments over the same depth interval. Segments will not be merged when the auto-trace function is used or when the "wrap" settings are different. You can manually merge segments by first selecting a curve segment then press the F5 function key.

Bulk Shifting a Curve Segment - Sometimes it’s useful to shift an entire curve segment. To move an entire curve segment at one time, first select the segment. Next, select one of the arrow buttons in the “Shift” toolbar. This moves the entire segment in the direction of the arrow.

Saving and Loading Your Work-In-Progress
You can save the digitized curve segments to an external file. This file stores both the digitizing line and digitizing track settings, but not depth-calibration lines. This is useful for creating a backup on a long digitizing project or for when you need to change gears and work on something else.

Store a Curve to the Database
The final step of digitizing a raster log is to store the traced line as a digital log. In
this step, the curve segments are resampled to the specified sample rate and merged together. When segments overlap in depth, earlier segments are replaced by later ones. In other words, where lines overlap, Petra will use the last drawn line. Once stored, the digital curve is available in Petra’s database for drawing in cross sections or calculations.

To store a curve, select the “Store” button on the blue “Curve” toolbar. This brings up the Log Digitization Details box. First, select the digital curve name you want the curve stored as. In the example below, we’ll stick with “GR_RAEQ.”

Notice that the options under “Track boundaries” are greyed out – since each segment stores its own scale, there’s no need to change this.

Next, set the depth sample rate, which just sets how many samples will be stored per unit of depth. The default is 1 foot, as shown in the example below. If you’ll be using this log for calculations with other logs, make sure that this number matches the sample rate of your other digital logs. Most digital logs are stored on a half foot sample rate.

Next, set the Database Curve Update Mode. If there’s already a curve stored with the same curve name, this determines how the digitized log will be stored. “Replace Curve” will completely erase the old digital log and replace it with the new digitized curve. “Merge With Curve” will keep the old log and only replace the sections you’ve digitized.

Finally, set the curve interpolation method. The linear method draws a straight line between control points, while a spline attempts to fit a curve between control points. The interpolation method on the main screen is linear, so most people digitizing already account for that when picking points. In other words, people mostly place the points close enough together for a linear interpolation to accurately trace the curve line.
The now digitized log now appears in Petra’s database, and can be used for calculations or display. In the example below, notice how GR_RAEQ now has a value for every depth.
Loading a Curve from the Database

The "Load" button under the "Curve" section lets you load a digital log curve from the database to display on top of a depth-registered raster curve. This is particularly useful for doing quality control on someone else’s digitizing work.

First, set the left and right track scales. Next, select the red “Scale” button at the top of the digitizing toolbar.

Next, select the pre-existing digital log curve on the “Log Curve to Digitize” dropdown menu. This is the log you’ll load into the digitizing screen. Select OK.

Finally, select the “Load” button on the “Curve” toolbar. This will replace any digitizing lines on the main screen with the digital data from the selected curve in the database.

Starting Another Curve

If you want to digitize more than one curve, you will need to use the "Edit>Clear" button on the toolbar. This will remove previously digitized segments from memory so
they don't get stored as part of the new curve.
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