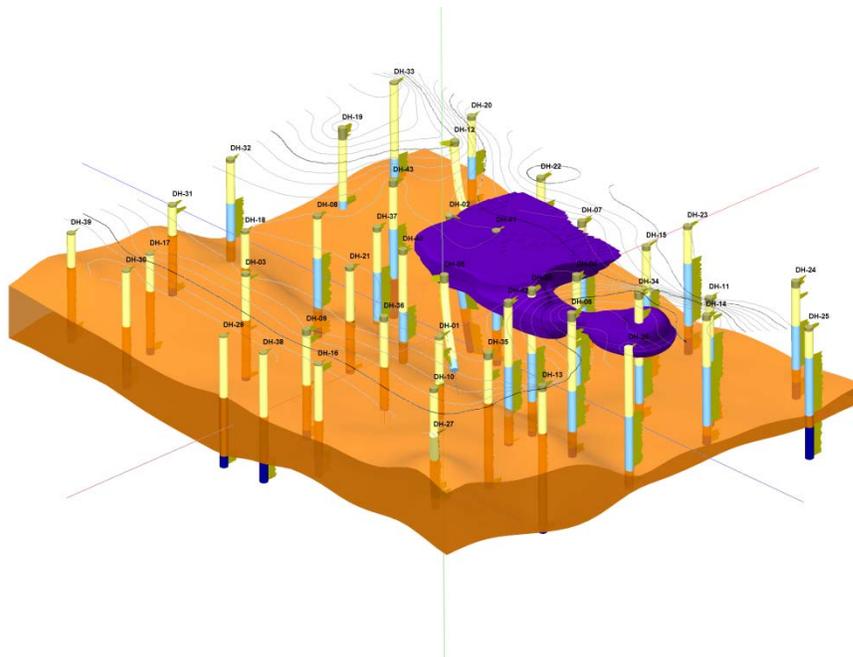


# RockWorks<sup>®</sup>15



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See complete terms of the license agreement during the installation of the software.

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## Welcome

RockWorks is an integrated software package for geological data management, analysis, and visualization. RockWorks specializes in **visualization of subsurface data** as logs, cross sections, fence diagrams, solid models, structural and isopach maps in both 2D and dynamic 3D windows.

The **borehole data manager** is used for easy entry of well data: geophysical / geotechnical / geochemical measurements, observed lithologies, stratigraphic contacts, water levels, fractures, downhole well surveys, all in linked database tables. From this data you can create point, contour, plan-view, and lithology/stratigraphy surface (geology) maps; logs; cross sections; and profiles. In addition there's an assortment of 3D diagrams: logs, surfaces, fence diagrams, and solid models.

RockWorks also contains a "flat" spreadsheet-style data window for use with the program's **RockWorks Utilities**: basic gridding and contouring, solid modeling, volumetrics, hydrology and hydrochemistry tools (drawdown & flow diagrams, Piper and Stiff diagrams), 2D and 3D feature analysis (rose and stereonet diagrams, lineation maps and densities), statistical computations and diagrams (histograms, scatterplots, ternary plots), survey mapping, coordinate conversions, and more. The RockWorks Utilities portion of the program can be purchased separately.

There are three graphic display windows in RockWorks. **RockPlot2D** displays 2-dimensional, "flat" images such as maps, logs, and cross sections. It offers save, export, and printing tools, as well as on-screen editing, drawing, digitizing and measurement tools. **RockPlot3D** is an interactive graphic display window that utilizes OpenGL for easy visualization of 3D images such as logs, fence diagrams, solid models, and 3D surfaces. It provides interactive rotation, panning, zooming, and layering of different images. Adjust lighting, filter solids, adjust colors, append images easily and quickly. View volumes instantly on the screen. **ReportWorks** is used to lay out pages for display and print. Insert RockPlot graphics (maps, cross sections, logs, diagrams, etc.) and raster images, draw scale bars and shapes, add text and legends, and more. Print and export tools take your RockWorks images to presentation stage quickly and easily.

**Upgrading?** See also page 25 for version-specific notices. Be sure to look at the "What's New" section (page 12). All previous users should refer to "A Brief Tour" on page 12.

## What's in this Book, and What's Not

Most of the documentation for the program is available in the Help messages which are built right into the program and are accessible via the **Help** menu, as well as within each of the program options windows. Since the Help has well over 1000 pages of material, we won't duplicate that information here, for obvious reasons. Instead, we'll try to offer general summaries of program function. We'll also direct you to the Help system:

? Watch for this symbol – it will direct you where to find more information in the Help system.

See also page 27.

## System Requirements

The minimum system requirements for RockWorks may vary, depending on the type of data you will be processing and the types of diagrams you will be creating and viewing.

In general, the more RAM, the faster the processor, the newer the operating system, the better. Here is our minimum recommended system setup for use of RockWorks:

Windows2000, NT, XP, Vista, or Windows 7.

(Windows98 & Windows ME are not supported.)

1 GB + of RAM

1.4 GHz or faster CPU.

Plenty of free disk space.

Display set to GREATER than 800 x 600 pixels.

? Index: Database: specifications

## Installing, Licensing, Starting Up, Uninstalling (all that)

### Installing RockWorks

RockWorks can be installed either from a RockWare-supplied CD or from a file you've downloaded from our web site.

! Downloading the installation program from RockWare's web site is recommended since the version on the web is always the most recent build. Just go to [www.rockware.com](http://www.rockware.com) and select the Downloads / Product Updates menu.

! ***You will need administrator level access to your computer to run the installation and licensing programs.***

### Install RockWorks from a CD

! Skip this step if you have already downloaded the installation program from the internet and don't wish to overwrite it with what may be an older version on the CD.

To install RockWorks from a RockWare-supplied CD, follow these steps:

1. Insert the CD into the CD drive of your computer. The CD menu program should start up automatically.

(If it does not, use Windows Explorer to browse for the CD drive. Double-click on the "setupcd" program in the root of the CD to start up the CD menu program.)

2. The CD menu program will display a variety of different programs that you can install as demos or "trialware" in addition to RockWorks. For now, simply select RockWorks from the menu along the left. You should see a description about the program in the pane to the right. Click the **Install Software** button in that pane to start the installation.
3. Follow the recommended installation settings. To proceed to the next screen at each installation step, click on the **Next** button. Should you need to go back to a previous window, click on the **Back** button. To cancel the installation entirely, click **Cancel**. **! Be sure to read the contents of the displayed license agreement. Click the **Accept** or **Do Not Accept** button as appropriate. If you choose the latter the installation will halt. Contact RockWare if you need additional information about our license agreement.**
4. When the installation is complete, the licensing program will start up automatically. Refer to Licensing RockWorks (page 4) for information about how to set up the licensing.
5. If you have purchased the software, please fill out the registration card for your license, or register online at [www.rockware.com](http://www.rockware.com) in the Support / Register Software page.

### Install RockWorks from the RockWare Website

If you wish to download and install RockWorks from our website, follow these steps:

1. Access the RockWare website: [www.rockware.com](http://www.rockware.com)
2. Click on the "Downloads" menu at the top of the home page, and choose Product Updates.
3. Find the RockWorks15 item, click the small "Download" link below it.
4. When requested, save the downloaded file ("rockwork15\_installation.exe") on your computer's Desktop (or other desired location).
5. When the download is complete, click the browser's **Run** or **Open** button. Or, you can use Windows Explorer to locate the downloaded file, and double-click on it to start up the RockWorks installation program.
6. Follow the recommended installation settings. To progress to the next screen at each installation step, click on the **Next** button. To go back to a previous window, click on the **Back** button. To cancel the installation entirely, click **Cancel**. **! Be sure to read the contents of the displayed license agreement. Click the **Accept** or **Do Not Accept** button as appropriate. If you choose the latter the installation will halt. Contact RockWare if you need additional information about our license agreement.**
7. When the installation is complete, the licensing program will start up automatically. Refer to page 4 for information about how to set up the licensing.

## Re-Installing RockWorks

RockWare releases updates to the RockWorks program when new features are added, problems are fixed, etc. These new revisions are posted to our website. They'll also be included on the next pressing of the RockWare CD. Like the original program, the updates can be installed from a CD or from an internet download.

To re-install RockWorks, you should follow the same instructions as listed in the previous two topics for step-by-step instructions about installing. You can install right over the top of the existing copy of the program.

! Re-installing should not require a new unlocking code.

**Do not** uninstall the program prior to re-installing because the licensing will be lost.

You can set up automatic notification of updates in **Tools / General Preferences**.

Check out the **Help / Download & Install** options in RockWorks itself.

## Licensing RockWorks

After running the installation program, the next step is to license the software. You'll see a screen that lists two important things:

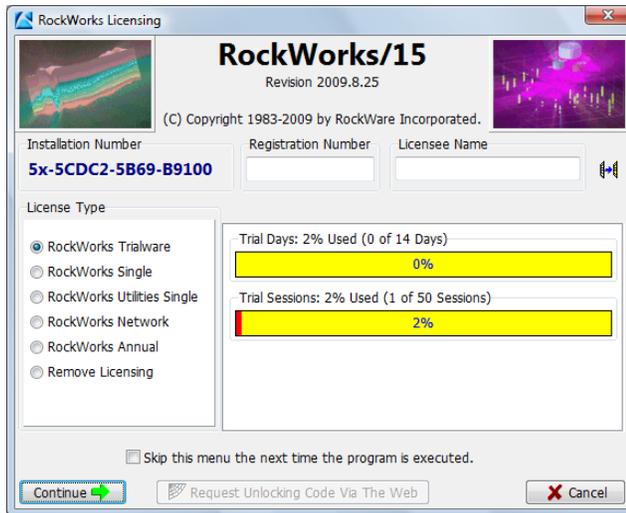
- An **Installation Number**: This is a number that's generated by the RockWorks program itself when it's first started. It is unique to each computer.
- A number of licensing options.

Choose the type of license to be set up at this time, as described in the following topics.

### Trial Mode

**RockWorks Trialware**: Choose this option in the licensing screen to run the full RockWorks for a two week trial period. Use this mode to test out the program or to use the program while you wait for your unlocking code or network license file.

The screen will show you the number of days and sessions left in your trial period.

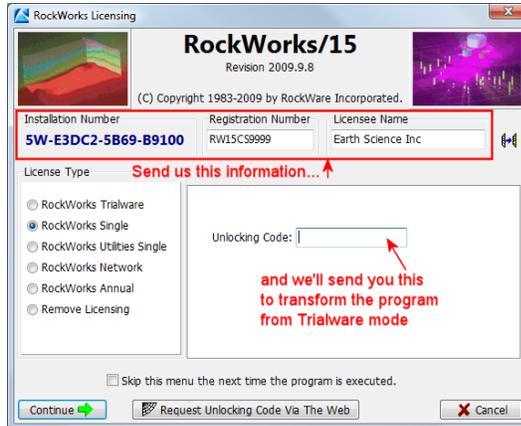


1. Click the **Continue** button to proceed into the program. (See Starting Up, page 10.)
2. If the trial days and sessions are used up you may be able to receive an extension code to extend the period. Contact RockWare for details.

### RockWorks Single License

Choose the **RockWorks Single** license type if you purchased a Single license of the full RockWorks program. With this license type, the software can be installed onto a single computer and the complete RockWorks program can be used by anyone who uses that computer. Running in this mode requires an "unlocking code" that is supplied by RockWare.

- ! You must have standard user or higher privileges (e.g. administrator) to unlock the Single license. Restricted users should contact their system administrator.



1. Enter the requested information.

**Licensee Name:** Type in your organization's name. This will be displayed in the program's startup screen.

**Registration Number:** Type into this field the letters and numbers that are printed on a sticker on the CD, User Manual, registration card, and/or receipt you received from RockWare. The registration number might start with the characters RW15CS or RW15AS. Contact RockWare if you can't locate this number.

2. Contact RockWare for your machine-specific **Unlocking Code**. You'll need to send us the Installation Number, the Registration Number, the Licensee Name, and your contact information.

Tip: Click the  button to copy the Installation Number, Licensee Name, and Registration Number from the startup screen to the Windows clipboard.

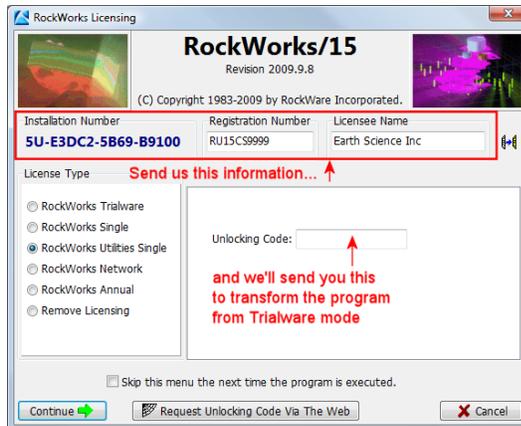
Tip: If you need to wait for your unlocking code, go ahead and run the program in trial mode, described above. All work done in trial mode is fully usable once you license the program.

3. When you receive your unlocking code from RockWare, type it into the **Unlocking Code** prompt.
4. Click the **Continue** button to proceed into the program. See Starting Up RockWorks (page 10).

## RockWorks Utilities Single License

**RockWorks Utilities Single:** Choose this if you purchased a Single license of the RockWorks Utilities portion of the program. With this license type, the software can be installed onto a single computer and the RockWorks Utilities portion of the program can be used by anyone who uses that computer. Running in this mode requires an "unlocking code" that is supplied by RockWare.

- ! You must have standard user or higher privileges (e.g. administrator) to unlock the Single license. Restricted users should contact their system administrator.



RockWorks Licensing

**RockWorks/15**  
Revision 2009.9.8

(C) Copyright 1983-2009 by RockWare Incorporated.

Installation Number <b>SU-E3DC2-5B69-B9100</b>	Registration Number RU15CS9999	Licensee Name Earth Science Inc
---	-----------------------------------	------------------------------------

License Type **Send us this information...**

RockWorks Trialware  
 RockWorks Single  
 RockWorks Utilities Single  
 RockWorks Network  
 RockWorks Annual  
 Remove Licensing

Unlocking Code:

**and we'll send you this to transform the program from Trialware mode**

Skip this menu the next time the program is executed.

1. Enter the requested information.
 

**Registration Number:** Type into this field the letters and numbers that were sent to you after purchase. The registration number might start with the characters RU15CS. Contact RockWare if you can't locate this number.

**Licensee Name:** Type in your organization's name. This will be displayed in the program's startup screen.
2. Contact RockWare for your machine-specific **Unlocking Code**. You'll need to send us the Installation Number, the Registration Number, the Licensee Name, and your contact information.
 

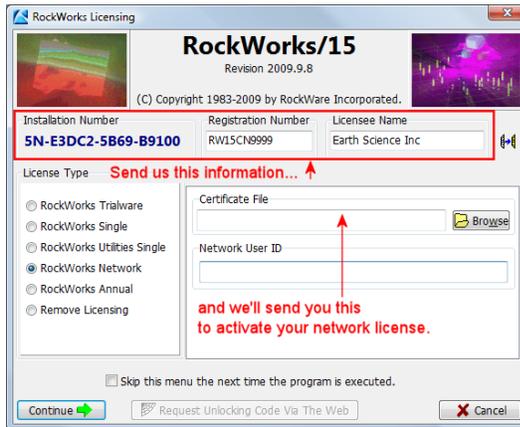
Tip: Click the  button to copy the Installation Number, Licensee Name, and Registration Number from the startup screen to the Windows clipboard.

Tip: If you need to wait for your unlocking code, go ahead and run the program in trial mode, described above. All work done in trial mode is fully usable once you license the program.
3. When you receive your Unlocking Code from RockWare, type it into the **Unlocking Code** prompt.
4. Click the **Continue** button to proceed into the program, and jump to page 10, Starting Up RockWorks.

## RockWorks Network License

**RockWorks Network:** Click in this button if you have purchased a network license for the program, which offers concurrent use of the program to multiple users. The network version requires a special network license certificate file, which RockWare will email to you, which must be stored on a network drive in a location where all users have access.

- ! You must have standard user or higher (e.g. administrator) privileges to set up the network licensing. Restricted users should contact their system administrator.



RockWorks Licensing

**RockWorks/15**  
Revision 2009.9.8  
(C) Copyright 1983-2009 by RockWare Incorporated.

Installation Number: **SN-E3DC2-5B69-B9100**    Registration Number: RW15CN999    License Name: Earth Science Inc

License Type: **Send us this information...**

RockWorks Trialware  
 RockWorks Single  
 RockWorks Utilities Single  
 **RockWorks Network**  
 RockWorks Annual  
 Remove Licensing

Certificate File:

Network User ID:

**and we'll send you this to activate your network license.**

Skip this menu the next time the program is executed.

1. Enter the requested information.
 

**Registration Number:** Type into this field the letters and numbers that are printed

on a sticker on the CD, User Manual, registration card, and/or receipt you received from RockWare. The registration number might start with the characters RW15CN or RW15AN. Contact RockWare if you can't locate this number.

**Licensee Name:** Type in your company's name. This will be displayed in the initial splash screen.

2. Contact RockWare for your **Certificate File**. This is a file that is supplied by RockWare after your purchase, initialized for the licensee name and the number of seats you purchased. You may not run the network version of RockWorks without access to the Certificate File which maintains the network count, among other things. You'll need to send us the Installation Number, the Registration Number, the Licensee Name, and your contact information.

Tip: Click the  button to copy the Installation Number, Licensee Name, and Registration Number from the startup screen to the Windows clipboard.

Tip: If you need to wait for your Certificate File, go ahead and run the program in trial mode, described above. All work done in trial mode is fully usable once you license the program.

3. When you receive your Certificate File from RockWare, enter the following information:

**Certificate File:** Use the Browse button to access the folder in which the network's certificate file has been installed.

When you/your network administrator receives the certificate file via email, save the file to a folder on a network drive to which all users have read and write access.

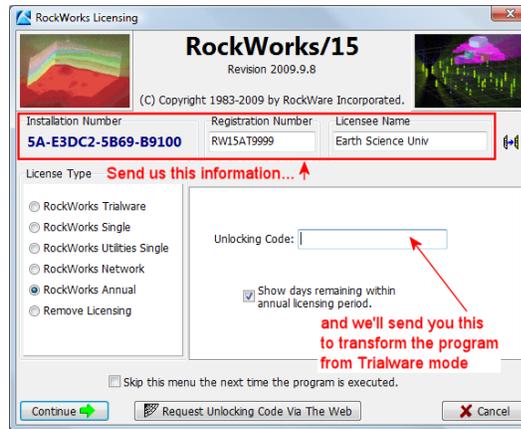
**Network User ID:** This is typically your name or other unique identifying string. The ID string is limited to 20 characters, including spaces. Your ID will be stored in the network Certificate File while you are using the program. When you exit RockWorks using the program's File / Exit command, your ID will be logged out of the Certificate File. The Certificate File will allow a specific number of unique users to log in at a time; for example if you purchased a 5-seat license, then 5 unique ID's are allowed to be logged in at any one time.

4. Click the **Continue** button to proceed into the program. See Starting Up RockWorks (page 10).

## RockWorks Annual License

**RockWorks Annual:** Choose this if you have purchased a time-limited (typically annual) license for the program. The software is typically installed onto a single computer and the program can be used by anyone who uses that computer, for a limited period of time. This requires an "unlocking code" which is supplied by RockWare.

- ! You must have standard user or higher (e.g. administrator) privileges to set up the annual licensing. Restricted users should contact their system administrator.



1. Enter the requested information.
 

**Registration Number:** Type into this field the letters and numbers that were sent to you after purchase. The registration number might start with the characters RW15CT or RW15AT. Contact RockWare if you can't locate this number.

**Licensee Name:** Type in your organization's name. This will be displayed in the program's startup screen.
2. Contact RockWare for your machine-specific **Unlocking Code**. You'll need to send us the Installation Number, the Registration Number, the Licensee Name, and your contact information.
 

Tip: Click the  button to copy the Installation Number, Licensee Name, and Registration Number from the startup screen to the Windows clipboard.

Tip: If you need to wait for your unlocking code, go ahead and run the program in trial mode, described above. All work done in trial mode is fully usable once you license the program.
3. When you receive your Unlocking Code from RockWare, type it into the **Unlocking Code** prompt.
4. Insert a check in the **Show days remaining** check-box if you'd like to be reminded of the number of days until the license expires, at each program startup.
5. Click the **Continue** button to proceed into the program, and jump to page 10, Starting Up RockWorks.

## Remove License

**Remove License:** Click in this button if you wish to remove the licensing from the current machine, typically to transfer the license to a different computer.

1. Click **Continue**.  
The program will prompt you to confirm the license removal.
2. Click **Yes** to continue with the removal. (Click **Cancel** to cancel the operation.)

If you clicked **Yes**, the program will remove all RockWorks licensing from your computer. It will also display a message with an important number.

3. **!** Write down the **Status Number** that is displayed; RockWare employees will ask you for this number to verify the license removal.

Note that this license removal does not affect the Trialware day/use counter.

## Contacting RockWare Inc.

To obtain RockWorks Single, RockWorks Utilities Single, or RockWorks Annual unlocking codes, or to obtain your network license certificate file, contact RockWare by:

web: Visit [www.rockware.com](http://www.rockware.com) and click **Support / Unlock Software**

Telephone:

within Colorado: 303-278-3534

within the U.S.: 1-800-775-6745

outside the U.S.: + 303-278-3534

Fax: + 303-278-4099

You will need to include: \* Your name, \* The name of the end user, if different, \* Your company's name (if applicable), \* The Registration Number, \* The Installation Number (for unlocking codes only), and \* How we should contact you (email, telephone, or fax).

## Starting Up RockWorks

### Starting RockWorks the First Time

After you have installed the program as described in the separate topic (page 2), and you have licensed the program as described in the previous topics, the program will now:

- Copy a folder of tutorial data files to your "Documents" or "My Documents" folder (in "RockWorks15 Data\Samples")
- Initialize all of the program's variables to factory defaults.
- Display the main program window, loading the Samples project.
- Display a Help window.

What now?

Get familiarized with the RockWorks windows in the **Brief Tour** – see page 12.

Run through some of the sample tutorials – click on the **Tutorials** button at the top of the Help window.

See **Getting Started Checklist** (page 32) for some important tips regarding the Borehole Manager when you are ready to enter your own data.

### Starting RockWorks the Next Time

If you've already installed and run RockWorks before, follow these steps to start up the program.

1. Click on the Start button on the Windows taskbar.
2. Click on the Programs or All Programs option.
3. Click on the RockWare group, and then on the RockWorks 15 group, then on the RockWorks15 program icon.

You'll see the main licensing screen there, with all of your pre-entered information.

If you are running the program in "Trialware" mode, you will see the number of sessions and the number of days you have left in your trial period. If RockWorks has been run before on this computer, the uses and/or days may be used up. If you need more time, contact RockWare and we may be able to provide an "extension code."

4. If you want to continue with the current license type, click the **Continue** button. The main RockWorks program window will be displayed.

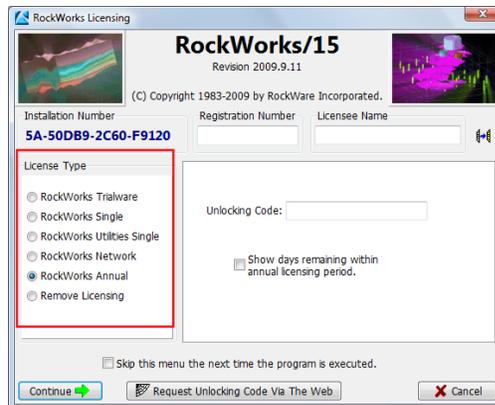
! You can click the **Skip this Menu** checkbox to bypass the startup screen in future sessions.

## Changing the Licensing

If you wish to change the type of license under which RockWorks is being run, you'll need to contact RockWare to make the necessary arrangements. You'll be issued a new license registration number.

Then, you can choose the new license type using one of these methods.

- ! DO NOT UNINSTALL the program to change the license type.
  - Start up RockWorks and choose a new license type on the program's startup screen.



- Or, if the startup screen has been hidden, select the **Tools / Change Licensing** option in the program itself, and the startup screen will be displayed.

Then, follow the instructions for that license type in the previous topics.

## Uninstalling RockWorks

If you own a Single license of RockWorks and you want to install your license on a different computer, you'll need to remove the program from the original machine. Follow these steps to remove the RockWorks licensing and program from your computer:

Step 1: Remove the licensing from your computer.

1. Follow the steps listed for Remove License on page 9 .
2. Write down the **Status Code**; RockWare employees will ask you for this number to verify the license removal.

Note that this license removal does not affect the Trialware day/use counter.

Step 2: Remove the program itself using the Window Control Panel (Add/Remove Programs).

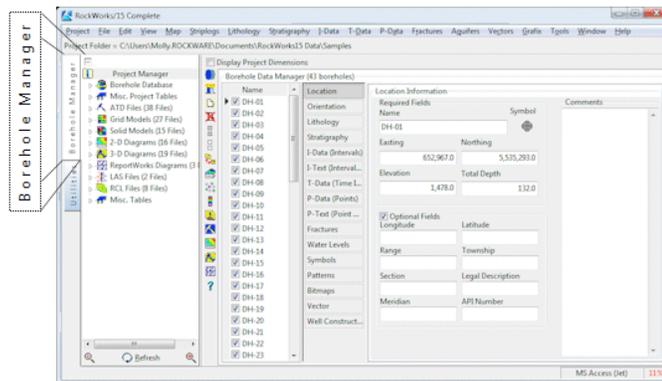
If you don't do Step 1 before uninstalling the program, the Status Code will be generated during program removal.

Uninstalling the program won't remove any of your data files from the computer.

## A Brief Tour

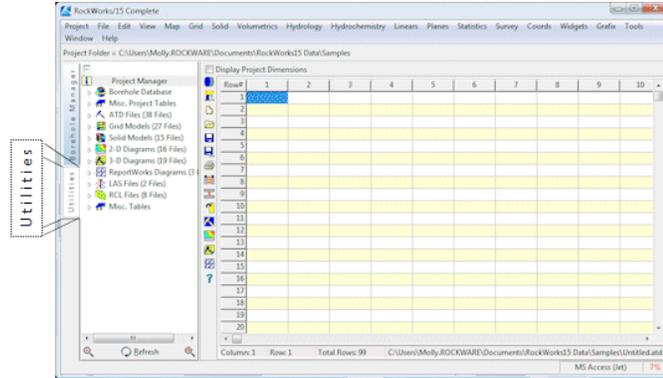
Here are some important landmarks within RockWorks:

1. **The Borehole Manager:** This is the data window and suite of menus for entering and working with borehole data. Here is where you do most of the sub-surface modeling and visualization in RockWorks: 2D and 3D logs, cross sections, fence diagrams, solid models, stratigraphic models, structure maps, etc. Borehole data is stored in a database (Access MDB by default). You can access the Borehole Manager using its tab along the left edge of the program window. The Borehole Manager is discussed starting in Chapter 2.

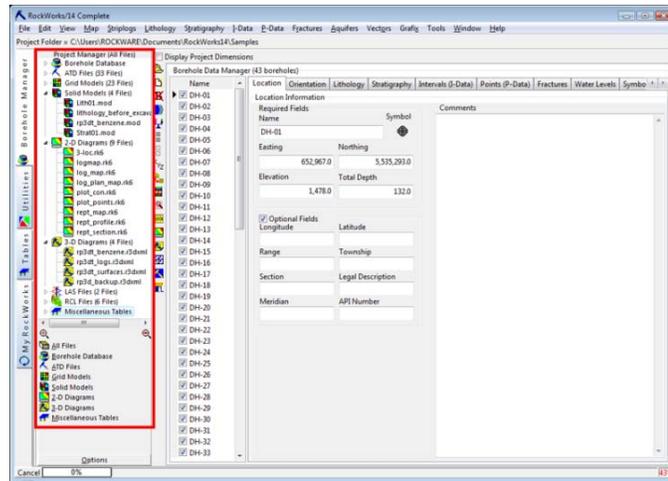


2. **The RockWorks Utilities:** This is a simpler, row-and-column type of data window with its own suite of menus. Here you can create many different types of maps, charts, and diagrams. Even if you are working primarily with borehole data, you will still use many of the tools in the RockWorks Utilities for analytical work (statistical analysis, grid & solid model math/filtering tools, etc.). You can access the Utilities window

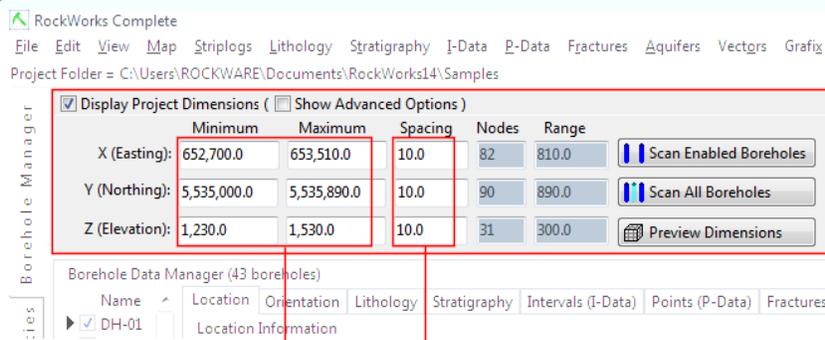
using its tab along the left edge of the program window. The RockWorks Utilities is discussed starting in Chapter 3.



- Project Manager:** This pane, along the left edge of the program window, displays RockWorks files that reside in the current project folder, and tables in the project database, for quick and easy access: Hover over graphic files to see previews, double-click on files to open them. See Chapter 4 for information about the Project Manager.



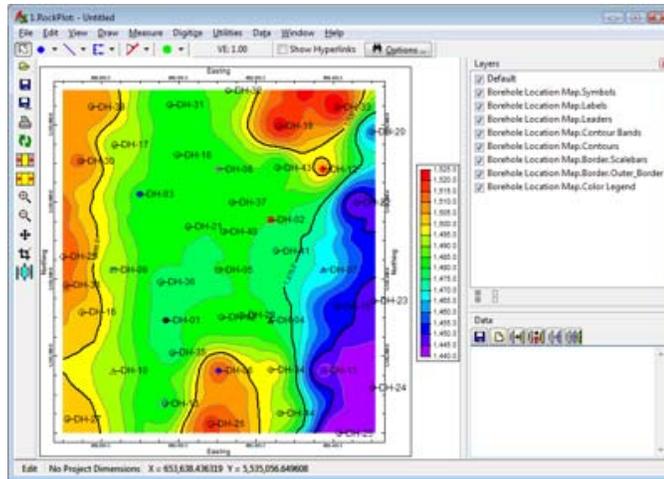
4. **Project Dimensions:** Here you establish the boundaries of your working project, for both borehole-related and general data, for consistency in modeling and boundary annotations. See Chapter 4 for details.



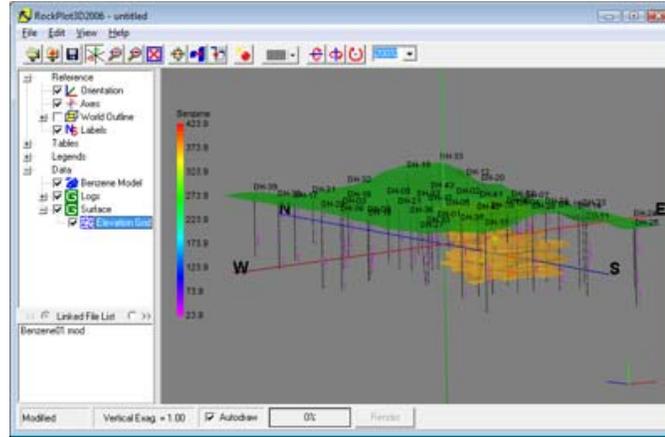
These settings establish project boundaries.

These determine grid & solid model densities. As you change the spacing, the number of nodes will change. These are IMPORTANT.

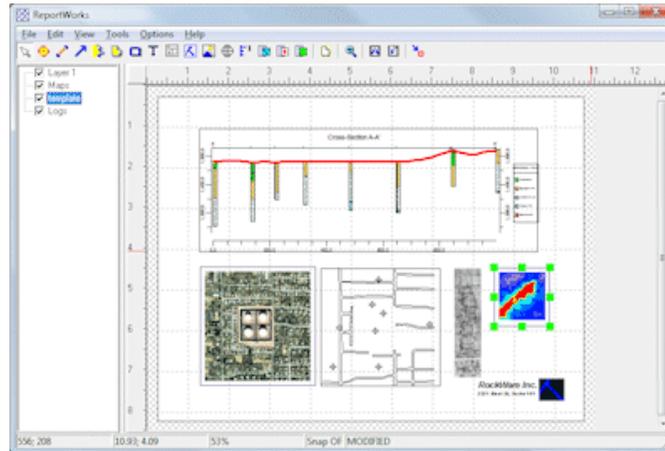
5. **RockPlot2D:** This is the window in which 2D (flat) maps, logs, and diagrams are displayed. This window is displayed automatically each time that a 2D graphic is generated. This window can either be embedded in the program Options window, or displayed as a stand-alone window. You can open a blank RockPlot2D window using the **Window / RockPlot2D** menu option. You can open saved RockPlot2D files using the Project Manager. See Chapter 23 for a discussion of RockPlot2D.



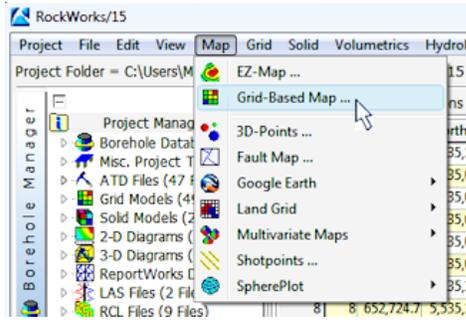
6. **RockPlot3D:** This is the interactive window in which 3D images are displayed (surfaces, solids, 3D logs, fence diagrams, and more.) This window is displayed automatically any time that a 3D graphic is generated. This window can be embedded in the program Options windows or displayed as a stand-alone window. You can open a blank RockPlot3D window using the **Window / RockPlot3D** menu option. You can open saved RockPlot3D files using the Project Manager. See Chapter 24 for information about RockPlot3D.



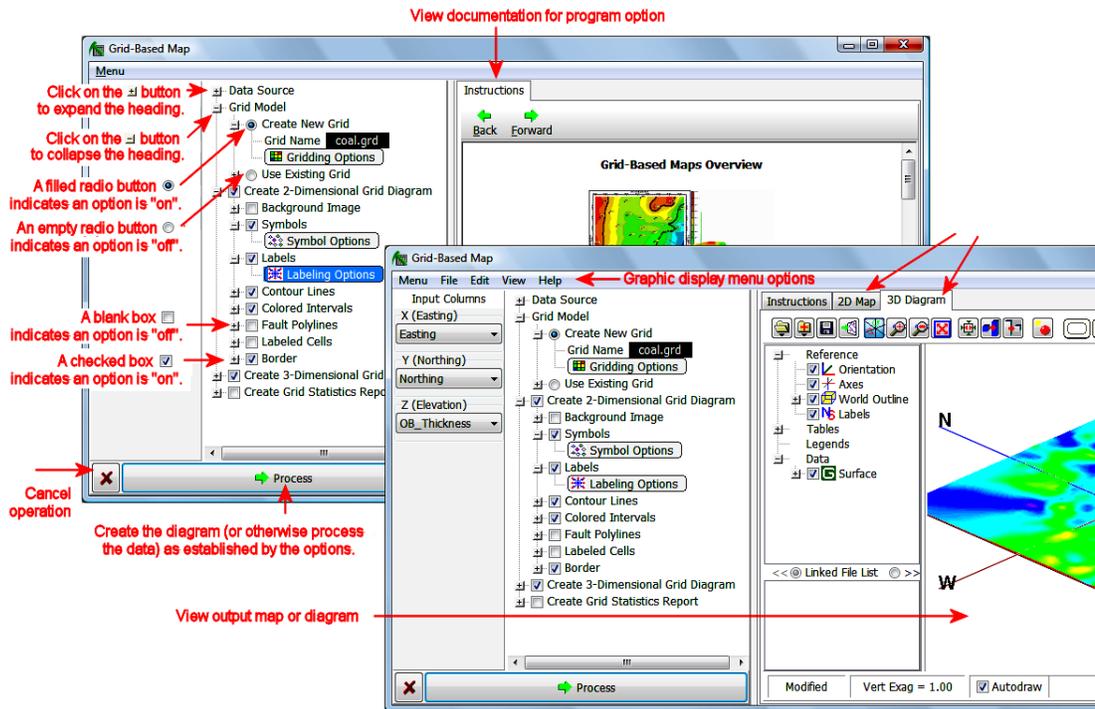
7. **ReportWorks:** This is the page layout program for raster images, RockPlot2D images, with legend, text, shape, scale bar annotations. You can open a blank ReportWorks window using the **Window / ReportWorks** menu option. You can open saved ReportWorks files using the Project Manager. See Chapter 25 for information about the ReportWorks program.



- Menus and Options Windows:** Most of the RockWorks tools are accessed by clicking on the drop-down menus at the top of the program windows and selecting an item from the menu's list. (Some options also have toolbar button equivalents.)



When a menu item or button is selected, a window with program options will be displayed. The options will be displayed in an expandable/collapsible outline format.



- ! New to RockWorks15 is the ability to display your map or diagram right within the Options window. This means that you can adjust any of the diagram options or fiddle with your data and then replot the image without having to leave the window.

- ! Not only that, but cross-section/profile/fence drawing windows, 3D output, and text reports are all displayed right within the Options window, as well.
- ! Not only that, but you can keep multiple Options windows open at any one time. Use the **Tools / General Preferences** option to establish how you want the “modality” of these windows to operate.
- ! You can save the current settings in an Options window using the **Menu / Save to RCL** option. Reload those settings at a later date using **Menu / Load from RCL**.  
Use your mouse to expand/collapse headings and select items as described in the picture. If you prefer to use your keyboard, here’s a list of shortcuts:

+	Expands the current node (equivalent to clicking on the “+” button).
-	Collapses the current node (equivalent to clicking on the “-“ button)
Ctrl+Enter	Opens the current node’s edit dialog (equivalent to double-clicking)
Space	Changes the state of a checkbox or radio button (equivalent to a single click in a checkbox or button)
Up and Down Arrows	Selects the next or previous node
Tab	Moves from the menu options to the Process button
Ctrl+0	Moves the focus to the tree menu (along the left).
Ctrl+1	Moves the focus to the Instructions tab
Ctrl+2, Ctrl+3, etc	Moves the focus to any additional tabs, in the order in which they’re displayed (Rockplot2D, Rockplot3D, text tab, etc.)
Enter	Accepts the settings and moves on to the next step (equivalent to clicking the <i>Process</i> button).
Escape	Cancel the dialog (equivalent to clicking the Windows Close button)
Right-click	Right-click on any of the nodes to view the behind-the-scenes menu name, group name, and parameter (variable) name. This information can be helpful if you are writing RCL scripts.

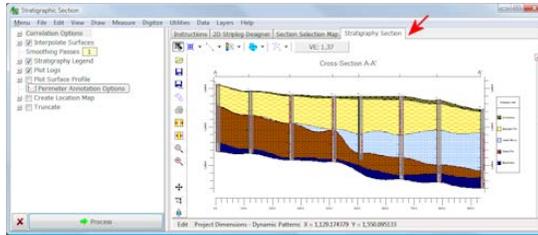
10. Scripting RockWorks: RockWorks can be run using “RCL” (RockWare Command Language) scripts, either from a program command line or using the **Tools / Compile RCL** menu option.

- ? Contents: Reference / RCL Scripting.

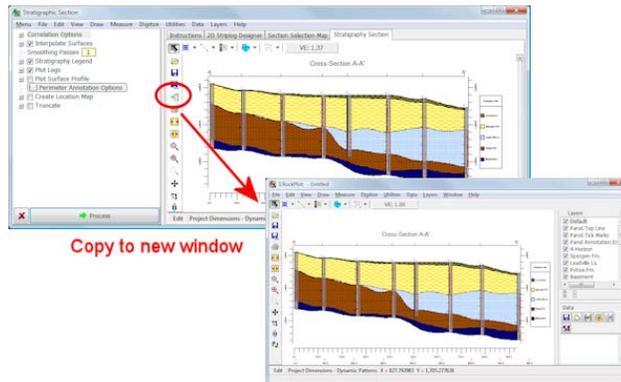
# What's New in RockWorks15

## New Interface Options

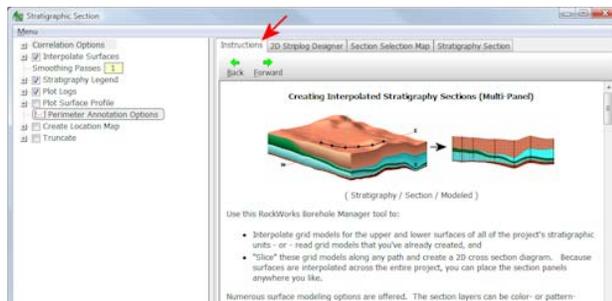
**Embedded Output:** 2D images, 3D images, text reports are displayed right within the program's Options window. This allows you to adjust settings and re-process the diagram with just a few clicks.



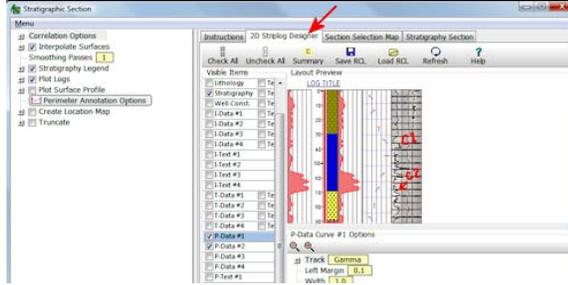
Easily **un-dock** the graphic into a stand-alone window.



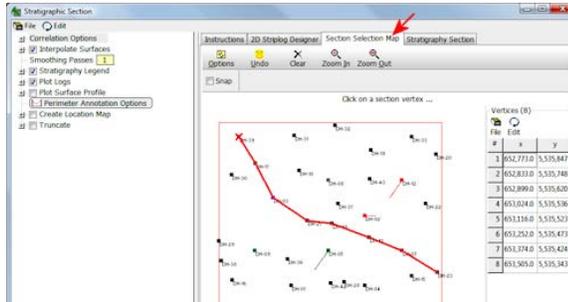
**Embedded Help:** See instructions for the current topic; you can adjust the tab stacking order.



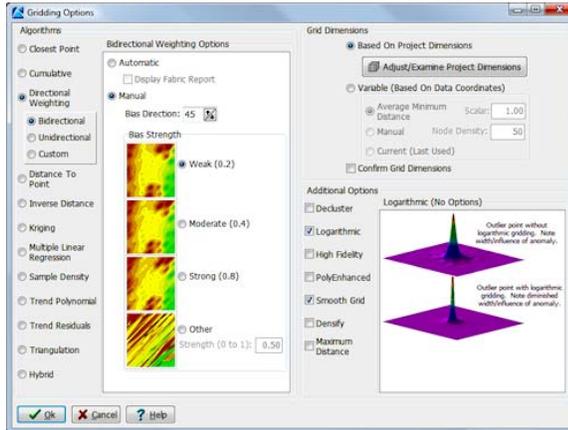
**Embedded Striplog Layout Tools:** Click on the Striplog Designer tab to define the log settings.



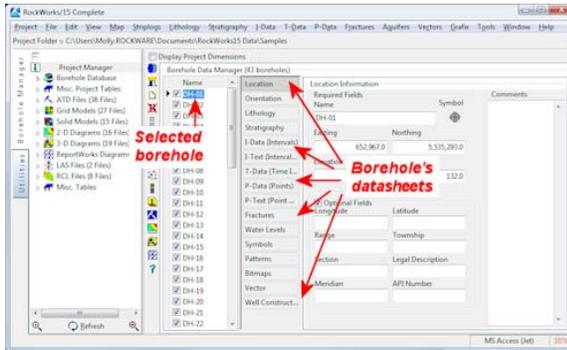
**Embedded Profile, Section, Fence tabs:** Click on the Selection Map tab to define the panel locations.



**Detailed Settings in Redesigned Windows:** Gridding, mapping, solid modeling, and many diagram options have been pulled out of the tree menus to their own dialog boxes. Much easier to use!



**Borehole Manager Tabs:** The data tabs are displayed along the left side of the program window (you can change back to tabs-on-top using **Tools / General Preferences / Main Menu Options**).



**Project Menu Settings:** Maintain separate menu settings for different projects.

**New Data Tools**

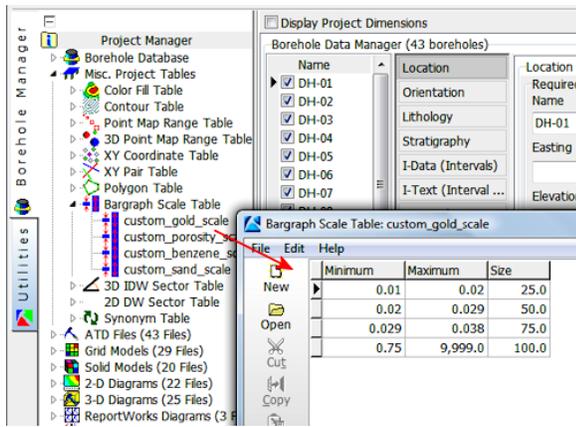
**Support of SQL and Other Databases:** MDB is still the default database type, but RockWorks now supports SQL Server and other ADO databases.



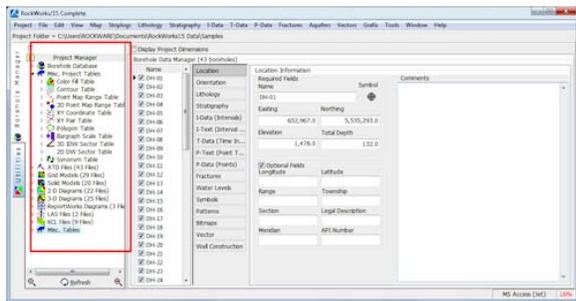
**Lithology Picker:** Pick your lithology intervals from logs, just like the stratigraphy picker.



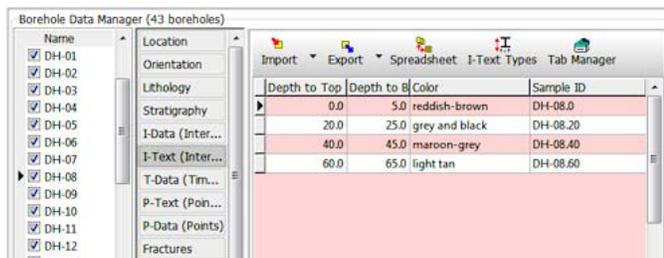
**Accessory Tables in Database:** Project-specific tables, such as Color-Fill, Polygon, and Bargraph Scaling are now stored in the project database. You can maintain multiple copies of each.



**Reorganized Project Manager:** Even easier to access your data, models, and graphics.



**I-Text and P-Text:** Use I-Text and P-Text tabs to enter downhole alphanumeric data - Sample numbers, comments, etc.

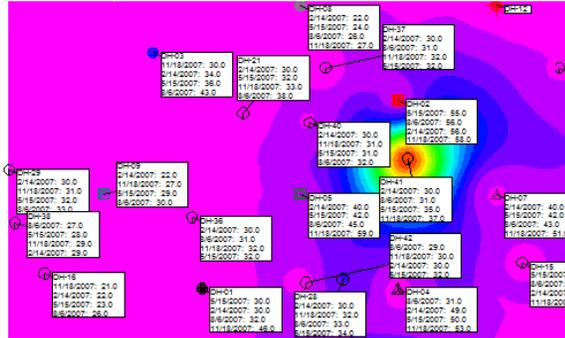


**Shapefiles:** Import Shapefiles and attributes into the Utilities datasheet.



**Point Map Layers (symbols and labels):** Added for Lithology, Stratigraphy, I-Data, T-Data, and P-Data plan/surface maps

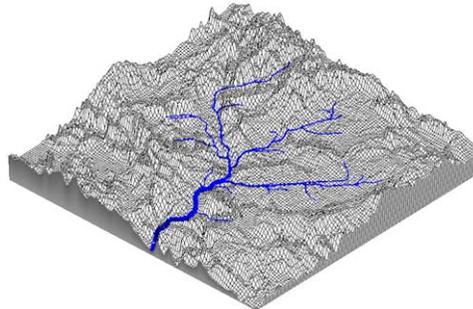
**Point Map Labels:** Detailed labels can display varied types of data – stratigraphy depths/elevations/thickness, water level dates/depts/elevations/thickness, T-Data values/dates/elevations/depts/thickness, and more.



**Transparency:** Adjust the transparency of color contour and raster layers in your RockPlot2D images.

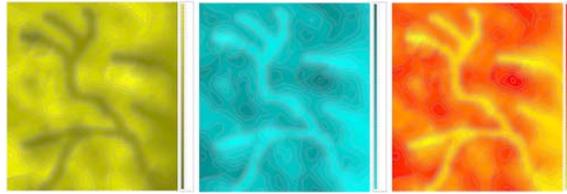


**Drainage Nets/Flow Maps:** New tools in 2D and 3D, with exports of line segments, fill sinks, and stratigraphy filters

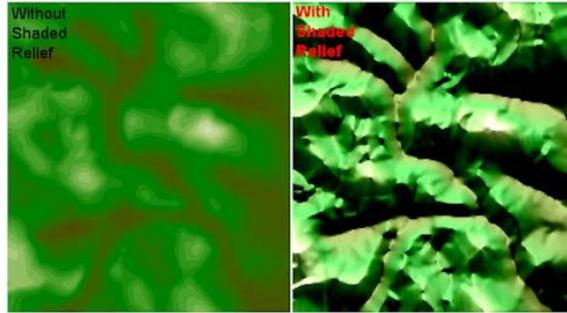


**Rose and stereonet diagrams from grid models:** Run a topography grid through a slope/aspect analysis and generate a Rose or Stereonet diagram.

**New color palettes:** Automatic palettes, custom palettes, and multiple color cycles

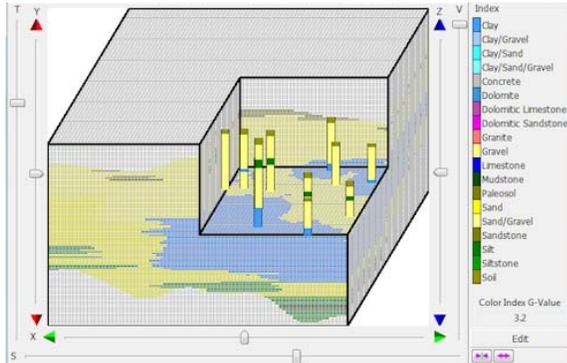


**Shaded relief:** Display 2D contour maps with a variety of shaded relief options

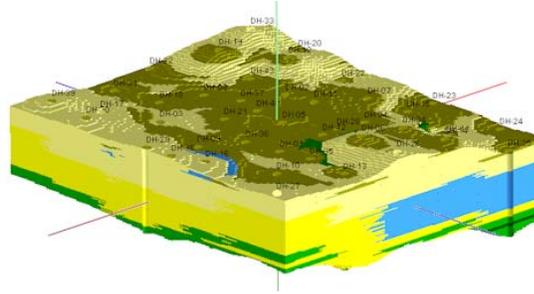


### New Solid Modeling and Display Tools

**Interactive Editor:** 3D solid model editor - edit individual voxels or blocks drawn as polyhedra.



**Filters:** Automatic filtering of ground surface AND borehole bases (manual options, too).



**Contours:** Display contours on the faces of 3D isosurface cutouts

**Animations:** Animate automatic beveling of voxel blocks or isosurfaces

### Other Tools

**Fault Surfaces:** Create 3D fault surfaces from contour polylines

**Rose Diagrams:** New Rose Diagram options for petal length

**Profiles and Sections:** Smoother solid model profile and section diagrams.

## RockWorks14 and RockWorks2006 Users Read This

There should be a seamless transition between RockWorks14 or RockWorks2006, and RockWorks15 – the Borehole Manager database and the RockWorks Utilities ATD files, grid and solid models, and all graphics files created in RockWorks2006 or 14 are fully compatible with RockWorks15. The program will be installed into a new folder, and a new “RockWorks15 Data” Samples folder will be created in My Documents (WinXP) or Documents (Windows Vista) folder.

Please read the previous topic – What’s New – for a list of some of the primary new features.

In addition, here’s a list of some of the changes which may affect your day-to-day work.

- **2D images, 3D images, text reports** and **computed datasheets** are displayed right within the program's Options window. Adjust settings and re-process the diagram with just a few clicks. You can select multiple types of output at once - a 2D map, a 3D surface, a grid report, etc. They'll all display in separate stick-up tabs.
- The Options windows also now display the **Striplog Designer** and the section, profile, and fence **Selection Maps** in stick-up tabs.
- The program is initially set up in **modal** state, meaning you can keep only one Options window open at a time. Use **Tools / General Preferences / Secondary Windows** to establish a non-modal state in which you can keep multiple windows open at once AND allow access to the database while an Options window is open.

- Your **menu settings** are now stored separately for each project. So, as you open a project, the program will load the suite of menu options you've established for that specific dataset. If you install updates, which we've been known to publish from time to time, the factory defaults won't affect your existing project settings. You can also import menu settings from another project if you wish. And, global settings - such as how the overall program window should look, whether to check for updates, etc. - are stored separately from the project-specific settings.
- Polygon tables, colorfill tables, fault tables, etc. - most of these **accessory tables** are now stored in your project database. You can maintain multiple copies of these tables, with specific names, right with your data. No more hunting down elusive TAB files. (Your existing TAB files are easily imported into the database tables.)
- The borehole **database tabs** (Location, Orientation, Lithology, etc.) are now docked on the left side of the window. You can put them back on top if you prefer that look - just use **Tools / General Preferences / Main Menu Options**.
- **RCL Users:** Some of the program's EXECUTE commands have changed, and many new menu variables are available. We encourage you to try your existing scripts and refer to the new error logs which will let you if there were any roadblocks.

A few of the other new features (see also What's New):

- RockWorks supports **SQL Server** and other ADO databases. When you create a new project, you have options other than the default MDB.
- Many new **dialog boxes** replace the tree menus for much easier navigation - gridding options, solid modeling options, contour settings, etc.
- We've added all sorts of **point mapping tools** to the Borehole Manager maps, with detailed labels (depths, thickness, dates, etc.)
- Now you can **wrap text** in your 2D striplogs.
- New **I-Text** and **P-Text** data tables for non-numeric data.
- We've added **transparency** to 2D color contours and raster images.
- **Constrain solid models automatically** above-ground and/or below-borehole. (Or you can define your surfaces manually.) Much easier!
- **Pick lithology intervals** using the new lithology picker.
- Use the **interactive solid model editor** to tweak your models.
- New **kriging** tools, including an interactive variogram editor and additional variogram models.
- And much more!

## LogPlot Users Read This

RockWorks15 contains a LogPlot Import program that functions as a batch importer of multiple LogPlot DAT files into the RockWorks MDB database. Using either log design or DAT file information, this tool can determine the LogPlot entities that can be imported into RockWorks, and, where possible, it will offer the user control over the specific import

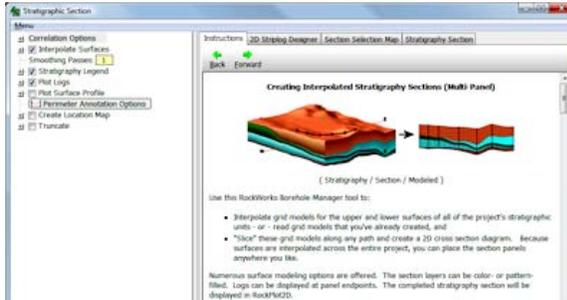
options. Lithology / stratigraphy data (LogPlot: “LITH”), geochemical data (LogPlot “Histogram”), geophysical data (LogPlot “Curve”), log symbols, text, well construction, raster images, orientation, and tadpole information can be imported. Once imported into RockWorks, the user has a variety of program tools at hand: strip logs, cross sections, solid models, surface maps, and more.

? Help Contents: Borehole Manager / Entering Your Borehole Data / Importing Data

### Getting Help

The following documentation and help resources are available for the RockWorks program:

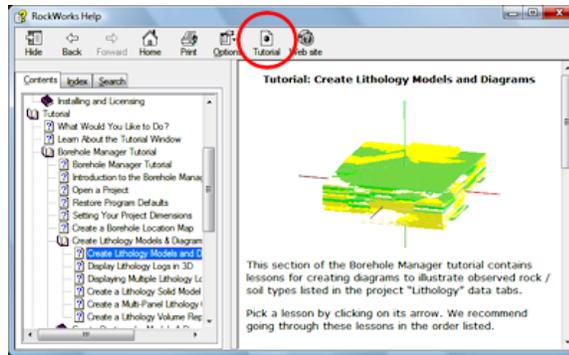
**Embedded help windows** - right in the program options windows:



**Built-in help system:** (Help / Contents or F1 in many windows)



Throughout this manual, look for the ? symbol to know where to get more information in the Searchable Help system.

**On-line tutorial:**

The tutorial lessons are included in the main Help system. You can access them:

- Via the **Help / Tutorials** menu option.
- Via **Help / Contents** and click the Tutorial button at the top of the window.
- Via **Help / Contents**, and look for the Tutorial heading in the left pane.

**Web Support Page:** Visit [www.rockware.com](http://www.rockware.com) and click on the Support menu for a variety of support options, including FAQ's, case studies, etc.

**Web Support Forum:** Join our user forum at [www.rockware.com](http://www.rockware.com) – click Support / User Forum - you can post questions, read existing postings, search on keywords, and more.

**User Manual:** The user manual is designed to be a “roadmap” to summarize program functions and to direct you to other resources for more information. The manual can be downloaded (PDF format) from [www.rockware.com](http://www.rockware.com), and click on the Support / RockWorks / Downloads / Documentation menu item.

**Contact RockWare:** If you own a registered \* RockWorks license, you are eligible for 1/2 hour of free telephone support and free email support, both subject to change. Technical questions can be emailed to: [tech@rockware.com](mailto:tech@rockware.com). The support telephone number is 303-278-3534, and listen to the switchboard menu for support. Technical staff hours is typically 9 – 4 (Mountain time zone). Our mailing address is: 2221 East St, Suite 101, Golden, Colorado 80401 USA. When you contact us, please be sure to include the revision number of the program (visible in Help / About), the version of Windows you are using, what you are trying to do in the program, and whether you are seeing an error.

Critical errors now generate a "bug report" that can be automatically sent to the RockWare support staff. This report keeps us from asking a bunch of obnoxious questions about your machine configuration and exactly where the bug occurred.

\* To register your license, mail in your yellow registration card or visit [www.rockware.com](http://www.rockware.com) and click Support / Register Software.

# Chapter 2 - The Borehole Manager

## Topics

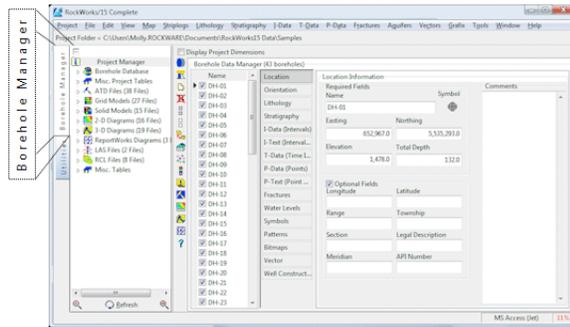
- Using the Borehole Manager ..... 29
- Getting Started in the Borehole Manager ..... 32
- Creating a New Project in the Borehole Manager ..... 33
- Manually Entering Your Data ..... 35
- Importing Data ..... 63
- Other Data Topics ..... 69
- The Borehole Database ..... 77
- Workflow in the Borehole Manager ..... 83

## Using the Borehole Manager

The Borehole Manager is the RockWorks data interface designed for entering downhole data. It is one of two main data windows available in RockWorks.

### How to access the Borehole Manager

1. Click on the large Borehole Manager tab along the left side of the program window.

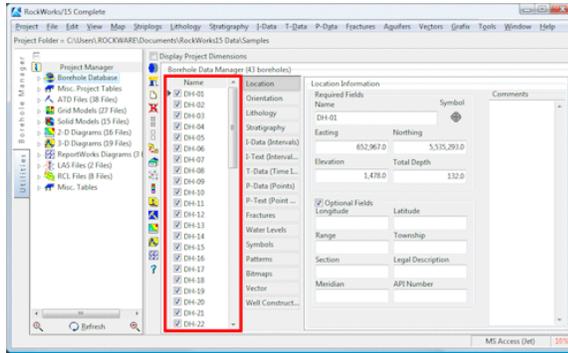


The program will bring the Borehole Manager window to the front. (You can also use the **Window / Borehole Manager** menu option.)

**!** The menu items at the top of the window will change depending on which data entry program is currently activated. The Borehole Manager and the RockWorks Utilities datasheet each has its own suite of menus and program options.

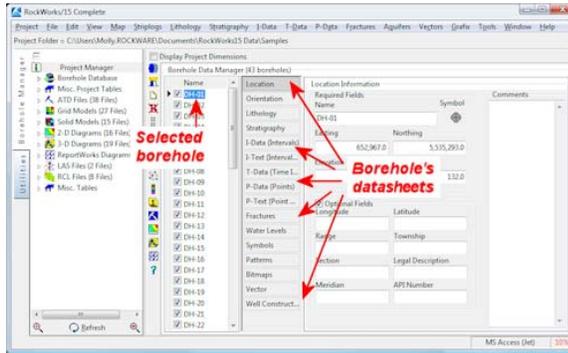
### Quick Tour of the Borehole Manager

The wells in the current project will be listed in the pane along the left side of the window.



Click on the name of the well whose data you wish to view. The program will load its data into the data tables.

! The data tabs can be displayed along the left edge of the program window (as shown below) or along the top, as you've specified under **Tools / General Preferences**.

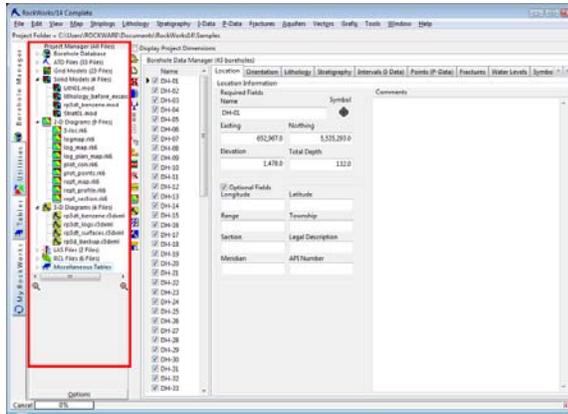


Just click on a tab to bring up that data for the current borehole.

### Using the Project Manager

The Project Manager is a pane that can be displayed along the left edge of the program window which displays various RockWorks program files in the current project folder. The name of the current project folder is always displayed right above the Project Manager pane at the top of the program window ("Project Folder =").

If you are just getting started in the program, the current project folder is probably the "Samples" folder in My Documents\RockWorks15 Data. If you've been working in a different project folder, then that folder's contents will be displayed. (RockWorks always tries to open the last-used project folder on startup.)

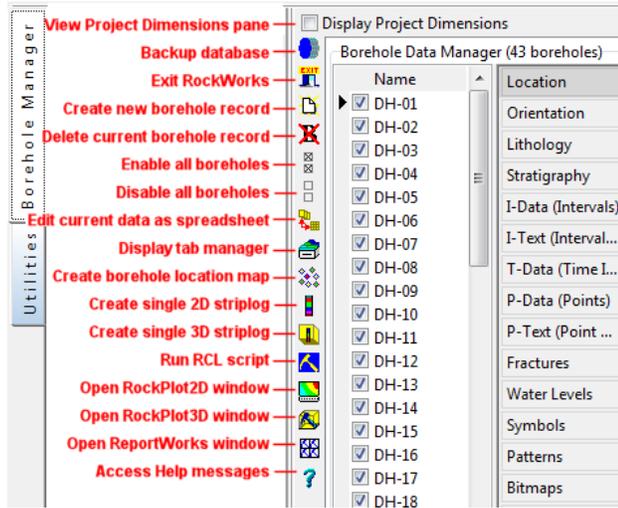


- **Expand** any file-type grouping by clicking the small “+” button by its heading; contract any grouping by clicking on the small “-“ button.
- **Open** a file by double-clicking on it.
- **Open a different project folder** by selecting the **Project / Open** menu item, or by clicking on the *Project Folder* = path which is displayed at the top of the program window.

See page 107 for more information about the Project Manager.

### Quick Summary of the Borehole Manager Buttons

Use the **Tools / General Preferences / Main Menu Options** to turn on the toolbar buttons described below.



## Go through the Tutorials

Before you start entering and visualizing/modeling your own data, we **HIGHLY** encourage you to go through some of the tutorial lessons accessible in the **Help / Tutorials** menu item. These lessons utilize a sample dataset that is installed with the program, and a variety of lessons with different types of data is offered. The purpose of the tutorial is to acquaint you with the structure of the data and the functioning of some of the menu options. Once you have some familiarity with how the program “thinks”, then you can start entering and processing your own data.

## Getting Started in the Borehole Manager

Here are some reminders about how RockWorks works and things to remember when working with the RockWorks Borehole Manager. We've noted pages with more information, where applicable.

1. **Create New Project:** When you're starting a new project, launch RockWorks and create a new project using **Project / New**. (p. 35)  
 Borehole data for each project is stored in a Microsoft Access database or MDB file. (p. 77)  
 Each project has its own database in its own project folder. Models and graphics are stored in the project folder, too.  
 The database file and the project folder share the same name ("SmithProject" folder would have the "SmithProject.mdb" database file).
2. **Enter Data:** Once the project is created, you can enter your data.  
 You can import your borehole data from Excel files, and other formats. (p. 63)  
 You can also hand-enter the borehole data. Use **File / New Log** to add a new borehole record. (p. 35)  
 Enter the downhole data into the appropriate data tab for the well. (p. 37)  
 Use the **Edit / Edit Data as Spreadsheet** as a neat tool for spreadsheet-style editing of a table, including copy/pasting, etc. (p. 59)  
 Quick database shortcuts: Tab advances cell to cell. Ctrl+Del deletes a row. Down-arrow adds a row to the end of the table. Right-click/**Rows** to add or delete a row.
3. **Project Dimensions:** When your borehole data is entered/imported, be sure to establish the project dimensions. (p. 100)  
 This is easily done by scanning all/enabled boreholes using the buttons.  
 If you'll be creating surface or solid models, be sure the project dimensions # nodes are dense enough (but not too dense!) to properly represent your data.
4. **Types Tables:** Remember that lithology materials, stratigraphy formations, and well construction materials link to respective "Types" tables that you create. (p. 51)  
 The formations in the Stratigraphy Types Table must be listed in order from the ground downward for proper modeling to take place.  
 RockWorks uses the background colors you've selected for the materials when displaying 3D logs, and 3D surfaces and solids.

5. **Display Observed Data:** Before you start creating interpolated models of your data, first look at the data as entered. The 2D and 3D log designers make it easy to select what kind of data to display in the logs, and the column order.  
Use the **Striplogs / Multi-Log 3D** tool to see the data as entered for all of the boreholes. (p. 126)  
Use the **Striplogs / Multi-Log Section** to see the log data in a hole to hole cross section. (p. 124)
6. **Interpolate Models:** When you're ready to interpolate surface models (Stratigraphy, Water Level) or solid models (Lithology, I-Data, T-Data, P-Data, Fractures), remember that the Model, Profile, Section, Fence, Plan, and Surface Map options can all utilize the same interpolated numeric model.  
Once you generate a model that looks right, you can select the Use Existing Model option (solid models) or un-check the Interpolate Surfaces option (surface models) to generate the other diagram types. They simply offer different ways to visualize the contents of the interpolated model.  
For this reason, many users find that using the Model option first, to create the numeric model and to visualize it in 3D, is a good way to check the accuracy of the interpolation.  
(See the following pages: Stratigraphy modeling: 151; Aquifer modeling: 167; Lithology modeling: 183; I-Data/T-Data/P-Data modeling: 191)
7. **Data Queries:** Use the database query tools to enable borehole subsets for modeling and display. There is a simple query and a complex query available. (p. 82)
8. **RockPlot2D** is the display window for 2D (flat) graphic images such as maps, cross sections, 2D logs, rose diagrams, and the like. It contains a whole fleet of editing tools. (p. 249)
9. **RockPlot3D** is the display window for 3D graphic images, such as solid voxel models, isosurfaces, fence diagrams, 3D surfaces, etc. It is interactive, with rotation, zooming, appending, etc. (p. 265)
10. **ReportWorks** is a page layout window for images (RK6, BMP, JPG, TIFF, etc.), text, legends, shapes, and more. (p. 277)
11. **Automation:** If you need to automate your work in RockWorks, you can do so with "RCL" (RockWare Command Language) scripts. (p. 297)

## Creating a New Project in the Borehole Manager

RockWorks uses folders as the basis for storing data (your project database) and other files (graphics, models, etc.) as you work within the program. Each project will have its own folder. So the first step in entering your own data in RockWorks is to create a new project:

1. Select the **Project / New** menu item from the Borehole Manager.
2. In the Create New Project window, you can browse for an existing folder on your computer or network to become your project folder, or create a brand new folder for the project data.
3. You can create the new project database using

- Using generic settings (check the “use system defaults” box), or
- Using another project you’ve previously created. This can be handy if you have customized that database and want to use those customizations for the new project. If you go this route, you can also import any of your Types tables (lithology/stratigraphy/etc.) AND you can even import some/all of the borehole data from the existing project.

4. Click OK, and the program will create a new borehole database in the project folder.

! The borehole database MDB file will have the same name as the project folder in which it’s created. RockWorks requires this. Keep this in mind if you share databases with co-workers.

? See the Help messages for information about creating MS SQL Server projects.

## What’s next

Once you have a new project created – comprised of a new folder and a new MDB file with the same name - you can start entering your data. While the RockWorks data interface is easy to use, it’s also true that getting your data into the program is one of the key components to how successful your work with the program will be. Garbage in, garbage out, so they say.

You have a number of choices in how to get your downhole data into the Borehole Manager, and you can use a combination of the methods summarized below.

- Manually entering (typing in) the data: Handy for small projects. You simply create a new well record for each borehole and click on the different data tabs to type in location information and downhole measurements. (See page 35.)
- Importing the data: There are a number of importers included in RockWorks:
  - Single or multiple boreholes and/or mixed types of data in multiple worksheets (for example, borehole locations and stratigraphy and geophysical curves for several holes): Excel or ASCII, via the **File / Import** menu. Specific layouts are required. This is a good way to get a lot of data into the program very quickly.
  - Single or multiple boreholes and a single worksheet of data: Bring in a table of rows and columns into the I-Data, I-Text, T-Data, P-Data or P-Text tables, using the **Import / CSV, XLS** options inside the **I-Data, T-Data, and P-Data** menus.
  - Commercial data (such as GDS, IHS, KGS, Tobin): Importers for these suppliers, encompassing a variety of types of data, are also in the **File / Import** menu.
  - Commercial data (LAS): One or more curves for one or more holes can be imported using the **File / Import / LAS** item.
  - Other programs (LogPlot, other databases, gINT, old versions of RockWorks): Also available in the **File / Import** menu.

Each import tool has its own requirements and processes.
- Copy/pasting the data: Many of the RockWorks borehole database tables offer an “edit as spreadsheet” option which allows pasting in of multiple rows and columns that

you've copied from Excel or similar program. Once you accept the insertion, RockWorks posts the data to the database.

- Transferring data from the RockWorks Utilities datasheet: Borehole location fields can be posted to the database from the Utilities using the **File / Transfer** menu. You can map specific columns to specific database fields.

How would a combination of these play out? Here's just one example: You could import all of your borehole locations from Excel, to create the initial borehole records. You could then hand-enter the downhole lithology data for the holes. You could then import geophysical measurements from separate LAS files for some of the holes. You could then hand register raster images for some holes. And so on.

If you have a particularly complicated set of data, a little here and a little there, in multiple sources, just contact our technical support team for some workflow suggestions. (tech@rockware.com).

? [Help Index: import: data-Borehole Manager](#)

## Manually Entering Your Data

### Creating a New Borehole Record

Each well in a borehole project is stored as a separate record in the project database. To create a new well in the existing project, follow these steps:

1. Access the Borehole Manager as necessary.
2. If necessary, access the project folder that contains the data to which you wish to add the new well.
3. Select the **File / New Log** command.
4. Enter the required fields for the borehole:

**Borehole Name:** This is a unique identifying field for the borehole. You cannot have multiple boreholes in the same database that share the same name.

**Easting, Northing:** Enter the Easting or X-coordinate and the Northing or Y-coordinate for the borehole in feet or meters. Be sure the units match the depth units (feet or meters) you'll be entering.

See page 38, for information about X,Y units.

If your locations are in longitude/latitude coordinates or Jeffersonian (RTS) descriptions, you'll need to enter 0 initially for this prompt, enter the coordinates you do have in the optional location fields and use the coordinate translation tools to compute the Easting coordinate.

**Elevation:** Type in the elevation at the top of the well. Be sure the elevation units (feet or meters) are the same as the Easting and Northing units. This should represent the point from which the depths of your other data fields (Lithology, Stratigraphy, etc.) are measured.

**TD:** Enter the total depth for the well. Be sure the TD units (feet or meters) are the same as the Easting, Northing and Elevation units. If the well is inclined or deviated, this should be the measured depth, not the true vertical depth.

5. Click **OK**.

The well name will be shown in the Borehole Name listing. The required fields that you entered will be displayed on the well's Location tab. There will be a blank suite of datasheets (Lithology, etc.) into which you can enter data for the borehole.

**!** You can also use the **File / Duplicate Log** option to create the new borehole record based on an existing borehole.

**?** Help Index : Optional Fields for information about adding customized fields to the location table.

**?** See also: Entering the Borehole Data (page 35).

## Deleting a Borehole Record

Each well in a borehole project is stored as a separate record in the project database. To remove an existing well record from the current project, follow these steps:

1. Access the Borehole Manager as necessary.
2. If necessary, access the project folder that contains the data you wish to edit.
3. In the pane to the left, click on the name of the Borehole File that you wish to remove from the current project. For example, to remove the borehole named "DH-5", click on that well's name.
4. Select the **File / Erase Log** command.

The program will prompt you, "Delete all the information for "*wellname*"? The data is not recoverable?"

5. Click **Yes** to continue and delete the entire borehole record from the database.

Click **Cancel** to cancel the **Erase Log** operation.

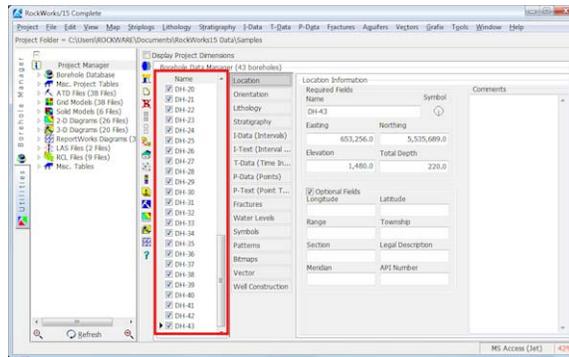
If you choose **Yes**, the data in the selected borehole file will be removed from the project.

**!** Any existing grid (surface) or solid (plume) models you've already created using the now-deleted borehole will NOT be automatically updated to reflect the data change. You'll need to re-generate models and graphics.

## Accessing a Well's Records

1. Access the Borehole Manager as necessary.
2. Open the existing project as necessary.

The wells in the current project will be displayed in the pane just to the right of the project manager pane.



### 3. Click on the name of the well you wish to view.

The program will load its data into the data tabs. You can click on the various data tabs to see that boring's data.

## Enabling/Disabling Borehole Records

Use the check-boxes to the left of the borehole names to turn the borehole on (checked) or off (un-checked). If the borehole is enabled, it will be included in borehole location maps and log section diagrams, and its data will be processed during surface or solid model interpolation. If the borehole is disabled, it will not be included in these maps, diagrams, or interpolation processes.

**!** You can use **Edit / Enable All Boreholes** to turn all borehole records on, and **Edit / Disable All Boreholes** to turn all borehole records off.

**?** See also: Querying Data (page 82) for database query tools for enabling/disabling boreholes

## Summary of the Datasheets

The RockWorks Borehole Manager uses data "sheets" for entering the different types of downhole data for each borehole. For example, if your well is inclined or deviated, you can enter the downhole survey information in the "Orientation" datasheet. If you have point-sampled geophysical data, you can enter these into the "Points (P-Data)" datasheet.

When you add a new well to a project, the program will display a blank suite of datasheets. Simply click on the corresponding button to bring that sheet to the front for entering your data. You may leave any sheets blank for which you have no data. Only the Location datasheet is required to contain data. The datasheets display a spreadsheet-type view of the information in the MDB database tables.

This section discusses the different datasheets and how you enter the data.

- ! Your downhole data – such as stratigraphic intervals or geophysical curves - must be entered using depths, not elevations. Behind the scenes, RockWorks will convert the depths to true elevations for modeling and diagram generation.
- ! The data buttons are listed to the right of the borehole names. You can switch the view to tabs on top using **Tools / General Preferences**.
- ? Help Contents: Borehole Manager / Entering Data for more detailed information.
- ? See also: Importing Data on page 63, and Editing the Data as a Spreadsheet on page 59.

## Location Datasheet

This is used to enter the well location information.

Location fields (standard)

- **Borehole Name:** (Required) This is a unique identifying field for the borehole comprised of alphanumeric characters, and it must be unique. It will be used as the index field for the borehole and will appear in labels for the borehole on maps and logs.
- **Easting, Northing:** (Required) Easting or X-coordinate and the Northing or Y-coordinate for the borehole in feet or meters.
  - The well location Easting (X) and Northing (Y) coordinates may be listed in global units (UTM meters or feet) or in local units (meters or feet).
  - The location coordinates must represent the same units in which the depths (total depth in the Location tab and data depths in the other tabs) are recorded. Thus, if your depths are entered in feet, so must be your Eastings and Northings. If your depths are entered in meters, then enter your Eastings and Northings in meters also. RockWorks does not require specific units, it simply assumes the map units and the depth units are the same.
  - RockWorks assumes you know what your units are - feet or meters or inches or centimeters - and as long as they are consistent (as described above) you do not need to declare them anywhere in the program. You can adjust the text that is plotted along map borders to specify the units (map border settings), and you can adjust some of the program's different report settings, to specify your units, in the report options windows.
  - If your location coordinates are in decimal longitude and latitude units (such as "-106.89765" or "42.574635"), you should enter these into the longitude and latitude prompts in the Location tab. Then use the Borehole Manager's **Map / Adjust Coordinates / Longitude/Latitude -> Easting/Northing** command to change them to UTM meters or feet.
  - If your location coordinates are in Range/Township/Section notation, should enter the Range, Township, Section, Meridian, and Description information in the appropriate prompts at the bottom of the Location tab. Then use the Borehole Manager's **Map / Adjust Coordinates / Jeffersonian -> Easting/Northing** command to change them to UTM meters or feet.

- The X-coordinates or Eastings must increase in value to the East, and the Y-coordinates or Northings must increase in value to the North. If you are using lon/lat coordinates for translation to meters or feet, be sure that western longitudes and southern latitudes are entered as negatives.
- Posting Locations from the RockWorks Utilities datasheet: If you have well location data listed in rows and columns in the RockWorks Utilities datasheet, you can transfer these data into the Borehole Manager using the **File / Transfer / Locations** -> **Borehole Manager** tool. The fields in the datasheet can be mapped to specific fields in the Location tabs.
- **Elevation:** (Required) Elevation at the top of the well. The elevation units (feet or meters) must be the same as the Easting and Northing units. This should represent the point from which the depths of your other data fields (Lithology, Stratigraphy, etc.) are measured.
- **TD:** (Required) Total depth for the well. Be sure the TD units (feet or meters) are the same as the Easting, Northing and Elevation units. If the well is inclined or deviated, this should be the measured depth, not the true vertical depth.
- **Longitude, Latitude:** (Optional) These fields can be used to store well locations in a decimal longitude and latitude format. There are coordinate conversion tools in the **Map / Adjust Coordinates** menu; these require that the lon/lat coordinates be in a decimal format (34.7625, not 34°45'45") and Western longitudes and Southern latitudes be negative.
- **Range, Township, Section, Legal Description, Meridian:** (Optional) Use these fields to store Jeffersonian location coordinates for the wells. There are coordinate conversion tools in the **Map / Adjust Coordinates** menu; these require that the locations comply to a specific format:
- **API Number:** (Optional) Use this field to define the API number, a unique identifier for oil and gas wells, for the hole. You can use the API number for the well ID, though they can be long and cumbersome for labels.
- ! Right-click on the Location tab to add custom, optional fields to the table. These customized fields can be used in queries (**View / Filter Boreholes** and **Select Boreholes**). Examples include drilling date, geologist name, etc.
- ! Use the **File / Transfer / Locations** -> **Utilities Datagrid** for quick editing of location tab fields, and you can transfer the edited data back to the database. See page 81 for more information.
- ! Use the **Edit / Adjust Total Depths** option for a quick means of adjusting TD to accommodate deeper data.
- ? Help Index: Location Data (Location details), and Optional Fields (customization)

## Orientation Datasheet

This tab is where you enter your downhole survey information, if the well is inclined or deviated (e.g. not vertical). If the well is vertical, this tab can be left blank.

Orientation fields:

- **Depth:** First depth at which a downhole survey measurement was made. The depth values must be positive. The depth units must be the same as the units declared for the xyz coordinates for the hole. For example, if the x,y location and collar elevation are expressed in local feet, then the depth listings must be in feet as well.
- **Bearing:** Bearing of the well at this depth. The bearings must be expressed in decimal azimuth degrees (0 to 360, with 0 = north).
- **Inclination:** Inclination at this depth. The inclination data follows a convention in which zero is a horizontal line, -90 points straight down, and +90 points straight up.

Borehole Data Manager (43 boreholes)

Depth	Azimuth	Inclination
0.0	0.0	-90.0
50.0	215.0	-60.0
100.0	215.0	-30.0

You can enter as many survey points as you like, to generate very detailed inclined, deviated, or horizontal well displays.

## Lithology Datasheet

Enter into this table observed downhole lithologies.

Lithology fields:

- **Depth to Top:** Measured depth to the top of the first lithologic interval for the well. The depth values must be positive.
- **Depth to Base:** Measured depth to the base of the first lithologic interval for the well.
- **Keyword:** Double-click in this cell and choose the material type from the Lithology Types Table (see page 52). Or, you can single-click in this cell, click the small down arrow, and choose the material type from the drop-down list. If the material type is not listed, you'll need to add it to the current Lithology Types Table.
- **Description:** This optional field can be used for recording any additional notes about the interval. This text can be plotted in 2D strip logs.

Borehole Data Manager (43 boreholes)

Depth to Top	Depth to Base	Keyword	Comment
0.0	10.1	Soil	gravelly
10.1	45.0	Gravel	coarse to fine
45.0	58.0	Silt	
58.0	104.1	Gravel	
104.1	180.5	Clay	
180.5	217.0	Sand	
217.0	229.0	Siltstone	

Lithology data can be displayed in 2D and 3D log and log diagrams using the options in the **Striplogs** menu. Lithology data can also be interpolated into a solid model for display as a 3D voxel diagram, 3D fence panels, 2D cross sections and profile panels, and lithology surface and plan-view maps (**Lithology** menu tools)..

? See Lithology v Stratigraphy on page 69 for help on definitions.

? Help Index: Lithology Data (lithology details)

## Stratigraphy Datasheet

Into this table you can enter interpreted downhole stratigraphic or formation data.

Stratigraphy fields:

- **Depth to Top:** Measured depth to the top of the first stratigraphic horizon for the well. The depth values must be positive.
- **Depth to Base:** Measured depth to the base of the first stratigraphic horizon for the well. If you don't know the formation base – perhaps the borehole ends mid-formation – you can leave this blank. See Missing Formations (page 72) for more information.
- **Formation:** Double-click in this cell and choose the unit name from the Stratigraphy Types Table – a library of stratigraphic names and patterns that is stored in the project database. Or, you can single-click in this cell, click the small down arrow, and choose the formation name from the drop-down list.

If the formation name is not listed, you'll need to add it to the current Stratigraphy Types Table. See page 54 for more information.

Depth to Top	Depth to Base	Formation
0.0	6.9	A-Horizon
6.9	72.5	Spergen Fm.
72.5	72.5	Leadville Ls.
72.5	159.0	Potosi Fm.
159.0	170.0	Basement

! Stratigraphic layers must be listed in the same order from borehole to borehole – RockWorks assumes a rather layer-cake approach to stratigraphy. Units can be missing or they can be listed with a thickness of zero (see Leadville Ls. in the example), but they cannot repeat and they cannot change order. If you have repeating materials (sand-clay-sand-clay) you need to enter this into the Lithology datasheet instead.

Stratigraphy data can be illustrated in in 2D and 3D log and log diagrams using the options in the **Striplogs** menu. Stratigraphy data can also be interpolated into surfaces for display as 2D and 3D structure and isopach maps, 3D stratigraphic models, 2D cross section and profile panels, 3D fence panels, and stratigraphic surface and plan-view maps (**Stratigraphy** menu tools)..

- ? See also these Stratigraphy data topics: Picking Stratigraphic Units from Log data (page 160), Lithology versus Stratigraphy (page 69), Missing Formations (page 72). See page 151 for information about the stratigraphy modeling tools in RockWorks.

## I-Data (Intervals) Datasheet

This table is used to enter measured, numeric values which were sampled at depth intervals (as opposed to single depth points) down the boreholes. This might apply to downhole geochemistry values (assays, concentrations) or geotechnical values (blow counts). Leave this table blank if you have no interval data. For interval data that is non-numeric, such as comments, use the I-Text tab.

I-Data fields:

- **Depth to Top:** Enter the measured depth to the top of the first sampled interval for the well. The depth values must be positive.
- **Depth to Base:** Enter the measured depth to the base of the first sampled interval for the well.
- **Column 1:** Here you enter the measured value for that downhole interval. If you have no data for an interval, you can leave the cell blank. Blank cells will simply be skipped during processing.
- **Column 2 - Column x:** Continue in this manner, typing in the measured value for each component, for that interval. Repeat for as many columns as you have measurements for, for that depth interval.

Click on the I-Data Types button at the top of the datasheet to define the column names for the measurement types (e.g. Benzene, Gold, percent-gravel, etc.) The columns link to an I-Data Types Table where names, data ranges, etc. are defined.

These data can be displayed as bar graphs along 2D and 3D strip logs (**Striplogs** menu), and can be interpolated into a solid model for display as isosurface or voxel models, vertical profiles, cross sections, fence diagrams, and plan maps (**I-Data** menu).

- ! Note that each I-Data sheet represents a merging of the records stored in the MDB table.
- ? See Editing the Data as a Spreadsheet (page 59) for how to view the data with multi-select and copy/paste tools.

## I-Text Datasheet

Use this table to enter **non-numeric** information that spans depth intervals, such as sample numbers or comments. The I-Data tab is limited to numeric information only; the I-Text tab allows for alphanumeric entries.

I-Text fields:

- **Depth to Top:** Measured depth to the top of the first sampled interval for the hole. The depth values must be positive.
- **Depth to Base:** Measured depth to the base of the first sampled interval for the borehole. (You may also use the <Tab> key to advance from cell to cell.)
- **Column 1:** Recorded information for that downhole interval, for that component. If you have no data for an interval, you can leave the cell blank. Blank cells will simply be skipped during processing.
- **Column 2 - Column x:** Additional data for that component, for that interval. Repeat for as many columns as you have entries for, for that depth interval.

Click on the I-Text Types button at the top of the datasheet to define the column names for the measurement types (e.g. Color, Sample ID, etc.) for the project. The columns link to an I-Text Types Table where column names are defined.

Example:

Depth to Top	Depth to Base	Sample ID	Color
0.0	5.0	DH-06.0	reddish-brown
20.0	25.0	DH-06.20	grey and black
40.0	45.0	DH-06.40	maroon-grey
55.0	60.0	DH-06.55	maroon-grey
75.0	80.0	DH-06.75	pink-grey
95.0	100.0	DH-06.95	reddish-brown
115.0	120.0	DH-06.115	brownish-red

These data can be displayed as text in 2D and 3D strip logs (**Striplogs** menu).

- ! Note that each I-Text datasheet represents a merging of the records stored in the MDB table.
- ? See Editing the Data as a Spreadsheet (page 59) for how to view the data with multi-select and copy/paste tools.

## T-Data (Time Intervals) Datasheet

This table is used to enter measured, numeric values which were sampled at depth intervals (as opposed to single depth points) and at specific dates. This might apply to downhole geochemistry values (concentrations) sampled at periodic intervals, such as in monitoring wells. Leave this table blank if you have no date-based interval data.

T-Data fields:

- **Depth to Top:** Measured depth to the top of the first sampled interval for the well. The depth values must be positive.
- **Depth to Base:** Measured depth to the base of the first sampled interval for the well.
- **Sample Date:** Date on which the sample was taken. You can also double-click in the cell to bring up an interactive calendar-selection window. Time information is optional.
- **Column 1:** Measured value for that downhole interval, for that date. If you have no data for an interval, you can leave the cell blank. Blank cells will simply be skipped during processing.
- **Column 2 - Column x:** Continue in this manner, typing in the measured value for each component, for that interval, for that date. Repeat for as many columns as you have measurements for, for that depth interval.

Click on the T-Data Types button at the top of the datasheet to define the column names for the measurement types (e.g. Mercury, Arsenic, etc.) The columns link to a T-Data Types Table where names, data ranges, etc. are defined.

Depth to Top	Depth to Base	Sample Date	Arsenic	Toluene
60.0	80.0	2/14/2007	0.0	15.0
60.0	80.0	5/15/2007	0.0	10.0
60.0	80.0	8/6/2007	0.0	4.0
60.0	80.0	11/18/2007	0.0	3.0

These data can be displayed as bar graphs along 2D and 3D strip logs (**Striplogs** menu), and can be interpolated into a solid model for display as isosurface or voxel models, vertical profiles, cross sections, fence diagrams, and plan maps (**T-Data** menu).

! Note that each T-Data sheet represents a merging of the records stored in the MDB table.

? See Editing the Data as a Spreadsheet (page 59) for how to view the data with multi-select and copy/paste tools.

## P-Data (Points) Sheet

This table is used to enter measured **numeric** values which were sampled at **single depth points** (as opposed to depth intervals) down the boreholes. This might apply to downhole geophysical measurements (gamma ray), drilling rate, etc. Leave this table blank if you have no point data.

P-Data fields:

- **Depth to Top:** Measured depth for the first measurement for the well. The depth values must be positive.
- **Column 1:** Measured value for that downhole point. If you have no data for this component, you can leave the cell blank. Blank cells will simply be skipped during processing.

- **Column 2 - Column x:** Continue in this manner, typing in the measured value for each component, for that depth. Repeat for as many columns as you have measurements for, for that depth.

Click on the P-Data Types button at the top of the datasheet to define the column names for the measurement types (e.g. Gamma, Resistivity, etc.) for the project. The columns link to a P-Data Types Table where names, data ranges, etc. are defined.

Depth	Gamma	Resistivity
0.0	68.6	50.7
1.0	42.2	164.7
2.0	64.7	153.4
3.0	71.8	167.0
4.0	53.3	58.8
5.0	25.8	64.6
6.0	62.8	100.1
7.0	62.4	192.4
8.0	70.0	95.8

These data can be displayed as curves along 2D and 3D strip logs (**Striplogs** menu), and can be interpolated into a solid model for display as isosurface or voxel models, vertical profiles, cross sections, fence diagrams, and plan maps (**P-Data** menu).

- ! Note that each P-Data sheet represents a merging of the records stored in the MDB table.
- ? See Editing the Data as a Spreadsheet (page 59) for how to view the data with multi-select and copy/paste tools.
- ? See Importing Data (page 63) for topics regarding importing LAS files, etc. See P-Data Manipulation Tools (page 198) for topics regarding manipulating the point values (resampling, converting to logarithmic/uranium grade, etc.)

### P-Text Datasheet

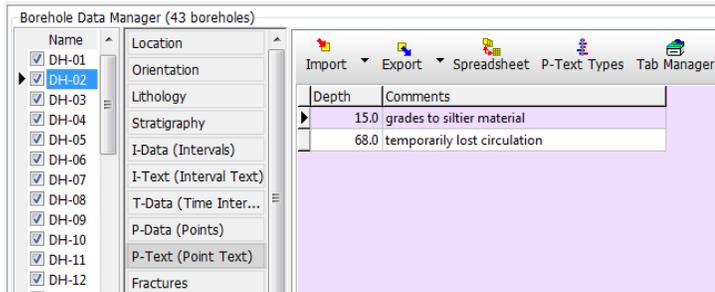
Use this table to enter **non-numeric** information that is recorded for **depth points**. The P-Data sheet (discussed above) is limited to numeric information only; the P-Text datasheet allows for alphanumeric characters.

P-Text fields:

- **Depth:** Measured depth to the first sampled point for the hole. The depth values must be positive.
- **Column 1:** Recorded data for that downhole point, for that component. If you have no data for a point, you can leave the cell blank. Blank cells will simply be skipped during processing.
- **Column 2 - Column x:** Click in (or <Tab> to) the next column to the right of the first, and type in the alphanumeric data for that component, for that interval. Repeat for as many columns as you have entries for, for that depth.

Click on the P-Text Types button at the top of the datasheet to define the column names for the measurement types (e.g. Color, Sample ID, etc.) for the project. The columns link to a P-Text Types Table where column names are defined.

Example:



These data can be displayed as text in 2D and 3D strip logs (**Striplogs** menu).

- ! Each P-Text datasheet represents a merging of the records stored in the MDB table.
- ? See Editing the Data as a Spreadsheet (page 59) for how to view the data with multi-select and copy/paste tools.

## Fractures Datasheet

Use this table to enter sub-surface fractures that you wish to display on logs and log cross sections, or model as a solid for display as a profile, cross section, fence, plan map, fracture surface map, or solid model.

Fracture data fields:

- **Depth:** Measured depth for the first fracture you wish to record. The depth values must be positive.
- **Direction:** Dip bearing in azimuth degrees (from 0 to 360) of the fracture.
- **Dip Angle:** Angle in degrees from horizontal (0 = horizontal, 90 = straight down).
- **Radius:** Fracture radius, in your data units (feet, meters). This will determine the size of the fracture disk as displayed on 3D striplogs, and will affect any fracture modeling you perform. This setting will be ignored if, during strip log setup, you set the Fractures / Dimensions to Fixed and enter a value there.
- **Aperture:** Fracture thickness. When displayed in RockPlot3D this will affect the thickness of the fracture disk as it's displayed with the logs. The fracture aperture is entered as actual thickness units, in the same units as your other downhole data. For example, if your other log data is entered in feet, the fracture aperture must also be entered as decimal feet. This setting will be ignored if, during strip log setup, you set the Fractures / Dimensions to Fixed and enter a value there.
- **Color:** Double-click in this cell and choose a color for the fracture "disk" that will be displayed in the logs and log sections.

Borehole Data Manager (43 boreholes)

Depth	Azimuth	Inclination	Radius	Aperture	Color
20.0	290.0	30.0	75.0	1.0	Red
55.0	305.0	45.0	75.0	1.0	Orange
76.0	295.0	20.0	50.0	1.0	Blue
95.0	315.0	31.0	90.0	1.0	Green

## Water Levels Datasheet

This table is used to enter one or more dates, depths, and optional text for observed water level(s) in the boreholes.

Water Level data fields

- Date:** Here you enter the date on which the measurement was taken, by typing it in or double-clicking in the cell and choosing a date. On logs, the date field can be displayed as a text label. For profile, plan, fence, and solid diagrams, RockWorks will use the Date field to match like measurements between wells. For this reason, you can enter the date in any numeric format; the program should be able to match "1/1/01" with "01/01/2001". You cannot use an alphabetic format (e.g. "January 1 2001"). The date and time formats will automatically adjust to U.S. or other formats based on the Windows Regional Settings.
- Depth to Top:** Measured depth to the top of the water level. The depth values must be positive.
- Depth to Base:** Measured depth to the bottom of the water interval. If you wish to display the water level as a surface of little or no thickness, set the Base depth to slightly greater than or equal to the Top depth. If you are not drilling to the base of the aquifer and wish to note the upper surface only, you can set the base depth to a value just slightly deeper than the top.

Borehole Data Manager (43 boreholes)

Date of Sample	Depth to Top	Depth to Base
2/14/2007	30.0	184.8
5/15/2007	30.0	184.8
8/6/2007	32.0	184.8
11/18/2007	46.0	184.8

Water level intervals can be displayed in logs and log sections as color-filled bars (**Striplogs** menu), and they can be modeled as surfaces for display as profile and cross section panels, fence diagrams, plan maps, or 3D surfaces (**Aquifers** menu).

## Symbols

Use this table to enter one or more depths for each borehole and the symbol to be plotted at each depth in individual logs and in log sections.

Symbol Tab fields

- **Depth:** Measured depth for the first symbol you wish to record. The depth values must be positive.
- **Symbol:** Double-click in this cell to pick the desired symbol from the displayed index to the library of symbols. You can pick a color for the symbol by clicking in the Color box. Click OK to return to the data table.
- **Caption:** Any text to be plotted with the symbol on the log. This is optional.

	Depth	Symbol	Caption
▶	10		Pump
	20		Pipe

? See page 287 for information about the RockWorks Symbol library.

## Patterns

Use this table to select specific graphic patterns to be plotted along a depth interval in individual logs or in log sections.

Data fields:

- **Depth to Top:** Measured depth to the top of the interval to be filled with the pattern block. The depth values must be positive.
- **Depth to Base:** Measured depth to the bottom of the pattern interval.
- **Pattern:** Double-click here to pick the desired pattern from the displayed index. You can pick foreground and background colors for the pattern by clicking in the Color boxes. You can also adjust the pattern density by adjusting the Density setting; the Preview box will show you the current design, colors, and density for your reference. Click OK to return to the data table. Initially, only the pattern number will be displayed in the cell, but when you <Tab> or click into another cell, the display will refresh with the graphic design and color.
- **Caption:** (optional) Any text to be plotted with the pattern on the log.

	Depth to Top	Depth to Base	Pattern	Caption
▶	10	20		Screen

? See the discussion of Lithology data and Stratigraphy data, earlier in this section, for information about entering downhole rock types and formation names, also associated with graphic patterns in logs and sections. See the discussion of Well Construction data, below, for information about entering downhole construction materials that allow multiple pattern columns.

## Bitmaps

Use this table to enter one or more depth intervals for each borehole and the name of the image to be plotted between these depths, in individual logs and in log cross sections. These can represent raster logs, downhole images, core samples, and more. Raster images are limited to display in vertical logs only (2D) and vertical and inclined logs only in 3D.

RockWorks contains an interactive tool for depth-calibrating the raster images.

1. Double-click in the **Filename** field to browse for the name of the first image to be listed for this well and click the Open button to open it. This file must reside in the current project folder.  
You will see the image displayed in a preview window. Now you can depth register the image. You can use the scroll bars to view portions of the image outside the current window, and the Image Size prompt to zoom in and out of the image display
2. Click on any point near the top of the log. This is typically the very top of the background grid, but it can actually be any point within the log where the depth is known.
3. Once the point has been selected, a red horizontal line will be drawn at the designated depth and you will be prompted to enter the depth at that location. Type in the depth and click OK.
4. Move the cursor to any point near the base of the log, using the scroll bars to move downward in the image. This is typically the very base of the background grid, but it can actually be any point within the log where the depth is known.
5. Once the lower point has been selected, a green horizontal line will be drawn at the designated depth and the user will be prompted to enter the depth at that location. Enter the depth and click OK.

The Raster Log Calibrator screen will disappear and the appropriate information be computed and displayed within the Bitmaps tab. This eliminates the need to load the raster image into another program to determine the header and footer offsets.

Depth to Top	Depth to Base	Header Base	Footer Top	Filename
5.0	40.0	0	257	bh_02_core_01.png
45.0	119.0	0	878	bh_02_core_02.png
120.0	170.0	0	261	bh_02_core_03.png

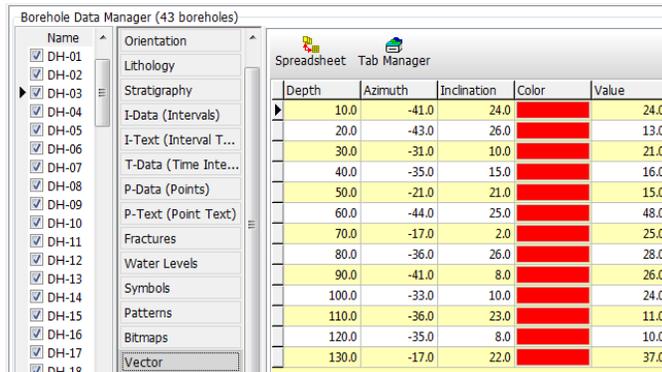
- ? Help Index: raster images/raster logs for more details about the calibration screens, and about the Bitmaps fields.

## Vectors

The Vectors table is used to enter directional data such as groundwater flow directions, tiltmeter data, sonar data (current flow), etc. This table can also be used to enter laser distance measurements in sub-surface, for cavern modeling.

Data fields:

- **Depth:** Measured depth to the vector origin. The depth values must be positive.
- **Direction:** Direction of the vector from the well, in azimuth degrees (from 0 to 360).
- **Inclination:** Vector's angle in degrees from horizontal (0 = horizontal, -90 = straight down, and 90 = straight up).
- **Color:** Double-click in this cell and choose a color for the vector arrow that will be displayed in the logs and log sections.
- **Magnitude:** Enter the current flow rate or any other parameter that is used to define the "strength" of the vector. This can be used to scale the vector arrow in the logs.  
! If these represent laser distance measurements in a cavern, the value will represent actual distance.



Depth	Azimuth	Inclination	Color	Value
10.0	-41.0	24.0	Red	24.0
20.0	-43.0	26.0	Red	13.0
30.0	-31.0	10.0	Red	21.0
40.0	-35.0	15.0	Red	16.0
50.0	-21.0	21.0	Red	15.0
60.0	-44.0	25.0	Red	48.0
70.0	-17.0	2.0	Red	25.0
80.0	-36.0	26.0	Red	28.0
90.0	-41.0	8.0	Red	26.0
100.0	-33.0	10.0	Red	24.0
110.0	-36.0	23.0	Red	11.0
120.0	-35.0	8.0	Red	10.0
130.0	-17.0	22.0	Red	37.0

Vectors are displayed as arrows in 3D logs, and as tadpoles in 2D logs and sections (**Striplogs** menu). They can be interpolated into "cavern" models using the **Vectors / Model** option.

## Well Construction

This table is used to enter depth intervals and well material "keywords" for display as a Well Construction diagram on striplogs. In addition, the user declares the inner and outer diameter for the materials for correct representation of width. The construction "keywords" are associated with graphic patterns just like lithologic keywords, and are easily selected from the data tab. In addition you can specify an "offset" from well center, enabling you to display two separate borings in a single Well Construction diagram.

Data fields:

- **Depth to Top:** Measured depth to the top of the interval to be filled with the pattern block. The depth values must be positive.
- **Depth to Base:** Measured depth to the bottom of the pattern interval.
- **Outer Diameter:** Determines the outer width of the pattern blocks in the Well Construction Column.
- **Inner Diameter:** Determines how far to the center of the Well Construction Column that the interval will be filled with the pattern block.

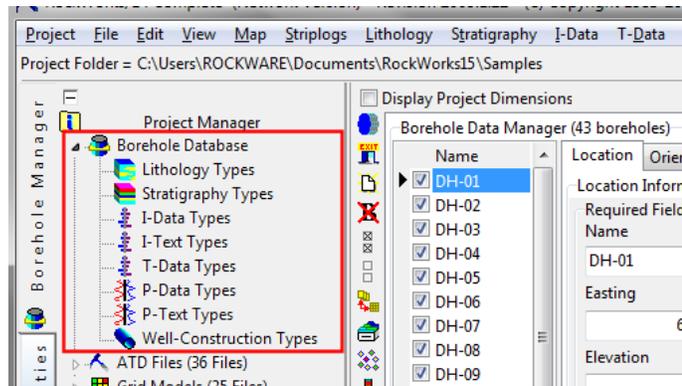
- **Material:** Double-click in this cell and choose the unit name from the Well Construction Types Table (see page 55). Or, you can single-click in this cell, click the small down arrow, and choose the name from the drop-down list. If the material name is not listed, you'll need to add it to the current Well Construction Types Table.
- **Offset:** (Optional) Declares the offset from the center of the well that this material block is to be plotted, enabling multiple borings within a single construction diagram. Negative values offset the block to the left of the center, positive values to the right.
- **Caption:** (optional) Enter here any text you want to be plotted with the diagram on the log.

Name	Depth to Top	Depth to Base	Outer Dia	Inner Dia	Material	Offset	Caption
DH-01	0.0	0.0	3.0	0.0	Cover	0.0	Cover
DH-02	0.0	0.0	6.0	0.0	Screen	0.0	Screen
DH-03	0.0	40.0	5.0	2.5	Grout	0.0	Grout
DH-04	0.0	50.0	0.5	0.0	1/2" PVC	-0.5	1/2" PVC
DH-05	0.0	100.0	0.5	0.0	1/2" PVC	0.5	1/2" PVC
DH-06	40.0	45.0	5.0	4.0	Bentonite	0.0	Bentonite
DH-07	40.0	70.0	4.0	2.5	Screen	0.0	Screen
DH-08	45.0	65.0	5.0	4.0	Gravel	0.0	Gravel
DH-09	50.0	60.0	1.0	0.0	Pump	-0.5	Pump
DH-10	65.0	70.0	5.0	4.0	Bentonite	0.0	Bentonite
DH-11	70.0	90.0	5.0	2.5	Grout	0.0	Grout
DH-12	90.0	95.0	5.0	4.0	Bentonite	0.0	Bentonite
DH-13	90.0	120.0	4.0	2.5	Screen	0.0	Screen

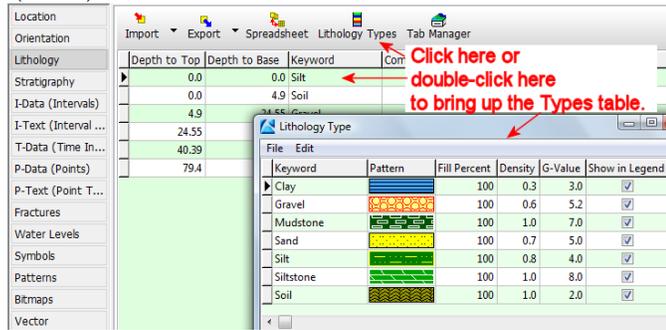
? Help Index: well construction for more details about how to enter and format the data.

### Linked Types Tables

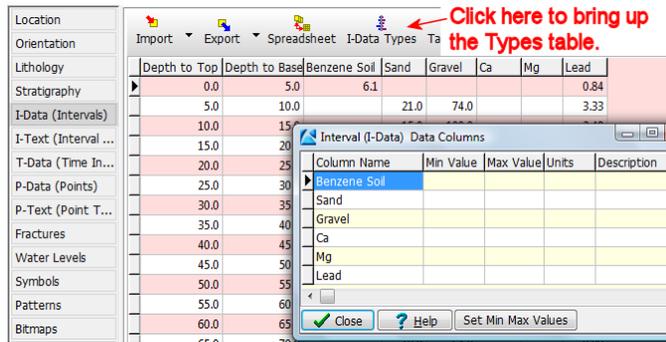
Some of the data tabs discussed in the previous section link to other tables which act as libraries, defining the *type* of data you are entering. You can access these Types tables via the Project Manager pane.



You can also access these from within the data tabs themselves. For example, from the Lithology data tab, use the Lithology Types button, or double-click on a Keyword cell to bring up the Lithology Types table.



Or, you can click on the I-Data Types button in the I-Data tab to bring up its Types table where the column headings are defined.



## Lithology Types Tables

The Borehole Manager database uses "Lithology" data tables (page 40) for entry of depth intervals and "keyword" (rock or soil type) names for each borehole. These materials can be illustrated in strip logs, and can be interpolated into a solid model for display as blocks, profiles, and more using the program's Lithology tools.

The "Lithology Types Table" defines for the program the names of the keywords for the current project's rock/material types, and the graphic pattern / color to use for each in logs and other diagrams. It serves as the reference library for the downhole lithology data. This table is stored in the project database.

Keyword	Pattern	Fill Percent	Density	G-Value	Show in Legend
Agglomerate		100	1.0	15.0	<input type="checkbox"/>
Asphalt		100	0.2	1.0	<input type="checkbox"/>
Basalt		100	1.0	19.0	<input type="checkbox"/>
Clay		100	0.3	5.0	<input checked="" type="checkbox"/>
Clay/Gravel		100	1.0	21.0	<input checked="" type="checkbox"/>
Clay/Sand		100	1.0	1.0	<input checked="" type="checkbox"/>
Clay/Sand/Gravel		100	1.0	1.0	<input type="checkbox"/>
Coal		100	1.0	20.0	<input type="checkbox"/>
Concrete		100	0.4	3.0	<input type="checkbox"/>
Dolomite		100	0.5	4.0	<input type="checkbox"/>
Granite		100	1.0	6.0	<input checked="" type="checkbox"/>

*Rock/soil "keyword" (sort column)*

*Rock/soil pattern & colors*

*Fill percent for logs*

*Rock density for mass computations*

*Numeric "G" value to represent the rock type in solid models*

*Display in diagram legend*

The Lithology Types Table lists for each rock/soil material:

- **Keyword:** The material name, such as *Sand* or *Limestone*. This field will link to the Lithology data table. You can use spaces, dashes, slashes in the keyword. We generally recommend keeping your keywords as short as possible for manageability and readability in logs and legends.
- **Pattern:** The pattern and colors to be used to represent the material in diagrams. You can click on the pattern cell to bring up a pattern selection window where you can select pattern design, foreground and background colors, line thickness, pattern repeating density, etc.  
**! In 3D logs and 3D models *the background color only is displayed*.** Pattern designs are not supported in the 3D OpenGL window.
- **Fill Percent:** The percent fill for the pattern when displayed in strip logs. At "100" the full log column will be filled with pattern. At "50" only half will.
- **Density:** The material's density, in weight per cubic unit. This is only used for mass computations in the program. If you don't know what to enter, just enter "1" and disregard any mass computations.
- **G-Value:** Used to define the numeric value to be used to represent the rock type in lithology solid models. Models can't contain words like "arenaceous limestone" but they can contain numbers like "12". Typically, this will be an integer value, such as "1" or "2". It's perfectly okay to assign a "1" to the uppermost name and increment the integer by "1" for each next rock type. These should be unique values for each material type.

- ! If you will be comparing models from different projects, you might want to be sure that like rock types in the different Lithology Types Tables are assigned the same G value.
  - ! It can be handy to number adjacent lithologies sequentially because of the way 3D lithology block models are displayed and filtered in RockPlot3D.
  - **Show in Legend:** Defines whether the material is to be displayed in any diagram legends and in the pop-up list linked to the lithology data table.
- ! **Handy to know:**
- You can click on the Keyword heading to sort the table by keyword. You can click on the G-Value heading to sort the table by G value.
  - Use the **Edit** menu tools to switch keyword case and to un-check material types not contained in the current project.
  - Add a new row by clicking in the last row and pressing the down-arrow on your keyboard.
  - You can delete a keyword (Ctrl+Del) and the program will offer automatic substitution of a different keyword for existing data records.
- ? Help Index: Lithology Types Table re: accessing, importing, exporting, etc.

## Stratigraphy Types Tables

The Borehole Manager database uses "Stratigraphy" data tables (page 41) for entry of depth intervals and formation layer names for each borehole. These formations can be illustrated in strip logs, as surface maps, fence diagrams, and more using the program's Stratigraphy tools.

The "Stratigraphy Types Table" defines for the program the names of the formations for the current project, and the graphic pattern / color to use for each formation in logs and other diagrams. It serves as the reference library for the downhole stratigraphic data. **This table is stored in the project database.**

Formation	Pattern	Fill Percent	Density	Order	Show in Legend
Overburden		100	0.2	1.0	<input checked="" type="checkbox"/>
Aquifer-1		100	0.3	2.0	<input checked="" type="checkbox"/>
Aquitard-1		100	0.1	3.0	<input checked="" type="checkbox"/>
Aquifer-2		100	0.2	4.0	<input checked="" type="checkbox"/>
Bedrock		100	0.3	5.0	<input checked="" type="checkbox"/>

Formation name

Formation pattern & colors

Fill percent for logs

Rock density for mass computations

Formation sequence top down, (sort column)

Display in diagram legend

The Stratigraphy Types Table lists for each formation:

- **Formation:** The formation name. This field will link to the data table.  
**Pattern:** The pattern and colors to be used to represent the formation in diagrams. You can click on the pattern cell to bring up a pattern selection window where you can select pattern design, foreground and background colors, line thickness, pattern repeating density, etc.  
  
**!** In 3D logs and 3D models **the background color only is displayed**. Pattern designs are not supported in the 3D OpenGL window.
- **Fill Percent:** The percent fill for the pattern (when displayed in strip logs). At "100" the full log column will be filled with pattern. At "50" only half will.
- **Density:** The formation's density, in weight per cubic unit. This is only used for mass computations in the program. If you don't know what to enter, just enter "1" and disregard any mass computations.
- **Order:** The formation's order, from the ground downward. This is important – it will affect program logic as it models your surfaces. (This "G" value will also be assigned for that layer in stratigraphic solid models, should you decide to save them.)
- **Show in Legend:** Defines whether the formation is to be displayed in any diagram legends.

**!** **Handy to know:**

- You can click on the Formation heading to sort the table by name. You can click on the Order heading to sort the table by order.
- Use the **Edit** menu tools to switch the case of the formation names, and to un-check types not contained in the current project.
- Add a new row by clicking in the last row and pressing the down-arrow on your keyboard.
- You can delete a formation name (Ctrl+Del) and the program will offer automatic substitution of a different formation for existing data records.

**?** Help Index: Stratigraphy Types Table re: accessing, importing, exporting, etc.

## Well Construction Types Tables

The Borehole Manager database uses "Well Construction" data tables for entry of depth intervals and different material types for construction information for each borehole. This information can be illustrated in strip logs and log sections.

The "Well Construction Types Table" defines for the program the names of the construction materials for the current project, and the graphic pattern / color to use for each material type. **This table is stored in the project database.**

Material	Pattern	Show in Legend
CONCRETE PLUG	[Pattern]	<input checked="" type="checkbox"/>
GRAVEL	[Pattern]	<input checked="" type="checkbox"/>
GRAVEL PACK	[Pattern]	<input checked="" type="checkbox"/>
GROUTED ANNULUS	[Pattern]	<input checked="" type="checkbox"/>
PIPE	[Pattern]	<input checked="" type="checkbox"/>
PVC SCREEN	[Pattern]	<input checked="" type="checkbox"/>
SAND PACK	[Pattern]	<input checked="" type="checkbox"/>
Screen	[Pattern]	<input checked="" type="checkbox"/>
Surface	[Pattern]	<input checked="" type="checkbox"/>
SURFACE CASING	[Pattern]	<input checked="" type="checkbox"/>
THREADED END PLUG	[Pattern]	<input checked="" type="checkbox"/>
THREADED JOINTS	[Pattern]	<input checked="" type="checkbox"/>

*Material Name*
*Material pattern and colors*
*Display in diagram legend*

The Well Construction Types Table lists for each material:

- **Material:** The material name, such as "casing" or "screen". This field will link to the data table.
- **Pattern:** The pattern and colors to be used to represent the material in log diagrams. You can click on the pattern cell to bring up a pattern selection window where you can select pattern design, foreground and background colors, line thickness, pattern repeating density, etc.  
**! In 3D logs *the background color only is displayed.*** Pattern designs are not supported in the 3D OpenGL window.
- **Show in Legend:** Defines whether the material is to be displayed in any diagram legends.

**! Handy to know:**

- Use the **Edit** menu tools to switch the case of the material names, and to un-check types not contained in the current project.
- Add a new row by clicking in the last row and pressing the down-arrow on your keyboard.
- You can delete a material type (Ctrl+Del) and the program will offer automatic substitution of a different keyword for existing data records.

**? Help Index:** Well Construction Types Table re: accessing, importing, exporting, etc.

## I-Data Types Tables

I-Data Types tables are used to define the columns displayed in the I-Data (Intervals) data tab.

Column Name	Min Value	Max Value	Units	Description
Benzene Soil	0	500		
Gravel	0	100		
Sand	0	100		
Ca	0.1	5.1		
Mg	0.5	5.9		
Lead	0.01	4.97		

This table defines for each column:

- **Name:** Name of the measured value you'll be recording, such as Benzene or Percent Sand – this will become the column heading. This field is limited to 31 characters.
- **Min Value, Max Value:** Define the minimum and maximum acceptable values for the component. These fields are optional.
- **Units:** Units you are measuring, such as PPM or Percent. For your reference only.
- **Description:** Descriptive information about the measurements, for your reference.

! **Handy to know:** Add a new row by clicking in the last row and pressing the down-arrow on your keyboard.

? See Help Index: I-Data Types for more information about using this table.

## I-Text Types Tables

I-Text Types tables are used to define the columns displayed in the I-Text (Intervals) data tab.

Column Name	Description
Sample ID	
Color	

This table defines for each column:

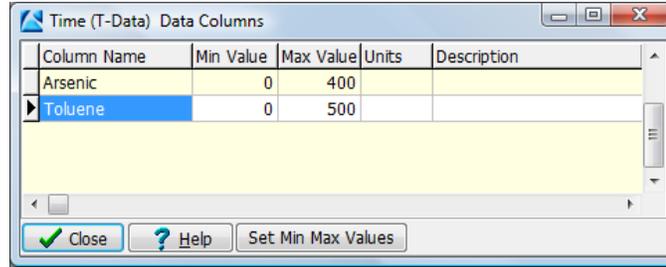
- **Name:** The name of the text you'll be recording, such as Sample ID or Color – this will become the column heading. This field is limited to 31 characters.
- **Description:** Descriptive information about the data, for your reference.

! Handy to know: Add a new row by clicking in the last row and pressing the down-arrow on your keyboard.

? Help Index: I-Data Types for more information about using this table.

## T-Data Types Tables

T-Data Types tables are used to define the columns displayed in the T-Data (Time-Based Intervals) data tab.



This table defines for each column:

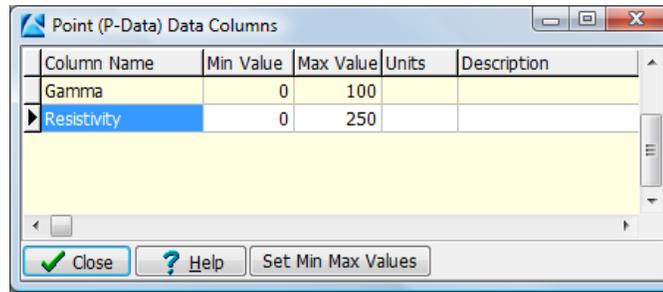
- **Name:** The name of the measured value you'll be recording, such as PCB or TCE – this will become the column heading. This field is limited to 31 characters.
- **Min Value, Max Value:** Define the minimum and maximum acceptable values for the component. These fields are optional.
- **Units:** The units you are measuring, such as PPM or Percent, for your reference only.
- **Description:** Descriptive information about the measurements for your reference.

! **Handy to know:** Add a new row by clicking in the last row and pressing the down-arrow on your keyboard.

? Help Index: T-Data Types for more information about using this table.

## P-Data Types Tables

P-Data Types tables are used to define the columns displayed in the P-Data (Points) datasheet.

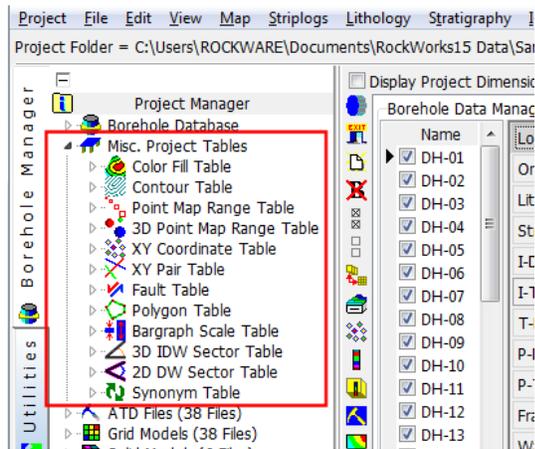


This table defines for each column:

- **Name:** The name of the measured value you'll be recording, such as Gamma or Resistivity - this will become the column heading. This field is limited to 31 characters.
  - **Min Value, Max Value:** Define the minimum and maximum acceptable values for the component. These fields are optional.
  - **Units:** The units you are measuring. This is for your reference only.
  - **Description:** Descriptive information about the measurements for your reference.
- ! **Handy to know:** Add a new row by clicking in the last row and pressing the down-arrow on your keyboard.
- ? See Help Contents: Index: P-Data Types for more information about using this table.

## Miscellaneous Project Tables

RockWorks relies on a variety of other lookup tables for miscellaneous operations such as custom coloration of contour bands, or the location of a polygon's vertices as it's used to filter a grid model.



These tables are stored in the project database, and are listed in the Project Manager under the Misc Project Tables heading. You can maintain as many versions of these tables as you wish. For example, you could create separate colorfill tables for all of the I-Data tracks in your project. You can assign each one a unique name for identification.

- ! In earlier versions of RockWorks, these tables were stored in separate text files with a .TAB file name extension. Now that they are stored in the project database, there are tools for importing (and exporting) the .TAB versions.
- ! At the time of this writing, ReportWorks and RockPlot3D, because they are stand-alone programs separate from RockWorks, still read the .TAB versions of the files. So, take note that you'll need to export TAB versions of your custom color tables (for example) for use in those programs.

### Summary of Miscellaneous Project Tables

**Color Fill Table:** Defines a listing of value intervals and their corresponding colors, to be used by the program when building 2D or 3D color-filled contour maps, solid models, profile or section panels, etc. for which you have requested "Custom" color intervals.

**Contour Table :** Defines a listing of Z-values and their corresponding line styles and (optionally) contour labels, to be used by the program when building 2D line contour maps for which you have requested "Custom" intervals.

**Point Map Range Table :** Defines a range of values and the graphic symbol/color to be used to represent that map site in variably-scaled point maps.

**3-D Point Map Range Table:** defines a range of values and the size and color for the spheres or cubes to be used to represent that location in variably-scaled 3D point maps.

**XY Coordinate Table:** Defines a listing of X,Y coordinate locations to be used to define the panel endpoints in a RockWorks cross section diagram (typically in a script, when you won't be defining the locations interactively).

**XY Pair Table:** Defines a listing of X,Y coordinate locations to be used to define the panel endpoints in a RockWorks fence diagram (typically in a script, when you won't be defining the locations interactively).

**Fault Table:** Defines panel endpoints of fault polyline(s) which can be used to apply faulting to selected gridding algorithms and display the lines in 2D contour maps and 3D surfaces.

**Polygon Table:** Defines the boundary vertices of a polygonal area, used to filter grid and solid models.

**Bargraph Scale Table:** Defines the size of I-Data and T-Data bargraphs in 2D and 3D striplogs, as a percent of the column width, based on measured values.

**3D IDW (Solid Modeling) Sector Table:** Defines one or more 3D regions within which the Inverse-Distance Table-Based solid modeling method will look for points as it's assigning a node value, and apply the user-defined modeling settings.

**2D IDW (Gridding) Sector Table:** Defines one or more 2D regions within which the Inverse-Distance Directional Weighting gridding method will look for points as it's assigning a node value, and apply the user-defined modeling settings.

**Synonym Table:** Defines target and replacement text to be used by the RockWorks Utilities **Edit / Columns / Translate** program.

? Help Index: Misc Project Tables for more information about their setup and use

### Editing Data as a Spreadsheet

Although the Borehole data tables look like spreadsheets, they are not. Instead, they are a fairly complicated merging of separate database fields. While you can type into these tables, just like you can with a regular spreadsheet, you cannot select a block of cells or copy/paste a block of cells like you can with a normal spreadsheet.

There is, however, a tool in the Borehole Manager's **Edit** menu that will load the active borehole's current (in front) data sheet into a spreadsheet-style editor and allow standard copy/paste editing tools: **Edit / Edit Data as Spreadsheet**.

Row#	Depth to Top	Depth to Base	Benzene	Porosity	Gold	Sand	Gravel	Clay
1	0	5	0.13	0.3	0.01	7	3	90
2	5	10	0.29	0.3	0.01	8	3	89
3	10	15	0.11	0.4	0.01	10	4	86
4	15	20	0.11	0.5	0.01	11	6	83
5	20	25	0.16	0.4	0.01	12	10	78
6	25	30	0.27	0.3	0.01	11	13	76
7	30	35	0.21	0.1	0.01	9	12	79
8	35	40	0.29	0.1	0.01	9	11	80
9	40	45	0.14	0.1	0.01	9	15	76
10	45	50	0.2	0.1	0.01	8	27	65
11	50	55	0.22	0.4	0.01	8	42	50
12	55	60	0.26	0.3	0.02	9	47	44
13	60	65	0.03	0.4	0.01	9	41	50
14	65	70	0.25	0.3	0.01	8	32	60
15	70	75	0.14	0.05	0.01	7	25	68
16	75	80	0.2	0.05	0.01	9	19	72
17	80	85	0.09	0.1	0.01	10	14	76
18	85	90	0.11	0.1	0.03	9	14	77
19	90	95	0.28	0.4	0.01	7	16	77

### Editing Modes

Refer to the status bar at the bottom of the window to see whether the editor is in **Range Select** mode, or in **Cell Editing** mode.

If you're in Cell Editing mode, you cannot select multiple cells. To return to Range Select mode press the Esc key.

### Selecting Cells

To select a single cell, single-click in the cell. You can use the cut, copy, or paste tools.

To select a range of cells, click and drag with your mouse. If it's non-responsive, press the Esc key first to toggle from Cell Editing to Range Select mode.

To select all of the cells, type Ctrl+A or choose the **Edit / Select All** menu item.

### Editing Tools

To edit a cell, double-click in the cell and type in a new value. Note that the Mode at the bottom of the window will read "Cell Editing".

Esc key: Returns spreadsheet mode back to Range Select from Cell Editing.



**Cut** (Ctrl+X): Removes the current cell or block of cells, storing the contents in your computer's clipboard memory.



**Copy** (Ctrl+C): Copies the current cell or block of cells, storing the contents in clipboard memory.



**Paste** (Ctrl+V): Pastes the contents of the clipboard into the worksheet, starting at the current cursor location.



**Delete** (Del): Removes the current cell or block of cells. It does not place the contents in the clipboard memory. This operation is not undo-able. Should you inadvertently delete data, you'll need to close the worksheet and cancel changes, and then reopen and edit the original data again.



**Cut All**: Removes data from all cells, storing the contents in clipboard memory.



**Copy All**: Copies all data into clipboard memory.



**Insert Row(s)**: Inserts a specified number of rows at a designated location.



**Delete Row(s)**: Deletes the row in which the cursor is currently located, or the rows currently selected.



Click this button to accept the changes and post the data to the database. You'll be returned to the Borehole Manager.



Click this button to cancel the editing changes and return to the Borehole Manager.

## Importing Data

### Overview

Another popular option for getting data into the Borehole Manager database is to import the data in bulk from another source. Many of these options can be used in combination with each other, and with manually entering some of the data. Most users will, indeed, use a combination of many methods for getting data into the program. There are a number of formats that are supported and which are described in detail in the Help messages. In this document, we'll focus on the most commonly-used formats, and offer the help topics where you can find more information.

? [Help Contents: The Borehole Manager / Entering Your Borehole Data / Importing Data](#)

### Importing ASCII Data

The Borehole Manager's **File / Import / ASCII** option is used to bring data into Borehole Manager from external ASCII files. This program will import data from one or more ASCII files into the borehole database. In addition to the borehole data, the program can also import other project information such as the project dimensions, lithology type table, stratigraphy type table, column titles, etc. The basic idea is to create a means for importing everything about a project from other applications.

A few important notes:

- This importer works very similarly to the Excel import discussed on page 64.
- The ASCII import tool can *append* to existing borehole records. This means that any data being imported that references existing borehole names (records) will simply be written to the existing record's fields. For example, if your existing database contains Location records for DH1 and DH2, you can append Lithology data for those same boreholes.
- You cannot, however, append to individual data tables. For example, if you already have lithology data stored in the borehole database, importing lithology data from the ASCII file will replace all of the existing lithology data. Or if you already have a Resistivity track for P-Data, importing Resistivity data from the ASCII file will replace all of the existing Resistivity data for that borehole.
- The format of the imported data must be the same as that produced by the export-to-ASCII (**File / Export / ASCII**) program, which exports either a single ASCII file or multiple ASCII files.
- Because of the relational nature of the RockWorks database tables, it is necessary for the data types to be defined so that the import tool will be able to bring all of your ASCII data into the database. For example, if you are importing downhole interval measurements for "Benzene" and "Toluene", these I-data field names need to be defined so the import tool knows where to put them. There are three ways to do this:
  - (Recommended) Include the Type definitions - lithology, stratigraphy, well construction, I-data, T-data, P-data, etc. - in the import file itself. See the discussion of the Types worksheets in the single ASCII file or multiple ASCII files Help topics.

- Define them in RockWorks before you import the ASCII data. Use the Project Manager to access the Borehole Database / Lithology Types, Stratigraphy Types (etc) Tables where you can create/modify the defined data types.
- Let the import tool define them on the fly. Note that you will then need to view the Types Tables to establish patterns, colors, data ranges, etc.

? Help Contents: Borehole Manager / Entering your Borehole Data / Importing Data / Importing ASCII Data re: how to format the ASCII file, and the steps for importing

## Importing Excel Data

### Multiple Data Types

The Borehole Manager's **File / Import / XLS (Excel)** option is used to bring data into the Borehole Manager from multiple worksheets in an external Microsoft Excel file, for one or more boreholes and a variety of data types. Each worksheet in the XLS file must contain a specific type of data (locations or stratigraphy, for example).

	A	B	C	D	E	F	G	H	I	J	K	
1	Bore	File	Easting	Northing	Elevation	TD	Symbol	Color	Comments	Enabled	Meridian	AP
2	DH-01	DH-01	652967	5535293	1478	132	5	0		TRUE		
3	DH-02	DH-02	653238	5535554	1480	188	35	255		TRUE		
4	DH-03	DH-03	652899	5535620	1484	171	5	16711680		TRUE		
5	DH-04	DH-04	653238	5535293	1480	229	60	0		TRUE		
6	DH-05	DH-05	653103	5535424	1480	142	22	32512		TRUE		
7	DH-06	DH-06	653103	5535162	1515	216	15	16711680		TRUE		
8	DH-07	DH-07	-----	-----	----	213	41	8323199		TRUE		
9	DH-08	DH-08	Data for multiple boreholes			178	5	8355711		TRUE		
10	DH-09	DH-09	652831	5535424	1490	176	11	8355584		TRUE		
11	DH-10	DH-10	652831	5535162	1492	159	41	32639		TRUE		
12	DH-11	DH-11	653374	5535162	1443	205	22	16711680		TRUE		
13	DH-12	DH-12	653374	5535685	1503	121	25	255		TRUE		
14	DH-13	DH-13	652964	5535078	1479	226	14	0		TRUE		
15	DH-14	DH-14	653263	5535052	1495	207	14	0		TRUE		
16	DH-15	DH-15	653410	5535329	1452	216	14	0		TRUE		
17	DH-16	DH-16	652749	5535314	1504	166	14	0		TRUE		
18	DH-17	DH-17	652833	5535748	1492	161	14	0		TRUE		

Multiple worksheets with different data types

A few important notes about the **File / Import / XLS** importer:

- The Excel import tool can *append* to existing borehole records. This means that data being imported that references existing borehole names can be written to the existing record's fields. For example, if your existing database contains Location and I-Data records for DH1 and DH2, you can append Lithology data for those same boreholes.
- You can append new boreholes to the project via the Excel import. If your XLS file references borehole names not already present in the project, it will create new borehole records, and bring in data for those boreholes. This can be an efficient way to merge projects.

- You cannot, however, append to existing data types for individual boreholes. For example, if you already have lithology data stored for a well in the database, importing lithology data from the Excel file will *replace* all of the existing lithology data for that borehole. Or if you already have a Resistivity track for P-Data, importing Resistivity data from the Excel file will replace all of the existing Resistivity data for that borehole.
- The format of the imported spreadsheet must be the same as that produced by the export-to-Excel (**File / Export / Excel**) program - there is a specific layout that RockWorks requires.
- Because of the relational nature of the RockWorks database tables, it is necessary for the data *types* to be defined so that the import tool will be able to bring all of your Excel data into the database. For example, if you are importing downhole interval measurements for "Benzene" and "Toluene", these I-data field names need to be defined so the import tool knows where to put them. There are three ways to do this:
  - (Recommended) Include the Type definitions - lithology, stratigraphy, well construction, I-data, T-data, P-data, etc. - in the Excel spreadsheet itself. See the discussion of the Types worksheets in the Excel File Format Help topic.
  - Define them in RockWorks before you import the Excel data. Use the Project Manager to access the Borehole Database / Lithology Types, Stratigraphy Types (etc) Tables where you can create/modify the defined data types.
  - Let the import tool define them on the fly. Note that you will then need to view the Types Tables to establish patterns, colors, data ranges, etc.

? Help Contents: Borehole Manager / Entering Data / Importing Data / Importing Excel Data re: how to format the file, and steps for importing the data.

## Single Data Types

The Borehole Manager's **Import / CSV/XLS** tools which are available in the **I-Data**, **T-Data**, and **P-Data** menus are used to read row and column data from a single worksheet in Excel file, and import the rows and columns into the I-Data, T-Data or P-Data table for a single borehole or for multiple holes. This is primarily designed for users who have measurements for multiple point-data components, by depths, that can't be easily brought into the RockWorks database using the main Excel import tool discussed above. The import works with XLSX, XLS, CSV, and TXT files, provided that Microsoft Excel is installed on the user's machine.

Here is an example of the kind of Excel data that can be brought into RockWorks using these tools; this subset lists measurement depths in the first column, and different geophysical measurements in columns 2 - 8. The columns can be in any order.

DEPTH	ILD	ILM	SFLU	SP	DPHI	GR	CALI
4950	3.5085	3.5102	4.6729	30.2272	0.076	-999.25	276.028
4950.5	3.5325	3.5597	4.5416	30.229	0.0851	-999.25	276.028
4951	3.6083	3.6094	4.5073	30.2307	0.0962	88.0754	278.3948
4951.5	3.7132	3.6871	4.6054	30.2325	0.1078	90.6814	277.189
4952	3.7938	3.767	4.8445	30.2343	0.1159	91.8636	274.0056

4952.5	3.8753	3.8756	5.1333	30.236	0.1244	92.3335	270.426
4953	3.9307	3.9303	5.4392	30.2378	0.1334	92.5751	267.2069
4953.5	3.9575	3.8997	5.639	30.2396	0.1472	93.8368	263.9627
4954	3.9264	3.8412	5.5964	30.4807	0.1183	97.5396	258.8914
4954.5	3.8961	3.8112	5.2783	30.4821	0.0955	100.383	257.2962
4955	3.8942	3.8405	5.0118	30.4839	0.0737	99.1916	267.9763

**Notes:**

- These import tools allow you to import one or many columns from the spreadsheet.
- They also allow you to append new data columns to existing drillholes. For example, if the drillhole already lists ILD and ILM columns, you can add new SP and GR columns to the hole, with the result being all 4 P-Data columns for the drillhole.
- This tool does not allow you to append new data to an existing column - if the specific column already exists, and you import it again, the original data will be replaced. For example, if the hole already lists ILD and ILM columns and you import ILD and ILM data again, the original data will be overwritten.

? Help Contents: Borehole Manager / I-Data Tools, T-Data Tools, and P-Data Tools / Importing Excel Data for additional details.

### Importing from an ADO Source (acquire)

Use the **File / Import / ADO (acquire)** option to import data from a database exported from an external source. This wizard was written specific to MDB data extracted from an acquire database. You may also be able to use it to import from another source for which you have an OLE DB provider, though these have not been specifically tested. Windows supplies providers for MS Access (MS Jet), MS SQL Server, Oracle, and most ODBC drivers, to name a few.

The process involves defining the data type and selecting the data file to be imported, mapping the import fields to the Borehole Manager fields, and importing the data, table-by-table. Mapping templates can be stored for future use.

? Help Contents: Borehole Manager / Entering your Borehole Data / Importing Data for a detailed step-by-step listing.

### Importing LAS Data

Use the **File / Import / LAS** or **File / Import / Multiple LAS** options to import data from a single or multiple LAS (Log ASCII Standard) files, version 1.2 - 2 for import into the Location, P-Data, and (optional) Orientation tables of an existing borehole or a new well record. You can select the curves in the LAS file to be imported, header information can be imported into Location table fields, and data "decimation" is available. Azimuth and inclination curves can be imported into the Orientation table for the single-file import.

? Help Contents: Borehole Manager / Entering your Borehole Data / Importing Data for a detailed step-by-step listing.

## Importing LogPlot Data

Use the **File / Import / LogPlot DAT** option to import data from one or more LogPlot DAT files into the Borehole Manager. The data field matching is done using a LogPlot DAT file or ENM file as a template, and a series of screens is displayed to specify which LogPlot data types are to be placed in which RockWorks database tables.

- ? Help Contents: Borehole Manager / Entering your Borehole Data / Importing Data for a detailed listing of the import steps.

## Importing RockWorks2002/2004 Data

In RockWorks version 2006 and newer, the Borehole Manager stores borehole records in a database file (\*.MDB) in the project folder, with the same name as the project folder. By contrast, earlier versions of the Borehole Manager stored borehole records in individual ASCII ".BH" files.

If you have upgraded from an earlier version of RockWorks you can import your ASCII .BH files into the database via two methods:

1. If you want to create the database in the existing RockWorks2002/2004 project folder, use the **Project / Open** option to open that folder. If the program finds .BH files but no .MDB file, it will automatically launch the import wizard. The MDB file that's created will be assigned the same name as the existing project folder.
2. If you want to create the database in a new project folder, create that folder and then use the **File / Import / RockWorks2002/2004** option to import the BH files. If you wish to use any of the existing models (GRD, MOD) or graphic images (RKW, XML, RWR) you'll need to copy them from your old folder to the new.

- ! This tool imports only the BH files, Lithology Table, Stratigraphy Table, and project dimensions from your older project. It will NOT import grid models, solid models, or graphic files.

- ? Help Contents: Borehole Manager / Entering your Borehole Data / Importing Data for a detailed listing of the import steps.

## Other Database Imports

Please refer to the Help messages for further details about these additional import tools:

- **Importing gINT Data:** Use the **File / Import / gINT** option to import data from the gINT software program into the Borehole Manager database. This program requires the following:
  - You have gINT, version 7.1.039 or newer, installed onto your computer.
  - You have created a "correspondence file" in gINT, as described in that program's documentation.
- **Importing GDS Well Data:** The **File / Import / GDS** option Geological Data Service's GDSII or flat-file format files into the Borehole Manager. A separate borehole record will be created for each well number.

- **Importing IHS Well Data: Error! Bookmark not defined.** The **File / Import / IHS PI/DWIGHT** option imports IHS Energy Group's 297 Well Data format files into the Borehole Manager. This format is an updated version of the legacy PI 197 Well Export format. A separate borehole record will be created for each well number.
- **Importing Kansas Geological Survey Well Data:** The **File / Import / Kansas Geological Survey** option imports tops data provided by KGS. This import uses the same framework as the IGH, GDS, and Tobin imports.
- **Importing Newmont Assay MDB Data:** Use the **File / Import / Newmont Assay MDB** option to import data from a Newmont Assay database into the Borehole Manager. The Collar, Survey, and Assays tables are imported.
- **Importing Pentrometer Data:** The **File / Import / Penetrometer** option reads a data file output from a Spectrum Technologies Field Scout SC-900 Soil Compaction Meter and import the measurements into the Borehole Manager's Point (P-data) tabs.
- **Importing ProSect Data:** The **File / Import / ProSect** option reads a data file from the RockWare ProSect program (.PRO) and imports the drillhole location, downhole survey, lithology, and assay measurements into the Borehole Manager database.
- **Importing RockWorks99 Data:** If your RockWorks99 ATD and TEM files contain downhole (borehole) data, such as stratigraphic layers, and/or linked LIT, HIS, CUR, or ZON files, you'll need to import them into the RockWorks Borehole Manager database.  
 ! If your RockWorks99 ATD/TEM files *do not* contain borehole information, you can open them into the other RockWorks data window, marked with the RockWorks Utilities data tab.
- **Importing Tobin WCS Well Data:** The **File / Import / Tobin WCS** option is used to import data from a Tobin Well Coordinate Service (WCS) file into the RockWorks Borehole Manager. WCS files contain well location and other miscellaneous well information which is imported into the borehole Location tabs. Assigning well names can be based on several data fields, and well symbol is based on the listed well status (D&A, GAS, etc.)
- **Importing Fugro CPT Data:** The Borehole Manager's **Lithology** and **P-Data** menus both contain an **Import / Fugro CPT Data** option which imports data from a Fugro Cone Penetrometer file into a Lithology or P-Data tab for the current drillhole. For the Lithology import, the program will concatenate similar intervals such that the lithology doesn't consist of hundreds of small intervals.
- **Importing Colog Data:** Use the Borehole Manager's **P-Data / Colog** option to import data from a Colog borehole geophysics file into the P-Data tab for the current drillhole.

## Other Data Topics

### Lithology versus Stratigraphy

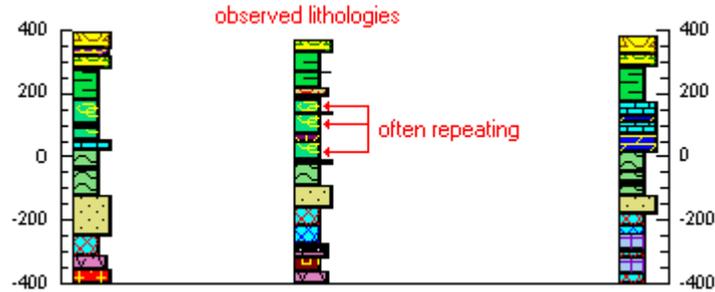
RockWorks recognizes two distinct types of borehole rock/soil material:

#### Observed Lithology

*What is "Lithology"?*

In RockWorks, "lithology" data represents your downhole rock or material types that aren't necessarily layered in a specific order. The Lithology entries can repeat (sand, clay, sand, clay). "Observed" is the key word. Observed lithology intervals for each borehole are entered into the Lithology tab, listing depth to top, depth to base, and rock or material type. This is what many people initially enter.

This means that if you do not initially know the regional stratigraphy, and cannot define discrete layering, you can still plot observed lithology in logs and log-based cross-sections.

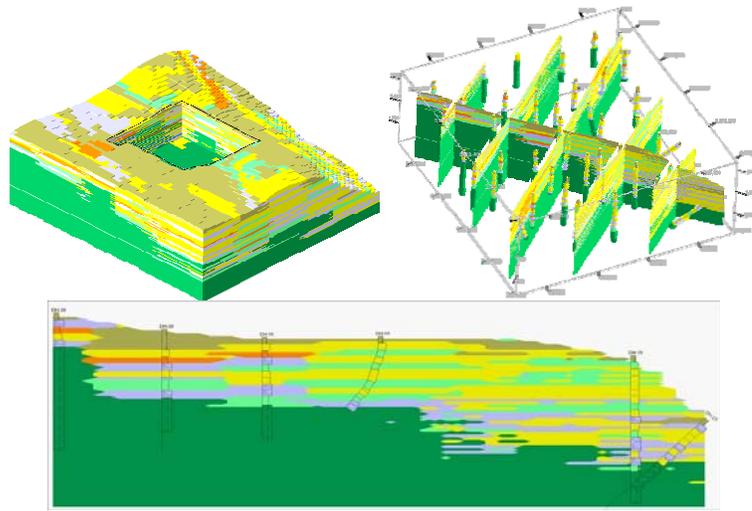


*How is Lithologies Defined?*

RockWorks stores in each project database a Lithology Types Table, where you define the names of the rock or material types, the colors and patterns to be used to represent them in logs and diagrams, and some additional settings. (Page 52)

*How is Lithology Modeled?*

RockWorks allows you to enter repeating lithology intervals within individual boreholes, so they cannot be modeled using surfaces. (You can't create a single surface for the top of a Sand layer, for example, if there are three "Sand" entries for a well.) Because of this, lithology data is modeled using solid modeling techniques, whereby the rock types basically "bleed" out from the boreholes into the surrounding space. This allows RockWorks to create panel sections / fences and block models representing interpolated material types, using the tools in the Borehole Manager's **Lithology** menu.

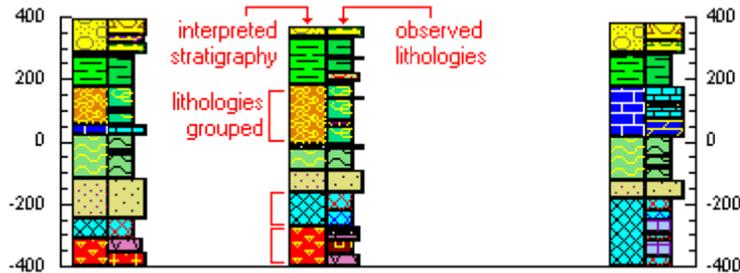


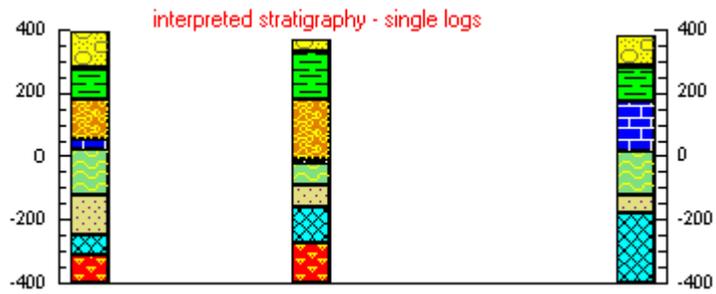
If you want to try to group your lithologies into interpreted stratigraphic units, you can do so by hand, or using the **Pick Contacts** tool in the **Stratigraphy** menu that allows you to view a lithology (or geophysical) cross section and point-and-click to record stratigraphy depths.

### Interpreted Stratigraphy

*What is "Stratigraphy"?*

These are interpreted formations, often groups of lithologies, which are distinctly layered in nature, are consistent between wells in their order from the surface downward, and never repeat within a borehole. Interpreted stratigraphy is entered into the Stratigraphy tab, with depth to formation top, depth to base, and formation name.



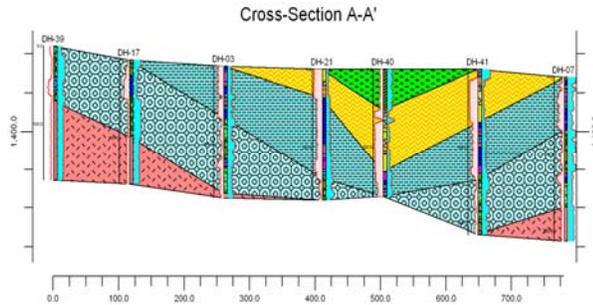


*How are Stratigraphy Units Defined?*

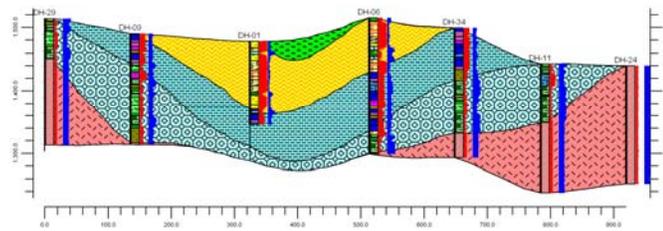
RockWorks stores in each project database a Stratigraphy Types Table , where you define the names of the ordered rock units or layers, the colors and patterns to be used to represent them in logs and diagrams, and some additional settings. (Page 54)

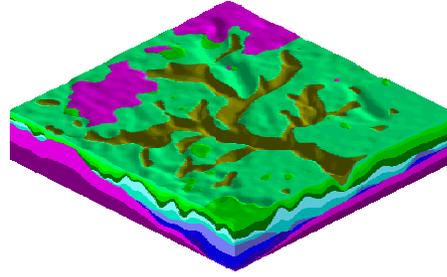
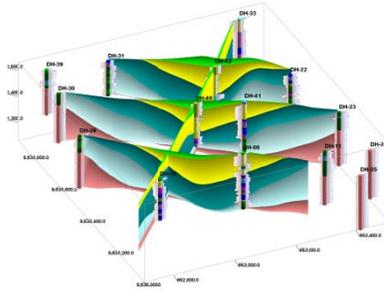
*How is Stratigraphy Modeled?*

Because stratigraphic units are distinctly layered, you can request simple log-to-log correlations (no modeling) in hole to hole or "straight" log sections.



RockWorks can interpolate surface models of each stratigraphic layer for 2D and 3D display; for slicing as profiles, sections, and fences; and for stacking as 3D diagrams.





### **Lithology**

Represents observed rock type

Is often the first step in entering borehole rock types

Can contain repeated sequences (sand, clay, sand, clay)

Rock types can vary in order between wells

No lateral variability

Data is entered in the Lithology tab

No simple correlation is possible in hole to hole cross sections

Is interpolated as a solid model, for display as slices, fences, or block diagrams

### **Stratigraphy**

Represents interpreted layers or formations

Is often the second step in entering borehole rock types.

Cannot contain repeated sequences

Stratigraphy layers must be consistent in order, from the top down, between wells

Often has lateral variability

Data is entered into the Stratigraphy datasheet

Simple correlations are possible in hole to hole cross sections.

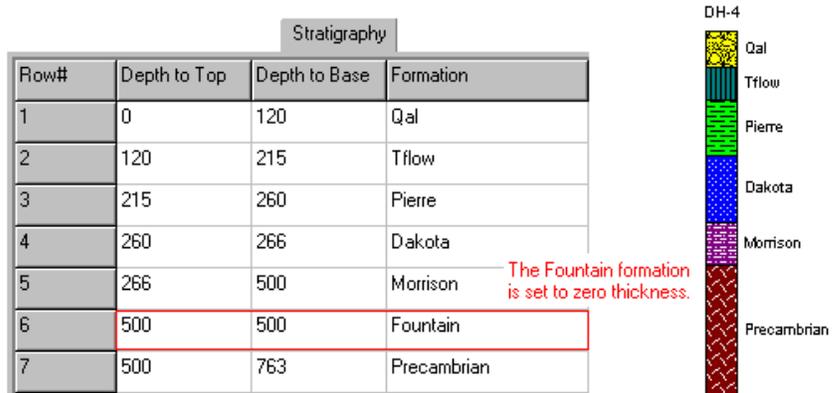
Is interpolated as surface models for display as maps, 3D surfaces, slices, fences, or block diagrams.

### **Missing Formations**

There are several ways to note missing stratigraphic formation data in the Borehole Manager "Stratigraphy" tab. The method you use will affect, at its most basic, how 2D strip logs and log sections are displayed. It will also affect how stratigraphic surface maps, thickness maps, profiles, fence diagrams, and block models are created.

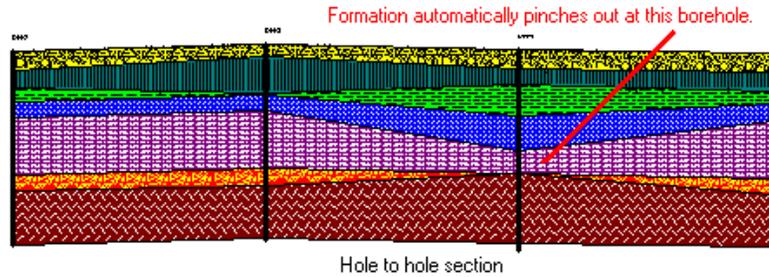
### Zero-Thickness Formations

One method of noting a missing formation is to assign the formation top an elevation that results in zero thickness.

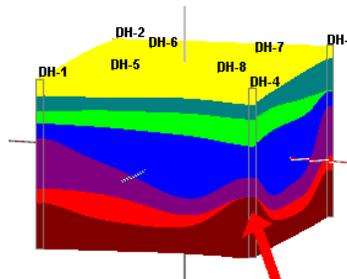


This formation would not appear in individual strip logs.

It would be displayed in hole to hole stratigraphy sections (**Stratigraphy / Section / Straight**) as pinched out at the well, with pattern fill.



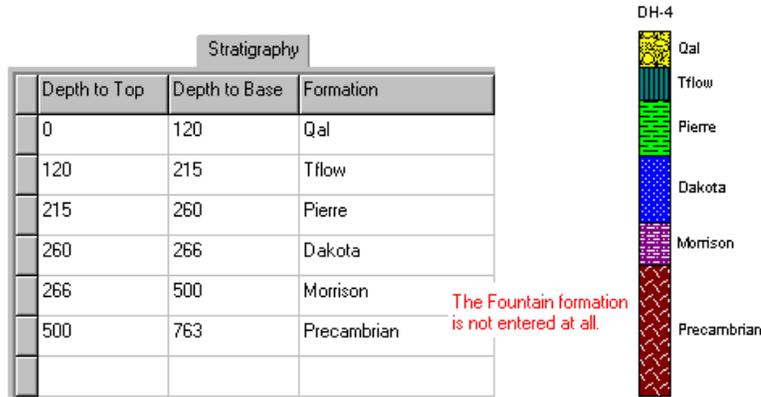
The formation's depths for that borehole would be included in computations that generate surfaces and thickness calculations. Note that in this stratigraphic model, the red surface is pulled up to lie on top of the lower surface.



**!** The **Stratigraphy** menu's **Fill in Missing Stratigraphy** option will insert zero-thickness formations into each borehole record. This can be a very handy tool but be sure (1) that you have correctly defined the stratigraphy order in your Stratigraphy Types table and (2) that you back up your database (when prompted) before completion of this process, just in case you're not happy with the results.

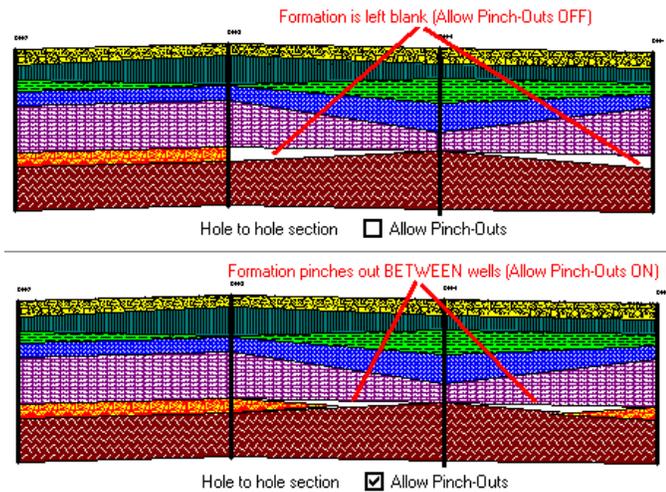
### Omitted Formations

Another way to note "no data" is omit the formation name altogether.

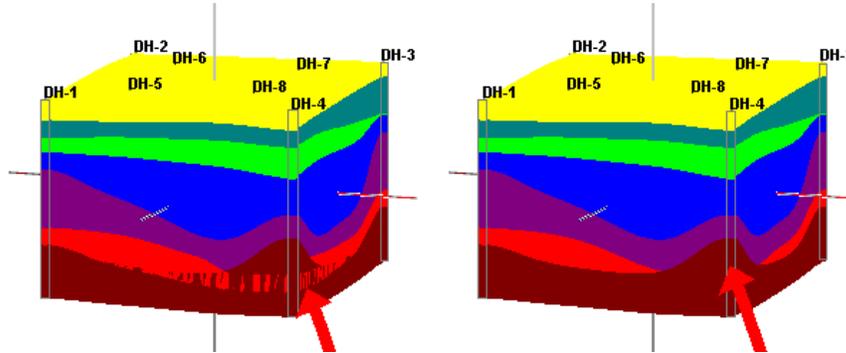


This tells the program that that formation is missing, and it should not be represented in individual strip logs.

It would be displayed in hole to hole sections as pinched out at the well with no fill, or pinched out between wells. There is an "Allow Pinchouts" option in the hole to hole Section window that offers the choice.



The omitted formation would not be included for that borehole in computations that generate surfaces and thickness calculations. Note how the red surface in the example on the left is not pulled up to lie on top of the lower surface since there is no data for the borehole. Its “interference” with the lower formation is noted with the splotchy lines. On the right, this interference is avoided by activating the “onlap” option in the stratigraphic model settings. Onlap tells the program to build the model from the bottom up and give lower units priority over upper ones.



### Missing Formation Bases

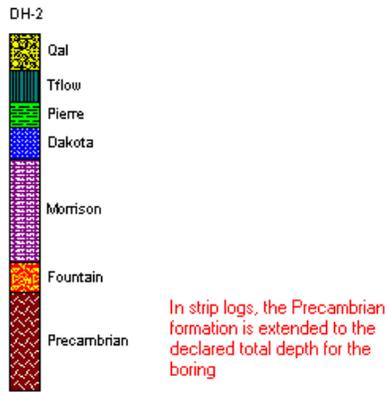
Another common scenario occurs when a borehole ends in the middle of a unit, challenging the geologist to decide whether to list the base of the boring as the base of the formation (not entirely correct) or to leave it blank. RockWorks permits you to leave a formation base blank, as shown below:

Stratigraphy			
Row#	Depth to Top	Depth to Base	Formation
1	0	76	Qal
2	76	146	Tflow
3	146	200	Pierre
4	200	266	Dakota
5	266	489	Morrison
6	489	554	Fountain
7	554		Precambrian

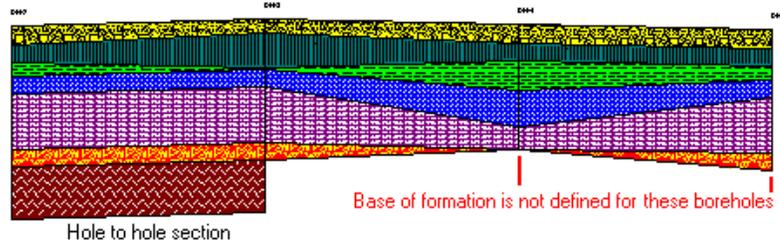
When the borehole ends mid-unit, you can leave the Depth to Base blank.

This will result in the following consequences:

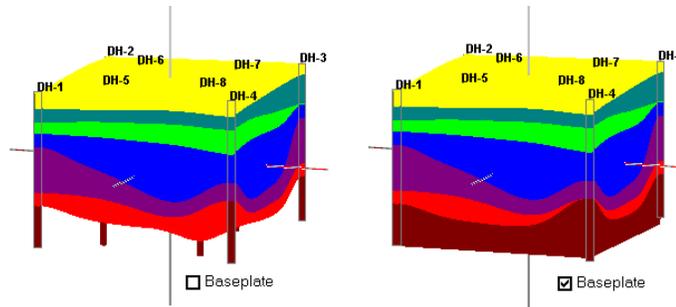
The formation will be extended to the base of the hole in strip logs:



The formation may or may not be included in hole to hole section panels for those borings in which its base is absent (as in “omitted formations,” above). You can choose whether to display the panel to the base of the borehole or omit it altogether.



The formation may or may not be included in stratigraphic models/profiles/fences – it depends on how many borings include the base (for most gridding methods, a minimum of 3 points are required to create a surface). If you there are inadequate control points to create a base surface (or a base surface that you like), you can request the generation of a “baseplate” in stratigraphic profiles, fence diagrams, and models. This simply sets an elevation for the base of the model.



## The Borehole Database

### Overview

Starting in RockWorks2006 and continuing to the current version, the data for the Borehole Manager is stored in a Microsoft Access-compatible database or MDB file. Some of the benefits of using a database structure for data storage include:

- **Relational integrity:** The database keeps track of records in a table that refer to records in other tables, such a stratigraphic unit for a borehole linking to the Stratigraphy Types Table.
- **Queries:** RockWorks contains some built-in query tools, that allow you (for example) to enable all boreholes that contain a particular formation or lie within a specific area. In addition, advanced users could use Access for detailed queries.
- **Data validation:** Numerical values are checked and stored, preventing entry of alphabetic characters. Date fields (like Water Level Dates) are validated to be actual date/time values.

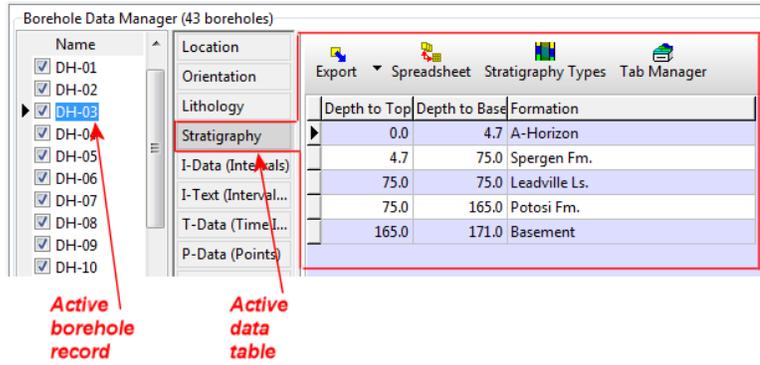
Some important notes:

- RockWorks uses a project folder for storage of all borehole data and related files.
- The MDB file that's created for a new project will be assigned the same name as the project folder. For example, if you create a new project folder named "Denver", then the project database will be named "Denver.mdb".
- When you access a folder containing .BH files from RockWorks2002 or RockWorks2004, the program will launch a wizard that will walk you through the steps to import the individual borehole files into the database.
- Lookup tables, such as those that define stratigraphy types and lithology types, are stored in the database.
- The data dictionaries, which define available fields, which tabs are displayed, etc., are stored in a "system" folder inside your project folder. This allows you to maintain custom data dictionaries for different projects.
- You do not need to have Access installed on your computer to use the RockWorks database. The behind-the-scenes database components, called the Microsoft Jet Database Engine, are installed with the Windows operating system. See the Help messages for more specifics re: Jet version compatibility.

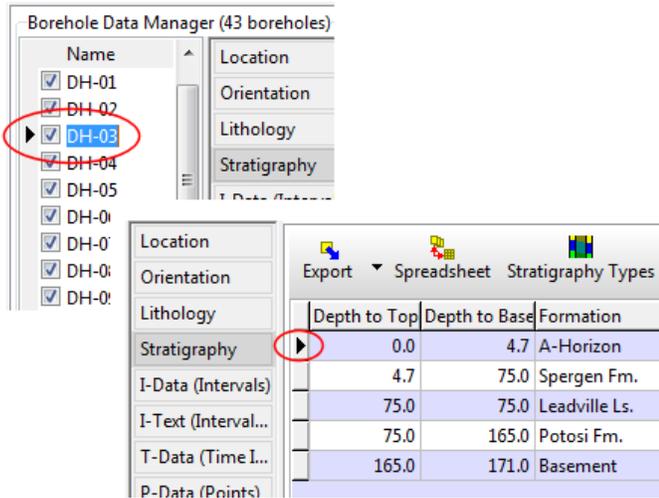
? [Help Contents: Borehole Manager / Entering Your Borehole Data / Borehole Manager Database.](#)

### Database Navigation Tips

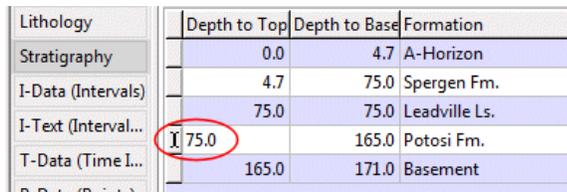
**Active Table:** The tables for each borehole are displayed in the Borehole Manager window, with stick-up tabs noting the table name.



**Active Row:** When you click on a record in the database, such as the name of a borehole or a row in the Stratigraphy table, the cursor will be shown as a triangle to show the active record.



**Editing Fields:** When editing, the record pointer will change to an "I-beam". This mode can be entered into by pressing the function key F2 or by double-clicking in the cell to be edited.



**Inserting Records:** Insert mode is indicated by the record pointer changing to an asterisk “\*”. A new record is inserted by

- Pressing the insert key or
- Moving to the last record and pressing the down-arrow key.
- Right-clicking and choosing Insert.

Lithology	Depth to Top	Depth to Base	Formation
Stratigraphy	0.0	12.3	A-Horizon
I-Data (Intervals)	12.3	135.0	Spergen Fm.
I-Text (Interval...)	135.0	151.0	Leadville Ls.
T-Data (Time L...	* 151.0		

**Canceling:** Both insert and edit modes can be cancelled by pressing the escape “Esc” key. This will cancel any edits that are in progress.

**Deleting Records:** Deleting a record is done by

- Typing Ctrl-Del (holding down the Ctrl key and pressing the Delete key)
- Right-clicking and choosing Delete.

? See also: Editing Borehole Records as a Spreadsheet (page 61).

? Help Contents: Borehole Manager / Entering Your Borehole Data / Borehole Manager Database:

- Checking your data and database integrity
- International number formatting
- Database engine specifications (and more...)

## Configuring the Data Tables

“Underneath the hood” of RockWorks is a collection of information about the RockWorks database itself. This “meta” data is called a Data Dictionary.

The Data Dictionary gives RockWorks a lot of versatility: You can change the names of your Borehole Manager tabs, their order and background color; even hide those tabs you do not use. You can add optional borehole information, such as the drilling company or date of initial boring or hide these optional fields if you do not use them.

! Changes that you make to the Data Dictionaries are stored in a "System" folder inside your project folder. This allows you to maintain different Dictionaries for different projects.

? Help Contents: Borehole Manager / Entering Your Borehole Data / Borehole Manager Database:

- Summary of the RockWorks Database Tables
- Database Engine Specs

## Customizing the Datasheet Display

The default setup for RockWorks will allow display of all of the datasheets discussed on page 37. You can adjust which data buttons are displayed and their display order, and you can customize the fields within the sheets, all of which can make the program easier to use by removing tabs you don't normally use and rearranging those that you do.

1. Access the Borehole Manager.
2. Open the existing borehole project if necessary.
3. Select the **View / Tab Manager** menu option. (You can also right-click on any of the tabs and choose Tab Manager.)
4. The following options are available:
  - Turn off the display of any data table. Note that the table will still be present in the database, it simply will not be displayed in the Borehole Manager window.
  - Change the order in which the buttons are displayed in the Borehole Manager window.
  - Change the name displayed on the button itself or the background color of the row-and-column view of the data.
  - Change the fields that are stored in the datasheet.

**!** At the time of this writing, new fields that you create in the database will not be usable by RockWorks, but they can be used to store accessory data for the borehole. For example, if you were to add a "Comments" field to the Stratigraphy data tab, you can add descriptive information about the formation intervals for storage in the database, even though you won't be able to display this text in a strip log.

**?** Help Index: Tab Settings

## Backing Up, Restoring, and Refreshing the Database

Use the **Project / Backup Database** tool to make a backup copy of the current .MDB file and the project's data dictionaries. We generally recommend that you do this from time to time, particularly before importing data, deleting data, or filtering data, should you inadvertently make changes you don't wish to keep. You can use the **Project / Restore Database** option to restore a backup copy as current.

Use the **Project / Refresh Database** option to reopen the current project database without having to exit and re-launch the program.

Use **Project / Archive Database to ASCII** to export the entire database to an ASCII file, zip format, for archival purposes or technical support. If you're working with a SQL Server, this is the only backup option in RockWorks.

## Checking the Data and Database Integrity

Use the **File / Check Database Integrity** tool to compare the contents of your current project database against the general program data dictionaries, to see a report of the items that are not in synch and to fix all those that it can. This can be helpful in the event that

fields have been added to one of your projects and you re-open another project and the older database no longer matches the modified data dictionaries.

Use the **File / Check Data Integrity** option to perform a database check (above) AND also read through the borehole data itself to check for mis-ordered stratigraphic units, misplaced Total Depths, etc.

## Exporting Borehole Data

The Borehole Manager's **File / Export** tools are used to export the contents of one or all boreholes to the following formats:

- ASCII (TXT) files (single or multiple files)
- Excel (XLS) files – each MDB data table is exported to an Excel worksheet within a single XLS file. Single, enabled, and all boreholes can be exported.
- LogPlot (DAT) files – the data for each borehole will be recorded to a LogPlot DAT file format. Single, enables, and all boreholes can be exported.
- RockWorks2004 (BH) files – the data for each borehole will be recorded to a RockWorks2004 BH file format.

? See Help Contents: Borehole Manager / Entering Your Borehole Data / Exporting Borehole Data.

? See also: Exporting Stratigraphy Data (page 163), Exporting Lithology Data (page 189), Exporting I-Data (page 197).

## Transferring Borehole Data to the RockWorks Utilities

There are several tools in RockWorks which allow you to transfer data from the borehole database to the flat datasheet in the RockWorks Utilities. At its most basic, this can be handy simply to view the data in a comprehensive row-and-column layout. You can also process the data using the tools in the Utilities menu, edit the data, and in some cases transfer the data back to the database.

The Borehole Manager's **File / Transfer / Locations -> Utilities Datagrid** tool is used to transfer borehole location information from the Location table to the RockWorks Utilities. There, you can view the data in a tabular format, edit it, process it (create maps, compute statistics, convert coordinates, to name a few) and even transfer your edits back to the Borehole Manager using the Utilities **File / Transfer / Locations -> Borehole Manager**.

The Borehole Manager's **File / Transfer / Stratigraphy -> Utilities Datagrid** tool is similar: It transfers all stratigraphy data from the database to the RockWorks Utilities datasheet. This can provide a quick method for viewing or adjusting your stratigraphic contacts. You can create structure maps using the **Map** menu tools, and you can compute thicknesses using the **Edit / Columns / Math** tools.

! Note that stratigraphy depths are converted to elevations when transferred to the datasheet. If you transfer any edits back, using the Utilities **File / Transfer / Stratigraphy -> Borehole Manager** option, the elevations are converted back to depths.

The Borehole Manager's **I-Data / Export / I-Data -> Utilities Datasheet** tool (and the similar tools in the **T-Data** and **P-Data** menus) transfers the measurements for a single track, for one or multiple boreholes to the Utilities Datasheet. There, you can perform calculations on the track measurements, compute statistics, etc.

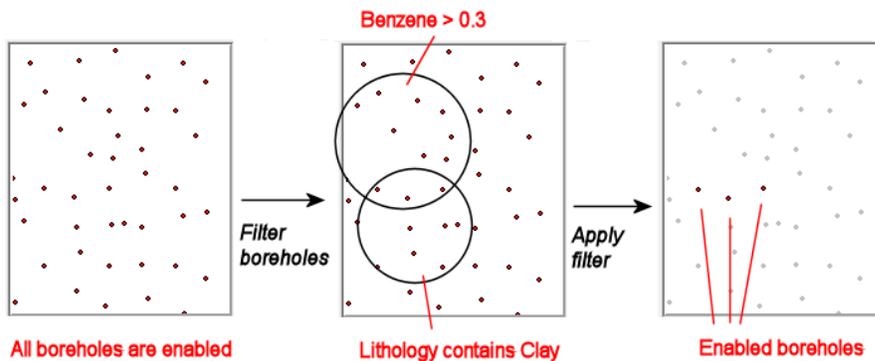
? Help Contents: Borehole Manager / Entering Borehole Data / Transferring Data.

## Querying the Data

### Simple Query

Use the **View / Filter Boreholes** tool to query all boreholes in the current project using one or more filters - such as a rectangular map area, specific stratigraphic formations, or specific Location table fields - and disable those boreholes that don't meet all of the criteria. This is a basic "AND" type of filter: each of the boreholes for which every criterion is true will be enabled and the remaining boreholes will be disabled.

Here is a cartoon that shows how the entire database is filtered based on two parameters, and only those wells where the criteria overlap result as enabled.



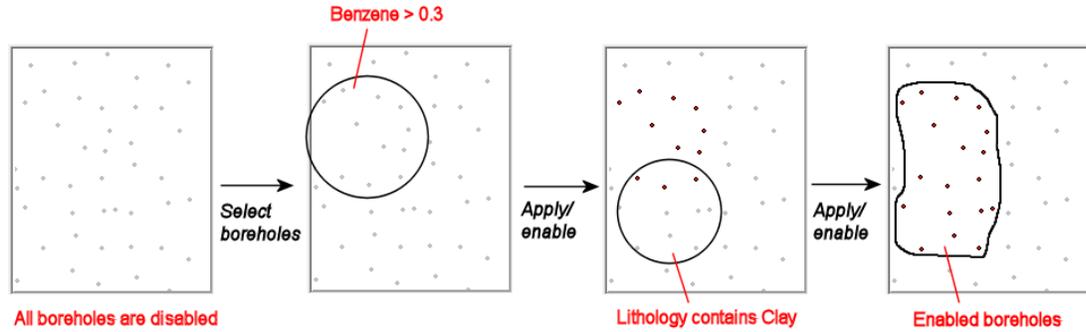
There is a preview window to the right where project boreholes are displayed in red, if currently enabled. Disabled boreholes can be invisible or shown in gray. Clicking the Apply button will leave the dialog box open but update the database using the selected filters and update the preview window.

Filters include map locations, vertical extents, lithology type, stratigraphy type, I-Data values, P-Data values, T-Data values, water level dates, and optional location fields.

### Complex Query

Use the **View / Select Boreholes** tool to query a subset of boreholes in the current project using one or more filters, and either enable or disable those boreholes. This is similar to the Filter option, except that the Select tool allows successive filters to be applied, and the enabling/disabling will apply only to the boreholes meeting the filter parameters, and no others. So, while the Filter Boreholes tool works as an AND filter, the Select Boreholes tool can function as an AND or OR filter.

Here is a cartoon that shows how successive Select filters can incrementally enable/disable boreholes using specific filters:



There is a preview window to the right where project boreholes are displayed in red, if currently enabled. Disabled boreholes can be invisible or shown in gray. Clicking the Apply button will leave the dialog box open but update the database using the selected filters and update the preview window.

Filters include map locations, vertical extents, lithology type, stratigraphy type, I-Data values, P-Data values, T-Data values, water level dates, and optional location fields.

### Locating the Closest Borehole

The **View / Locate Closest Borehole** option can be used to determine the borehole record whose X and Y coordinates are closest to an XY coordinate pair typed in by the user. This tool is also available interactively in the Rockplot2D window.

? Help Contents: Borehole Manager / Entering Borehole Data / Querying the Database.

### Workflow in the Borehole Manager

Once you have your project data entered into the Borehole Manager, here are some possible workflows:

- Establish your project dimensions
  - Where: **Project Dimensions** pane at the top of the program window
  - Why: Sets up overall dimensions of your maps and diagrams. Sets up dimensions and node density for 2D (Grid) and 3D (Solid) models. See page 100.
- Create a borehole location map
  - Where: **Map / Borehole Locations**
  - Why: This confirms that your XY location data is good, creates a reference map for your use, and can create a ground surface grid model for your solid models. See page 110.
- Create a 3D view of your log data

- Where: **Striplogs / Multi-log 3D**, activating as many of the downhole data types as you like.
- Why: This gives you a quick look at your all of borehole locations in 3D and confirms that your downhole data is entered properly. See page 126.
- Create a multi-log profile or section
  - Where: **Striplogs / Multi-Log Profile or Multi-Log Section**, activating as many of the downhole data columns as you like.
  - Why: If you prefer a 2D view of your logs this can confirm that your downhole data is entered properly. See page 122.
    - ! Note that inclined and deviated wells will be displayed as vertical in Multi-Log Section diagrams.
- Interpolate your data – use the menus to create interpolated models and graphics of specific data types.
  - Stratigraphy data (see page 151)
  - Water Level data (see page 167)
  - Lithology data (see page 183)
  - P-Data, I-Data, T-Data (see page 191)
  - Fracture and Vector data (see page )
- View/manipulate/print/export your graphics in the RockPlot2D and Rockplot3D windows. (See page 249and 265.)
- Use the **Grafix** menu to add items to your 3D views. (See page .243)
- Use the ReportWorks program to create page layouts of images, text, legends, etc. (See page 277.)

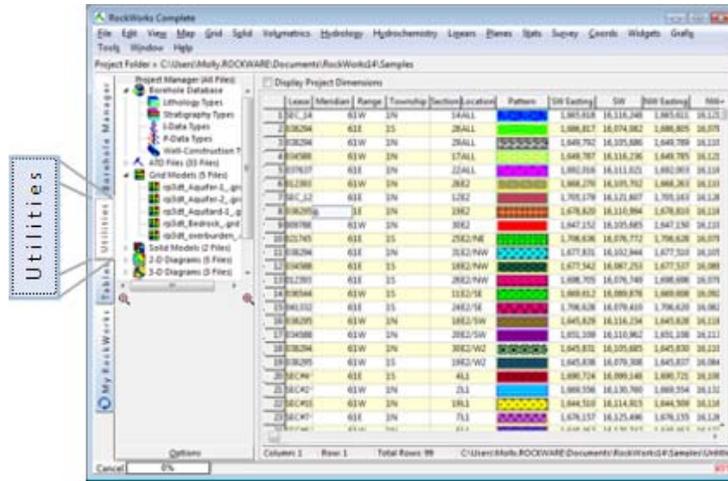
# Chapter 3 - The RockWorks Utilities Datasheet

## Topics

- Entering Your Data ..... 85
- Using the Datasheet ..... 86
- Editing the Datasheet ..... 94
- Importing Data ..... 97
- Exporting Data from the RockWorks Utilities Datasheet..... 97
- Transferring Data to the Borehole Manager ..... 98
- Digitizing Data ..... 98

## Entering Your Data

The RockWorks Utilities datasheet is one of the two main data windows in RockWorks. It is used for entering general types of data.



(The other main data window is the Borehole Manager, specifically for entering borehole data – downhole stratigraphy, lithology, geochemistry, geophysical measurements, water level, etc. See Chapter 2 for information about that data window.)

The data you enter into the RockWorks Utilities datasheet can include simple XYZ data for generating point and contour maps, strike and dip measurements for stereonet plots, hydrochemical ion lists for Piper diagrams, and many more. The RockWorks Utilities datasheet looks a bit like a spreadsheet – data can be entered in a row and column format, with cut-copy-paste options. Note, however, that most of the computation tools available in Excel are not available in this simplified datasheet.

ID	Symbol	Easting	Northing	Gold	Silver	Lead	Zinc	Tin	
1	1	814.2	330.8	0.078	0.0837	0.0976	0.0929	0.0798	
2	2	52.2	258.8	0.1058	0.095	0.1021	0.1044	0.0975	
3	3	140.1	130.6	Sample geochemistry data					0.0762
4	4	658.1	550.2	Sample geochemistry data					0.068
5	5	25.6	698.8	0.0924	0.1154	0.0869	0.0839	0.0919	

ID	Symbol	Strike	Dip	Line	
1	1	138.0	40	---	
2	2	93.8	88	---	
3	3	135.0	37	---	
4	4	249.9	57	---	
5	5	27.4	67	---	
6	6	225.3	72	---	
7	7	211.4	38	---	
8	8	Sample strike and dip data			---
9	9	117.0	4	---	
10	10	201.9	53	---	
11	11	297.5	89	---	
12	12			---	
13	13			---	

The data you enter into the RockWorks Utilities datasheet can be used to create many different types of maps and diagrams within RockWorks.

The RockWorks Utilities datasheet is saved in an ASCII Tab-Delimited format with the file name extension ".atd". The column headings and column styles (text or symbols or lines or colors) are stored in a header block at the top of the file.

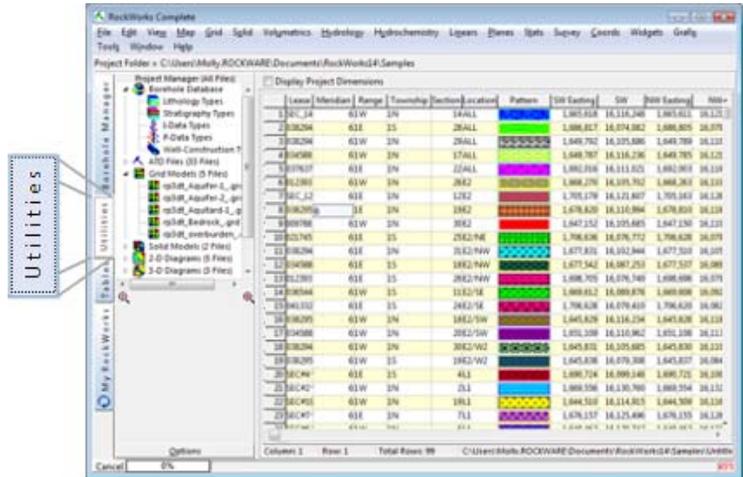
? Help Contents: Reference / ATD File Format

### Using the Datasheet

The "RockWorks Utilities" datasheet is a basic row-and-column data window that is one of two data windows available in RockWorks. This section discusses how to create new datasheet files, and how to open, save, and print these data files.

### How to access the datasheet

To access the RockWorks Utilities datasheet, click on the Utilities tab along the left side of the main program menu:



## How to create a new datasheet

To display a new, blank datasheet, follow these steps:

1. Access the RockWorks Utilities Datasheet.
2. Select the **File / New Datasheet** command.  
If there have been changes in the existing datasheet that have not yet been saved, the program will prompt you whether you wish to save them.  
Click **Yes** to save changes in the existing datasheet, or click **No** to discard the changes in the existing datasheet.
3. Choose from the next window the desired layout for the new file.  
This window will list a variety of column layouts, from generic styles with numbered column titles, to hydrochemistry ion layout. You may expand topics (click on the "+" symbol) to view sub-topics. When you click on a layout sample, the column titles and their types will be displayed to the right.  
**!** If you don't know which to choose or prefer to design your own column titles, choose **Numbered Column Titles**. Later, use the **View / Columns** tool to modify the column names and types.
4. Click **OK**.

The program will display a new, untitled datasheet, with the column headings you selected. The file will be displayed as untitled in the upper title bar ("untitled.atd").

## How to open an existing datasheet (RW2002-current)

To open an existing datasheet that you have saved in RockWorks version 2002 to current, you have a couple of options:

Using the Project Manager:

1. Expand the ATD Files heading and just double-click on the name of the ATD file you wish to open. (See page 107 for more information.)

Using the Menus:

1. Access the RockWorks Utilities datasheet.
2. Select the **File / Open** command.
3. In Browse for the ATD file you wish to open.  
**Tip: Use File / Recent** for a quick list of recently-accessed data files.

The program will load the file information into the datasheet's cells. The column headers are loaded from the header block listed in the file. The name of the current data file will be displayed in the title bar at the top of the program window.

You can refer to the files in the "My Documents\RockWorks15 Data\Samples" folder for formatting examples.

- ?** Help Contents: RockWorks Utilities / Entering Data / Using the Datasheet re: opening a RockWorks99 (and earlier) datasheet

## How to save a datasheet

Changes you have made to the data currently displayed in the RockWorks Utilities datasheet can be saved on disk using the **File / Save** or **Save As** command.

If the data file already has a name (as shown at the bottom of the program window), selecting **Save** will save the current version on disk, under the same name.

If the data file is untitled (as shown at the bottom of the program window), or if you choose **Save As**, the program will display a dialog box, in which you can specify the name under which the data file is to be saved.

1. **File Name:** Type here the name to assign to the data file. Data files are stored with an ".atd" file name extension, for "ASCII Tab-Delimited" files.
2. Click **Save**.

The program will save the information in the data window on disk, and the current name shown at the bottom of the program window will be updated as necessary.

## How to print your datasheet

To output the data contained in RockWorks Utilities datasheet to your printer, select the **File / Print** command. You can set the columns to "Yes" (to print) or "No" (to omit from the print job): Use the Printer Setup button to access your printer settings.

? Help Contents: RockWorks Utilities / Entering Data / Using the Datasheet

## Laying Out Your Datasheet

The RockWorks Utilities datasheet in RockWorks is used to enter rows and columns of a variety of different kinds of data. This section discusses how to set up different kinds of data for use in the program, and how to change the column headings and column types.

! With a few exceptions, most of these data structures are flexible. In the examples provided, we have tried to illustrate the minimum required data as well as "typical" data layouts, but you can organize your data columns any way you wish. During processing you can always specify which spreadsheet columns contain what data.

? Help Contents: RockWorks Utilities / Entering Data / Laying Out Your Datasheet for much more information, including examples, for all of these data layouts.

## Data for Maps and General Diagrams

### XYZ Data

"XYZ" data can be entered into the RockWorks Utilities datasheet to represent X and Y location coordinates and a measured "Z" value of some kind, such as elevations or geochemistry. This basic data layout can be run through **Map / EZ Map** to create a simple point map or line/color-filled contour map. Or, you can create a grid model of the XYZ data (**Map / Grid-Based Map**) for display as a 2D contour map or 3D surface.

Sample files: xy\_elevations.atd

Template: **File** / **New**: Generic / XYZ (Easting, Northing, Elevation) or XYZ (ID, Symbol, Easting, Northing, Elevation).

### Multivariate Data

"Multivariate" data can be entered into the RockWorks Utilities datasheet to list 2 or more components to be represented in a ternary diagram (**Stats** / **Ternary**, page 239), in a multi-variate map (**Maps** / **Multivariate** / **Pie**, **Barchart**, **Starburst**, page 112).

Sample Files: soil\_properties.atd for z-values representing soil components (sand, gravel, clay), geochemical measurements, and geotechnical parameters for use in a ternary diagram, display in maps, and more.

Template: **File** / **New**: Generic / Ternary Diagram for a generic data layout. Or Civil Engineering / Soil Classification. Remember that you can change column names and column types easily using **View** / **Column Titles**.

### Land Grid Well Descriptions

"Land Grid" well descriptions are entered into the RockWorks Utilities datasheet using a Range, Township, and Section notation format. RockWorks can compute (or "spot") X,Y location coordinates for these descriptions using a commercial or idealized reference land grid as reference (**Coords** / **Jeffersonian Points** -> **Cartesian**, page 117). Once the wells have X,Y location coordinates, their locations can be displayed in a point map (**Map** / **EZ Map**).

Sample files: spot.atd

Template: **File** / **New**: Jeffersonian Land Grid / Congressional well locations.

- ! Also required for translation of this type of well location description into X,Y is a "reference" land grid file that contains necessary section boundary coordinate information. These land grid data files must be created by you prior to spotting your wells, by importing commercial land grid data, creating an idealized land grid, or downloading the RockWorks LandBase.

### Land Grid Lease Descriptions

"Land Grid Lease" descriptions are entered into the RockWorks Utilities datasheet using a Range, Township, and Section notation format. RockWorks can compute (or "spot") X,Y location coordinates for the lease corners using a reference land grid), via the **Coords** / **Jeffersonian Polygons** -> **Cartesian** option. Once the leases have X,Y corner coordinates computed, their locations can be displayed in a lease map (**Map** / **Land Grid** / **Lease Map**).

Sample files: lease\_map.atd

Template: **File** / **New**: Jeffersonian Land Grid / Leases

- ! Also required for translation of this type of well location description into X,Y is a "reference" land grid file that contains necessary section boundary coordinate information. These land grid data files must be created by you prior to spotting your wells, by importing

commercial land grid data, creating an idealized land grid, or downloading the RockWorks LandBase.

### Other Map Data

Please refer to the Help messages for formatting details for these data types:

- Survey (Bearing, Distance) Data
- Survey (Triangulation) Data
- Shotpoint Data
- Global Map Point Data
- Global Map Polyline Data
- Google Earth Point, Polygon, and Polyline Data

? Help Contents: RockWorks Utilities / Entering Data / Laying Out Your

### Grid Model Lists

#### Stratigraphy Grid Lists

These files are used to build a 3D stratigraphic fences, models, and stacked surfaces from existing grid models. They are used in the RockWorks Utilities **Grid / Grids** -> **Stratigraphic Fence, Grids** -> **Stratigraphic Model**, and **Grids** -> **Stacked Surfaces** options.

Sample file: grid\_list.atd

Template: **File / New**: Stratigraphy / Grid Lists.

- ! When creating the list of units, be sure to list them in reverse order (with the lowest stratigraphic unit at the top of the listing to highest stratigraphic unit at the bottom of the listing). This convention is due to a restriction within the OpenGL environment.
- ! All of the GRD models must have the same dimensions and node spacing in order for the program to be able to build the stratigraphic diagrams. They must also reside in the same project folder as the ATD file.

#### Other Lists

Please refer to the Help messages for formatting details for these data types:

- Multi-Variate Anomaly Grid Lists
- Grid to Logs Lists

? Help Contents: RockWorks Utilities / Entering Data / Laying Out Your Datasheet / Grid Lists

## Data for Solid Models

### XYZG Data

"XYZG" data can be entered into the RockWorks Utilities datasheet to represent X, Y, and Z location coordinates (easting, northing, and elevation) and a measured "G" value of some kind, such as geochemistry or geophysical measurements. This basic data layout can be run through **Solid / Model** for display as a 3-dimensional isosurface or block diagram.

- ! Use the Borehole Manager instead of the RockWorks Utilities datasheet if you have well-based data with multiple downhole measurements for each well. See *Entering the Borehole Data* (page 37).

Sample files: xyzg.atd

Template: **File / New:** Generic / XYZG.

## Hydrology/Hydrochemistry Data

### Hydrochemistry (Ion) Data

Anion and cation concentrations can be entered into the RockWorks Utilities datasheet for the purposes of creating Piper diagrams, Stiff diagrams, Durov plots, computing total dissolved solids, and/or ion balances (**Hydrochemistry** menu, page 227). These "hydrochemistry" files list cation and anion concentrations in parts per million (or milligrams per liter). There are 4 required cations and 4 required anions; additional cations and anions may be included as you wish.

Sample files: hydrochemistry.atd

Template: **File / New:** Hydrology/Hydrogeology / Hydrochemistry

### Other Data

Please refer to the Help messages for formatting details for these data types:

- Drawdown Data
- Hydrograph Data

- ? Help Contents: RockWorks Utilities / Entering Data / Laying Out Your Datasheet

## Planar and Linear Data

### Strike and Dip Data

Strike and dip measurements can be entered into the RockWorks Utilities datasheet for the purposes of creating strike and dip maps, rose diagrams (bearings only), stereonet diagrams, and of computing planar intersections (see Chapter 14). There are a variety of ways you can structure these files, depending on your desired output.

Sample files: planes.atd

Template: **File / New:** Structural Geology / Strikes and Dips

### Lineation Endpoint Data

Lineation endpoint data can be entered into the RockWorks Utilities datasheet for the purposes of computing lineation azimuth/midpoint/lengths and lineation densities & intersections, and for creating rose diagrams, lineation maps, and arrow maps (**Linears** menu, see Chapter 14).

Sample file: lines.atd

Template: **File / New:** Structural Geology / Lineation Endpoints for a simple X1Y1X2Y2 layout, or Colored Lineations for a setup that will also include an ID and linestyle column.

- ? See Digitizing data (page 98) for information about digitizing line endpoint data directly into the datasheet; Movement Data structure (below) for X1Y1X2Y2 data that also have elevation and time measurements associated with them, for movement analysis.

### Other Data

Please refer to the Help messages for formatting details for these data types:

- Beta Pairs Data
- Movement Data

- ? Help Contents: RockWorks Utilities / Entering Data / Laying Out Your Datasheet

### 3D Graphic Data

These files are read by the tools in the **Grafix / 3D Utilities** menu.

### Horizontal Panel Image Lists

These files are used to display one or more raster images (BMP, JPG, TIFF, PNG, AFI, VST, PCX, PCC, EMF and WMF) as non-vertical panels in RockPlot3D. (See **Grafix / 3D Utilities / Images / Panels / Horizontal**, page 244.) This program requires 14 columns of information: The names of the images to be displayed in the OpenGL panels, their layer name, and the X, Y, and Z coordinates for each corner.

Sample file: mine\_level\_bitmaps.atd which references these bitmaps:  
gold\_1450\_level.bmp, gold\_1400\_level.bmp, and gold\_1350\_level.bmp.

Template: **File / New:** Grafix3D / Horizontal Image Panels.

- ! OpenGL vertical panels are assumed to be vertical and coordinates for only two corners are required. By contrast, RockWorks allows you to enter X, Y, and elevation coordinates for each corner of these "horizontal" panels. Thus, these panels are not required to be horizontal.

## Vertical Panel Image Lists

These files are used to display one or more raster images (BMP, JPG, TIFF, PNG, AFI, VST, PCX, PCC, EMF and WMF) as 3-dimensional panels in RockPlot3D. (See **Grafix / 3D Utilities / Images / Panels / Vertical**, page 244.) This program requires 8 columns of information: The names of the images to be displayed in the OpenGL panels, their layer name, and the X, Y, and Z coordinates for the lower-left and upper-right corners of the bitmap image.

Sample file: gpr\_panels.atd which references these bitmaps: gpr\_south.jpg, gpr\_north.jpg, gpr\_west.jpg, and gpr\_east.jpg.

Template: **File / New:** Grafix 3D / Vertical Image Panels

## 3D Oriented Objects

These files are used to build a 3D image containing cone shapes at specific XYZ locations, with a declared bearing and inclination. (See **Grafix / 3D Utilities / Oriented Objects**, page 245.) This program requires 7 columns of information: The object name, color, X, Y, and Z coordinates, bearing, and inclination. The Length column is optional.

Sample file: fossils.atd

Template: **File / New:** Grafix 3D / 3D Oriented Samples

## Horizontal Tanks

These files are used to build a 3D image containing horizontal cylinders at specific XYZ locations, with a declared radius and color. (See **Grafix / 3D Utilities / Storage Tanks / Horizontal**, page 245.) This program requires 8 columns of information: The object name, X and Y location of one end of the tank, X and Y coordinate for the other end of the tank, tank elevation, radius, and color.

Sample file: buried\_tanks.atd

Template: **File / New:** Grafix 3D / Horizontal Storage Tanks

## Vertical Tanks

These files are used to build a 3D image containing vertical cylinders at specific XYZ locations, with a declared radius, height and color. (See **Grafix / 3D Utilities / Storage Tanks / Vertical**, page 245.) This program requires 8 columns of information: The object name, X Y Z location of the tank, radius, height, and color.

Sample file: surface\_tanks.atd

Template: **File / New:** Grafix 3D / Vertical Storage Tanks

## Other Data

Please refer to the Help messages for formatting details for these data types:

- 3D Discs
- 3D Cube Image Lists

- 3D Spheres
- Surface Objects (buildings, etc.)
- 3D Triangles
- 3D Tubes

? [Help Contents: RockWorks Utilities / Entering Data / Laying Out Your Datasheet](#)

## Editing the Datasheet

### Editing the Datasheet - Overview

This section summarizes some of the tools used to modify the contents of the RockWorks Utilities datasheet in RockWorks.

? [Help Contents: RockWorks Utilities / Entering Data / Datasheet Mechanics](#)

## Changing Column Titles and Styles

### Change a data column title

To change the name of a column in the current RockWorks Utilities datasheet, follow these steps:

1. Access the RockWorks Utilities datasheet.
2. Select the **View / Columns** command.
3. In the Title column type in the new text for the column title.  
**!** You should limit the column names to 20 characters, including spaces.
4. Repeat this process for as many columns as you wish in the scrolling list, by clicking in each cell and typing a new name.

### Change the Column Type

The column "type" determines how the information in a RockWorks Utilities datasheet column will be displayed or how it will "behave": as text, graphic symbols, graphic lines, graphic patterns, a hyperlink to a file, and so on.

To change the column type, follow these steps:

1. Access the RockWorks Utilities datasheet.
2. Select the **View / Columns** command.
3. Click in the Data Type cell for the column to be changed.  
The program will display a pop-up window that lists all of the available column types.
4. Select the data column's type by clicking in the appropriate selection.

**Text columns** display their contents as textual characters, both alphabetic and numeric. Most of your columns will probably be set to **Text** columns, including X and Y location coordinates, any sample ID's, measured data values, and other project information. Text columns simply display their contents as letters and numbers.

You may also display symbols, colors, lines, and patterns as text if you prefer not to see their graphic display.

**Symbol columns** display the contents of the column as graphic symbols, in a user-selected color. You can select a specific symbol for each well or sample site.

**Color columns** display the contents of the column as a block of color.

**Line columns** display the contents of the column as graphic lines in a user-selected color. These are typically used when plotting lineation or arrow maps (**Linears** menu).

**Pattern columns** display the contents of the column as a graphic pattern. These are often used in lease boundary files to declare a particular pattern with which to fill the lease area in a map.

**File columns** are used to list file names, such as grid models, images, or other files to be processed within the program. Setting a column to this type will cause the program to display an open-file dialog if the user double-clicks on the cell. This capability provides a useful method for browsing for file names when setting up datasheets for program such as the **Grafix / 3D-Utilities / Images / Panels / Vertical** application. Note that file names can also be listed in basic Text-style columns.

**Hyperlink columns** are used to URL addresses. These are typically done in Google Earth placemark files, from which the URLs can be included in the Google Earth description display.

**Image columns** are used to list image file names. Whenever the user clicks on a cell within that data column, the program will automatically display a file-selection dialog, with an image-preview screen. This is very similar to the "File" data type except that the dialog now previews the image.

5. Repeat this process for as many columns as you wish in the scrolling list, by clicking in each cell and choosing a type.

## Other Data Editing Tools

**Edit** menu:

**Cut:** Removes the contents of the highlighted cell(s) in the current datasheet, placing the contents in the computer's clipboard memory for later pasting.

**Copy:** Places a copy of the contents of the highlighted cell(s) of the current datasheet in the clipboard memory for later pasting.

**Paste:** Replaces the contents of the current cell (and subsequent cells if applicable) in the current datasheet with the contents of the clipboard.

**Delete:** Deletes the contents of the highlighted cell(s) in the current datasheet. The contents are not placed on the computer's clipboard memory; they are just deleted.

**Cut All:** Removes the entire contents of the current datasheet, placing the contents in the computer's clipboard memory for later pasting. This is the same operation as would occur if you were to hand-select all of the cells in the current datasheet and then select the **Edit / Cut** command.

**Copy All:** Places a copy of the entire contents of the current datasheet in the clipboard memory for later pasting. This is the same operation as would occur if you were to hand-select all of the cells in the current datasheet and then select the **Edit / Copy** command.

**Paste All:** Replaces the current datasheet with the contents of the clipboard.

**Columns / Insert:** Inserts a new, blank column in the active datasheet.

**Columns / Delete:** Deletes one or more columns from the active datasheet.

**Columns / Math:** Performs simple arithmetic operations on the values within a selected column in the current datasheet.

**Columns / Merge:** Merges the contents of two columns in the active datasheet, with a user-specified separator.

**Columns / Increment:** Lists numeric values in a column, incrementing the values by the real number you declare.

**Columns / Combine:** Used to combine symbol + color columns or linestyle + color columns, in the RockWorks Utilities datasheet only.

**Columns / Statistics:** Used to compute basic statistics (range, mean, standard deviation, etc.) for a single column of values in the datasheet.

**Columns / Filter:** Used to filter out data values that fall outside a user-defined range.

**Columns / Fix:** Strips out commas, tabs and spaces from numeric values in a selected column.

**Rows / Insert:** Inserts a user-specified number of rows above the currently active row in the datasheet, offering the user the option to change the default row number.

**Rows / Delete:** Deletes a user-specified number of rows in the current datasheet, offering the option to change the default row number.

**Rows / Go to:** Advances to a specific row in the current datasheet.

**Rows / Sort:** Sorts the rows in the current datasheet based on a selected column of values.

**Digitize / Points:** If you have a tablet digitizer and driver installed, you can digitize depths and values from a paper curve trace into the current data window.

**Digitize / Lines:** If you have a tablet digitizer and driver installed, you can digitize line endpoints into the current data window.

**Filter:** Filters data from the current datasheet based on settings for 1 to 5 columns.

**Random / Completely Random:** Generates a list of completely random numbers in the selected datasheet column, based on a user-specified value range.

**Random / Normal Distribution:** Generates a list of random numbers in the selected datasheet column. These random numbers will comply with a normal distribution, based on the user-declared value range.

**Refresh:** Forces the program to redraw the contents of the current datasheet, in case recent changes are not represented.

**View menu**

**Columns:** Accesses the window where column titles and types are established.

**Find Closest Point:** Use this tool to enter a known X and Y coordinate and to locate the data record in the RockWorks Utilities window that is closest to that point.

**Odd Numbered Row Color:** Establishes the color in which the odd numbered rows in the RockWorks Utilities window will be displayed.

**Even Numbered Row Color:** Establishes the color in which the even numbered rows in the RockWorks Utilities window will be displayed.

## Importing Data

Many of you will enter your data right within the RockWare program's RockWorks Utilities datasheet, by typing directly from the keyboard, or by cutting and pasting data from another document.

Another method of getting data into the program is to import data from other applications or commercial sources. The following tools are available in the **File / Import** menu; see the Help topics listed below for details.

? Help Contents: RockWorks Utilities / Entering Data / Importing Data:

- Importing ASCII Data into the Datasheet.
- Importing DBF Files into the Datasheet.
- Extracting XYZ Coordinates from DXF Files
- Extracting XYZ Coordinates from DXF into ASCII files
- Importing DXF Lineations into the Datasheet
- Importing Garmin GPS Data
- Importing Geonics Conductivity Data
- Importing DeLorme Data.
- Importing GSM-19 Magnetometer Data.
- Importing Laser Atlanta Data.
- Importing ModPath Pathline Data.
- Importing NEIC Earthquake Data
- Importing RockBase Data.
- Importing SEG-P1 Shotpoint Data.
- Importing Tobin WCS Data.
- Importing XLS (Excel) Data.

## Exporting Data from the RockWorks Utilities Datasheet

If you wish to export the data contained in the RockWorks Utilities datasheet, use the **File / Export** command. It offers export as a text file, a DBF-format file, or a Microsoft Excel (XLS) file. See these Help topics:

? Help Contents: RockWorks Utilities / Entering Data / Exporting Data:

- Exporting the Datasheet to ASCII Format

Exporting the Datasheet to DBF Format  
Exporting the Datasheet to XLS Format

## Transferring Data to the Borehole Manager

Use the **File / Transfer** tools to transfer the following data from the RockWorks Utilities to the Borehole Manager:

**Locations -> Borehole Files:** This tool reads specific data fields from the RockWorks Utilities datasheet and records them in the Borehole Manager Location tabs. This can be useful if you have done some coordinate manipulation in the RockWorks Utilities and want the new coordinates to be represented in the Borehole Manager's BH files. Or, this can also be a handy way to start a new set of BH files with location information for a new project.

**Stratigraphy -> Borehole Files:** This tool reads specific data fields from the RockWorks Utilities datasheet and records them in the Borehole Manager Stratigraphy tabs. This can be useful if you have done some manipulation of the stratigraphic elevations in the RockWorks Utilities and want the modified data to be represented in the Borehole Manager.

- ! The Stratigraphy Transfer tool works only with vertical boreholes.
- ? Help Contents: RockWorks Utilities / Entering Data / Transferring Data to the Borehole Manager

## Digitizing Data

RockWorks offers two tools in the **Edit** menu that permit you to use an electronic digitizing tablet to enter either X and Y point data or line endpoints directly into the RockWorks Utilities datasheet. In this way, you can enter your sample site location coordinates or lineation endpoint coordinates directly off of a paper map.

The digitizing tool is also available in the Polygon Vertices editor (see page 59 Miscellaneous Project Tables).

- ! In order to use the digitizing capability of the program, you must have an electronic digitizer attached to your computer and a Windows "driver" for the digitizer installed on your computer. These drivers are supplied by the digitizer manufacturer. You must also be sure that you have correctly set up your digitizing tablet. If there is no communication between the digitizer and your computer, you aren't going to be able to digitize any points!
- ? See also: Digitizing Data from Bitmaps (page 247), and RockPlot2D Digitizing Tools (page 260).
- ? Help Contents: RockWorks Utilities / Entering Data / Digitizing



# Chapter 4: Project Dimensions and the Project Manager

## Topics

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## Overview

As discussed briefly back in Chapter 1, RockWorks relies on a “Project Folder” for organizing different files that pertain to your work in the program. The Project Folder will contain your borehole database file, your Utilities ATD files, as well as output models, maps, and such. When you start work with a new project site, you need to create a new project folder for the input data and program output.

Even if you are not working in the Borehole Manager, a project database (MDB file) is created each time you create a new Project Folder.

The process of creating Project Folder is discussed back in Chapter 1. The process of entering borehole data is discussed in Chapter 2. The process of entering data into the RockWorks Utilities datasheet is discussed in Chapter 3.

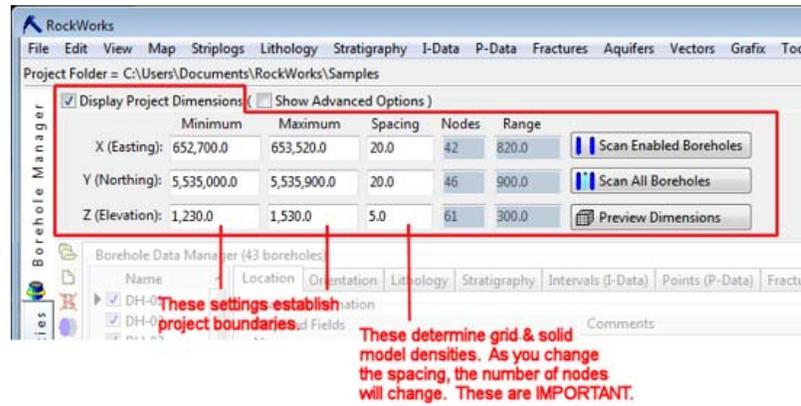
This chapter discusses the next step in your work through the program: Setting your Project Dimensions and working with the Project Manager.

## Project Dimensions

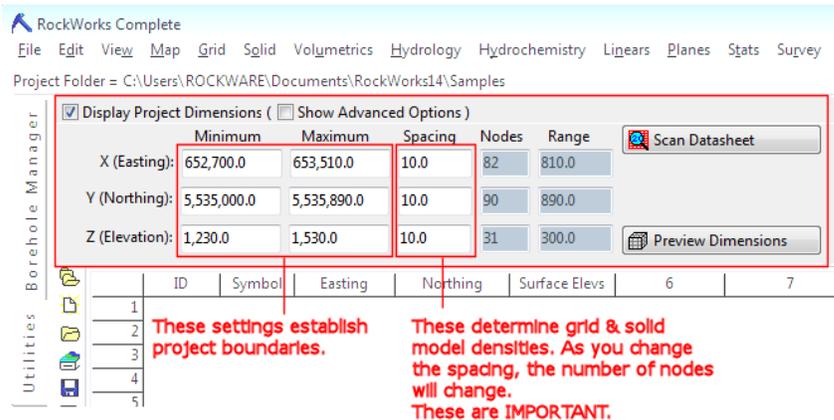
### What are Project Dimensions?

They define the boundary coordinates of your project, and the spacing of the nodes for grid and solid models, which can apply universally to the current project. They are also used to scale diagrams, to scale items within diagrams, and even the patterns displayed within diagrams.

The current Project Dimensions can be viewed at the top of the RockWorks program window by inserting a check in the Display Project Dimensions box. The Project Dimensions pane looks like this when you are working in the Borehole Manager:



The Project Manager pane looks like this when you are working in the RockWorks Utilities:



The Project Dimensions window is also displayed when you click the Adjust Project Dimensions link from many of the program's menus, shown below.



The project dimensions are stored in the current project database. Though these dimensions can be overridden during model and diagram creation, we generally recommend that you utilize these dimensions for your grid models, solid models, and diagram annotations for ease and consistency. For example, all the project grid models must have the same dimensions and node densities if you wish to perform any mathematical or filtering operations with them. The same holds true for solid models.

## Setting the Project Dimensions - Borehole Manager

For new projects the dimensions will default to a range of 0 to 100 along all axes.

1. The first step in setting project dimensions is by scanning the borehole data you have entered. You have two options:

**Scan Enabled Boreholes:** Click on this option if the dimensions are to be established by scanning only the boreholes that are enabled (have check-marks). This can be handy if you have some boreholes with incomplete data that you've disabled.

**Scan All Boreholes:** Click on this button if the dimensions are to be established by scanning all of the boreholes.

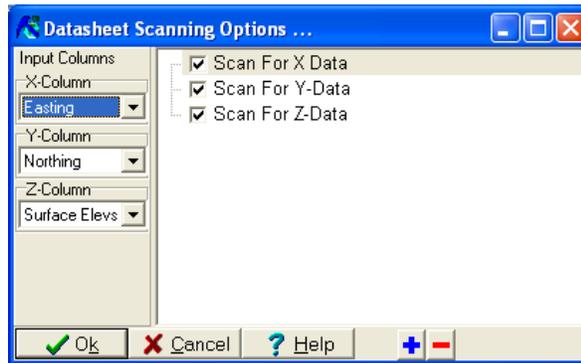
! Of course, you can hand-enter the desired boundary coordinates or modify scanned coordinates at any time. Just click in any of the available fields and type in your preferred values.

2. The second step is to review the Project Dimensions (jump to page 103).

## Setting the Project Dimensions – RockWorks Utilities

For new projects the dimensions will default to a range of 0 to 100 along all axes.

1. The first step in setting project dimensions is by scanning the data you have entered into the RockWorks Utilities datasheet using the **Scan Datasheet** button:
2. Define the columns to be scanned



**Input Columns:** Click the down-arrow to select from the drop-down list the name of the column in the datasheet that contains the Easting or X-coordinate units and the Northing or Y coordinate units to be scanned to establish the West -> East, and South ->North-extends of your data. If your datasheet contains elevation ranges, you can select the appropriate column for the Z-Column prompt. For any axes you don't choose to scan, below, the column setting will be ignored.

**Scan for X-Data, Y-Data, Z-Data:** Check the boxes for the columns, defined above, to be scanned. If you leave any options un-checked, that data will not be scanned for the project dimensions. If you are generating 2D maps only, you should scan for X and Y Data only. If you are generating 3D solid models, you should scan for all three axes.

- ! Of course, you can hand-enter the desired boundary coordinates or modify scanned coordinates at any time.
- ! No map data? No worries. There are some instances in which you don't have to establish any project dimensions (you can leave them at the default 0 to 100):
  - If your project consists of files containing only lineation bearings for creating rose diagrams.
  - If your project consists of files containing only planar bearings and dips for creating stereonet diagrams.
  - If your project consists of files containing only hydrochemistry measurements for creating Piper, Stiff, or Durov diagrams.
  - Etc.

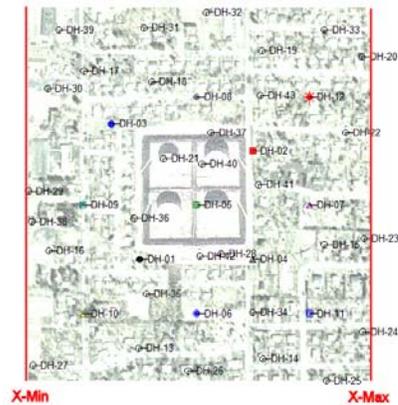
### Reviewing the Project Dimensions

Next, you must review the scanned settings to be sure they make sense.

**Minimum and Maximum:**

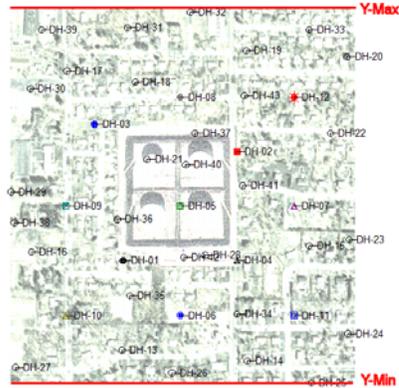
The **X-Minimum** and **X-Maximum** coordinates will define the western and eastern map extents of your project.

	Minimum	Maximum
X (Easting):	652,700.0	653,520.0
Y (Northing):	5,535,000.0	5,535,900.0
Z (Elevation):	1,230.0	1,530.0



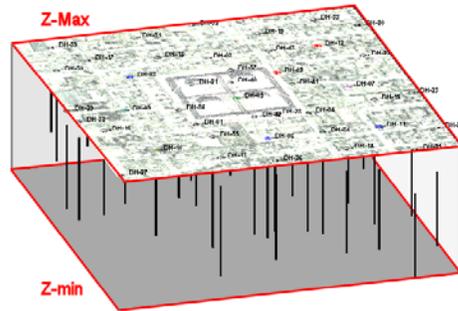
The **Y-Minimum** and **Y-Maximum** coordinates will define the southern and northern map extents of your project.

	Minimum	Maximum
X (Easting):	652,700.0	653,520.0
Y (Northing):	5,535,000.0	5,535,900.0
Z (Elevation):	1,230.0	1,530.0



If you are working in the Borehole Manager or have scanned for Z-dimensions in the Utilities, the **Z-Minimum** and **Z-Maximum** coordinates represent the elevation extents of the project.

	Minimum	Maximum
X (Easting):	652,700.0	653,520.0
Y (Northing):	5,535,000.0	5,535,900.0
Z (Elevation):	1,230.0	1,530.0

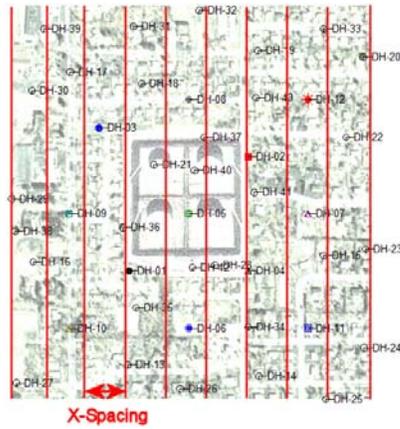


**Spacing:** These settings pertain to interpolated models only. They represent the spacing between nodes along each axis and (hence) the density of the models the program will create.

***LOOK AT THESE NUMBERS.***

Node density affects the quality of the model and the time necessary to generate it.

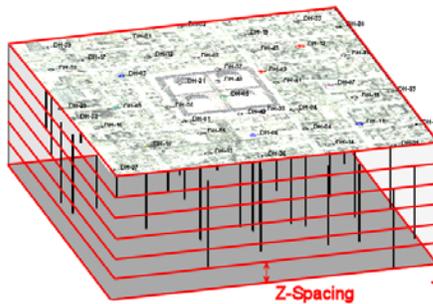
The **X-Spacing** will define how far apart grid and solid model nodes will be from west to east. It is declared in your map units.



The **Y-Spacing** will define how far apart grid and solid model nodes will be from south to north. It is declared in your map units.



If you are working in the Borehole Manager or have scanned for Z-dimensions in the Utilities, the **Z-Spacing** will define how far apart grid and solid model nodes will be from the lowest elevation to the top elevation in the project. It is declared in elevation units. (Which should, incidentally, be the same units – feet or meters – as your X,Y map units.)



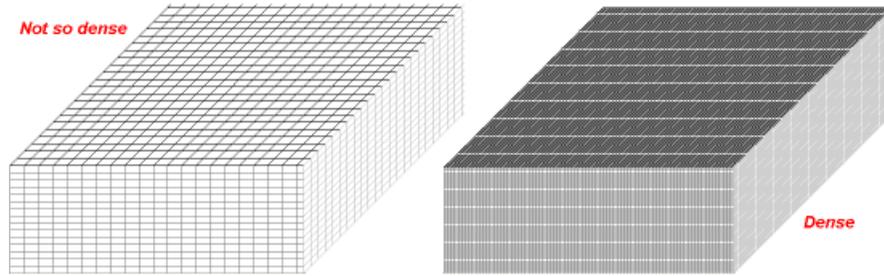
	Spacing	Nodes
X (Easting):	40	21
Y (Northing):	40	23
Z (Elevation):	10	31

*Spacing between model nodes from west to east, in your map units.*  
*Spacing between model nodes from south to north, in your map units.*  
*Spacing between model nodes from lowest to highest elevation, in your depth units.*

*Number of nodes represented.*

**Nodes:** These display the number of nodes that will be generated along each axis. These are computed automatically, based on the dimensions divided by the spacing. You cannot edit the node settings. If you need to change the number of nodes along any axis, adjust the spacing setting and the number of nodes will be updated automatically.

**Preview Dimensions:** You can click on the **Preview Dimensions** button to see a quick view of how dense your models will be:



**Show Advanced Options:** Insert a check here to display project dimension statistics and other settings. These are discussed fully in the Help messages.

## How Do I Know what Node Spacing to Set?

**X Spacing and Y Spacing:** You might want to start with a density that will create at least one node between each control point. Let's say your boreholes average about 100 feet apart. You would not want to set the X and Y spacing to 200, because much of your data won't be recorded in the models. You might start at a value of 25 or 50.

- ! Create a map of your borehole locations (**Map / Borehole Locations**) or your Utilities sample locations (**Map / EZ Map**) and use the **Measure / Distance** tool to measure the distance between the map symbols.
- ! Refer to the **Show Advanced Options / Statistics / Average Minimum** setting for the program-computed average minimum distance.

**Z Spacing:** The Z-spacing will affect solid models only, and you need to look at the downhole resolution of your data. If your lithologies vary over 3 or 5 feet, don't set the vertical spacing to 10 – a lot of the material won't be represented in the lithology model.

- ! Denser is not always better. You might create less-dense models on trial runs and increase the density only if you feel the detail of the data is not being represented. For example, if your P-Data is measured every 0.10 feet, beware of using that for the z-spacing of the nodes

if it results in a model with many hundreds or thousands of nodes vertically. It will take forever to model and render, and may not help pick out your anomalies.

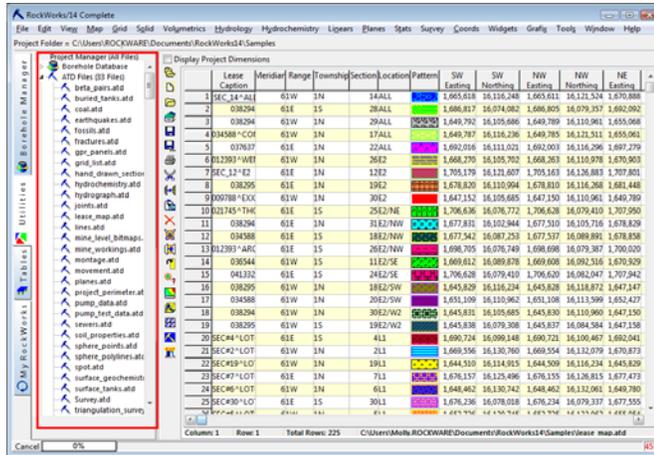
! Keep in mind that a solid model with 50 x 50 x 50 nodes (125,000 total) requires one-eighth the computations of a 100 x 100 x 100-node model (1 million nodes)

? Help Contents: Project Dimensions and Preferences

## Project Manager

### Using the Project Manager

The Project Manager is a pane that can be displayed along the left edge of the program window which displays various RockWorks program files in the current project folder.



- Expand any file-type grouping by clicking the small “+” button by its heading; contract any grouping by clicking on the small “-” button. You can use the and buttons to expand all/collapse all.
- **Borehole Database:** This heading lists the data Types tables that exist in the current project database. You can open any of these tables by double-clicking on the table name. (See page 51.)
- **ATD Files:** This heading lists all of the ATD files that have been created in the current project folder. You can open a RockWorks Utilities data file into the datasheet by double-clicking on its name in the Project Manager pane. (Or, right-click on the file name and choose the Load File option.) See page 85 for information about ATD files.
- **Grid Models:** This heading lists all of the grid models that have been interpolated for the current project, such as stratigraphic surfaces or GRD files created in the Utilities Grid-Based Map option. You can create a 2D contour map or 3D surface of an existing grid model by double-clicking on the GRD file name and establishing the map/diagram

settings. (Or, right-click on the file name and choose Display Grid.) See page 139 for information about general gridding concepts.

- **Solid Models:** This heading lists all of the solid models that have been interpolated for the current project, such as lithology models or I-Data models. You can create a 3D voxel or isosurface diagram of an existing solid model by double-clicking on the MOD file name and establishing the diagram settings. (Or, right-click and choose Display Solid.) See page 171 for information about general solid modeling concepts.
- **2D Diagrams:** This heading lists all of the RockPlot2D maps and diagrams that have been created and saved as “RK6” files in the current project. You can hover over any of these files to view a preview of the image. You can double-click on any of these to display them in a Rockplot2D window. (The previews can be disabled via the **Tools / General Preferences / Project Manager / Display Diagram Previews** option.) See page 249 for information about RockPlot2D diagrams.
- **3D Diagrams:** This heading lists all of the RockPlot3D views that have been created and saved as “R3DXML” files in the current project. You can hover over any of these files to view a preview of the image. You can double-click on any of these to display them in a RockPlot3D window. (The previews can be disabled via the **Tools / General Preferences / Project Manager / Display Diagram Previews** option.) See page 265 for information about RockPlot3D diagrams.
- **ReportWorks Diagrams:** This heading lists all of the ReportWorks documents that have been created and saved as “RW6” files in the current project. You can double-click on any of these files to display them in a ReportWorks window. See page 277 for information about ReportWorks documents.
- **LAS Files:** This heading lists all of the LAS (Log ASCII Standard) files that you have saved in the current project folder. These are not files that RockWorks generates; they typically contain geophysical log data. You can double-click on any of these file names to start the LAS (single-file) import process. See page 66 for more information.
- **RCL Files:** This heading lists all of the RCL (RockWare Command Language) files that you have saved in the current project folder. These are text files that contain lists of program commands, to run the software in batch mode. (They can also be sent to RockWare technical support for trouble-shooting.) You can double-click on one of these file names to start the batch process. See page 297 for more information.
- **Misc Tables:** This heading lists any miscellaneous tables that can be referenced by the current project, such as the RockWare pattern or symbol libraries. You can double-click on a file name to load the table into its appropriate editor. See page 285 for details.
- Establish the default width of the Project Manager pane using the **Tools / General Preferences / Project Manager / Width** setting. This is established in pixels.
- Open a different project folder using the **Project / Open** menu option, or by clicking on the *Project Folder* = path at the top of the program window.

# Chapter 5 – 2D and 3D Point Maps, Other Base Maps

## Topics

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## Overview

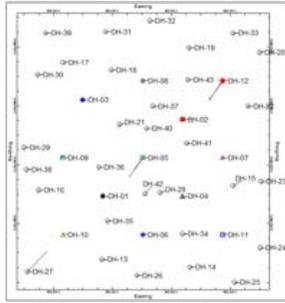
RockWorks contains dozens of tools which are designed to illustrate your sample locations in what we call “point maps”. These maps can use simple map symbols to denote sample sites, or they can use mini-diagrams (logs, stereonets), scaled circles, and more. Use point maps to verify that your borehole or sample locations have been entered correctly (e.g. do the coordinates look right? Does their layout look right?), and as overlays with other map layers (e.g. contours).

## 2D Point Maps

The procedures you will follow to create a point map will vary depending on whether you have entered your data into the Borehole Manager or into the RockWorks Utilities datasheet (where you have X and Y locations, at minimum). 2D point maps are displayed in RockPlot2D.

- ! Use point maps as overlays over other 2D maps (isopachs, structural contours, etc.). Just save the borehole location map in RockPlot2D, and you can then append this map to any other 2D plan image in your project (RockPlot2D **File/Append**).
- ! Use point maps as overlays over your 3D views (solid models, 3D surfaces, etc.). In RockPlot2D, choose **File / Export / RockPlot3D** to float the map at a particular elevation, or drape the map over an existing grid surface.

## Borehole Manager: Borehole Locations



Use the Borehole Manager's **Map / Borehole Locations** tool to create a 2-dimensional (plan view) of your borehole locations.

Data source: Borehole database Location tabs.

Other map options include labels (ID, elevations, thickness, etc.), borehole trace plots for deviated holes, borders, and bitmap backgrounds. You can also request surface contours as a map layer, which will generate a grid model of the borehole surface elevations (also read from the Location tabs) for display as line or color-filled contours with your point map (see page 145).

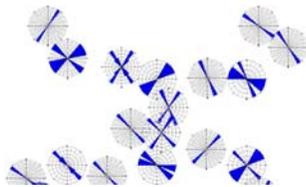
- ! Use the surface contours grid model as a surface filter for your solid models (lithology, I-Data, etc.)
- ! Check your coordinates: If your borehole locations (as entered into the Location tabs) are not in Eastings and Northings, you'll need to translate your longitude/latitude or Range/Township/Section descriptions first.



Borehole Manager Tutorial: Create a Borehole Location Map

- ? Help Contents: Borehole Manager / Location Maps & Coordinate Tools

## Borehole Manager: Rose Diagram Maps

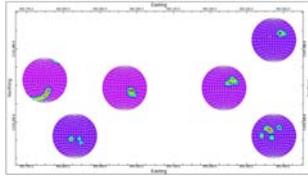


The Borehole Manager's **Fractures / Rose Map** option creates maps that illustrate fracture orientations at each enabled borehole location using rose diagrams.

Data source: Borehole database Location tabs (X,Y) and Fractures tabs (azimuth measurements)

- ? See the description of Rose diagrams (page 232) for information about their structure.
- ? Help Contents: Borehole Manager / Fracture Tools

## Borehole Manager: Stereonet Diagram Maps

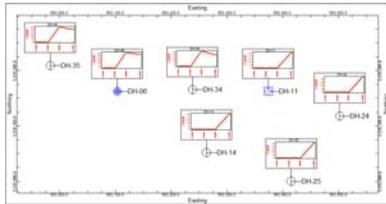


The Borehole Manager's **Fractures / Stereonet Map** option creates maps that illustrate 3D fracture orientations at each enabled borehole location using stereonet diagrams.

Data source: Borehole database Location tabs (X,Y) and Fractures tabs (azimuth and dip data)

- ? See the description of Stereonet diagrams (page 233 ) for information about their structure.
- ? Help Contents: Borehole Manager / Fracture Tools

## Borehole Manager: Time-Graph Maps

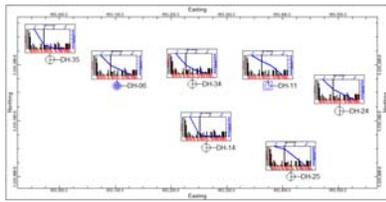


The Borehole Manager's **T-Data / Time Graph Map** option creates maps that illustrate one or two T-Data components over time in small charts, for each enabled borehole location. The components can be displayed as symbols and lines or bargraphs.

Data source: Borehole database Location tabs (X,Y) and T-Data (1 or 2 components and dates)

- ? See the description of Time Graphs (page 196) for information about their structure.
- ? Help Contents: Borehole Manager / T-Data Tools

## Borehole Manager: Hydrograph Maps



The Borehole Manager's **Aquifers / Hydrograph Map** option creates maps that illustrate water levels and (optionally) precipitation over time in small charts, for each enabled borehole location. The components can be displayed as symbols and lines or bargraphs.

Data source: Borehole database Location tabs (X,Y) and Water Levels tabs (water levels and dates). If

you want to display precipitation values as well, the precipitation measurements and their dates need to be loaded into the RockWorks Utilities datasheet.

- ? See the description of Hydrographs (page 228) for information about their setup. See Hydrograph Data (page ) for information.
- ? Help Contents: Borehole Manager / Aquifer Tools

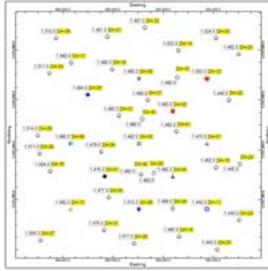
## Borehole Manager: Log Maps

The **Striplog** menu's mapping tools, for display of maps with mini-logs or projected logs, are discussed on page 124.

## RockWorks Utilities: EZ Maps

The **Map / EZ-Map** tool builds 2-dimensional (flat) maps for X, Y, and Z coordinate data that can include several map layers: symbols, labels, background bitmaps, map axis labels, and triangulation network. (See also page 144 regarding the line and color contour layers.)

Data source: RockWorks Utilities "XYZ" file (page 88)



Map symbols can be uniform or unique – read right from the datasheet.

Map symbols can be scaled based on a measured value, using a continuous scheme or a customized scale table.

Multiple labels can be displayed with each map symbol, with a variety of formatting options.

EZ Map can automatically offset labels to prevent overprinting.

Include background images to verify point locations.



RockWorks Utilities Tutorial: Create Point and Surface Maps

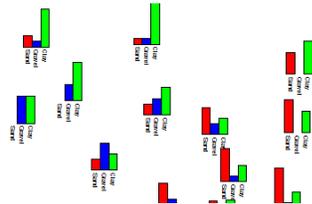


Help Contents: RockWorks Utilities / Mapping Tools / Contour and Point Maps / Creating Easy Maps

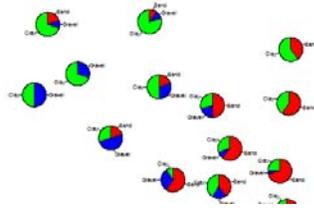
## RockWorks Utilities: Map / Multivariate Maps

The **Map / Multivariate Maps** tools are used to create maps that illustrate two or more components at specific X,Y locations.

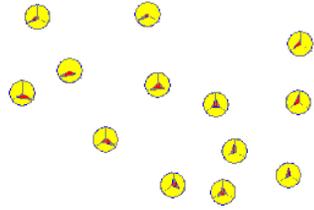
Data source: RockWorks Utilities datasheet "Multivariate" data (page 89)



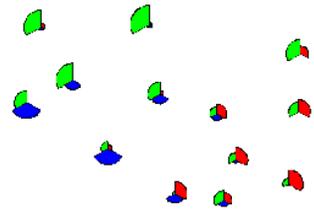
**Bar chart maps** illustrate the relative percentage of the selected variables as varying-length histogram bars at each sample location.



**Pie chart maps** illustrate the relative percentage of the selected variables as varying-width pie "slices" at each sample location. Examples include whole-rock geochemistry, relative sand/silt/clay ratios, and non-geological parameters such as population breakdowns.



**Spider maps** illustrate the relative percentage of the selected variables as polygons within a circle, at each sample location.



**Starburst maps** illustrate the relative percentage of the selected variables as varying-length pie "slices" at each sample location. Each component within a starburst has a scaling factor that determines the radius of the wedge. This allows you to create diagrams for variables with different units. For example, one wedge within a starburst could represent amount of silica, which another could represent amount of fracturing, which a third might represent amount of alteration.

Notes: Refer to the Help messages for details about how to set up the data columns and apply a scaling multiplier for the starburst and bar chart maps.

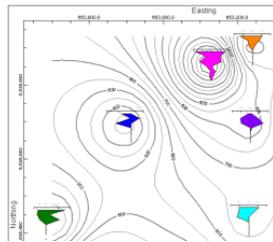


RockWorks Utilities Tutorial: Analyze Component Data



Help Contents: RockWorks Utilities / Mapping Tools / Multivariate Maps

## RockWorks Utilities: Stiff Diagram Maps



The RockWorks Utilities **Hydrochemistry / Stiff Maps** command is used to read a listing of ion concentrations from the datasheet, create a Stiff diagram for each sample, and plot the diagrams at each sample location in a map.

Data source: RockWorks Utilities "hydrochemistry" file, with XY sample locations and multiple cation and anion listings.

Notes: You may choose up to 4 additional cations and up to 4 additional anions for display in the Stiff polygons.



See the description of Stiff diagrams (page 230) for information about their structure.

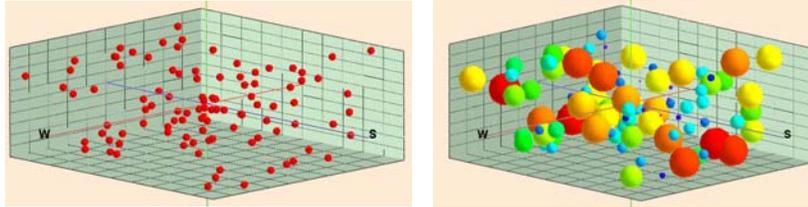


Help Contents: RockWorks Utilities / Hydrochemistry Tools

## 3D Point Maps

In addition to the 2D point maps discussed above, RockWorks also contains a tool for visualizing control points in 3D space. Use these 3D point maps to verify that your borehole or sample locations have been entered correctly (e.g. do the XYZ coordinates look right? Does the layout of the points look right?), and as overlays with other 3D views (e.g. isosurfaces, voxel models).

### RockWorks Utilities: 3D Points



The **Map / 3D Points** tool is used to plot points in 3D space representing X, Y, Z points listed in the Utilities datasheet. It has two main sub-options titled "Simple" and "Advanced".

- The "Simple" version will prompt the user for three columns within the datasheet that contain the X (Easting), Y (Northing), and Z (Elevation) for a list of points. The output from this program will be displayed as equally-sized red spheres.
- The "Advanced" program offers variable symbols, variable sizing, and other options.

Datasheet: RockWorks Utilities "XYZG" file (page 91)

Note: This tool used to be listed in the Grafix / 3D Utilities / Spheres program.

? Help Contents: RockWorks Utilities / Creating Maps / Plotting Points in 3 Dimensions

## Google Earth Maps



The Utilities **Map** menu contains a **Google Earth** submenu that offers plotting of

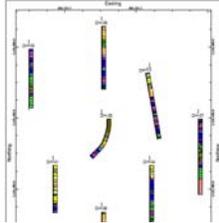
- Placemark maps,
- Polygon maps, and
- Polyline maps in Google Earth.

These tools create a Google Earth KMZ (Keyhole markup language binary) file based on the contents of point, polygon, or polyline information listed in the Utilities datasheet. The resulting maps can be loaded automatically into the Google Earth application (installed separately from RockWorks).

Data source: RockWorks Utilities datasheet, polyline, polygon, and placemark data.

? Help Contents: RockWorks Utilities / Creating Maps.

## Log Maps



The Borehole Manager **Striplogs** menu contains tools for displaying small logs for enabled boreholes in a plan view display.

? These tools are described in the chapter on logs - see page 124.

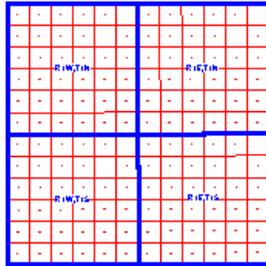
## Land Grid Maps

The RockWorks Utilities **Map / Land Grid** menu contains two tools designed to work with Jeffersonian Land Grid information:

- \* It creates "section maps" that illustrate Range, Township, and Section lines (either commercial or idealized, or based on the RockWare Landbase).
- \* It creates maps illustrating lease boundaries.

In order to create a land grid section or lease map, you must have a set of land grid data imported or "interpolated" into the program, or have downloaded the RockWare Landbase containing data for the area of interest.

### RockWorks Utilities: Section Maps



The **Map / Land Grid / Section Map** tool generates a map that illustrates Jeffersonian land grid boundaries (Range, Township, Section) for one or more Townships

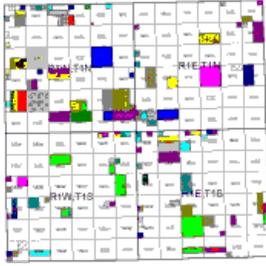
Data Source: Land Grid Table (page 290) or the RockWare Landbase.

Output window: RockPlot2D

! In order to create a land grid section map, you must have already created a "Land Grid Table" which lists the longitude and latitude coordinates of each section's corners. Or, you can download the RockWare Landbase (see Help / Download / RockWare Landbase).

? Help Contents: RockWorks Utilities / Creating Maps

## RockWorks Utilities: Lease Maps



The **Map / Land Grid / Lease Map** tool creates a map illustrating lease block boundaries, filled with patterns and/or colors.

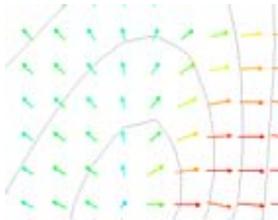
Data source: RockWorks Utilities land grid lease descriptions (page 89).

Output window: RockPlot2D

Notes: The input data file should include lease corner coordinates and patterns. Use the **Coords / Spot Jeffersonian Polygons** tool if your lease blocks are listed only in Range, Township, and Section descriptions. (You need to have X, Y corner coordinates.)

? Help Contents: RockWorks Utilities / Creating Maps

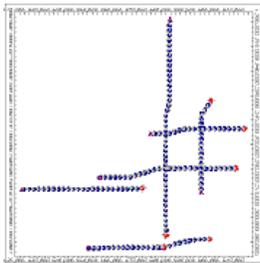
## Directional Maps



The RockWorks Utilities **Grid / Directional Analysis / Directional Maps** option is used to illustrate slope and aspect grid models as a variety of 2-dimensional gradient and flow maps.

? These are discussed under Grid Model Tools. See page 209 for more information.

## Shotpoint Maps



The RockWorks Utilities **Map / Shotpoints** command is used to create a map that illustrates shotpoint locations as read from the datasheet.

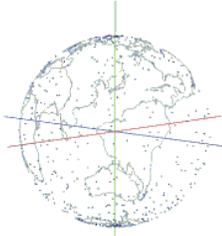
Data source: RockWorks Utilities shotpoint data (page 90). The shotpoint data must include (at minimum) a shotpoint line number, a symbol, and an X and Y coordinate for the individual shotpoint. You may optionally include the point number (not used in the map) and a label for points, typically representing distance. Each seismic line will have two or more data rows containing individual point records.

Output window: RockPlot2D

Notes: See also Importing SEG-P1 Data (page 97) re: import of SEG-P1 shotpoint files.

? Help Contents: RockWorks Utilities / Creating Maps

## Global Maps



The RockWorks Utilities **Map / Sphereplot 2D** and **3D** options create global maps in either a spherical or cylindrical (flat) projection, or in 3D format. 2D maps can contain low-resolution global information (coastlines, islands, rivers) from a program database. It can also read user-entered longitude and latitude coordinates from the main datasheet for plotting of individual points and/or connected line segments ("polylines") on the global map. Applications include seismic events, volcanoes, ocean temperatures, atmospheric temperatures, and more.

Datasheet: RockWorks Utilities, global map point and/or polyline data (page 90).

Output window: RockPlot2D and RockPlot3D

? Help Contents: RockWorks Utilities / Mapping Tools / Global Maps

## Translating Map Coordinates

### Borehole Manager: Translating Map Coordinates

Use the Borehole Manager's **Map / Adjust Coordinates** tools to translate longitude and latitude or land grid (range/township/section) well locations into Eastings or Northings.

The Borehole Manager requires that the well locations, which are entered into the Location tab, be declared in the same units as the depth data. This assures that the downhole surveys, stratigraphic volumes, and solid (lithology, geochemistry, etc.) volumes are correctly computed.

Data source: Borehole database, Location tabs.

? Help Contents/Borehole Manager/Location Maps & Coordinate Tools

### RockWorks Utilities: Translating Map Coordinates

The RockWorks Utilities **Coords** menu contains a number of utilities that can be used to translate coordinates that are listed in the RockWorks Utilities datasheet. A few of these are listed below:

- **Longitude / Latitude to UTM:** Converts X,Y location coordinates from a longitude and latitude format (in decimal degrees) to a Universal Transverse Mercator (UTM) format in meters or feet. RockWorks offers 23 coordinate conversion schemes including NAD83 and NAD27.
- **UTM to Longitude / Latitude:** Converts UTM (Universal Transverse Mercator) XY coordinates (in feet or meters) to longitude/latitude coordinates (in decimal degrees). The same coordinate projections as above are offered.
- **Jeffersonian Points -> Cartesian:** Translates well locations listed in Range, Township, Section descriptions (footage or quarter/quarter) to Cartesian X,Y coordinates. This translation is based on either a "Land Grid Table" of "idealized"

or commercially-purchased data, or the RockWare Landbase data which covers portions of the U.S.

- **Jeffersonial Polygons -> Cartesian:** Generates X,Y coordinates for each corner of leases that are listed with Range, Township, Section descriptions (quarter/quarter or lots). This translation is based on either a "Land Grid Table" of "idealized" or commercially-purchased data, or the RockWare Landbase data which covers portions of the U.S.
- And more.

? [Help Contents: RockWorks Utilities / Coordinate Conversion Tools.](#)

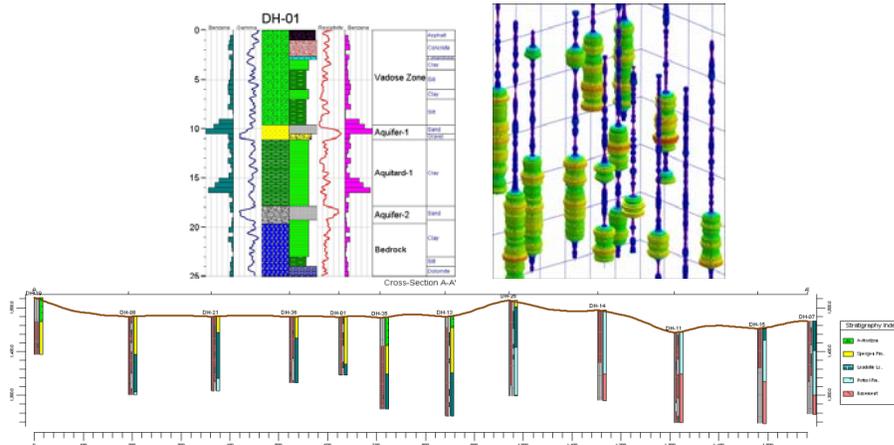
# Chapter 6 - Strip Logs & Log Sections

## Topics

- Overview ..... 119
- Striplog Layout Options..... 120
- 2D Logs, Projected Log Profiles, and Log Sections ..... 122
- Log Maps..... 124
- 3D Logs ..... 125
- Google Earth Stratigraphy Columns ..... 126
- Log Item Summary ..... 127
- Computing Borehole Survey Coordinates and Creating Diagrams ..... 134
- Comparing Log Endpoints..... 134

## Overview

There are a variety of tools available in the Borehole Manager's **Striplogs** menu for creating 2-dimensional (flat) or 3-dimensional logs of individual or multiple borings. The log data is taken directly from the Borehole Manager data tabs. Logs provide a very good way to view and confirm the raw data in your project – is my stratigraphy entered right? do the logs look like they're in the right place? where do I have high geochemistry values?



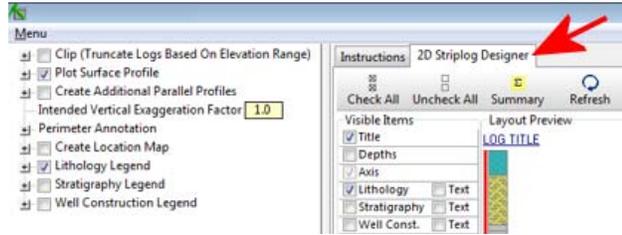
The log options are pretty much the same for all of the 2D log diagrams and for all of the 3D log views. You may choose to include any combination of the available items in the logs; see page 127 for a list of the log items.

**!** Striplogs can be created alone using the **Striplogs** menu tools. You can also add striplogs as a layer, on the fly, as you are creating other interpolated diagrams: 2D profiles and sections, 3D solid models, stratigraphic models, and fence diagrams. Just look for the Plot Logs option in these windows.

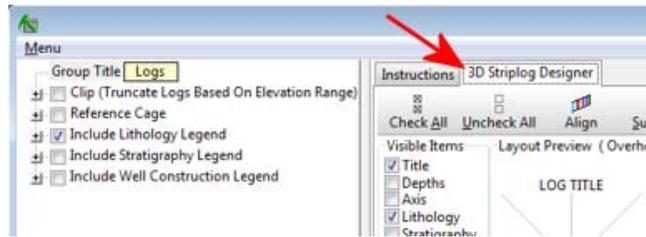
## Striplog Layout Options

Defining the arrangement of the columns in the logs is done within the 2D and 3D log designer tabs which are displayed in the program Options windows.

2D log designer

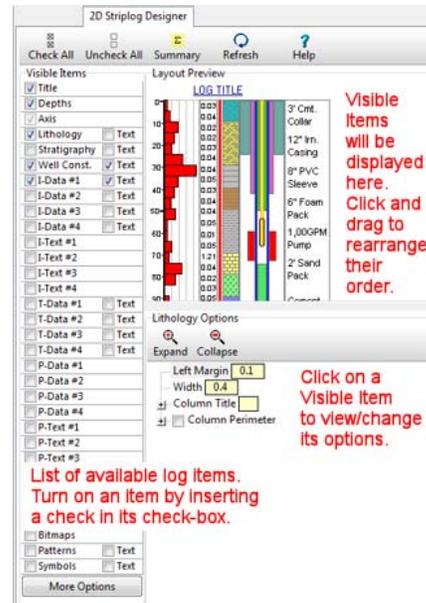


3D log designer



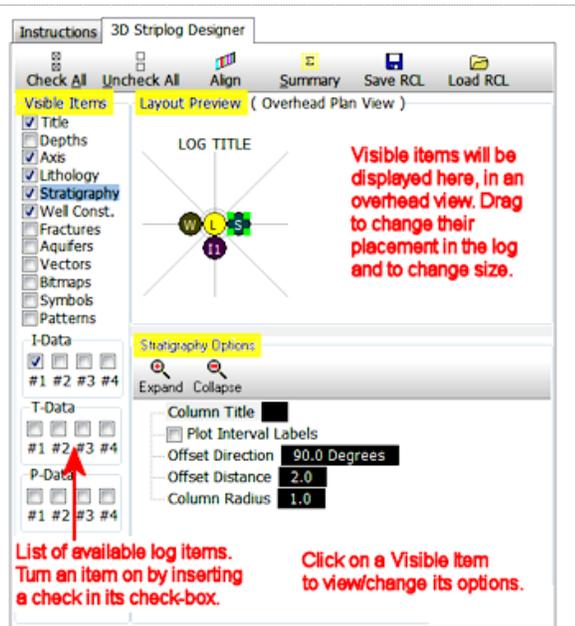
### 2D Striplog Designer

- Turn items on/off by checking/unchecking the Visible Items check-boxes.
- Visible Items will be displayed in the Layout Preview
- Click and drag the columns in the Layout Preview to change their position in the log.
- Click on a Visible Item to view or change its options.



### 3D Striplog Designer

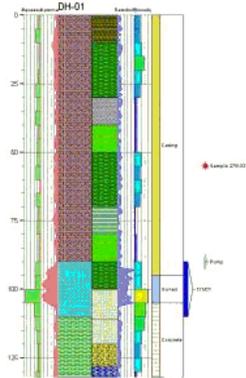
- Turn items on/off by checking/unchecking the Visible Items check-boxes.  
Tip: turn off all but the Title and Axis to generate 3D stick diagrams.
- Visible Items will be displayed in the Layout Preview which offers a bird's eye view of the log columns
- Click and drag the circles in the Layout Preview to change their position in the log.
- Resize the columns by clicking and dragging on a circle's corner handle, or by typing in a different Column Radius.
- Click on a Visible Item to view or change its options.



- ? See also: Profiles and Sections in later chapters for information about creating vertical slice views (“profiles”) of interpolated stratigraphic or solid models.

## 2D Logs, Projected Log Profiles, and Log Sections

### Single 2D Strip Logs



Use the Borehole Manager's **Striplogs / Single Log (2D)** tool to create a vertical, 2-dimensional (flat) strip log of a single well. The log can include any combination of the available log items listed on page 126. The log data is read from the database. The boring can be vertical, inclined, or deviated.

Menu command: **Striplogs / Single Log (2D)**

Output window: RockPlot2D

Notes: Before selecting the menu command, be sure to click on the name of the borehole whose data is to be displayed in the log, so that its name is highlighted. Be sure also that the check-box to the left of the borehole name is checked so that the borehole is enabled.

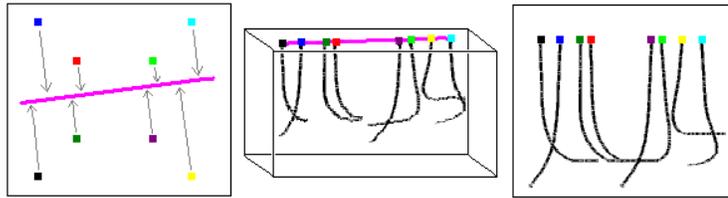


Borehole Manager Tutorial.

? Help Contents: Borehole Manager / Logs and Cross Sections

### What is a Log Profile?

A log profile is one in which the logs of individual borings are "projected" onto a single profile line cut.

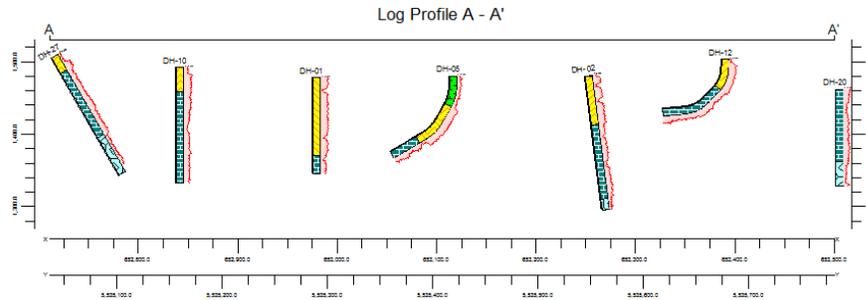


These diagrams can display vertical, inclined, and deviated boreholes. By projecting onto a line of section, the orientation of the logs will be honored.

In log profiles, the distance between logs is determined by their perpendicular projection onto the profile line. (This differs from hole-to-hole sections, in which the distance between the logs is proportional to the well distances on the ground.) In RockWorks, drawing the profile line is easily done on a plan-view display of the well locations, or you can enter known coordinates for the section endpoints. In addition, you can enter a filtering distance to limit the cross section to only proximal wells.

? Help Contents: Reference / Laying Out Profiles, Sections & Fences.

## 2D Log Profiles



Use the Borehole Manager's **Striplogs / Multi-Log Profile** tool to create a projected 2-dimensional vertical display of strip logs of multiple boreholes. The logs can include any combination of the available log items listed on page 126. The log data is read from the database. The borings can be vertical, inclined. There is an option to create multiple, parallel profiles automatically.

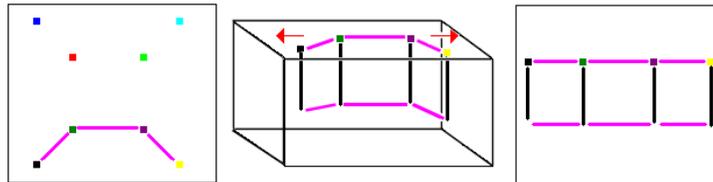
Menu command: **Striplogs / Multi-Log Profile**

Output window: RockPlot2D

Notes: When drawing the profile line among the boreholes, the program offers a “clipping” zone beyond which distant logs will not be projected onto the profile. See page 203 for information about drawing the profile slices.

? Help Contents: Borehole Manager / Logs and Cross Sections

## What is a Hole to Hole Cross Section?



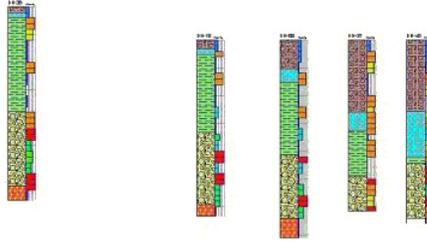
A hole to hole cross section is created by selecting individual boreholes, in any order, that are to be displayed from left to right in the section.

Hole to hole sections can include strip logs (with any/all available log items displayed). The logs can be hung on any listed stratigraphic interval.

In hole to hole sections, the distance between logs is proportional to the physical distances between the boreholes on the ground. (This differs from log profiles, in which the distance between logs is determined by their perpendicular projection onto a single profile line.) Because the hole to hole trace can contain multiple segments that differ in direction, it's impossible to project a 3-dimensional log, so all boreholes are plotted as vertical.

In RockWorks, drawing the hole to hole section lines is easily done on a plan-view display of the borehole locations. The program will remember the traces from one session to the next within the current project.

## 2D Hole to Hole Log Sections



Use the Borehole Manager's **Striplogs / Multi-Log Section** tool to create a 2-dimensional vertical display of strip logs of multiple boreholes. The logs can include any combination of the available log items listed on page 126, whose data is read from the data tabs. Multi-log sections also offer the ability to hang the section from a selected stratigraphic unit.

Menu command: **Striplogs / Multi-Log Section**

Output window: RockPlot2D

Notes: Unlike log profiles, logs in hole-to-hole sections must be plotted as vertical.

In a hole-to-hole cross section, the order in which the drill holes are selected will make a big difference in the appearance of the diagram. The first hole you select, regardless of its position in the map, will be at the left edge of the cross section, and the last will be at the right edge. The intermediate drill holes will be spaced in the diagram relative to each other in space. You do not need to include all boreholes in the cross section.

See page 205 for information about drawing the section trace.



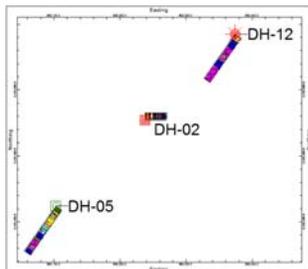
Borehole Manager Tutorial



Help Contents: Borehole Manager / Logs and Cross Sections

## Log Maps

### Multi-Log Plan View Map



Use the Borehole Manager's **Striplogs / Multi-Log Plan-View** tool to create a projected plan view display of all active boreholes. This is designed to display the true displacement of deviated or inclined drill holes, as projected onto a horizontal plane. This tool should not be used if your holes are vertical, since they will appear as small dots.

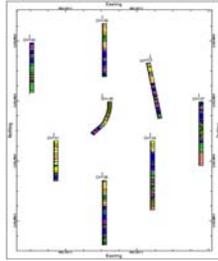
The log can include any combination of the available log items listed on page 126. The log data is read from the borehole database.

Notes:

- It is not advisable to include the Depth labels in the logs since they will not project well into the plan-view plane. They can also slow the generation of the image.
- This tool can be slow – be sure to turn off all non-essential boreholes and/or use the Omit Vertical Boreholes setting to avoid lengthy processing.

? Help Contents: Borehole Manager / Logs and Log Sections

## Multi-Log Map



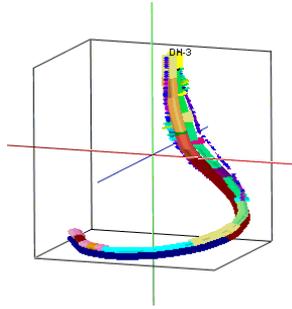
Use the Borehole Manager's **Striplogs / Multi-Log Map** tool to create a map that shows your borehole locations, with a small view of each log next to the map symbol. Unlike the projected view mentioned above, this tool simply creates a mini version of each log and plots it next to the borehole location symbol.

The log can include any combination of the available log items listed on page 126. The log data is read from the database.

? Help Contents: Borehole Manager / Logs and Log Sections

## 3D Logs

### Single 3D Strip Logs



Use the Borehole Manager's **Striplogs / Single Log 3-D** tool to create a three-dimensional view of the strip log of a single well. The log can include any combination of the available log items listed on page 126. The log data is read from the borehole database.

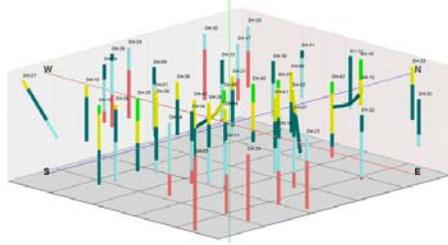
Menu command: **Striplogs / Single Log 3-D**

Output window: RockPlot3D

Notes: Before selecting the menu command, be sure to click on the name of the borehole whose data is to be displayed in the log, so that its name is highlighted. Be sure also that the check-box to the left of the borehole name is checked so that the borehole is enabled.

? Help Contents: Borehole Manager / Logs and Log Sections

## Displaying Multiple Logs in 3D



Use the Borehole Manager's **Striplogs / Multi-Log 3-D** tool to create a three-dimensional view of the strip logs of all currently enabled wells. The logs can include any combination of the available log items listed on page 126. The log data is read from the borehole database.

Menu command: **Striplogs / Multi-Log 3-D**

Output window: RockPlot3D

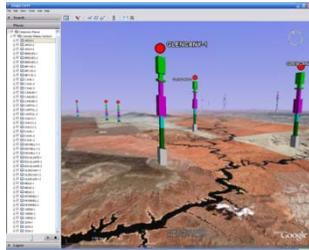
Notes: Before selecting the menu command, be sure to enable those boreholes whose data is to be displayed in the logs.



Borehole Manager Tutorial

- ? Help Contents: Borehole Manager / Logs and Cross Sections / Displaying Multiple Logs in 3D.

## Google Earth Stratigraphy Columns



Use the Borehole Manager's **Striplogs / Google Earth Stratigraphy Columns** tool to plot stratigraphic columns representing your currently enabled boreholes within Google Earth. The base of each stratigraphic column is positioned at the ground surface (Google Earth does not allow for sub-surface displays).

Menu command: **Striplogs / Google Earth Stratigraphy Columns**

Output window: Google Earth

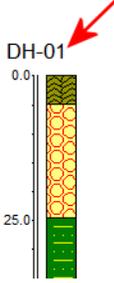
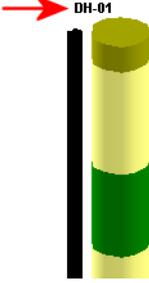
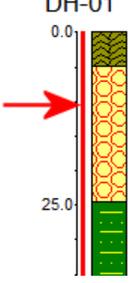
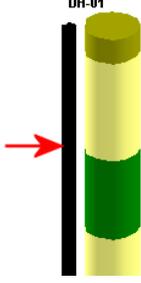
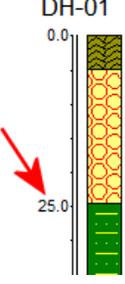
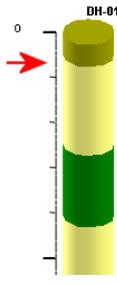
- ! This tool requires that decimal longitude and latitude degree coordinates are listed in each borehole's Longitude and Latitude fields in the Location tabs. It does not convert Easting and Northing coordinates.
- ? Help Contents: Borehole Manager / Logs and Cross Sections

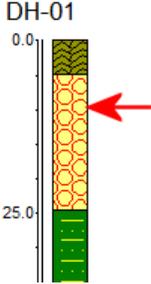
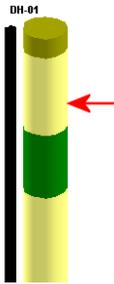
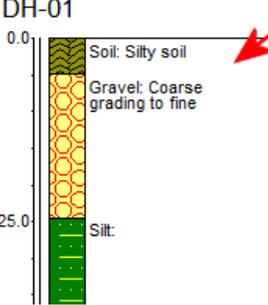
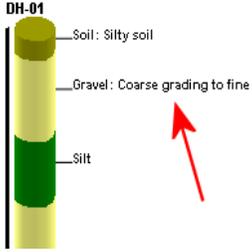
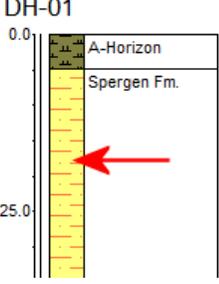
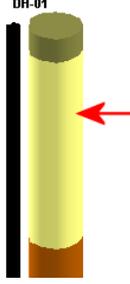
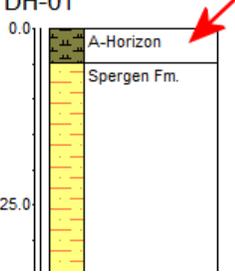
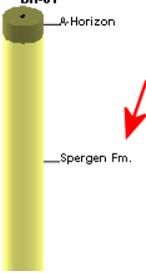
## Log Item Summary

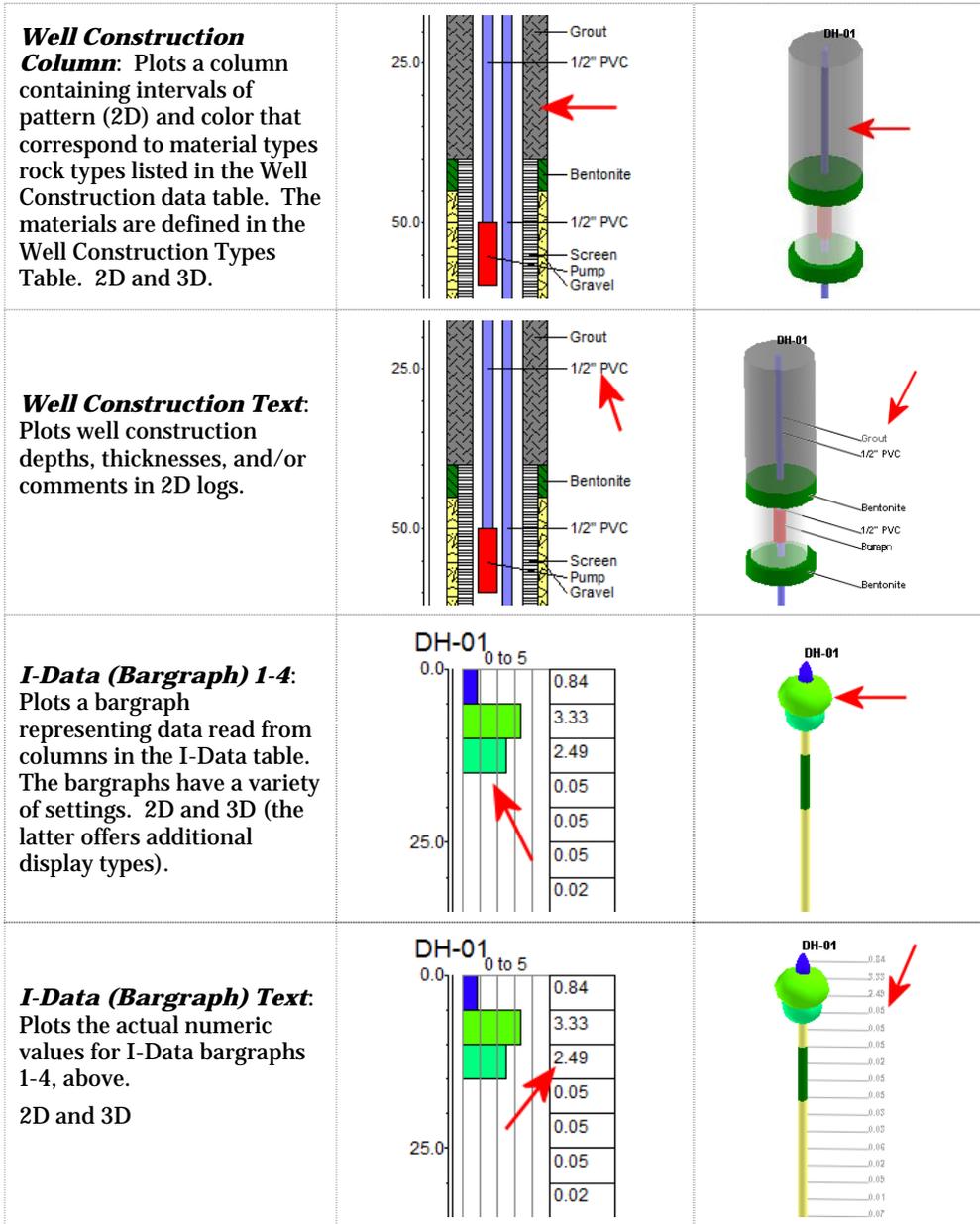
### Log Components

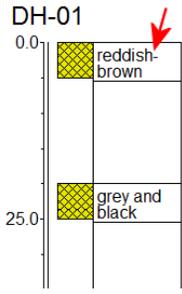
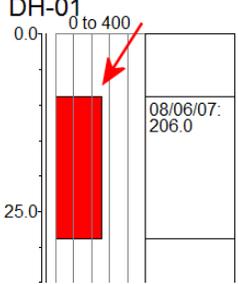
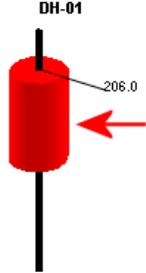
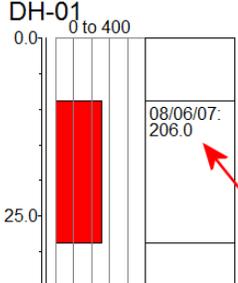
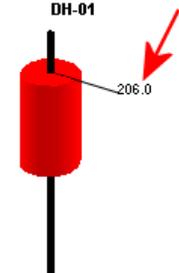
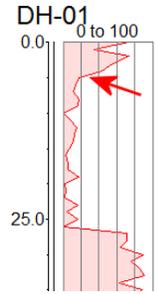
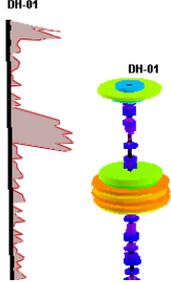
The following items are available for display in strip logs, displayed individually or in groups, in 2D or in 3D. Note that not all components are available for all log views.

- ! Because OpenGL does not support them, **pattern designs are not drawn on 3D logs**. Instead, lithology, stratigraphy, well construction, and pattern intervals are shown on the cylinders using the **background color** defined for the materials.

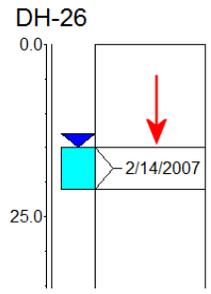
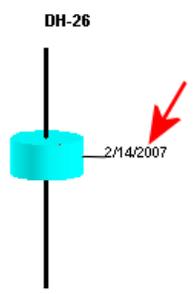
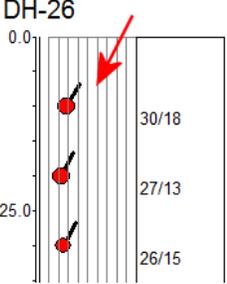
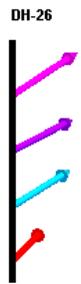
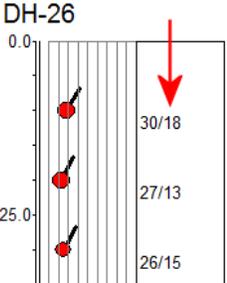
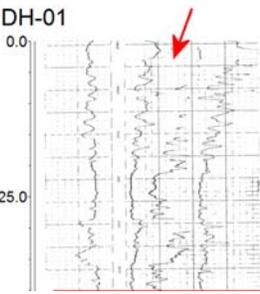
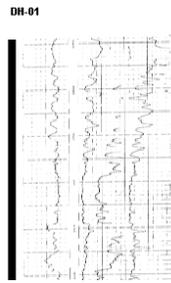
Log Item	2D	3D
<p><b>Title:</b> Plots the boring's name at the top of the log, read from the Location tab. Font settings adjust the text orientation, thickness, etc.</p>		
<p><b>Axis:</b> Plots the log's trace down the hole. This is always activated in 2D and is the location above which the title is plotted. You can adjust the line style, thickness, and color. Handy also for simply showing well locations in sections and 3D views.</p>		
<p><b>Depth Labels:</b> Plots depth labels down the log. Settings include labeling interval, font style, etc. 2D and 3D.</p>		

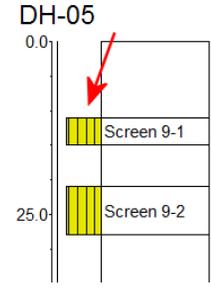
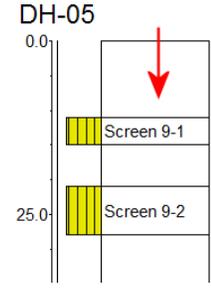
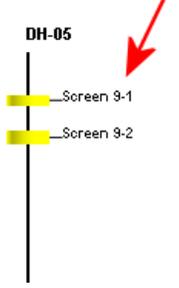
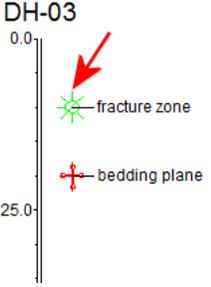
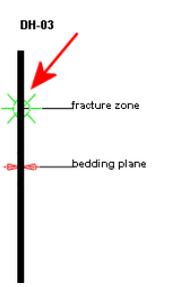
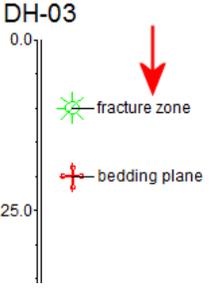
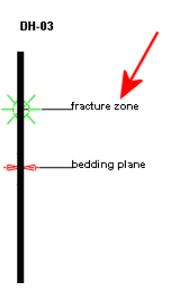
<p><b>Lithology Column:</b> Plots a column containing intervals of pattern (2D) and color that correspond to observed rock types listed in the Lithology datasheets. The materials (etc.) are defined in the Lithology Types Table. 2D and 3D.</p>		
<p><b>Lithology Text:</b> Plots lithology depths, keywords, thicknesses, and/or comments in 2D logs; keywords and descriptions in 3D.</p>		
<p><b>Stratigraphy Column:</b> Plots a column containing intervals of pattern (2D) and color that correspond to formation names listed in the Stratigraphy datasheets. The formation names (etc.) are defined in the Stratigraphy Types Table. 2D and 3D.</p>		
<p><b>Stratigraphy Text:</b> Plots stratigraphy depths, thickness, and/or keywords in 2D logs; formation name in 3D</p>		



<p><b>I-Text 1-4:</b> Plots the alphanumeric data stored in columns in the I-Text table as textual labels on the log. 2D only.</p>		<p>n/a</p>
<p><b>T-Data (Bargraph) 1-4:</b> Plots a bargraph representing data read from columns in the T-Data table. Includes a date filter. 2D and 3D (the latter offers additional display types).</p>		
<p><b>T-Data (Bargraph) Text:</b> Plots the actual numeric values for T-Data bargraphs 1-4, above. Dates &amp; values in 2D; values only in 3D.</p>		
<p><b>P-Data (Curve) 1-4:</b> Plots a point to point curve, with or without fill, representing data read from columns in the P-Data table. The Curves have a variety of settings, and in 3D you have the option of plotting discs. 2D and 3D.</p>		

<p><b>P-Text 1-4:</b> Plots the alphanumeric data stored in columns in the P-Text table as textual labels on the log. 2D only.</p>		<p>n/a</p>
<p><b>Fractures:</b> Represented with a tadpole column in 2D logs and oriented disks in 3D logs to show fracture depth, orientation and dip</p>		
<p><b>Fractures Text:</b> Plots fracture measurement values in 2D logs</p>		<p>n/a</p>
<p><b>Aquifers:</b> Plots one or more interval blocks (representing depth to surface and base declared in the Water levels table) in 2D and 3D logs. Water level symbols are also available.</p>		

<p><b>Aquifer Text:</b> Plots date labels in 2D logs.</p>		
<p><b>Vectors:</b> Represented with a tadpole column in 2D logs and with arrows in 3D logs to show the direction and bearing declared in the Vectors table. 2D and 3D.</p>		
<p><b>Vectors Text:</b> Plots vector measurement values in 2D logs.</p>		<p>n/a</p>
<p><b>Bitmaps:</b> Plots raster images of a variety of formats between specified depth intervals. Typically used to show raster logs or downhole photos. 2D and 3D.</p>		

<p><b>Patterns:</b> Plots user-selected pattern blocks between specific depths in the log, as read from the Patterns table. 2D and 3D.</p>	 <p>DH-05 0.0 25.0 Screen 9-1 Screen 9-2</p>	 <p>DH-05 Screen 9-1 Screen 9-2</p>
<p><b>Patterns Text:</b> Plots any Pattern captions in 2D logs.</p>	 <p>DH-05 0.0 25.0 Screen 9-1 Screen 9-2</p>	 <p>DH-05 Screen 9-1 Screen 9-2</p>
<p><b>Symbols:</b> Plots user-selected symbols at specific depths in the log, as read from the Symbols table. 2D and 3D.</p>	 <p>DH-03 0.0 25.0 fracture zone bedding plane</p>	 <p>DH-03 fracture zone bedding plane</p>
<p><b>Symbols Text:</b> Plots any Symbol captions in 2D logs.</p>	 <p>DH-03 0.0 25.0 fracture zone bedding plane</p>	 <p>DH-03 fracture zone bedding plane</p>

## Other Log and Profile/Section Settings

**Other Options:** This grouping contains settings that control downhole resolution for deviated boreholes.

**Clip Logs:** This tool allows you to specify an elevation range for display in the single or multiple log diagrams. 2D and 3D.

**Hang Section:** Allows the user to align a selected stratigraphic unit on a horizontal line in profiles and sections.

**Plot Surface Profile:** Displays in profiles and sections a line representing the ground surface, read from a user-specified grid file.

**Perimeter Annotation:** Profiles and sections can be annotated with elevation labels, X,Y or distance labels, panel coordinates, titles, and other text.

**Create Location Map:** The program will create a map illustrating the trace of the profile, cross section, or fence diagram. The map can be generated stand-alone and/or embedded (in 2D).

**Lithology Legend:** This legend displays rock types and colors as read from the project's Lithology Types Table. Settings include location, size, and offset. 2D and 3D.

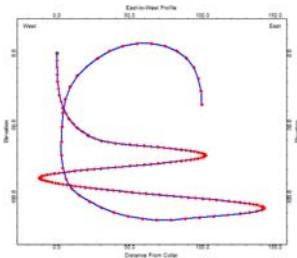
**Stratigraphy Legend:** This legend displays formation names and colors as read from the project's Stratigraphy Types Table. Settings include location, size, and offset. 2D and 3D.

**Well Construction Legend:** This legend displays well construction material names and colors as read from the project's Well Construction Types Table.

**Reference cage:** (3-dimensional log displays only) The reference frame labels elevations, and X and Y coordinates.

? Help Contents: Reference / 2D Striplog Options, 3D Striplog Options.

## Computing Borehole Survey Coordinates and Creating Diagrams



The **Striplogs / Borehole Survey** option is used to read depths, bearings, and inclinations from the Orientation tab of the current borehole, and compute XYZ coordinates at user-specified intervals down the borehole that are recorded in a new datasheet. It also offers a 2D diagram views of the deviated borehole – in plan view and section view. A 3D display is also offered.

## Comparing Log Endpoints

Use the **Striplogs / Endpoint Comparison** tool to generate a listing of the spatial relationships for the endpoints of all active boreholes. It is used by drilling companies

when comparing multiple, complex boreholes. The output from this program is displayed within the RockWorks Utilities datasheet.

The available computations include any of the following: For each borehole: total depth and XYZ coordinates. For each borehole pair: azimuth & inclination; 3D, horizontal, and vertical distances; relative offsets; and borehole base midpoints.

Row#	Point-A	Point-B	A-TD	B-TD	A->B Azi.	A->B Inc.	B->A Azi.	B->A Inc
1	DH-01	DH-02	132.0	188.0	49.32	-7.28	229.32	7.28
2	DH-01	DH-03	132.0	171.0	348.25	-5.64	168.25	5.64
3	DH-01	DH-04	132.0	229.0	90.0	-19.32	270.0	19.32
4	DH-01	DH-05	132.0	142.0	54.54	15.77	234.54	-15.77
5	DH-02	DH-03	188.0	171.0	280.07	2.75	100.07	-2.75
6	DH-02	DH-04	188.0	229.0	187.13	-9.47	7.13	9.47
7	DH-02	DH-05	188.0	142.0	227.39	15.61	47.39	-15.61
8	DH-03	DH-04	171.0	229.0	133.97	-7.5	313.97	7.5
9	DH-03	DH-05	171.0	142.0	149.38	11.71	329.38	-11.71
10	DH-04	DH-05	229.0	142.0	289.01	33.03	109.01	-33.03

**Notes**

# Chapter 7 – Gridding, Contour Maps, and 3D Surfaces

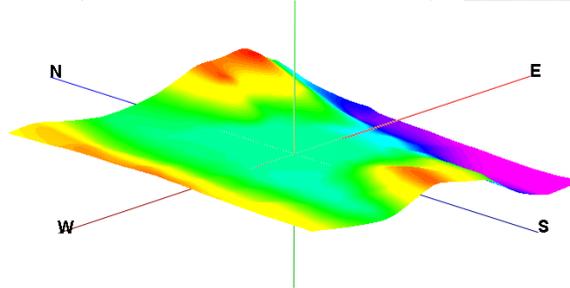
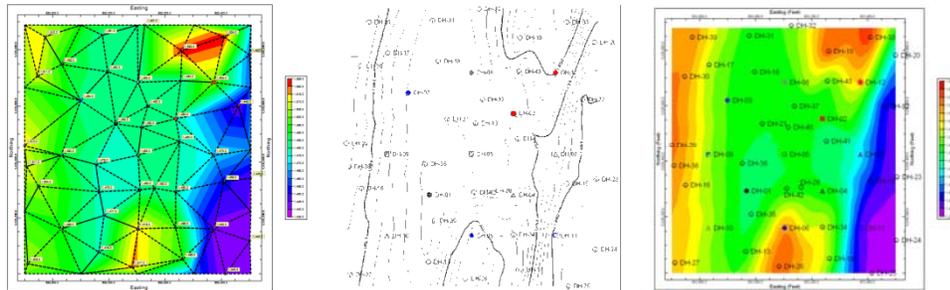
## Topics

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- Other Gridding Options..... 141
- Grid Model Dimensions..... 143
- 2D Contour Maps – How to Create Them..... 143
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## Overview

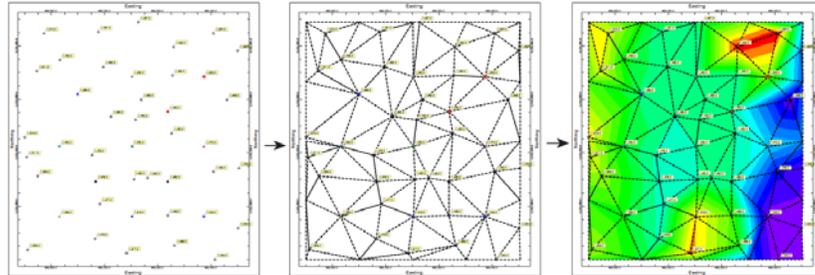
The previous chapters discuss some of the tools in the RockWorks program that allow you to visualize your data as-is, with no interpolation: various point maps display your sample/borehole locations in plan view, and various striplog diagrams display downhole data in 2D and 3D.

RockWorks also contains tools to transform the observed data into interpolated models, “filling in the blanks” where no samples exist. This chapter discusses contour maps: triangle-based (“easy”) and grid-based, in 2D and as 3D surfaces.



## Delaunay Contouring – aka “EZ” Contouring

One method of creating a contour map from XYZ points is to construct a series of triangles between the data points, with a data point at each triangle vertex. (The triangles are constructed so that the angles are as close as possible to equi-angular.) Contour lines are then interpolated between the triangle vertices and connected together to form the map. We refer to this process as Delaunay Contouring; it is also often referred to as "dip-contouring" by some geologists.



**Benefits:** Because it by-passes the gridding step, this mapping method operates the most quickly. In addition, it honors all of the data values; many people prefer this method of contouring since there is no loss of data integrity as a result of gridding. The results of this method probably look a lot like what you would get if you drew the contours by hand. We often use this method to get a quick view of potential contours before proceeding to create a grid-based map for comparison purposes.

**Drawbacks:** RockWorks cannot build 3D surface maps using this method. This method can leave blank areas in the map where there are no control points, unless you tell the program to insert "edge points." Contours tend to be very angular. You cannot use any of the gridding tools in the program with the resulting surface (isopach computations, etc.)

**Menu Item:** Delaunay triangulation is available in the RockWorks Utilities **Map / EZ Map** option – turn on the line and/or color contours. The triangle network is also available as an optional layer.

**Data source:** RockWorks Utilities XYZ files (page 89). If you wish to contour data from the Borehole Manager in this fashion, here are some methods for getting your downhole data into the Utilities datasheet:

- Borehole elevations: Use **File / Transfer / Locations -> Utilities Datagrid** to transfer your borehole location data to the Utilities datasheet. Then select the Easting and Northing columns for X and Y, and the Elevation column for Z.
- Stratigraphy data: Use **File / Transfer / Stratigraphy -> Utilities Datagrid** to transfer your borehole locations and stratigraphy contacts to the Utilities datasheet. The depths will be converted to elevations during the transfer. Then select the Easting and Northing columns for X and Y, and the desired top or base for the Elevation value.
- T-Data: Use the **T-Data / Export / T-Data -> Utilities Datasheet** option to transfer your T-Data measurements.

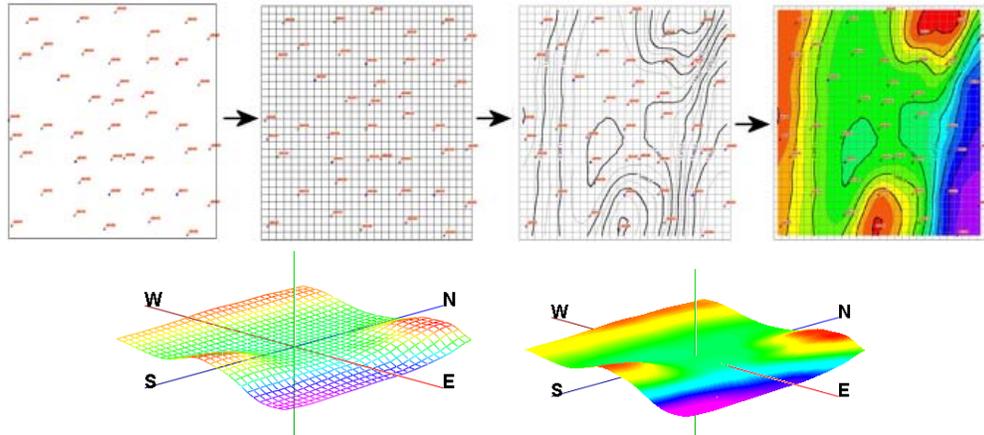
Output window: RockPlot2D

You must have at least four XYZ point triplets to create a Delaunay contour map using the RockWorks Utilities **Map / EZ Map** tool. The **Planes / 3-Point** tool requires only 3 input triplets.

## Grid-Based Contouring

Gridding is a process in which scattered, spatially-distributed data can be transformed into a continuous array or grid of numeric values. Data to be gridded can represent anything from topographic elevations in your county to ratings of local pizza joints, as long as the original data points have location coordinates (X and Y) and a measured "Z" value of some kind. The locations coordinates must be in a Cartesian coordinate system.

You might picture a data grid as a grid of imaginary lines that overlays your source data points. In the process of gridding, the program assigns a value to the grid line intersections, called grid nodes. Contours can then be drawn based on the values of the grid nodes. Gridded data can also be displayed as a 3-dimensional surface.



A grid file is the computer file of numbers that contains the results of the gridding process. It contains a listing of the X and Y location coordinates of the regularly-spaced grid nodes and the extrapolated Z value at each node. Grid files are stored in the project folder and have a ".GRD" file name extension.

**Benefits:** Grid-based surfaces can be displayed in 3D and can be combined with other surfaces to illustrate stratigraphic layers. Grid models can be filtered (constraining filters, polygon filters, etc.). Arithmetic operations can be done between grid models to generate isopach models (Elevation Grid A – Elevation Grid B), total thickness models (Isopach Grid A + Isopach Grid B), stripping ratio models (Isopach Grid A / Isopach Grid B), etc. Grid models can be used to constrain solid models, such as to null values above the ground surface or to restrict volume computations to a stratigraphic unit. Grid-based volume tools and grid editing tools are available.

**Drawbacks:** Gridding is an estimation process, and each gridding method operates differently, so determination of accuracy can be subjective (i.e. be skeptical).

Menu Items (and Data Source)

- Within RockWorks, you can perform "basic" gridding of generic X,Y,Z data for 2D and 3D maps using the RockWorks Utilities **Map / Grid-Based Map** command (reading RockWorks Utilities XYZ files – page 88).
- You can create grid models of stratigraphic surfaces and aquifer surfaces in the Borehole Manager (**Stratigraphy** and **Aquifers** menus, reading Stratigraphy and Water Level data).
- Grid models of downhole quantitative data, to illustrate highs, lows, averages, or sums are offered in the **Statistics Map** options in the **P-Data**, **I-Data**, and **T-Data** menus (reading a track of values from the P-Data, I-Data, or T-Data tabs)
- The RockWorks Utilities **Grid** menu contains a plethora of grid manipulation and analysis tools (reading XYZ data or existing GRD models).
- The RockWorks Utilities **Solid** menu contains tools for extracting grid models from solid models.
- The RockWorks Utilities **Volume** menu contains tools for computing volumes from grid models.

Output window: RockPlot2D and/or RockPlot3D

- ! The process of grid-based contouring generates TWO output files: the numeric grid model (GRD) and the graphic diagram (the 2D map or the 3D surface) which is created to represent the model.

## Gridding Methods

RockWorks offers several methods to do this interpolation of your data. Each operates differently, and each has strengths and differences. They are described very briefly here; please refer to the Help messages for more details.

- **Closest Point:** Each grid node is simply assigned the value of the closest control point.
- **Cumulative:** Nodes represent the sum of the control point values within the node area. Helpful for modeling weighted occurrence data.
- **Directional Weighting:** Uses Inverse-Distance with a directional weighting bias. You can specify a uni-directional bias, bi-directional, or create a custom table that lists directions and weighting values.
- **Distance to Point:** Each grid node is assigned a value that represents its distance, in your X,Y map units, to the closest control point. This can be used to generate confidence models.
- **Inverse-Distance:** A common method using a weighted average approach to compute node values. You can vary the weighting value to make the gridding more / less localized.
- **Kriging:** Its strength is in identifying patterns across the data, including directional trends. You can choose from Automatic kriging, whereby the program picks the best variogram model to use in gridding the data, or you can do it all manually. An interactive Variogram Editor is included, as well as graphic and text reports to analyze correlation.

- **Multiple Linear Regression:** Simple distance weighting is applied to a regression analysis. It first fits a first-order polynomial to the data points to remove regional trend. It determines the control points that lie within a minimum distance from the node and it populates a sum of squares matrix with the data in the search box using inverse-distance weighting. It solves the matrix for regression coefficients, calculates the estimated Z value at the node, and adds back in the regional trend.
- **Sample Density:** This algorithm assigns grid node values by simply counting the number of occurrences of control points within the corresponding grid cells.
- **Trend Surface Polynomial:** It finds regional trends in your data. In automatic mode, the program will find the surface with the best fit to your data points, trying different orders of the trend surface equation (e.g. a flat surface, a surface with one bend, two bends, etc.). How well the surface fits is determined by a "correlation factor" that the program computes for each surface that is fit to the data. The greater the correlation factor the better the fit.
- **Trend Surface Residuals:** It determines local differences from regional trends. First, it tries to fit a polynomial trend surface to your data (This is the same process as is done using the Trend Surface Polynomial method.) It then compares the source data points with the computed trend surface. These "residual" differences are the localized components. The program then grids the residuals using the Inverse-Distance gridding method.
- **Triangulation (grid-based):** The data points are connected into triangles by imaginary lines, with a data point at each triangle vertex, and the triangles as close as possible to equi-angular. The slope of each triangle is computed from the three X, Y, and Z corner points. The grid nodes that lie within each triangle are assigned a z-value based on their intercept with the sloping triangular plane. Those grid nodes that lie outside the triangle network can be assigned values using the Inverse-Distance gridding method, with a weighting exponent of "2" and quadrant searching turned off.
- **Hybrid:** Estimates a surface using two or more different gridding methods, with an option to weight the methods differently.

? [Help Contents: Reference / Gridding Reference](#)

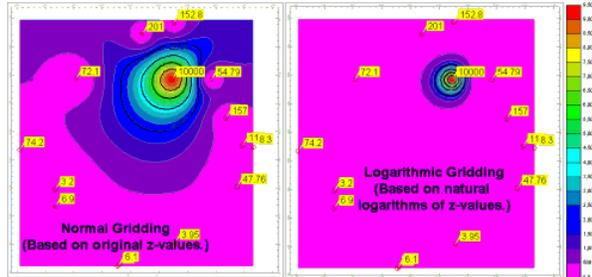
## Other Gridding Options

In addition to various gridding methods, there are a number of other options available to fine-tune the interpolation of your data. These are summarized briefly here; see the Help messages for more details.

- **Decluster Points:** Used to "pre-grid" clustered data points, also helpful for duplicate points. Prior to modeling, the program will lay an imaginary "pre-grid" over the data points, at a resolution you declare. If a single data point lies within the cell, then the cell is assigned that point's z-value. If more than one point lie within the cell, then the cell is assigned an average of all of the z-values. Any pre-grid cells with no data points are discarded. It is the pre-gridded data that is then sent on to the surface modeling routine.

This option works nicely if you have data sampled along lines or in clusters, such as along seismic lines.

- **Logarithmic:** The Logarithmic gridding option can be helpful for creating grid models of highly anomalous data. Data sets that contain large "outliers" (i.e. values that are far beyond the typical range of data) are typically problematic when the goal is to highlight these anomalous regions. By computing and gridding the natural logarithm of the control point values, the regional effects of these outliers is more localized as shown by the following diagram. The net effect is to highlight anomalous regions (e.g. contaminant plumes).



! The logarithmic capability should be restricted to data sets that contain geochemical or geophysical data with grossly anomalous data points. It is not well suited for surface elevation data due to the fact that these data sets typically include negative z-values (i.e. sub-sea elevations).

- **High-Fidelity:** When selected, this option will "tweak" the final grid model (after the smoothing option has been applied) such that the contours will do a better job of honoring the control points, regardless of the algorithm or the grid smoothing (below). The capability uses a recursive algorithm that grids the residuals, adds them back into the original model, and repeats the process until the cumulative error drops below a threshold. Note that those cells that contain more than one control point are re-defined such that the node value equals the average of all of the control point values within the cell.
- **Polyenhancement:** This option works nicely if your data has any regional trend. If activated the program will fit a polynomial surface to your data and compute the residuals for each control point (representing the difference between the source z-value and the polynomial-computed z-value). The program will then grid the residuals using the selected gridding method (Triangulation, Inverse-Distance, etc.). The residuals grid and the polynomial grid are then added together.

You may select Automatic to have the program compute the best-fitting polynomial for your data. Or, you can select the order of the polynomial yourself by clicking in one of the remaining radio buttons. For a summary of how well each polynomial order fits your data, you can run, separately, a Trend Surface Report (RockWorks Utilities **Grid** menu, page 209).

- **Smooth Grid:** When activated, this tool averages the Z-values in the grid model based on a user declared "filter" size. The smoother can be run 1 or more times, to get rid of spurious "noise" within the grid model and bring out regional trends. (This is also available as a filter within the **Grid / Filter** menu.) The Filter Size defines how many adjacent nodes should be used when computing the average (smoothed) Z-value for each grid node. If you enter "1", then each node will be assigned the average of

itself and the 8 nodes immediately surrounding it, 1 layer deep. If you enter "2", the node will be assigned the average of itself and the 24 nodes immediately surrounding it, 2 layers deep. When in doubt, enter "1". The Iterations setting defines the number of times the entire model should be run through the smoother.

- **Densify:** This feature will automatically add additional points to the xyz input by fitting a Delaunay triangulation network to the data and then adding the midpoint of each triangle to the list of xyz points. The net result is that the subsequent gridding process is now using more control points which tends to constrain algorithms that may become "creative" in areas where there is little control.
- **Faulting:** RockWorks offers two gridding methods that support faults: Inverse Distance and Multiple Linear Regression. Faults are defined as "polylines" within project Fault Tables. Multiple (discontinuous) polylines can be defined for a single project. These polylines can contain many vertices. Faulting can be applied to a single grid surface, or to multiple grids in a stratigraphic model, but note that the faults are assumed to be vertical.

? [Help Contents: Reference / Gridding Reference](#)

## Grid Model Dimensions

The Grid Dimensions options are used to establish the number of nodes to be created in the grid model and the boundary coordinates of the model. These options are available:

**Hardwire Project Dimensions:** Choose this dimensioning option if the grid dimensions are to be taken from the current Project Dimensions settings (see page 83). This is generally a good idea, particularly in projects where multiple models are going to be created and may need to undergo comparison, mathematical, and filtering operations (in which all models must be dimensioned the same). Use the **Adjust/Examine Project Dimensions** button to view and/or reset the project's dimensions.

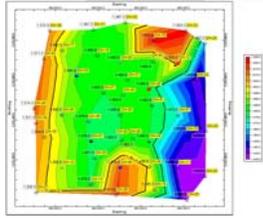
**Variable (Based on Data Coordinates):** Choose this dimensioning option if the grid dimensions are to be established based on the current data being modeled. This could be an option for modeling a subset of the entire project or for testing the effect of different node densities without having to reset the entire project's dimensions. There are several methods available.

? [Help Contents: Reference / Gridding Reference](#)

## 2D Contour Maps – How to Create Them

This section lists some of the program tools that generate 2D contour maps.

## RockWorks Utilities: Map / EZ Map



**Map / EZ-Map** builds 2-dimensional (flat) maps for X, Y, and Z coordinate data, using the Delaunay triangulation technique. The maps can include several map layers. (On page 112, we discussed creating a simple point map of X,Y data. It's the same program tool – just be sure to turn on line or color contours.)

Datasheet: RockWorks Utilities “XYZ” file (page 88)

Because this contouring method draws a triangulation network among the given control points only, the Interpolate Edge Points map option can be used to force the map edges to a full rectangular shape.

Delaunay triangulation is only available in the RockWorks Utilities window. If you are working with Borehole Manager data, you can transfer locations, stratigraphy, and other data to the RockWorks Utilities window for mapping there. See page 81 for details.

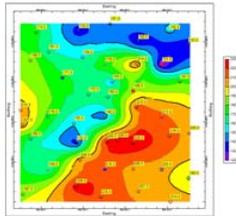


RockWorks Utilities Tutorial: Create Point and Surface Maps



Help Contents: RockWorks Utilities / Mapping Tools / Contour and Point Maps

## RockWorks Utilities: Map / Grid-Based Map



**Map / Grid-Based Map** creates grid models of XYZ data in the RockWorks Utilities datasheet or in an external ASCII file. The Z values can represent surface elevations or geochemistry or virtually any measured value. You can choose the "gridding" method used to model the Z values. You can then create a 2-dimensional (flat) map or 3-dimensional surface map of the grid model. This section discusses 2D maps.

Datasheet: RockWorks Utilities “XYZ” file (page 88). This tool will also grid and map XYZ data stored in an external ASCII file

Notes: This tool can create a grid model alone (no map), a map of an existing grid model (no new grid), or a new grid model and map. Since the grid model is saved on disk, you can create a map from an existing grid model - no need to re-grid. This is useful if you have processed a grid model through the filtering tools in the RockWorks Utilities **Grid** menu.



Use the Project Manager to create a quick 2D map or 3D surface illustrating a grid model: just double-click on a GRD file name and establish the map settings. (See page 107.)



If you have borehole data and wish to create grid-based formation structure maps, isopach maps, or surface elevation maps, see the next topics.

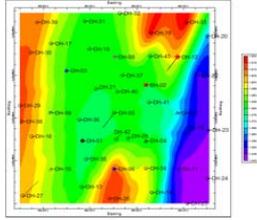


RockWorks Utilities Tutorial: Create Point and Surface Maps 2D.



Help Contents: RockWorks Utilities / Mapping Tools / Contour and Point Maps

## Borehole Manager: Map / Borehole Locations



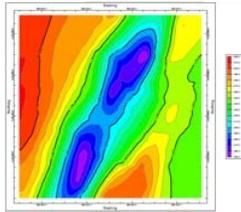
The Borehole Manager **Map / Borehole Locations** is used to create a symbol map of the borehole locations. It can also be used to generate a grid model and a 2D contour map of the borings' surface elevations.

Use this surface elevation grid model to clip your solid models (lithology, P-data, I-data, etc.) so as to set nodes above the ground to zero. Just specify the surface grid as the Upper Surface Filter under Model Constraints.

To create a 3D image of the resulting surface grid model, you can use the Project Manager: double-click on the GRD file name and establish the map options.

? Help Contents: Borehole Manager / Location Maps & Coordinate Tools

## Borehole Manager: Stratigraphy / Structural Elevations / 2D

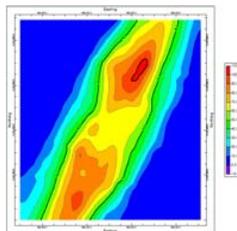


The Borehole Manager **Stratigraphy / Structural Elevations / 2-Dimensional** creates (1) a grid model of the elevations at the top or base surface of a selected stratigraphic unit and (2) a 2-dimensional (flat) contour map representing the grid model. You can choose the gridding method to be used to model the formation elevations. The structure map can include a variety of map layers.

Be sure you have your formations listed correctly in the Stratigraphy Table. The grid model that's created in this program will be stored in the project folder and can be manipulated using the RockWorks Utilities **Grid** menu tools. If you wish to transfer your stratigraphic data to the RockWorks Utilities datasheet, you can do so using the **File / Transfer / Stratigraphy** -> **Utilities Datagrid** or **Stratigraphy / Export** tools.

? Help Contents: Borehole Manager / Stratigraphy Tools / Structure Maps 2D & 3D

## Borehole Manager: Stratigraphy / Stratigraphic Thickness / 2D (Isopach)



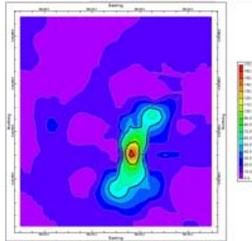
This tool creates a 2-dimensional (flat) contour map representing the thickness of a selected stratigraphic unit. The "isopach" map can include line contours, color contours, border annotation, and/or labeled cells (representing grid values). RockWorks creates the thickness model by gridding the formation's upper surface elevations, gridding the formation's lower surface elevations, and then subtracting the lower grid from the upper. The resulting isopach grid can be saved for future use.

## Notes:

- Be sure you have your formations listed correctly in the Stratigraphy Table.
- If you want the program to save on disk the grid model of formation thickness, be sure to insert a check in the *Save Grid* box and enter a grid file name.

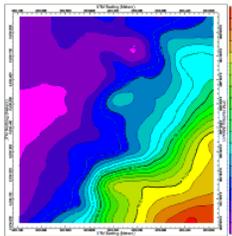
? Help Contents: Borehole Manager / Stratigraphy Tools / Isopach Maps

### Borehole Manager: I-Data, P-Data, T-Data, Fractures / Plan-Map



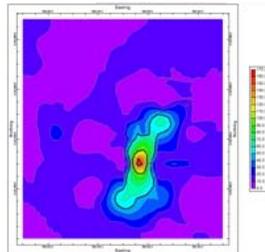
The Borehole Manager's **I-Data**, **P-Data**, **T-Data**, and **Fracture / Plan Map** tools create a solid model representing the downhole data (or read an existing model) and slice it horizontally at a user-specified elevation. The resulting grid model (GRD) can be displayed as a 2-dimensional map in which the data values can be color-coded in a variety of ways. These maps are discussed in Chapters 10-13.

### Borehole Manager: Aquifers / Plan-Map



The Borehole Manager's **Aquifer / Plan** tools are used to create a 2-dimensional (flat) contour map of the aquifer surface, base, or thickness for a particular date or date range. These maps are discussed in Chapter 9 – Modeling Water Levels.

### Borehole Manager: I-Data, P-Data, T-Data / High-Low-Average-Sum Statistics-Maps

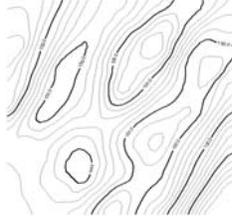


The Borehole Manager's **I-Data**, **P-Data**, and **T-Data / Statistics Map** tools provide a quick look at a specific G value range without creating a solid model. These programs extract an XY location for each borehole and the high/low/sum/average value (as requested) for a specific track for that location, and create a grid model and 2D and/or 3D map to illustrate this data. The data values can be color-coded in a variety of ways. These maps are discussed in Chapter 12 - I-Data, T-Data, and P-Data Modeling.

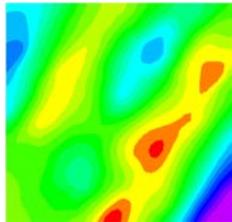
## Other Contouring Tools

The RockWorks Utilities **Grid** menu offer a number of grid model filtering and manipulation tools. Most of these menu items offer the option to create a map of the resulting grid – see Chapter 15 - Grid Model Tools.

## 2D Contour Map Layers



Line contours can be drawn at regular, logarithmic, or user-defined intervals. Contour lines can be smoothed and displayed with labels. Line style and color can be defined for labeled and unlabeled contours. Options for omitting zero-value, low-value, or high-value contours are available.

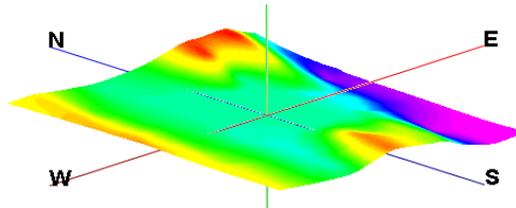


Color contours: Numerous color schemes exist, or define your own. Boolean grid models can be displayed with specific colors for the zero and 1-value nodes. Custom color tables can be created for specific value ranges. A color legend is available.

Colors can be applied gradationally (typical contours) or using a classification (paint-by-numbers) approach.

? See all of the 2D map layers on page 296.

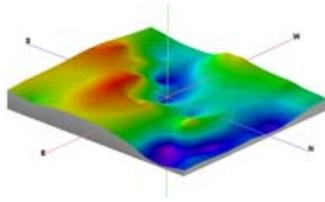
## 3D Surface Maps – How to Create Them



3-dimensional surface maps are really just a 3D view of a 2-dimensional contour map. Like the 2D maps, they illustrate quantitative values that have been measured over space. Like the 2D maps, they can be used to illustrate geological topics (surface elevations, formation thickness, average geochemical concentrations) as well as non-geological topics such as crime incidents in a precinct.

RockWorks offers both a grid-based and a non-grid based means of creating 2D maps. By contrast, 3D surface maps must be generated from a grid model. See the previous section for details. 3D surface maps are displayed in the RockPlot3D window.

## RockWorks Utilities: Map / Grid-Based Map



This tool is used to create grid models of XYZ data in the RockWorks Utilities datasheet or in an external ASCII file. The Z values can represent surface elevations or geochemistry or virtually any measured value. You can choose the gridding method to be used to model the Z values. You can then create a 2-dimensional (flat) map or 3-dimensional surface map or flat projection of the grid model. This section discusses 3D maps.

If you have borehole data and wish to create grid-based formation structure maps, see a later topic in this section.

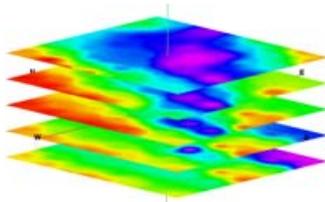
Datasheet: RockWorks Utilities “XYZ” file (page 88) Note that this tool will also grid and map XYZ data stored in an external ASCII file

- This tool can create a grid model only (no surface), a surface of an existing grid model (no new grid), or a new grid and surface. Since the grid model is saved on disk, you can create a surface from an existing grid model - no need to re-grid. This is useful if you have processed a grid model through the filtering tools in the RockWorks Utilities **Grid** menu, created the grid originally in the Borehole Manager, etc.

! Use the Project Manager to create a quick 2D map or 3D surface illustrating a grid model: just double-click on a GRD file name and establish the map settings. (See page 107.)

? Help Contents: RockWorks Utilities / Mapping Tools / Contour & Point Maps

## RockWorks Utilities: Grid / Grids -> 3D Stack



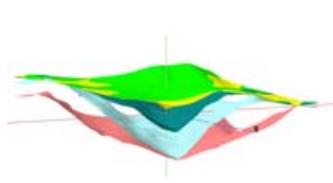
The RockWorks Utilities **Grid / Grids -> 3D Stack** program is used to plot multiple, flat grids in 3D space for the purpose of visual comparisons. These grid models can represent any real number values (geochemical concentrations, elevations, porosity values, quality readings, you name it). These are grid models that already exist on your computer.

Datasheet: RockWorks Utilities. It reads a file containing a single column of grid (.GRD) file names, listed from the top down in the same order in which they are to be stacked, top-down, in the diagram.

- Be sure the grid models actually exist in the current project folder.
- Once displayed in RockPlot3D, you can turn individual surfaces on and off by inserting/removing the check-marks by the grid model names in the RockPlot3D data tree (you may need to expand the “Stack” heading). If you expand the grid model groups in the data tree, and double-click on any of the Flat Grid entities, you can adjust the color scheme, drawing style, and other visual characteristics.

? Help Contents: RockWorks Utilities / Grid Model Tools / Stacked Surface Tools.

## Borehole Manager: Stratigraphy / Structural Elevations / 3D

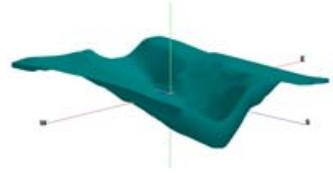


Use this tool to create 3-dimensional images representing the surface elevations of one or all stratigraphic unit(s) in the project.

If you create surfaces for all formations, the program will automatically name the grid models using the formation name with the “\*.grd” file name extension. Be sure you have your formations listed correctly in the current Stratigraphy Types Table.

- ? Help Contents: Borehole Manager / Stratigraphy Tools / Structure Maps 2D & 3D.
- ? See also Chapter 8 - Stratigraphy Modeling

## Borehole Manager: Stratigraphy / Stratigraphic Thickness / 3D



Use this tool to create a 3-dimensional image which represents the thickness of a selected stratigraphic unit. The completed image will be comprised of a surface representing the formation's top, a surface representing the formation's base, and enclosing sides.

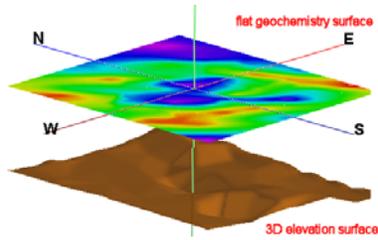
Notes: In RockPlot3D the program will display the computed volume and mass of the selected formation. In order for these computations to be accurate, be sure that your depth units are the same as your X,Y units (such as feet) so that the cubic volume (as in ft<sup>3</sup>) makes sense. In addition, the mass computation is based on the density per cubic unit as declared in your Stratigraphy Types Table.

- ? Help Contents: Borehole Manager / Stratigraphy Tools / Isopach Maps 2D & 3D.
- ? See also Chapter 8 - Stratigraphy Modeling

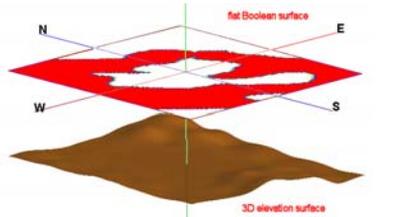
## Other 3D Surface Tools

The RockWorks Utilities **Grid** menu offer a number of grid model filtering and manipulation tools. Most of these menu items offer the option to create a 3D surface display of the resulting grid – see Chapter 15 - Grid Model Tools.

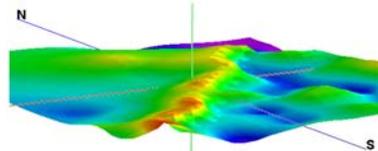
## 3D Surface Map Layers



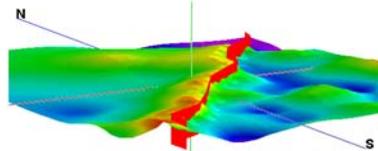
**Flat Surface:** Displays a grid model as a color-coded flat surface in the 3D window, rather than a true 3D surface. You can define the elevation at which the surface is to be floated.



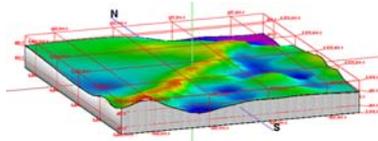
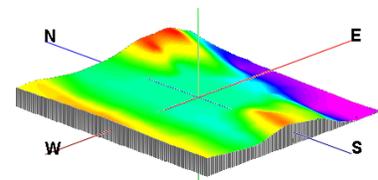
**Boolean Colors:** If the grid model being represented in the diagram is a Boolean "true/false" grid model, in which there are only two values: 0 (for "false") and 1 (for "true"), this option allows you to define the colors to be used to represent the Boolean values.



**Faults:** If your grid model contains faults, you can display these with your 3D surface.



**Skirt:** This option adds a solid "skirt" around the perimeter of the surface. The skirt is comprised of vertical panels drawn to a user- or automatically-defined elevation, with a variety of draw options.



**Reference Cage:** Adds axis coordinates in a wire cage around the surface.

# Chapter 8 - Stratigraphy Modeling

## Topics

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- Stratigraphy Computation Tools ..... 163
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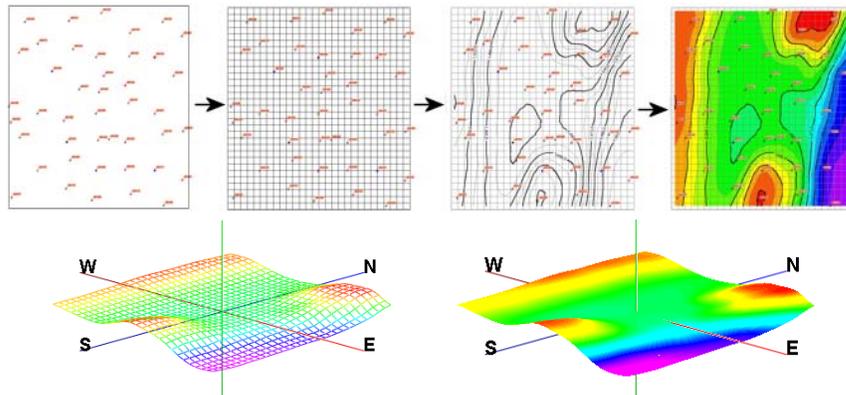
## Overview

### What is Stratigraphy?

In RockWorks, stratigraphy is considered as subsurface intervals of distinct rock types that do not repeat within a single well and do not vary in order between wells. Stratigraphy can represent localized, grouped lithologies (soils, clay-1, conglomerate, clay-2) or regional formations (Navaho sandstone, Wingate Sandstone, Chinle Shale). If your subsurface rock or soils are not layered, it should be entered as "lithology" (page 40).

### How is Stratigraphy Modeled?

In the previous chapter we discussed the concept of Delaunay ("EZ") contouring whereby triangle-based contours can be drawn directly from the control points based on their location (X and Y) and the Z value being contoured. We also discussed the concept of gridding, whereby the scattered sample points can be interpolated into a regular array of X,Y,Z points. A grid model can be visualized graphically as a 2D contour map or a 3D surface.



RockWorks uses similar concepts for creating stratigraphic diagrams and modeling stratigraphic surfaces in the Borehole Manager, offering

- “EZ” (or “straight”) stratigraphic profiles and fence diagrams. Stratigraphic correlations are drawn with straight-line panels. (Profiles and fences only.)
- Grid-based stratigraphic surfaces for display in maps, profiles, sections, 3D models, fence diagrams, and more.

## Typical Workflow

1. Define your formation names (page 54). Be sure you define the formation order with the youngest (uppermost) formation at #1, and proceeding downward.
2. Enter your borehole locations and stratigraphy data (pages 38 and 41), or import your data (page 63)
3. Establish your Project Dimensions (page 100). For stratigraphy models, be sure the X and Y spacing for the nodes is half the average minimum distance between your boreholes, or closer. The min/max settings for the elevation axis should comply with the elevation extents of the boreholes. The spacing setting for the Z axis won't be used unless you decide to save a solid model version of your stratigraphy model.
4. Create a borehole location map to verify well locations (page 110). Be sure your well locations look correct.
5. Display your downhole stratigraphy in 2D and 3D logs (pages 122 and 125) Does it look like the downhole stratigraphy intervals are entered correctly? Are the formations consistent in order between the wells?
6. Create a stratigraphy model (page 157), and include your 3D logs with the output diagram. Does it look like the surfaces accurately represent your stratigraphic contacts? You can expand the Stratigraphy Model heading in RockPlot3D to turn on/off formations and to drill down to individual surfaces. If you have problems getting the surfaces to honor the data, check your Project Dimensions node spacing, check your data (insert pinchouts?), try a different algorithm, and fiddle with some of the other gridding options.
7. Create other stratigraphic diagrams. If the stratigraphy model does a good job representing your units, you can create your cross sections, profiles, etc., using the same grid models: turn Interpolate Surfaces *OFF* so that the program won't keep regridding the formations.

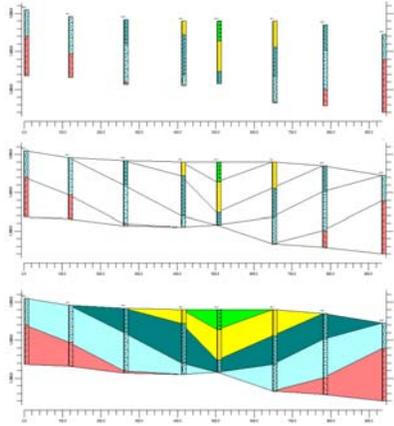


Help Tutorial: Borehole Manager / Create Stratigraphy Models and Diagrams

## Non-Interpolated Stratigraphy Diagrams

These “straight” diagrams are generated with no interpolation (gridding). Instead, like formations between adjacent boreholes are simply connected with straight lines. These offer quick cross section and fence diagram views without the complication of gridding.

## “Straight” Stratigraphic Cross Sections

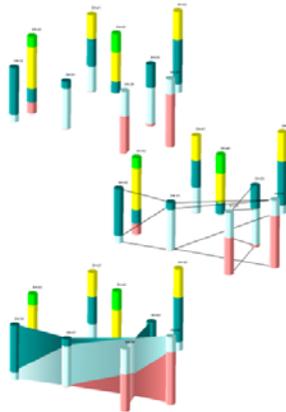


Use the Borehole Manager's **Stratigraphy / Section / Straight** tool to create a 2-dimensional (flat) vertical multi-panel profile of a multiple stratigraphic layers read from the Stratigraphy data tabs, between multiple points in the study area. The panel endpoints must coincide with borehole locations. The section's layers can be color- or pattern-filled, and striplogs can be appended.

Unlike the Modeled section, the Straight section correlations will simply be drawn as straight lines between like formations in adjacent boreholes. Sections can be hung on a specified stratigraphic unit; see below. A map illustrating the section location can be requested.

- ? See page 205 for information about drawing the section slice.  
See page 157 for creating “modeled” sections based on grid surfaces.  
See page 119 for the **Striplogs** menu tools if you only want to display stratigraphy logs in 2D or 3D, individual logs or multiple wells.
- ? Help Contents: Borehole Manager/ Stratigraphy Tools / Profiles, Sections, Fences / Creating Straight Stratigraphy Sections.

## Straight Stratigraphic Fence Diagrams



There are two tools in the Borehole Manager **Stratigraphy** menu for creating fence diagrams based on straight-line (non-interpolated) contacts:

**Stratigraphy / Fence / Straight**

**Stratigraphy / Fence (ESRI-Format) / Straight**

Fence panel spacing can be regular (in a variety of configurations), or you can draw your own panels. The stratigraphy will be color-coded based on the formation's background color in the Stratigraphy Types Table. 3D striplogs can be included and a map illustrating the panel locations can be requested. Unlike Modeled fences (page 159) the Straight fence correlations will simply be drawn as straight lines between like formations in adjacent boreholes.

- ? See page 206 for information about drawing the fence panels.  
See page 41 for tips about entering your stratigraphy data.  
See page 159 for creating “modeled” fence diagrams based on grid surfaces.

See page 119 for the **Striplogs** menu tools if you only want to display stratigraphy logs in 2D or 3D, individual logs or multiple wells.

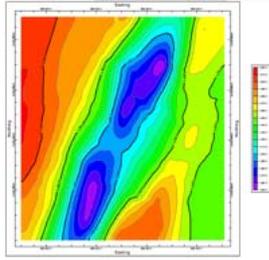
? Help Contents: Borehole Manager / Stratigraphy Tools / Profiles, Sections, Fences

## Interpolated Stratigraphy Structure Maps and Isopachs

The RockWorks **Stratigraphy** menu offers several tools for generating maps that represent your formation structure and isopachs in 2D and in 3D. These tools all rely on grid models to represent the elevations or thickness.

? See also Chapter 7 – Gridding, Contour Maps, and 3D Surfaces.

### Stratigraphy / Structural Elevations / 2D

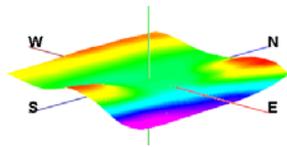


Use the **Stratigraphy / Structural Elevations / 2-Dimensional** tool to create (1) a grid model of the elevations at the top or base surface of a selected stratigraphic unit and (2) a 2-dimensional (flat) contour map representing the grid model. You can choose the gridding method to be used to model the formation elevations. The structure map can include a variety of map layers.

- Be sure to type in a name for the grid model that is created. It will be stored in the project folder and can be manipulated using the RockWorks Utilities **Grid** menu tools.

? Help Contents: Borehole Manager / Stratigraphy Tools / Structure Maps 2D & 3D

### Stratigraphy / Structural Elevations / 3D / One Surface

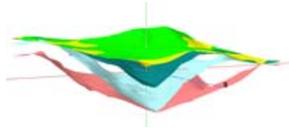


Use this tool to create (1) a grid model of the elevations at the top of a selected stratigraphic unit and (2) a 3-dimensional surface representing the grid model. You can choose the gridding method to be used to model the formation elevations.

- Be sure to type in a name for the grid model that is created. It will be stored in the project folder and can be manipulated using the RockWorks Utilities **Grid** menu tools.
- Once displayed in RockPlot3D you can manipulate the surface style and colors, etc.

? Help Contents: Borehole Manager / Stratigraphy Tools / Structure & Isopach Maps.

## Stratigraphy / Structural Elevations / 3D / All Surfaces

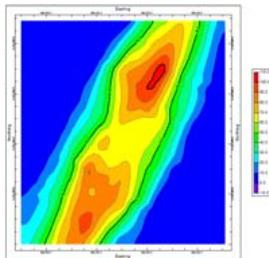


Use this tool to create (1) a grid model of the elevations at the top of all stratigraphic units and (2) 3-dimensional surfaces representing the grid models. You can choose the gridding method to be used to model the formation elevations.

- The grid models are named automatically by the program, using a “*formation.grd*” syntax, where *formation* is the name of the unit as entered into the Stratigraphy Types table.. All of the GRD files are stored in the project folder and should be visible under the Grid Models heading in the Project Manager.
- Once displayed in RockPlot3D you can manipulate the surface styles and colors, etc.

? Help Contents: Borehole Manager / Stratigraphy Tools / Structure and Isopach Maps

## Stratigraphy / Stratigraphic Thickness / 2D (Isopach)

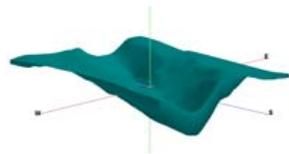


Use this tool to (1) interpolate a grid model for the top and base of the user-selected stratigraphic unit or adjacent units, (2) subtract the lower surface from the upper, resulting in a thickness GRD model, and (3) create a 2-dimensional (flat) contour map representing the thickness model. The "isopach" map can include line contours, color contours, border annotation, and/or labeled cells (representing grid values).

If you want the program to save on disk the grid model of formation thickness, be sure to insert a check in the *Save Grid* box and enter a grid file name.

? Help Contents: Borehole Manager / Stratigraphy Tools / Structure & Isopach Maps

## Stratigraphy / Stratigraphic Thickness / 3D



Use this tool to (1) interpolate a grid model for the top and base of the user-selected stratigraphic unit or adjacent units, (2) subtract the lower surface from the upper, resulting in a thickness GRD model, and (3) create a 3-dimensional image which represents the thickness grid model. The completed image will be comprised of a surface representing the formation's top, a surface representing the formation's base, and enclosing sides.

- The grid models are named automatically by the program, using a “*formation\_top.grd*” and “*formation\_base.grd*” syntax, where *formation* is the name of the unit as entered into the Stratigraphy Types table.. All of the GRD files are stored

in the project folder and should be visible under the Grid Models heading in the Project Manager.

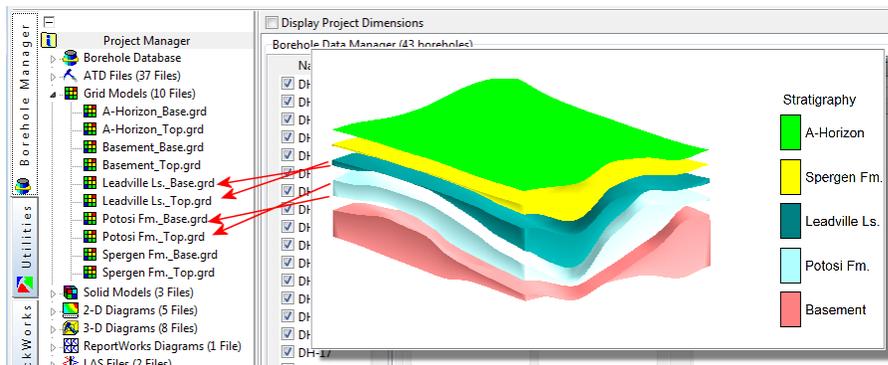
! In RockPlot3D the program will display the computed volume and mass of the selected formation. In order for these computations to be accurate, be sure that your depth units are the same as your X,Y units (such as feet) so that the cubic volume (as in ft<sup>3</sup>) makes sense. In addition, the mass computation is based on the density per cubic unit as declared in your Stratigraphy Types Table.

? Help Contents: Borehole Manager / Stratigraphy Tools / Isopach Maps 2D & 3D.

## Interpolated Stratigraphy Models and Diagrams

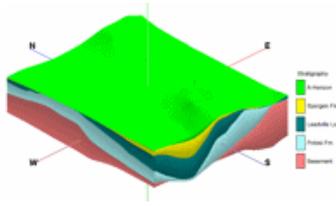
The RockWorks **Stratigraphy** menu offers several tools for generating models that represent your formation structure, for display as 3D models and fence diagrams, as 2D profiles and sections, and as geology maps. For each formation the program will generate a grid model for the upper surface and a grid model for the base surface.

The grid models that are generated to represent the formation surfaces are named automatically by the program, using a “*formation\_top.grd*” and “*formation\_base.grd*” syntax, where *formation* is the name of the unit as entered into the Stratigraphy Types table.. All of the GRD files are stored in the project folder and should be visible under the Grid Models heading in the Project Manager. The example below shows an “exploded” view of a stratigraphy model (in which the formations are separated by blank space) and the grid models that were created to represent the surfaces.



? See Chapter 7 for more details about gridding.

## Stratigraphic Models



Use the Borehole Manager's **Stratigraphy / Model** tool to create a 3-dimensional surface diagram that illustrates stratigraphic layers. The stratigraphy layers will be color-coded based on the formation's background color in the Stratigraphy Types Table.

This process involves the interpolation of a grid model for the upper and lower surface of each of the stratigraphic units using the user-selected gridding method. These grid models will be stored in the project folder.

The completed diagram will be displayed in a RockPlot3D window, with formation upper surfaces, lower surfaces, and side panels. Volume and mass of each formation will be displayed in the RockPlot3D window.

The program offers optional creation of a 3D solid model representing the stratigraphy grid models layered from the bottom up, for use with other analysis tools.

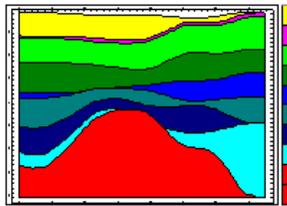
- ! Insert a check in the Save Model option if you want the program to store on disk a numeric 3-dimensional solid model, with voxel nodes representing stratigraphy type.

Use a ".mod" file name extension for the solid model file. RockWorks will not use this MOD file when displaying the stratigraphic surfaces in RockPlot3D at this time; it will instead display the grid surfaces. But, you may still want to store the model on disk for later filtering, volumetric computations, etc., and later 3D display with the RockWorks Utilities **Solid** menu tools.

If you have requested a stratigraphic solid model, it will be initialized using the current project dimensions. RockWorks will then "insert" each formation's surface into the solid model, by assigning the voxel the integer "G" value listed in the Stratigraphy Types Table. The program will store this stratigraphic solid model file on disk using the file name you requested. You can use this for volume computation (page 161).

- ? Help Contents: Borehole Manager/ Stratigraphy Tools / Creating 3D Stratigraphic Models and Diagrams

## Stratigraphic Profiles



Use the Borehole Manager's **Stratigraphy / Profile** tool to create a 2-dimensional (flat) vertical profile of a multiple stratigraphic layers read from the Stratigraphy data tabs, between any two points in the study area. The profile layers can be color- or pattern-filled. During the process of building the profile, the program will create a grid model for each of the active stratigraphic layers using the user-selected gridding method; or existing grid models can be used if no new interpolation is desired.

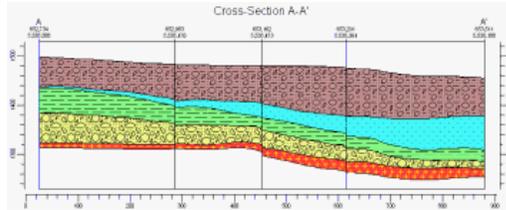
Striplogs can be appended, and any inclined/deviated wells will be projected onto the slice, honoring true well geometry. A map of the profile location can be created automatically. There is also an option to create multiple, parallel profiles automatically.

- ! Un-check the *Interpolate Surfaces* check-box if the grid models already exist in the project folder and don't need to be interpolated again. This can be a handy way to include GRD files that are the result of editing/filtering/other operations (page 209) .

See page 203 for information about drawing the profile slice.

- ? Help Contents: Borehole Manager/ Stratigraphy Tools / Profiles, Sections, Fences

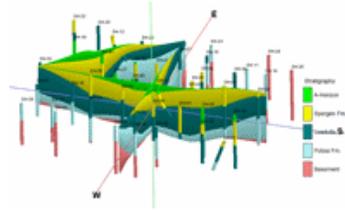
## Interpolated Stratigraphic Cross Sections



Use the Borehole Manager's **Stratigraphy / Section / Modeled** tool to create a 2-dimensional (flat) vertical multi-panel profile of a multiple stratigraphic layers read from the Stratigraphy data tabs, between multiple points in the study area. The panel endpoints can be anywhere within the project area – they don't need to coincide with borehole locations. The section's layers can be color- or pattern-filled. During the process of building the section, the program will create a grid model for each of the active stratigraphic layers using the user-selected gridding method; or existing grid models can be used if no new interpolation is desired. You can request generation of a map illustrating the section panel locations.

- ! Un-check the *Interpolate Surfaces* check-box if the grid models already exist in the project folder and don't need to be interpolated again. This can be a handy way to include GRD files that are the result of editing/filtering/other operations (page 209) .
- ! Striplogs can be appended. However, note that in cross-sections, logs are always displayed as vertical. If your wells are inclined or deviated, this will be accurately represented in the interpolation panels, but not in the logs. If you need non-vertical logs displayed in a section view, you should opt for a Profile diagram, above, which will honor true well geometry.
- ? See page 153 for creating "straight" sections using no interpolation.  
See page 159 for interpolated sections in 3D.  
See page 205 for information about drawing the section slice.
- ? Help Contents: Borehole Manager/ Stratigraphy Tools / Profiles, Sections, Fences

## Interpolated Stratigraphic Fence Diagrams – RockPlot3D and ESRI Shapefile Output



There are two tools in the Borehole Manager **Stratigraphy** menu for creating fence diagrams based on interpolated stratigraphic surfaces:

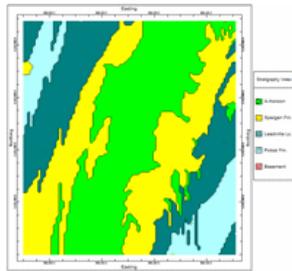
- **Stratigraphy / Fence / Modeled**
- **Stratigraphy / Fence (ESRI-Format) / Modeled**

Fence panel spacing can be regular (in a variety of configurations), or you can draw your own panels. The stratigraphy will be color-coded based on the formation's background color in the Stratigraphy Types Table. During the process of building the fence panels, the program will create a grid model for the upper and lower surface of each of the active stratigraphic layers using the user-selected gridding method; or existing grid models can be used if no new interpolation is desired.

3D striplogs can be appended, and a map illustrating the fence panel locations can be requested.

- ! Un-check the *Interpolate Surfaces* check-box if the grid models already exist in the project folder and don't need to be interpolated again. This can be a handy way to include GRD files that are the result of editing/filtering/other operations (page 209) .
- ? See page 206 for information about drawing the fence panels.  
See page 153 for fences drawn with straight-line panels (not interpolated)
- ? Help Contents: Borehole Manager/ Stratigraphy Tools / Profiles, Sections, Fences / Creating Interpolated Stratigraphic Fence Diagrams

## Surface-Based Stratigraphy Geology Maps



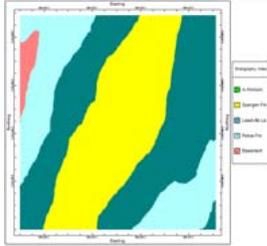
Use the Borehole Manager's **Stratigraphy / Surface Map** tool to create a 2-dimensional map representing the stratigraphy where it intersects a designated surface, typically the surface topography. In other words, it creates a geological map based on downhole stratigraphic data. The process involves creating a stratigraphic model for the study area, storing it as a temporary solid model (MOD), and determining the intersection of the different formations with a user-specified surface model. This is stored as a RockWorks grid model (GRD), and the map is displayed in the RockPlot2D window. Strat types are represented with colors and/or patterns, with a variety of options.

- You need to be sure that the dimensions and node density of the grid model onto which the model is projected matches the current project dimensions.

- Use the RockPlot2D **Export** / **RockPlot3D** tool to drape the surface stratigraphy map over a grid model and display it in 3D.

? Help Contents: Borehole Manager/ Stratigraphy Tools / Stratigraphic Geology Maps

## Horizontal Stratigraphy Geology Maps

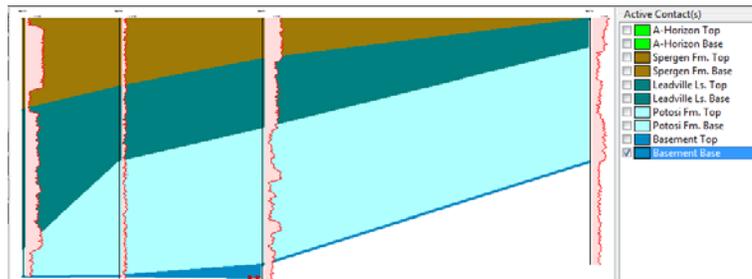


The Borehole Manager's **Stratigraphy / Plan Map** tool is used to create a 2-dimensional map representing the stratigraphy along a horizontal slice, at a specified elevation. This is stored as a RockWorks grid model (GRD), and the map is displayed in the RockPlot2D window. Strat types are represented in the map with colors and/or patterns, with a variety of options.

? Help Contents: Borehole Manager/ Stratigraphy Tools / Stratigraphic Geology Maps

## Stratigraphy Data Tools

### Pick Stratigraphic Contacts



Use the Borehole Manager's **Stratigraphy / Pick Contacts** tool to determine depths to stratigraphic tops (and bases) from geophysical, raster, lithology, or other log data.

This is one of the most powerful tools in this program since it lets you visualize existing lithology blocks or geophysical curves in a 2D display, and then point-and-click to pick the stratigraphic contacts. The contact depths are recorded in the project's Stratigraphy tabs.

! This tool will assign formation depths assuming vertical boreholes. If your boreholes are deviated, you may need to eventually edit by hand the picked formation depths, based on how the stratigraphic surfaces or log intervals look when displayed in diagrams that can accommodate the borehole's deviated downhole trace.

We encourage you to follow very carefully the steps listed in the How To section of the Help messages which are summarized below.

1. Enter your known data: Typically this would be lithology intervals down the hole, or

geophysical (elog) measurements.

2. **Build a log section:** This is not required, but it's helpful to be sure your data is good, for setting up the proper section alignment, for viewing the known data to be picked from, and for determining the formations that are present.
3. **Create a Stratigraphy Types Table:** With a good idea of the look of the existing downhole lithology or geophysical data, you need to create a "Stratigraphy Types Table" which lists the names of the formations, from the surface downward, that are represented in your project.
4. **Set up the formation picker display:** This should be set up just like the hole to hole section in step 2.
5. **Pick the wells to be displayed:** You can choose the same boreholes as were chosen in step 2, or pick a new selection of wells.
6. **Pick the first formation in the Contact Picker window:** Select the name of the formation to be recorded by inserting a check in its check-box. (You can select a formation base *and* the next unit's top if you want them to be picked simultaneously.) Left-click on each log where that formation's top is displayed. The program will record the depths in the table.  
Note that you can add formation names to the Stratigraphy Types Table while you are in the Contact Picker window.
7. **Pick the next formations:** Select the name of the next formation to be recorded, left-click to pick tops and right-click to pick bases. Continue in this manner for additional formations.
8. **End the session:** Click on the Exit button and discard, save, or adjust-and-save changes.

What next? Now that you have the stratigraphic units defined, use the **Stratigraphy / Model** tool to create a 3-dimensional model of the units. Use the other **Stratigraphy** menu tools to create structural surface maps, isopach maps, etc as described earlier in this chapter.

? Help Contents: Borehole Manager / Stratigraphy Tools / Picking Stratigraphic Contacts

### Fill in Missing Stratigraphy

Use the Borehole Manager's **Stratigraphy / Fill in Missing Stratigraphy** tool to insert missing units into each borehole's Stratigraphy tab, setting them to zero thickness. This relies on the formation order defined in the Stratigraphy Types table and provides a means of adding control for surface interpolation.

! You can opt for creating a backup of the project database before continuing with this operation, which is a very good idea.

? See also: Missing Formations (page 72).

? Help Contents: Borehole Manager / Stratigraphy Tools

## Consolidating Stratigraphy

Use the Borehole Manager's **Stratigraphy / Consolidate** tool to locate identical, contiguous stratigraphic intervals (without regard for any associated comments) and consolidate them into a single interval. This utility is primarily designed for users who are importing data from other programs that store data at uniform intervals.

! You can opt for creating a backup of the project database before continuing with this operation, which is highly recommended.

? Help Contents: Borehole Manager / Stratigraphy Tools

## Exporting Stratigraphy Data to ASCII

Use the Borehole Manager's **Stratigraphy / Export / ASCII XYZ File** tool to export stratigraphy depth, elevation, or thickness data for each borehole to an ASCII (Text) XYZ file. The resulting file will contain the X and Y location coordinates for the formation contact in each borehole (taking into account any boring deviation or inclination), and the selected depth, upper elevation, lower elevation, or thickness. (Thickness is drilled thickness, as recorded in the Stratigraphy tab, not grid-based thickness.) This file can be imported into the RockWorks Utilities datasheet or into other applications, or opened automatically into the default Windows text editor (such as Notepad).

Output window: ASCII XYZ file representing observed depth, upper elevation, base elevation, or thickness.

! To load this exported file into the RockWorks Utilities datasheet, follow these steps: Click on the RockWorks Utilities tab, choose **File / New Datasheet**, select the "Generic XYZ" format for the layout, and use the **File / Import / Into RockWorks Utilities / ASCII** option to import the text file into the data window.

? Help Contents: Borehole Manager / Stratigraphy Tools / Exporting Stratigraphy Data

## Exporting Stratigraphy Thickness to the Utilities Datasheet

Use the Borehole Manager's **Stratigraphy / Export / Hanson Aggregates** tool to export to the RockWorks Utilities datasheet a listing of the thickness of all stratigraphic units of all boreholes.

The list will contain the name of the borehole, the name of the unit, the unit thickness, and a blank Key column. The latter is for subsequent classification use within non-RockWare software.

? Help Contents: Borehole Manager / Stratigraphy Tools / Exporting Stratigraphy Data

## Stratigraphy Computation Tools

### Stratigraphic Volume Reports (Solid Model)

Use the Borehole Manager's **Stratigraphy / Volumetrics (Based on Solid Model)** tool to read a saved stratigraphic solid model and compute the total volume or mass for each stratigraphic layer as a function of the relative depth/elevation. The resulting computations are displayed in the RockWorks Utilities datasheet.

**Input:** This tool reads data from an existing stratigraphic solid model (MOD file) created if Save Model is checked in the **Stratigraphy / Model** menu item (page 156).

**Output window:** RockWorks Utilities datasheet

- You can select from the following results: Nodes, Volume, Mass, or Percent.. Nodes reports the numbers of nodes of each stratigraphic type at each elevation slice. Volume will be reported in cubic units (typically meters or feet, depending on your X, Y, and depth/elevation units). If you select the Mass option, these computations are based on the Density Factor declared in the current Stratigraphy Types Table which declare mass per cubic unit. Percent represents the percent volume of each stratigraphy type at each elevation level. Multiple units can be selected.
- Because this is based on a voxel model, the vertical spacing of the model nodes (defined in the Project Dimensions) will have a large effect on the resulting volume computations.

? Help Contents: Borehole Manager / Stratigraphy Tools / Creating a Stratigraphic Volume Report

### Stratigraphic Volume Reports (Grid Models)

Use the Borehole Manager's **Stratigraphy / Volumetrics (Based on Grid Models)** tool to compute volume of each unit as determined by the grids that are generated during by **Stratigraphy / Model** program. Because it is not solid-model-based, this eliminates the need to adjust the solid model z-spacing (voxel height) for optimum accuracy. The resulting computations are displayed in the RockWorks Utilities datasheet.

**Input:** This tool reads data the grid models (GRD) that are created for each stratigraphic unit via the **Stratigraphy / Model** menu item (page 157).

**Output window:** RockWorks Utilities datasheet

- You can request both Volume and Mass. Volume will be reported in cubic units (typically meters or feet, depending on your X, Y, and depth/elevation units). If you select the Mass option, these computations are based on the Density Factors declared in the current Stratigraphy Types Table which declare mass per cubic unit.

? Help Contents: Borehole Manager / Stratigraphy Tools / Creating a Stratigraphic Volume Report

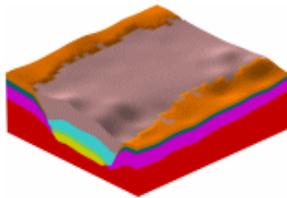
## Advanced Stratigraphy Topics

The RockWorks Utilities **Grid** menu contains a number of tools that you can use to edit, filter, and otherwise modify existing GRD files in your project. There are also tools for importing grid models from other sources. (The **Grid** menu options are discussed on page 209 of this book.) You may find these tools handy for fine-tuning your stratigraphic models which are generated in the Borehole Manager. If you modify any of the stratigraphic surfaces and wish to generate a new 3D model display, for example, you have a couple of choices:

1. Run the **Stratigraphy / Model** option and turn OFF the *Interpolate Surfaces* option. RockWorks will read the existing GRD files for the model and simply recreate the diagram.
2. Use the RockWorks Utilities **Grid** menu options to build a new diagram from a list of GRD file names.

Please visit the RockWare website for RockWorks Case Studies concerning advanced stratigraphy modeling tools. Simply go to [www.rockware.com](http://www.rockware.com), access the RockWorks page, expand the Support section to the left, and click on Case Studies.

## Manually Building 3D Stratigraphic Diagrams



The RockWorks Utilities **Grid / Grids** -> **Stratigraphic Model** tool is used to create a 3D stratigraphic model diagram based on a list of existing grid models that represent the top ("superface") and base ("subface") of each unit. These are grid models that must already exist on your computer.

This program is designed for two types of applications:

- Users who have created their grid models within other applications (e.g. ModFlow, Surfer) and wish to use RockWorks to create stratigraphic (or hydrostratigraphic) diagrams.
- Users who have created their grid models within the Borehole Manager portion of RockWorks but need more flexibility in dealing with stratigraphic relationships (e.g. special manipulations with the grids).

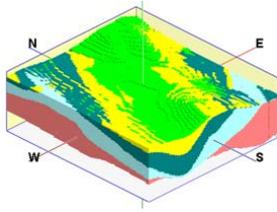
This is a "manual" way of creating the kind of stratigraphic model that's available in the Borehole Manager's **Stratigraphy / Model** tool.

Datasheet: RockWorks Utilities. This tool reads a "stratigraphy gridlist" data file (page 90).

Notes: Be sure the grid models that are listed in the datasheet actually exist in the current project folder. Use the "cutoff" setting to erode thin layers.

- ? Help Contents: RockWorks Utilities/ Grid Model Tools / Stratigraphic Tools / Manually Building 3D Stratigraphic Diagrams

## Manually Building 3D Stratigraphic Solid Models



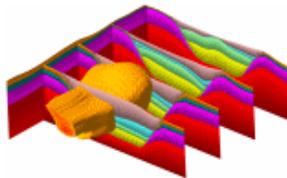
The RockWorks Utilities **Grid / Grids -> Solid** tool is used to create a 3D stratigraphic solid model (\*.MOD) based on a list of existing grid models that represent the top ("superface") and base ("subface") of each unit. This program is similar to **Grids -> Stratigraphic Model** except that this program creates a numeric solid model (that can be subsequently manipulated) whereas the **Grids -> Stratigraphic Model** program just creates a diagram.

- The grid models must already exist on your computer.
- The grid models must match the XY dimensions and node density of the current project dimensions.

Datasheet: RockWorks Utilities. This tool reads a "stratigraphy gridlist" file (page 90).

? Help Contents: RockWorks Utilities/ Grid Model Tools / Stratigraphic Tools / Manually Building 3D Stratigraphic Solid Models

## Manually Building 3D Stratigraphic Fences



The RockWorks Utilities **Grid / Grids -> Stratigraphic Fence** tool is used to create a stratigraphic fence diagram based on a list of existing grid models that represent the top ("superface") and base ("subface") of each unit. These are grid models that must already exist on your computer. You may request regular fence panel spacing, in a variety of configurations, or you can draw your own panels.

This program is designed for two types of applications:

- Users who have created their grid models within other applications (e.g. ModFlow, Surfer) and wish to use RockWorks to create stratigraphic (or hydrostratigraphic) fence diagrams.
- Users who have created their grid models within the Borehole Manager portion of RockWorks but need more flexibility in dealing with stratigraphic relationships (e.g. special manipulations with the grids).
- This is a "manual" way of creating the kind of stratigraphic fence that's available in the Borehole Manager's **Stratigraphy / Fence / Modeled** tool.

Datasheet: RockWorks Utilities. This tool reads a "stratigraphy gridlist" data file (page 90).

Notes: Be sure the grid models that are listed in the datasheet actually exist in the current project folder. Use the "cutoff" setting to erode thin layers. See page 206 for information about drawing the fence panels. The example shown above has been combined with a 3D plume isosurface.

? Help Contents: Borehole Manager/ Grid Model Tools / Stratigraphic Tools / Manually Building 3D Stratigraphic Fences

## Importing Stratigraphic Contacts from Grids into Stratigraphic Logs

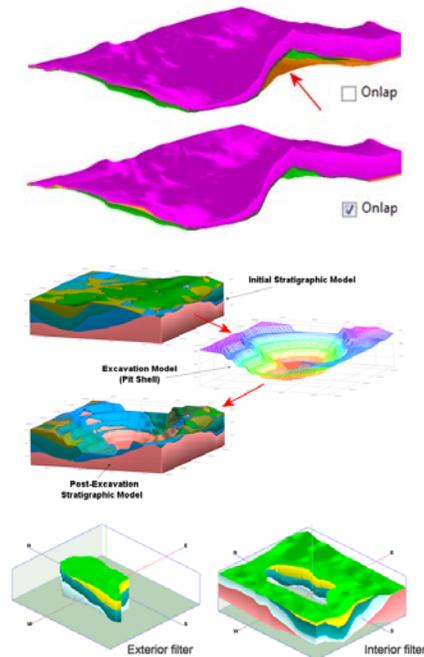
Given a list of grid models, the RockWorks Utilities **Grid / Grids -> Stratigraphic Logs** program will define (or redefine) the contacts within existing stratigraphic logs based on the contents of a list of one or more stratigraphic surface models. Sample applications include: Interpolating elevations for missing contacts within borehole files (e.g. lost circulation intervals), estimating what a log might look like before the borehole is drilled (i.e. prediction).

Caveats: Items within the datasheet "Unit" column must already exist within the project's Stratigraphy Types Table. This program only works with vertical boreholes.

? Help Contents: RockWorks Utilities / Grid Model Tools / Grid Stratigraphic Tools

## Stratigraphy Modeling Options

In addition to all of the gridding options that are discussed on page 140, there are several modeling options specific to stratigraphy modeling.



**Onlap:** This option "fixes" stratigraphy models in which portions of an upper unit extend below the base of a lower unit. The sequence of formations within the Stratigraphy Types Table must be listed correctly from top to bottom (i.e. the younger formations at the top and the lower formations at the base), and there must be good control at the base of the model.

**Constrain Model Based on Ground Surface:** This option lets you constrain your stratigraphic model with another surface, such as a ground surface grid, pit excavation grid, etc.

**Polygon Filter:** Clips stratigraphic surfaces inside or outside a user-defined polygon.

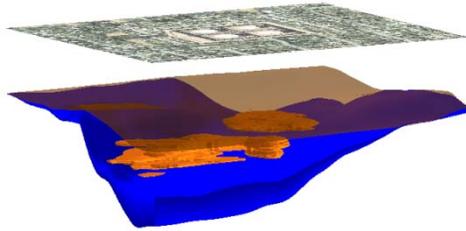
? Help Contents: Reference / Stratigraphy Modeling Reference

# Chapter 9 – Modeling Water Levels

## Topics

Overview .....	167
Typical Workflow .....	167
Interpolated Aquifer Diagrams .....	168
Exporting Water Level Data .....	170

## Overview



Aquifer water level depths are entered into the Borehole Manager Water Levels tab. This table allows you to also enter the date on which the sampling was taken, so that a single borehole can have multiple water levels listed.

You can use the tools in the Borehole Manager **Aquifer** menu to create models of these water surfaces for a specific date or

date range, and to visualize them as 2D profiles, sections and plan maps, and as 3D surface diagrams and fences. These can be particularly useful when combined with other 2D and 3D diagrams of your project.

The water levels are modeled using surface modeling (gridding) tools.

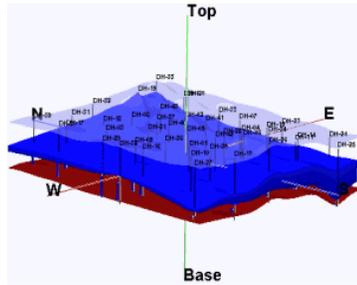
- ! Use the water level grid models to constrain T-Data models for samples taken the same date. (See page .)
- ? Refer back to Chapter 7 for more details about the process of gridding.

## Typical Workflow

1. Enter your borehole locations and water level data (pages 38 and 47)
2. Establish your Project Dimensions (page 100).
3. Create a borehole location map to verify well locations (page 110)
4. Display your aquifer levels in 2D and 3D logs (Chapter 5)
5. Create an Aquifer Model (below)
6. Create other Aquifer diagrams

## Interpolated Aquifer Diagrams

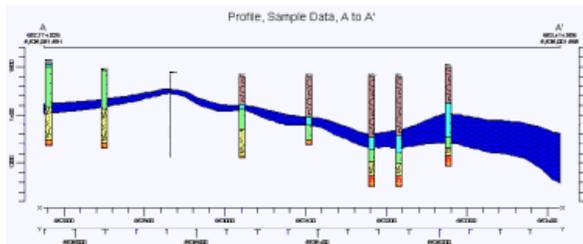
### 3D Aquifer Model



The Borehole Manager's **Aquifers / Model** tool creates a 3-dimensional diagram that illustrates a selected aquifer layer at a particular date or over a specified date range. The layers will be displayed in the color of your choice. During the process of building the 3D diagram, the program will create a grid model for the upper and lower surface of the aquifer using the user-selected gridding method. These grid models will be stored in the project folder.

The completed diagram will be displayed in a RockPlot3D window, with the upper surface, lower surface, and side panels. Volume of the aquifer will be displayed. The aquifer block can be combined with other 3D diagrams, such as the stratigraphy block diagram above. The grid models that make up the model will be named: “*date\_top.grd*” and “*date\_base.grd*.”

### Aquifer Profile Diagram

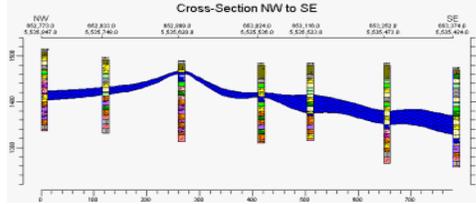


The Borehole Manager's **Aquifers / Profile** tool creates a 2D vertical profile of a single aquifer listed for a particular date or date range in the Water Levels tab. The profile can be drawn between any two points in the study area. The profile can be color- or pattern-filled. Striplogs can be projected onto the panel plane, and true well orientation will be honored. During the process of building the profile, the program will create a grid model of the upper and lower surface of the aquifer using the user-selected gridding method. You can request an automatic map representing the location of the profile cut. There is an option to create multiple, parallel profiles automatically.

! The grid models will be named automatically: “*date\_top.grd*” and “*date\_base.grd*.”

? See page 203 for information about drawing the profile slice.

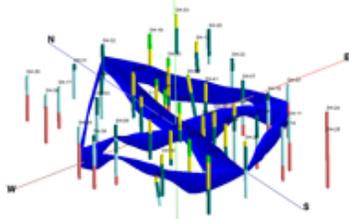
## Aquifer Section Diagram



Use the Borehole Manager's **Aquifers / Section** tool to create a 2D vertical multi-panel profile of a single aquifer listed for a particular date or date range in the Water Levels tabs. The panel endpoints can be anywhere within the project area. The profile can be color- or pattern-filled. During the process of building the section, the program will create a grid model of the upper and lower surface of the aquifer using the user-selected gridding method. A map representing the section location can be created automatically.

- ! Striplogs can be appended. However, note that in cross-sections, logs are always displayed as vertical. If your wells are inclined or deviated, this will be accurately represented in the interpolation panels, but not in the logs. If you need non-vertical logs displayed in a section view, you should opt for a Profile diagram, above, which will honor true well geometry.
- ! The grid models will be named automatically: “*date\_top.grd*” and “*date\_base.grd*.”
- ? See page 205 for information about drawing the section slice.
- ? Help Contents: Borehole Manager / Aquifer Tools / Creating Aquifer Sections

## Aquifer Fence Diagram

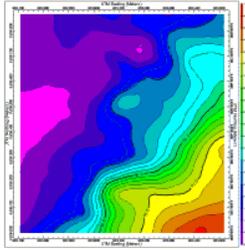


The Borehole Manager's **Aquifers / Fence** tool creates a 3-dimensional fence diagram that illustrates the aquifer at a selected date or date range. You may request regular panel spacing, in a variety of configurations, or you can draw your own panels. During the process of building the fence panels, the program will create a grid model for the upper and lower surface of the aquifer layers using the user-selected gridding method. 3D logs can be appended, and you can request a map representing the fence panel locations.

The completed fence diagram will be displayed in a RockPlot3D window, where you can manipulate the image and append other 3D images.

- ! The grid models will be named automatically: “*date\_top.grd*” and “*date\_base.grd*.”
- ? See page 206 for information about drawing the fence panels.
- ? Help Contents: Borehole Manager / Aquifer Tools / Creating a Water Level Fence Diagram

## 2D Aquifer Surface or Thickness Map



The Borehole Manager's **Aquifers / Plan** tool creates a 2-dimensional (flat) contour map of the aquifer surface, base, or thickness for a particular date or date range. During the process of building the contour map, the program will create a grid model for the upper and lower surfaces of the aquifer, and of the aquifer thickness, using the user-selected gridding method. The grid models will be stored as ".grd" files on disk.

- ? Help Contents: Borehole Manager / Aquifer Tools / Creating a 2D Aquifer Surface or Thickness Map

## Exporting Water Level Data

The Borehole Manager's **Aquifer / Export** tool exports water level depth, elevation, or thickness data for each borehole for a selected date or date range to an ASCII (Text) XYZ file.

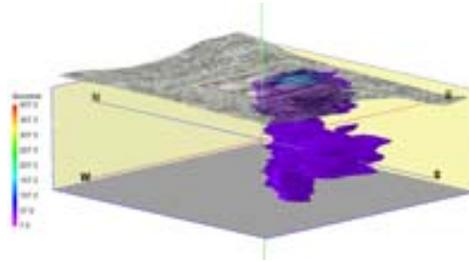
- ? Help Contents: Borehole Manager / Aquifer Tools / Exporting Water Level Data

# Chapter 10 – Solid Modeling

## Topics

- Overview ..... 171
- What Can I do with a Solid Model? ..... 172
- Solid Modeling Methods..... 174
- Solid Model Dimensions..... 175
- General Solid Modeling Options ..... 176
- Solid Model 3D Diagram Options ..... 178
- Solid Models – How to Create Them..... 180

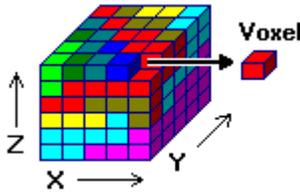
## Overview



In the last 3 chapters we’ve discussed the process of gridding, by which data samples that have an X and Y coordinate and a measured value of some kind (elevations, concentrations) can be interpolated into a continuum of values. This interpolation technique can be applied to any XY spatially-distributed data, including stratigraphic and water level elevations. Gridding = Surface Modeling.

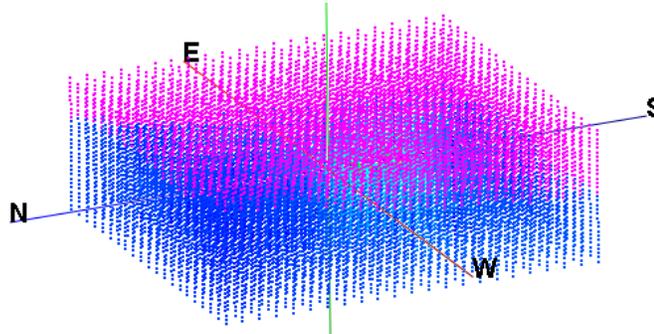
Now it’s time to add another dimension to the modeling for data types that have more than one measured value for any XY location, such as multiple Gamma measurements or gold assay values downhole.

Solid modeling is a true 3-dimensional gridding process, used to create a 3-dimensional array of regularly-spaced nodes from your irregularly-spaced data. For known X, Y, and Z points in space (such as depths along boreholes) the program can interpolate measured values such as geochemistry, geophysical measurements, even lithology types, or any other downhole or subsurface quantitative value, across the project area.



A solid model is a computer file of numbers that contains the results of the solid modeling process. It contains a listing of the X, Y, and Z location coordinates of the regularly-spaced 3D nodes (which we call “voxels”), and the interpolated “G” value at each node. We use the letter “G” to denote the voxel value; it originally represented “Grade” in mining applications but can also represent concentrations, counts, etc. Solid model files are stored in the project folder and have a “.MOD” file name extension.

Using the Project Dimensions X, Y, and Z minimum and maximum values to dimension your project area, the program then initializes the regularly-spaced voxels using the X, Y, and Z spacing settings.



The G value is then estimated based on the G value of the given data points.

There are several methods offered to do this interpolation of your data. Each operates differently, and each has strengths and differences. These are discussed shortly.

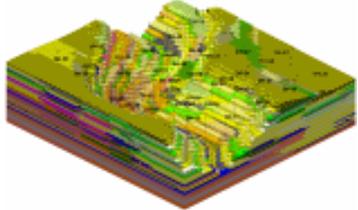
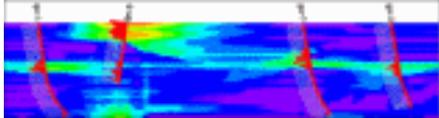
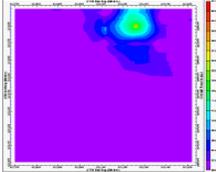
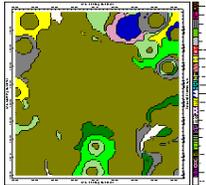
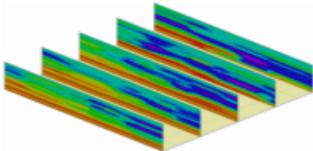
#### Menu Items (and Data Source)

- The RockWorks Utilities **Solid / Model** tool creates solid models from X, Y, Z, and G data listed in the Utilities datasheet or in an external ASCII file.
- The Borehole Manager **Lithology, I-Data, T-Data, P-Data, Fractures, and Vectors** menus create solid models from lithology, interval- or point-sampled quantitative data, fracture or vector data in the respective datasheets.

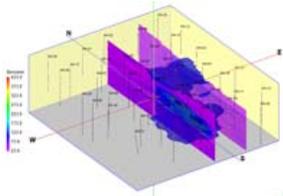
## What Can I do with a Solid Model?

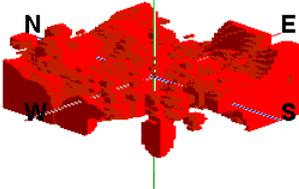
Once you have a solid model (or “.MOD”) file created, illustrating the distribution of your geochemistry, geophysical measurements, lithology, or other measured values, it can be used in a variety of ways:

#### **View it:**

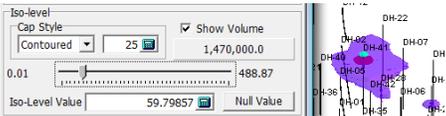
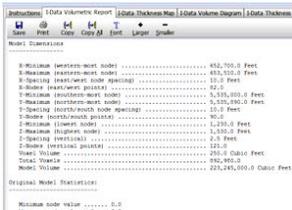
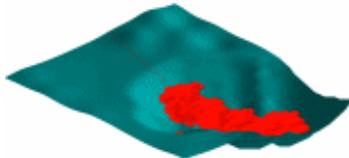
<p>Illustrate it as a 3-dimensional voxel or isosurface diagram, as in this 3D lithology voxel diagram</p>	
<p>Display a vertical slice of the model as a 2-dimensional section (multiple slices) or profile (1 slice) as in this 2D geochemistry profile diagram.</p>	
<p>Display a horizontal slice of the model as a 2-dimensions “plan” map, as in this example from a geochemistry model.</p>	
<p>Extract model values where they lie along a surface, as in this example of a lithology “surface map”.</p>	
<p>Display multiple vertical slices of the model as a 3-dimensional fence diagram, as in this example from a p-data model.</p>	

**Manipulate it:**

<p>Use the RockPlot3D window to visually manipulate solid models, setting high and/or low G value nodes to transparent, inserting slices, rotating the display.</p>	
---	--

<p>Use the RockWorks Utilities <b>Solid</b> menu tools to filter models, perform computations on nodes, edit models, and more.</p>	
--	--

**Compute its volume (and mass):**

<p>Volume is automatically computed for the solid models (and updated as filters are applied) when displayed in RockPlot3D.</p>	
<p>Create a detailed volume report of the model after filtering it based on G values, surface polygons, overburden ratios, and more.</p>	 <pre> Model Dimensions ----- X-Maximum (western-most node) ..... 452,700.0 Feet X-Maximum (eastern-most node) ..... 453,700.0 Feet Z-Spacing (east-west node spacing) ..... 10.0 Feet Z-Maximum (southern-most node) ..... 5,331,000.0 Feet Z-Maximum (northern-most node) ..... 5,332,000.0 Feet Z-Spacing (north-south node spacing) ..... 10.0 Feet Z-Minor (horizontal gridline) ..... N/A Z-Maximum (lowest node) ..... 1,250.0 Feet Z-Maximum (highest node) ..... 1,250.0 Feet Z-Spacing (vertical) ..... 2.0 Feet Z-Minor (vertical gridline) ..... 10.0 Voxel Volume ..... 250.0 Cubic Feet Total Volume ..... 850,000.0 Model Volume ..... 223,145,000.0 Cubic Feet  Original Model Statistics ----- Minimum node value ..... 0.0 Maximum node value &gt; 0 ..... 0.0             </pre>
<p>Create a simplified pit design by fitting a grid surface below specified zones of a solid model.</p>	

**Solid Modeling Methods**

There are several methods offered to perform the 3-dimensional interpolation of your data. Each operates differently, and each has strengths and weaknesses.

**Lithology Models**

- **Horizontal Lithoblending:** This is the method that RockWorks uses to interpolate solid lithology models. This is not available for I-Data, T-Data, P-Data, Fracture, or Vector models. The lithblending algorithm assigns the solid model voxel nodes by looking outward horizontally from each borehole in search circles of ever-increasing diameter. It first assigns the voxels immediately surrounding each borehole the closest lithology value. (Lithology “G” values are declared in the active Lithology Table.) It then moves out by a voxel, and assigns the next “circle” of voxels the closest lithology value, effectively “bleeding” the lithology types outward from the wells in a horizontal

fashion. It continues in this manner until the program encounters a voxel that is already assigned.

### All Other Solid Models

- **Closest Point:** The most basic solid modeling method, in which the value of a voxel node is set to be equal to the value of the nearest data point. Honors your control points but can generate models with abrupt changes.
- **Distance to Point:** This method assigns each solid model node a value equal to the distance to the closest control point, thus generating a confidence model based on distance.. The distance is recorded in your X,Y,Z units.
- **Inverse Distance:** This method assigns a voxel node value based on the weighted average of neighboring data points, either all points or those directionally located, using fixed or variable weighting exponents.
  - **Isotropic:** The program will use all of the available data points when computing a voxel node's value, useful when modeling uniformly distributed data in non-stratiform environments. Drawbacks: Highs are concentrated around the boreholes. Weighting exponent = "2".
  - **Anisotropic:** Instead of using all available control points for the Inverse-Distance modeling, the program will look for the closest point in each 90-degree sector around the node, useful for modeling drill-hole based data in stratiform deposits. Tends to connect up highs and lows at the same elevation. Weighting exponent = "2".
  - **Weighting:** Uses all data points, but weights them differently based on their horizontal v. vertical positioning from node. Useful for controlling the lenticularity of the model. Weighting exponent = user-declared.
- **Horizontal Biasing:** This method functions like the Inverse Distance method except that the user can define a vertical distance from each voxel node beyond which points will no longer be used in computing the node value

? [Help Contents: Reference / Solid Model Reference / Solid Modeling Methods](#)

## Solid Model Dimensions

The Model Dimensions options are used to set the boundary coordinates and the number of nodes to be created in the solid model. The more nodes you specify, the denser the model. Remember that a 10-node x 10-node x 10-node model (very low resolution) will contain 1,000 nodes; a 50-node x 50-node x 50-node model will contain 125,000 nodes; and a 100 x 100 x 100 model will contain 1 million nodes. The more computations the program needs to do, the longer the time required to create the model. Denser is not always better. You might start with less-dense models on trial runs. These settings are offered:

**Hardwire Project Dimensions:** Choose this option if the solid model dimensions are to be taken from the current Project Dimensions settings (see page 83). This is generally a good idea, particularly in projects where multiple models are going to be created and may need to undergo comparison, mathematical, and filtering operations (in which all models must be dimensioned the same). Use the **Adjust / Examine Project Dimensions** button to view and/or reset the project's dimensions.

**Variable (Based on Data Coordinates):** Choose this option if the solid model dimensions are to be established based on the current data being modeled. This could be an option for modeling a subset of the entire project or for testing the effect of different node densities without having to reset the entire project's dimensions. You can define the number of nodes to be created along the horizontal axes (W – E and S to N) and along the vertical axis.

? [Help Contents: Reference / Solid Model Reference / Solid Model Resolution](#)

## General Solid Modeling Options

In addition to the modeling methods listed above, there are several other options which can be used to fine-tune the interpolation. These can be grouped into data filters (which act on the source data), modeling options (which are applied during the modeling process) and model constraints (which are applied after the model is interpolated.) Please refer to the help message topics listed at the end of this section for more detailed information, applications, and graphic examples.

- **Data Filters:** These options filter the well data before interpolation begins. You can access these by expanding the “Track” heading in the options windows.
  - **Spatial (XYZ Filtering):** Filters out data points from processing, based on their location in space.
    - **X Filter, Y-Filter, Z-Filter:** You can define a specific coordinate range for any/all of the X, Y, and/or Z axes within which data will be included in the modeling process.
    - **Upper Surface Filter:** Filters out log data that is positioned above a user-defined surface (GRD file). Handy if you wish to process values that were measured within a specific stratigraphic unit, for example.
    - **Lower Surface Filter:** Filters out log data that is positioned below a user-defined surface (GRD file). Note that these surface filters are for the original data; see below for filters that constrain the solid model once it's created.
    - **Remove Duplicates:** Removes duplicate XYZ entries prior to modeling.
  - **Filter based on G Values:** Limits the solid model interpolation to data points with measured values within the specified range.
    - **Discard Low Values, Discard High Values:** These options allow you to define a value threshold below/above which the data point will not be included in the modeling. Helpful to remove null values or erroneous highs.
    - **Replace Low Values, Replace High Values:** These allow you to define a value threshold below/above which the data point will be replaced by a user-defined value. Helpful to generalize highs and/or lows.
  - **Resample at Regularly-Spaced Intervals:** These tools allow you to resample the source data to coarser intervals (i.e. P-Data) to speed processing, or finer intervals (i.e. I-Data) for smoothing. Different options are available for different data types.
    - **Closest Point:** (P-Data) The resampled point will be assigned the value of the closest original point.
    - **Enclosing Interval:** (I-Data, T-Data) The resampled points will use the data value listed for the depth interval within which the resampled interval lies.

- **Weighted Average:** (I-Data, T-Data, P-Data) The resampled points will be a weighted average of nearby values.
  - **Cubic Spline:** (P-Data) Resamples points based on a cubic spline method.
  - **Distance Filter:** Limits resampling to intervals that are within a user-defined downhole-distance from a defined interval. This prevents sparse data from being resampled where it shouldn't be.
  - **Add Additional Control:** Adds dummy points to the source data so that modeling procedures aren't overly influenced by limited high data values. This is handy in situations where zero (or below threshold) values have not been entered into the database, and additional low control is needed.
  - **Declustering:** Averages clumps of points and sends the new, smaller set of averaged points to the modeling routine. When modeling densely-sampled downhole geophysical or geochemical data, this can speed up the processing tremendously, with little degradation of data.
- **Modeling Options:** These options are applied during the modeling process.
    - **Tilted Modeling:** Biases your data modeling with a user-selected direction and dip. Helpful to apply a regional gradient for lithology modeling or other horizontally-biased algorithms.
    - **Warp Model Based on Grid:** Biases your solid model with a grid model (surface). It works much like the tilted modeling, above, except that instead of a dipping (flat) plane, the model is warped based on a user-selected surface (grid) model. Be sure the grid model and the solid model being created have the same X,Y dimensions and node spacing.
    - **Logarithmic:** Helpful for creating solid models of highly anomalous data. The control point G-values are converted to natural logarithms, a solid model is interpolated based on the logarithmic data, and the nodes within the model are then converted back to the original units by exponentiation. Data sets that contain large "outliers" (i.e. values that are far beyond the typical range of data) are typically problematic when the goal is to highlight these anomalous regions. By computing and gridding the natural logarithm of the control point values, the regional effects of these outliers is more localized.
    - **High-Fidelity:** When selected, this option will "tweak" the final solid model (after the smoothing option has been applied) such that the node values will do a better job of honoring the control points, regardless of the algorithm or the smoothing. This is accomplished by modeling the residuals, adding the residuals model to the initial model, and then overwriting the node values with the original control point values. Unlike the grid version of high fidelity, this is not an iterative algorithm (too slow).
    - **Smooth Model:** This tool averages the G-values in the solid model based on a user declared "filter" size. The smoother can be run 1 or more times, to get rid of spurious "noise" within the solid model and bring out regional trends. (This is also available as a filter within the **Solid / Filter** menu.)
  - **Model Constraints:** These filters are applied to the solid model after interpolation is complete.
    - **Upper Surface Grid Filter:** (previously called "stratabound") Sets nodes located above a user-selected grid model (GRD file) or above the borehole tops (automatic) to a user defined value or a null value. This is most commonly used to "hide" those solid model nodes that are located above the ground surface.
    - **Lower Surface Grid Filter:** Sets nodes located below a user-selected grid model (GRD file) or below borehole bases (automatic) to a user-defined value or a null value. This can be used to hide those model nodes that lie below the drillhole bases or below a known stratigraphic boundary surface.

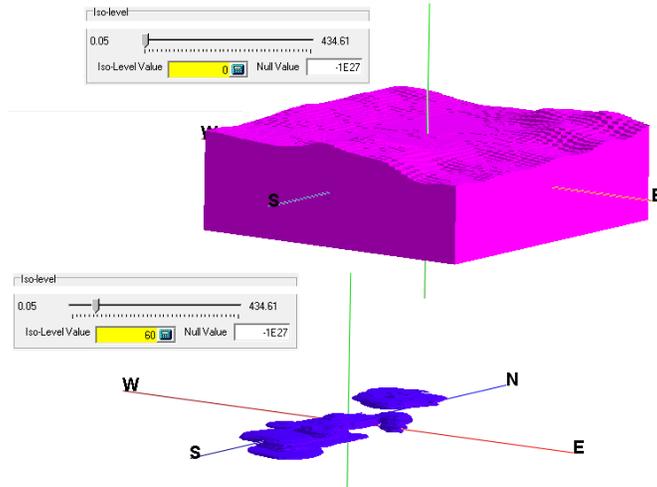
- **Distance Filter:** Sets nodes which are located beyond a user-defined distance from a control point, to a user-specified or null value. This can be a means of expressing confidence in a model.
- **Polygon Filter:** Sets nodes that lie either inside or outside a user-defined polygon to a user-specified value or null value.

? Help Contents: Reference / Solid Model Reference

## Solid Model 3D Diagram Options

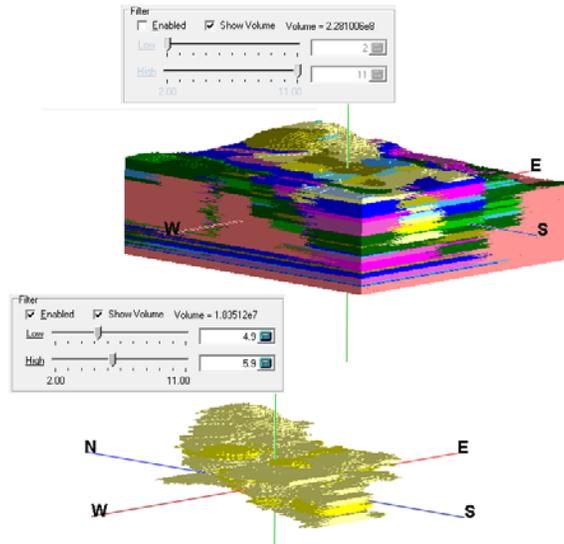
### Diagram Type : Isosurface

In an isosurface diagram, the model's G values are enclosed in a "skin" that can be conceptualized like a 3-dimensional contour. Within RockPlot3D you can interactively adjust the **minimum value** enclosed within the isosurface contour. Real number models (I-Data, T-Data, and P-Data) are generally best displayed as isosurfaces.

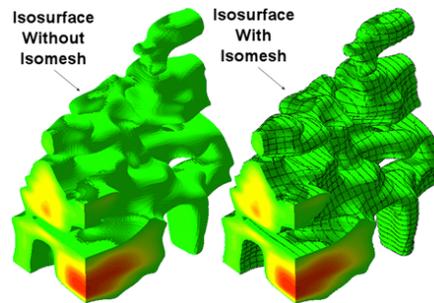


**Diagram Type:**  
**All Voxels**

In an all-voxel diagram, you'll see color-coded voxels themselves, which usually look more angular and blocky than isosurfaces. In RockPlot3D you can adjust both the **minimum and maximum node values** to be displayed. Lithology models should be displayed using an All-Voxel view. Real number models that you need to filter for low or mid-range values can be displayed as All-Voxels.



**Iso-Mesh:** Plots a series of polylines that represent three-dimensional contours at a user-defined cutoff. By plotting these lines in conjunction with an isosurface, a more distinct diagram can be created.



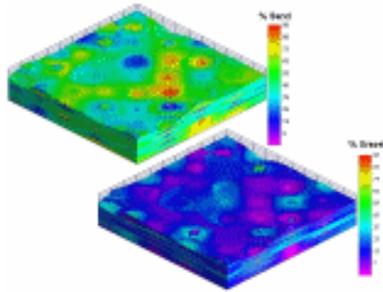
**Plot Logs:** Includes 3D logs of all active boreholes in the 3D diagram. All of the standard 3D log design options are available. (See page 127.)

**Reference Cage:** Includes 3D axis coordinates labels.

**Include Legend:** Includes a color legend for the model.

## Solid Models – How to Create Them

### RockWorks Utilities: Solid / Model



Use the **Solid / Model** tool to read XYZG data from the RockWorks Utilities datasheet and interpolate a solid model of this data. The X (Eastings), Y (Northings) and Z (elevation) coordinates note the sample locations, and "G" represents the measured value to be modeled. G can represent geochemical concentrations, geophysical measurements, etc. A variety of modeling algorithms are available. The solid model will be represented in RockPlot3D as an "isosurface" diagram or as an all-voxel diagram.

Datasheet: RockWorks Utilities "XYZG" file (see 89).

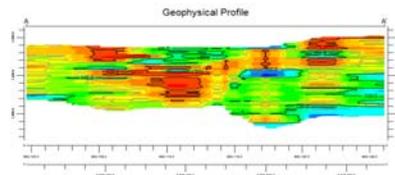
Output: This tool can generate a solid model file (.MOD) and a 3D isosurface or all-voxel diagram.

- ! You can use this tool to create a solid model *and* 3D diagram. Or, you can create a solid model only (e.g. no diagram). Or you can create a 3D diagram from an already-existing solid model (e.g. no new model interpolated).
- ! Use the Project Manager to create a quick voxel or isosurface diagram that illustrates an existing solid model: just double-click on a MOD file name and establish the diagram settings. (See page 107.)
- ? Help Contents: RockWorks Utilities / Solid Model Tools / Creating Solid Models from XYZG Data

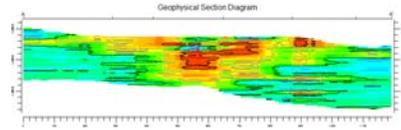
### RockWorks Utilities: Other Solid Menu Diagram Options

Once you have a solid model interpolated and saved in your project folder as a MOD file (using the **Solid / Model** option defined above or using any number of other RockWorks solid model tools), you can use the following **Solid** menu options to display the model as a different type of diagram.

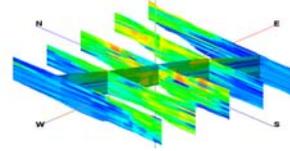
**Solid / Profile:** Reads an existing MOD file and displays a 2D vertical slice of the model between two user-defined points.



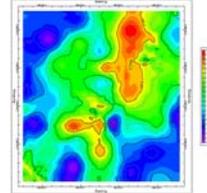
**Solid / Section:** Reads an existing MOD file and displays a series of connected vertical panels as a 2D cross section, drawn along a user-defined path.



**Solid / Fence:** Reads an existing MOD file and displays one or more panels in 3D, at user-defined locations.



**Solid / Plan:** Reads an existing MOD file and displays a 2D horizontal slice of the model at a user-selected elevation.



? See page 203 for information about drawing the profile, section, and fence locations.

? Help Contents: RockWorks Utilities / Solid Model Tools / Creating Solid Model Profile Diagrams, Section Diagrams, Fence Diagrams, Plan-View Diagrams

## Borehole Manager: Solid Modeling Tools

See the following chapters for information about data-specific types of solid modeling in the Borehole Manager:

Lithology modeling: page 183

I-Data, T-Data, P-Data modeling: page 191

Fracture Modeling, Vector Modeling: page 199



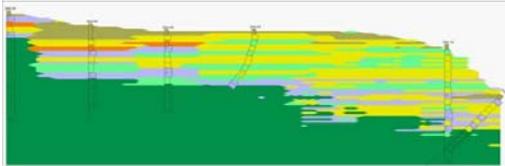
# Chapter 11 - Lithology Modeling

## Topics

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Lithology Computation Tools .....	187
Lithology Data Tools.....	188

## Overview

### What is Lithology?



In RockWorks, Lithology is defined as subsurface intervals of rock or soil types that are not necessarily layered. Lithology materials can repeat within a borehole (sand, clay, sand, clay) and can be listed in any order.

Some background: In its early days, RockWorks only offered interpolation of stratigraphic data. Because Stratigraphy is modeled using surface modeling techniques, this means that a single material, such as "clay" can only be present at one location in a borehole (a single surface can't be in two places in the same hole). This presented a dilemma to users working on localized environmental projects in which subsurface materials weren't organized in any type of layered fashion, or even to users working on larger regional projects in which observed lithologies had not yet been grouped into formational layers. While it is certainly possible to group your subsurface materials in a "sand-1", "clay-1", "sand-2", "clay-2" manner and apply surface modeling techniques to these as distinct layers, we decided it would make more sense to create a new type of data.

So, we introduced the Lithology data type. The Lithology datasheets list depths and observed rock types. Unlike stratigraphy listings, lithology types can repeat, and don't need to be listed in the same order in each boring.

### How is Lithology Modeled?

Lithology is interpolated using solid modeling techniques. (You can refer back to Chapter 10 for general information about the concepts of solid modeling.) The resulting solid model can be sliced vertically (profile, section, and fence diagrams), sliced horizontally (plan map), displayed on a surface, and/or displayed as a 3D block.

Lithology types are stored in the solid model not as words (like "sand") but as integer or real number values, based on the "G" value you have listed for each rock type in the Lithology TypeTable (page 52). For example, "gravel" might be coded with a "1", and "sand" with a "5," for example. In the output diagrams, each lithology is represented using the background color you've selected for its pattern, also in the Lithology Types Table.

There is a specific solid model algorithm, called "horizontal lithoblenning," which is designed to interpolate lithology from depth intervals in borings. This method is different from other solid modeling algorithms in two main ways: The lithology types are "bled" out from the boreholes in a horizontal fashion, and the lithology G values are assigned as-is – no gradation or averaging occurs.

- Optional surface filtering is available to zero-out nodes above a surface model (such as the ground surface) or a stratigraphic unit, and/or below a unit. Additional options include applying a regional tilt to the modeling, as well as warping the lithology model based on a surface. (See Solid Modeling Options on page 175.)
- Once you have the solid model file created, you can use that existing model for future block, fence, profile, section, and plan diagrams. (They can all share the same MOD file without having to recreate it each time; choose Use Existing Model in the diagram's Options window.)

## Typical Workflow

1. Define your lithology material types in your Lithology Types Table (page 52). Be sure the G value for each material is unique – RockWorks will use that value to represent the rock type in the solid model.
2. Enter your borehole locations and lithology data (page 38) or import data (page 63).
3. Establish your Project Dimensions (page 100). For lithology models, be sure the X and Y spacing for the nodes is half the average minimum distance between your boreholes, or closer. Be sure the Z (elevation) spacing of the nodes is no greater than the smallest sampling interval in the Lithology tabs, so that the materials will show up in the model.
4. Create a borehole location map to verify well locations (page 110). Do the well locations look correct (no goofy outliers)?
5. Display your downhole lithology data in 2D and 3D logs (page 119). Does it look like the downhole lithology data is entered accurately? Do you like the patterns and colors you've selected to represent the materials?
6. Create a lithology model (page 185), and include your 3D logs with the output diagram. Does it look like it accurately represents your subsurface materials? Use the RockPlot3D filtering options to view specific lithotypes, and confirm that they coincide with the log data. If some of the lithology types aren't showing up in the model, check the vertical (Z) spacing of the Project Dimensions.
7. Create other lithology diagrams – cross sections, fence diagrams, etc. – using the existing lithology MOD file.

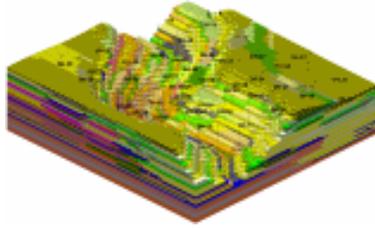
## Lithology Modeling and Display Tools

This section discusses the **Lithology** menu tools which are used to interpolate your lithology materials into a solid model and then display the model as a variety of different types of diagrams.



Help Tutorial: Borehole Manager / Create Lithology Models and Diagrams

## Lithology / Model

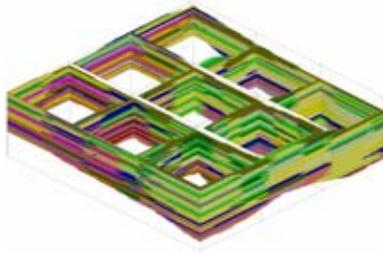


Use the Borehole Manager's **Lithology / Model** tool to interpolate a solid model representing your lithology types (or to read an existing model), and to create a 3-dimensional voxel diagram that illustrates these lithology types. The lithologies will be color-coded based on their background colors in the Lithology Types Table. 3D striplogs can be appended. Once displayed in RockPlot3D, selected lithology types can be displayed and volumes computed.

You can use this tool to create a solid lithology model and 3D diagram. Or, you can create a solid lithology model only (e.g. no diagram). Or you can create a 3D diagram from an already-existing lithology solid model (e.g. no new model interpolated).

- ! Lithology models are displayed as all-voxel diagrams, with each voxel color-coded based on its assigned material type. In RockPlot3D, the patterns you've defined for your lithotypes are not displayed. Instead, it uses the background colors you selected for the lithology.
- ? Help Contents: Borehole Manager / Lithology Tools / Creating 3D Lithology Models

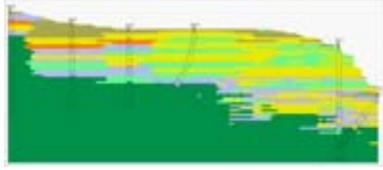
## Lithology / Fence



Use the Borehole Manager's **Lithology / Fence** tool to interpolate a solid model or read an existing model representing lithology and create a 3-dimensional fence diagram that illustrates material types with color-coded panels. You may request regular panel spacing, in a variety of configurations, or you can draw your own panels. 3D logs can be appended.

- ! Choose *Use Existing Model* in the Options window if you already have a good solid lithology model (MOD file) and don't need to re-interpolate. Just browse for the MOD file name in the project folder.
- ! Lithology fence panels will be displayed in 3D using the background colors you selected for the lithology patterns. This is because the RockPlot3D window (and its OpenGL engine) do not support patterns.
- ? See page 203 for information about drawing fence panel traces.
- ? Help Contents: Borehole Manager / Lithology Tools / Creating Lithology Fence Diagrams

## Lithology / Profile

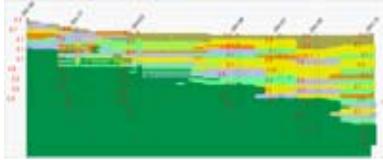


Use this tool to interpolate a solid model, or read an existing model representing lithology, and create a 2-dimensional (flat) vertical profile, between any two points in the study area. Lithology types are represented on the profile panel using patterns and/or colors.

Striplogs can be projected onto the panel plane, and true orientation will be honored. There is an option to create multiple, parallel profiles automatically. You can request generation of a map illustrating the profile slice location.

- ! Choose *Use Existing Model* in the Options window if you already have a good solid lithology model (MOD file) and don't need to re-interpolate. Just browse for the MOD file name in the project folder.
- ? See page 203 for information about drawing profile panel traces.
- ? Help Contents: Borehole Manager / Lithology Tools / Creating Lithology Profile Diagrams

## Lithology / Section

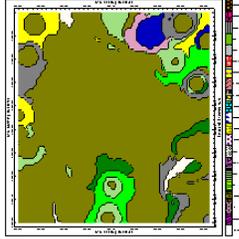


This tool is used to interpolate a solid model or read an existing model representing lithology and create a 2-dimensional, vertical, multi-paneled section of lithology. The section panel endpoints can be drawn anywhere in the study area.

Lithology types are represented on the section panel using patterns and/or colors. You can request generation of a map illustrating the section panel locations.

- ! Choose *Use Existing Model* in the Options window if you already have a good solid lithology model (MOD file) and don't need to re-interpolate. Just browse for the MOD file name in the project folder.
- ! Striplogs can be appended. However, note that in cross-sections, logs are always displayed as vertical. If your wells are inclined or deviated, this will be accurately represented in the interpolation panels, but not in the logs. If you need non-vertical logs displayed in a section view, you should opt for a Profile diagram, above, which will honor true well geometry.
- ? See page 203 for information about drawing section panel traces.
- ? Help Contents: Borehole Manager / Lithology Tools / Creating Lithology Section Diagrams

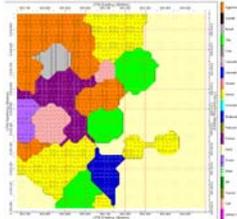
## Lithology / Surface Map



This tool is used to interpolate a solid model, or read an existing model representing lithology, and create a 2-dimensional map representing the lithology where it intersects a designated surface, typically the surface topography. In other words, it creates a geological map based on downhole lithology data. This is stored as a RockWorks grid model (GRD), and the map is displayed in the RockPlot2D window.

- ! As with the other **Lithology** menu options, choose *Use Existing Model* in the Options window if you already have a good solid model (MOD file) and don't need to re-interpolate. Just browse for the MOD file name in the project folder.
- ! You need to be sure that the dimensions and node density of the grid model along which the lithology is extracted and the lithology solid model are the same.
- ? Help Contents: Borehole Manager / Lithology Tools / Creating Lithology Surface Maps

## Lithology / Plan Map



The **Lithology / Plan Map** tool is used to interpolate a solid model, or read an existing lithology model, and create a 2-dimensional map representing the lithology along a horizontal slice, at a specified elevation. This is stored as a RockWorks grid model (GRD), and the map is displayed in the RockPlot2D window.

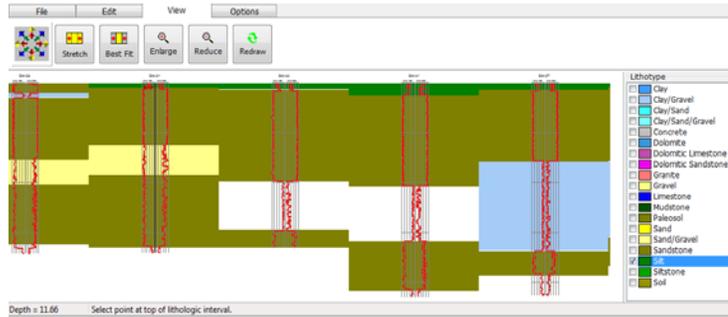
- ! Choose *Use Existing Model* in the Options window if you already have a good lithology solid model (MOD file) and don't need to re-interpolate. Just browse for the MOD file name in the project folder.
- ? Help Contents: Borehole Manager / Lithology Tools / Creating Lithology Plan Maps

## Lithology Computation Tools

See Chapter 17 - Computing Volumes for a discussion of how to compute lithology volumes.

## Lithology Data Tools

### Pick Lithology Intervals



Use the Borehole Manager's **Lithology / Pick Intervals** tool to display log data (such as geophysical curves or raster logs) and interactively determine the depths of lithology intervals. This tool is similar to the **Pick Contacts** tool in the **Stratigraphy** menu, except that materials can repeat downhole.

! This tool will assign lithology depths assuming vertical boreholes.

We encourage you to follow very carefully the steps listed in the How To section of the Help messages which are summarized below.

1. Enter your known data: Typically this would be geophysical (elog) measurements.
2. Build a log section: This is not required, but it's helpful to be sure your data is good, for setting up the proper section alignment, for viewing the known data to be picked from, and for determining the material types that are present.
3. Create a Lithology Types Table: With a good idea of the look of the existing downhole geophysical data, you need to create a "Lithology Types Table" which lists the names of the lithology materials that are represented in your project
4. Set up the lithology picker display: This should be set up just like the hole to hole section in step 2.
5. Pick the wells to be displayed: You can choose the same boreholes as were chosen in step 2, or pick a new selection of wells.
6. Pick the first lithotype in the Contact Picker window: Select the name of the lithology material to be recorded by inserting a check in its check-box. In each log, click the top and base of the interval or intervals where this material is present. The program will record the depth intervals in the data listing below the image.
7. Pick the next material: Select the name of the next lithotype to be recorded, and click the top and base of each interval in each log. Continue in this manner for additional lithology types. Note that you can re-pick lithotypes at any time. It does not matter the order in which you pick the lithotypes or define the intervals in the logs.
8. End the session: Click on the Exit button and discard or save changes.

What next? Now that you have the lithology intervals defined, use the **Lithology / Model** tool to create a 3-dimensional solid model of the rock types. Use the other **Lithology** menu tools to create sections, profiles, maps, etc. as described earlier in this chapter.

? Help Contents: Borehole Manager / Lithology Tools / Picking Lithology Intervals

## Consolidating Lithology

Use the Borehole Manager's **Lithology / Consolidate** tool to locate identical, contiguous lithology intervals (without regard for any associated comments) and consolidate them into a single interval. This utility is primarily designed for users who are importing data from other programs that store data at uniform intervals.

! You can opt for creating a backup of the project database before continuing with this operation, which is highly recommended.

? Help Contents: Borehole Manager / Lithology Tools

## Exporting Lithology Data to ASCII

Use the Borehole Manager's **Lithology / Export / ASCII XYZG** option to extract X, Y, Elevation coordinates and lithology "G" values from all active wells in the borehole database, and store them in an XYZG file.

## Converting Lithology Data to I-Data

Use the Borehole Manager's **Lithology / Export / I-Data** option to transfer lithology observations to a track in the project's I-Data table. This tool converts lithotypes to quantitative values based on a lookup table (representing porosity, permeability, conductivity, etc.). This lookup table simply lists the project's lithology types in one column, and the numeric value to be posted in the I-Data tab for those lithology intervals.

Notes

# Chapter 12 - I-Data, T-Data, and P-Data Modeling

## Topics

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## Overview

The tools in the **I-Data**, **T-Data**, and **P-Data** menus are almost identical. They simply model different data:

- The **I-Data** options interpolate data pulled from a user-selected track in the I-Data sheets, which represents quantitative data measured at downhole depth intervals.
- The **T-Data** options interpolate data pulled from a user-selected track in the T-Data sheets, which represents quantitative data measured at downhole depth intervals with a date record.
- The **P-Data** options model data pulled from a track in the P-Data sheets, which represents quantitative data measured at downhole depth points.

These downhole data types are interpolated using solid modeling techniques, as discussed back in Chapter 10. Unlike lithology models, discussed in the previous chapter, these data models are usually gradational, illustrating a continuum from lows to highs.

Notes:

- Optional surface filtering is available to null-out nodes that lie above a surface model (such as the ground surface) or a stratigraphic unit, or to null-out nodes that lie below a unit. Additional options include applying a regional tilt to the modeling, as well as warping the model based on a surface. (See Solid Modeling Options on page 175.)
- Once you have the solid model file created, you can use that existing model for future profile, section, fence, and plan diagrams. (They can all be drawn to represent the same MOD file without having to re-interpolate it each time; choose *Use Existing Model* in the diagram's Options window.)

## Typical Workflow

1. Enter your borehole locations and I-Data or T-Data or P-Data (pages 38 - 44) or import your data (page 63). You can define your column headings using the Types tables, as discussed on pages 57 - 58.

2. Establish your Project Dimensions (page 100). For solid models, be sure the X and Y spacing for the nodes is half the average minimum distance between your boreholes, or closer. Be sure the Z (elevation) spacing of the nodes is no greater than the smallest sampling interval in the data tabs, so that measurements will show up in the model. However, if you have really finely-sampled P-Data, it may be unrealistic to make your model that fine; you may consider using the resampling options to cull out some of the measurements.
3. Create a borehole location map to verify well locations (page 110). Do the well locations look correct (no goofy outliers)?
4. Display your downhole I-Data, T-Data or P-Data in 2D and 3D logs (page 119). Does it look like the downhole data is entered accurately? Can you spot highs/lows in the observed data that you want to watch for in the interpolated model?
5. Create a solid model, and include your 3D logs with the output diagram. Does it look like the model accurately represents your data? Use the RockPlot3D filtering options to view specific data ranges, and confirm that they coincide with the log data. If you aren't getting good data representation in the model, check the vertical (Z) spacing of the Project Dimensions. See also the Trouble-shooting suggestions at the end of this chapter.
6. Once you get a good model, you can create other diagrams – cross sections, fence diagrams, etc. – using the existing solid MOD file.

## I-Data, T-Data, and P-Data Modeling and Display Tools



Help Tutorial: Borehole Manager / Create I-Data Models and Diagrams



Help Tutorial: Borehole Manager / Create T-Data Models and Diagrams



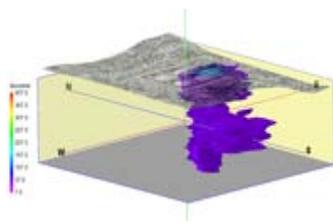
Help Tutorial: Borehole Manager / Create P-Data Models and Diagrams

## Notes on T-Data Modeling

T-Data (which represents Time-Based Interval Data) is a lot like I-Data, but with a few notable differences.

- You may have only one sample downhole per date or date range that you wish to model. While you certainly can create a solid model of this data, it may be easier to use the **T-Data / Statistics Map** option to create a simple 2D contour map of the high values.
- If you do create a solid model for the T-Data and if you have water level measurements for the same date or date range as your T-Data samples, you may want to create your **Aquifer / Model** first, and then use those resulting surfaces to constrain your T-Data solid model (turning on the *Upper Surface Grid Filter* and *Lower Surface Grid Filter* and browsing for the “*date\_top.grd*” and “*date\_base.grd*” files). This will constrain the solid model to the aquifer.

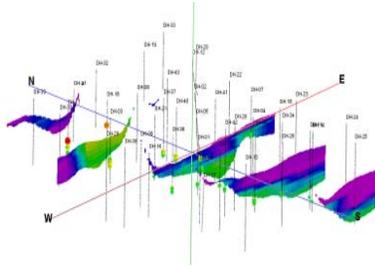
## I-Data, T-Data, P-Data / Model



Use the **Model** tool in the three menus to interpolate a solid model or read an existing model representing your downhole I-Data, T-Data, or P-Data values, and to create a 3-dimensional isosurface or voxel diagram that illustrates the model. The data values can be color-coded in a variety of ways. 3D striplogs can be appended. Once displayed in RockPlot3D the isosurface or voxel display can be filtered for viewing specific data ranges, and volumes can be displayed.

- ? Help Contents: Borehole Manager / I-Data Tools, T-Data Tools, P-Data Tools / Creating Solid Models & 3D Diagrams

## I-Data, T-Data, P-Data / Fence

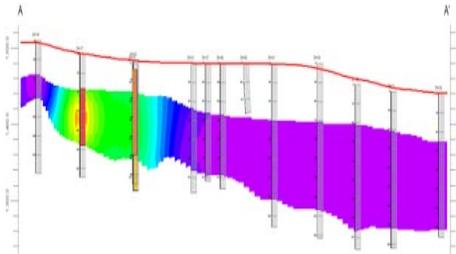


This tool interpolates a solid model or reads an existing model representing your downhole I-Data, P-Data, or T-Data values, and creates a 3-dimensional fence diagram that illustrates the model along 3D slices. You may request regular panel spacing, in a variety of configurations, or you can draw your own panels. The model's data values can be color-coded in a variety of ways. 3D striplogs can be appended. You can request output of a map that displays the location of the fence panels.

- ? See page 206 for information about drawing the fence panels.

- ? Help Contents: Borehole Manager / I-Data Tools, T-Data Tools, P-Data Tools / Creating Fence Diagrams

## I-Data, T-Data, P-Data / Profile

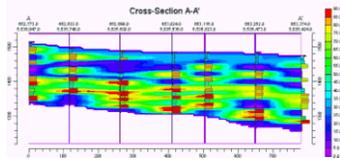


Use the **Profile** tool to interpolate a solid model or read an existing model representing your downhole I-Data, T-Data, or P-Data values, and create a 2-dimensional (flat) vertical profile diagram, sliced between any two points in the study area. The data range can be color-coded in a variety of ways. Striplogs can be projected onto the panel plane, and true well orientation will be honored

There is an option to create multiple, parallel profiles automatically. You can request generation of a map illustrating the profile slice location.

- ? See page 203 for information about drawing the profile slice.
- ? Help Contents: Borehole Manager / I-Data Tools, T-Data Tools, P-Data Tools / Creating Profile Diagrams

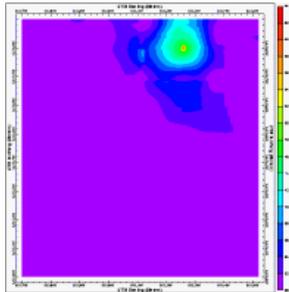
### I-Data, T-Data, P-Data / Section



The **Section** tool interpolates a solid model or reads an existing model representing your downhole I-Data, T-Data, or P-Data values and creates a 2-dimensional vertical multi-panel profile diagram. The panel endpoints can be placed anywhere in the project. The data range can be color-coded in a variety of ways. You can request generation of a map illustrating the cross section panel locations.

- ! Striplogs can be appended. However, note that in cross-sections, logs are always displayed as vertical. If your wells are inclined or deviated, this will be accurately represented in the interpolation panels, but not in the logs. If you need non-vertical logs displayed in a section view, you should opt for a Profile diagram or a Fence diagram, both of which will honor true well geometry.
- ? See page 205 for information about drawing the Section trace.
- ? Help Contents: Borehole Manager / I-Data Tools, T-Data Tools, P-Data Tools / Creating Sections (Multi-Panel)

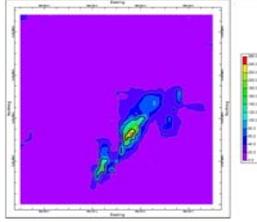
### I-Data T-Data, P-Data / Plan Map



The **Plan Map** tool interpolates a solid model or reads an existing model representing your downhole interval, time-interval, or point data and slices it horizontally at a user-specified elevation. The resulting grid model (GRD) can be displayed as a 2-dimensional map in which the data range can be color-coded in a variety of ways. Standard mapping options are available.

- ? Help Contents: Borehole Manager / I-Data Tools, T-Data Tools, P-Data Tools / Creating Plan-View Maps

## I-Data T-Data, P-Data / Surface Map



The **Surface Map** tool interpolates a solid model or reads an existing model representing your downhole interval, time-interval, or point data and extracts the G values where they intersect an existing surface (GRD file). The resulting grid model (GRD file) can be displayed as a 2- or 3-dimensional map in which the data values can be color-coded in a variety of ways. Standard mapping options are available.

- ! You need to be sure that the dimensions and node density of the grid model along which the data is extracted and the solid model are the same.
- ? Help Contents: Borehole Manager / I-Data Tools, T-Data Tools, P-Data Tools / Creating Surface Maps

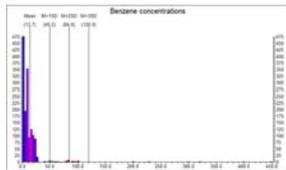
## I-Data, P-Data, T-Data Statistics Tools, Graphs, and Maps

### Creating Statistics Reports

The Borehole Manager's **I-Data**, **T-Data**, and **P-Data / Stats** tools are used to calculate statistics for a single track of samples in the current database. Spatial and G-value filters are available, as is resampling. Statistics include simple summaries (population, min, max, range, mean, etc.) as well as Mean + - 1, 2, 3, and 4 Standard Deviations.

- ! Use the **Stats** tool to get a textual summary of your data values before you even start plotting or interpolating.
- ? Help Contents: Borehole Manager / I-Data Tools or T-Data Tools or P-Data Tools/ Statistical Tools / Generating a Statistical Report

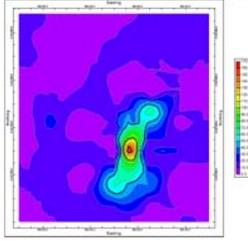
### Creating Frequency Histogram Plots



The Borehole Manager **I-Data**, **T-Data**, and **P-Data / Histogram** options are used to read a single track of data from the database and determine the frequency or percentage of the total number of measurements for that variable that falls in each user-defined grouping or "cell." These values are represented as a bar histogram plot.

- ! Use the **Histogram** tool to get a graphical summary of your data values before you even start plotting or interpolating.
- ? Help Contents: Borehole Manager / I-Data Tools or T-Data Tools or P-Data Tools/ Statistical Tools / Generating a Frequency Histogram

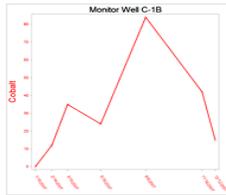
## Creating High-Low-Average-Sum Statistics-Maps



The Borehole Manager's **I-Data**, **T-Data**, and **P-Data / Statistics Map** tools provide a quick look at a specific G value range without creating a solid model. These programs extract an XY location for each borehole and the high/low/sum/average value (as requested) for a specific track for that location, and create a grid model and 2D and/or 3D map to illustrate this data. The data values can be color-coded in a variety of ways.

- ! A **Statistics Map** differs from a **Plan Map** in that this map is not extracted from a solid model.
- ! This map can be especially useful for T-Data measurements.
- ? Help Contents: Borehole Manager / I-Data Tools or T-Data Tools or P-Data Tools/ Statistical Tools / Creating Statistics Maps

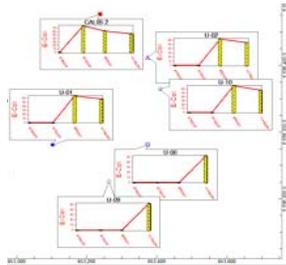
## T-Data / Time-Graphs



The **T-Data / Time Graph** option plots T-Data as a function of time, for a given borehole. You can plot one or two T-Data Tracks, using symbols and lines or bargraphs.

- ? Help Contents: Borehole Manager / T-Data Tools / Plotting T-Data Measurements Over Time – Single Borehole

## T-Data / Time-Graph Maps



The **T-Data / Time Graph Map** option creates maps that illustrate one or two T-Data components over time in small charts, for each enabled borehole location. The components can be displayed as symbols and lines or bargraphs. Each mini-graph is displayed in a pointmap “callout” box.

- ? Help Contents: Borehole Manager / T-Data Tools / Plotting T-Data Measurements Over Time – Multiple Boreholes

## I-Data and T-Data Computation Tools

See Chapter 17 - Computing Volumes (page 223) for information about the volume-computing tools in the **I-Data** and **T-Data** menus.

## I-Data, P-Data, T-Data Tools for Data Manipulation & Export

### Extracting I-Data and T-Data Values to a Datasheet

Use the **Extract** tool in the **I-Data** and **T-Data** menus to extract the data for a single track for all enabled boreholes, and list the results in a data tab. A variety of spatial filtering, data filtering, G-value filtering, and resampling options are offered. The X, Y, Z locations of the exported points will be determined by the borehole locations (Location tab), downhole survey, if any (Orientation tab) and depth intervals listed for the downhole time- or interval data. The G values will be taken from the selected data track. The Z values will represent elevation.

### Exporting I-Data, I-Text, T-Data, P-Text, and P-Data

Use the Borehole Manager's **Export** option to export I-Data, I-Text, T-Data, P-Data, and P-Text data to the following:

**Export / ASCII File or Datasheet:** Extract X,Y,Elevation coordinates and G values for a selected track from the borehole database, and store them in an XYZG file or in the RockWorks Utilities datasheet.

**Export / ASCII CSV:** Exports all tracks of I-Data, I-Text, T-Data, P-Data, or P-Text measurements for the current / enabled/all boreholes to an ASCII comma separated variable (CSV) file for use in Excel.

? [Help Contents: Borehole Manager/ I-Data Tools, T-Data Tools, P-Data Tools](#)

## P-Data Manipulation Tools

The options in the **P-Data / Analyze** menu perform the following data manipulations:

**Add Random:** Adds random numbers to a P-Data track.

**Gamma Counts -> Uranium Grade:** Reads Gamma measurements from a P-Data track and converts the data to uranium grade values in an I-Data track. Conversion constants can be uniform or pulled from custom fields in each borehole's Location tab.

**Logarithm:** Computes the logarithm of a given p-data column. Logarithmic conversions are useful when you want to show the variations within the low values despite high values that otherwise "squish" the curve when using the autoscale option.

**P-Data Histograms by Lithology:** Determines data values for a selected P-Data track and the specific lithology entries where they occur. RockWorks will generate a composite diagram with frequency histograms for each lithotype. An optional report will show an outlier summary.

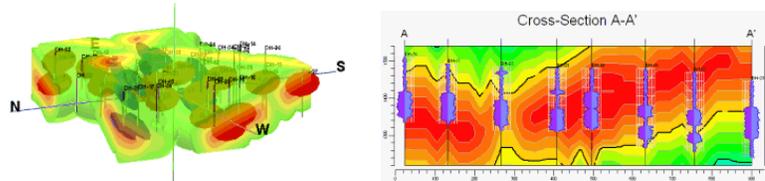
**Resample:** Resamples a P-Data track, storing them in a new output track. Filters are also available. This can be helpful if your source data is sampled at too fine an interval to be practical for modeling or log display.

# Chapter 13 – Fracture Modeling, Vector Modeling

## Topics

Fracture Modeling Overview .....	199
Fracture Modeling and Diagrams.....	200
Exporting Fracture Data.....	202
Creating Solid Models of Downhole Vector Data.....	202

## Fracture Modeling Overview



Use the tools in the Borehole Manager's **Fractures** menu to generate a solid model of fracture locations and display this model in a variety of ways: as a vertical profile slice, a multi-paneled profile or “section,” a 3D fence with any number and arrangement of panels, a horizontal slice or plan map, and as a 3D isosurface or voxel diagram.

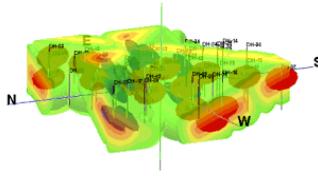
Downhole fracture data is entered into the Borehole Manager's Fractures datasheets. The fractures are listed with depth, fracture orientation, and dip angle, radius and thickness. In addition, color is specified for the fracture disc as displayed in 3d logs. The radius, listed in your map units, affects the size of the disc in logs and, for modeling purposes, the extent of the influence of the fracture.

- A specific modeling method is used for the interpolation of the fracture model. Fracture model G values represent distance to the closest fracture, so that low values represent proximal fractures, and high values represent areas where fractures are not prevalent. For this reason, there's an option to “negate” the node values (e.g. multiply by -1) so that you can isolate the highs rather than the lows.
- Optional surface filtering is available to zero-out nodes above a surface model (such as the ground surface) or a stratigraphic unit, and/or below a unit. See the solid model constraint options.
- Once you have the solid model file created, you can use that existing model for future isosurface, fence, profile, section, and plan diagrams. (They can all share the same MOD file without having to recreate it each time; choose *Use Existing Model* in the diagram's Options window.)
- Automatic maps illustrating the location of profile, section, and fence panels can be created.
- See page 203 for information about drawing profile, section, and fence panel traces.

? Help Contents: Borehole Manager / Fracture Tools

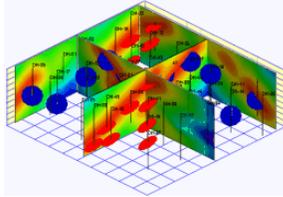
## Fracture Modeling and Diagrams

### Fractures / Model



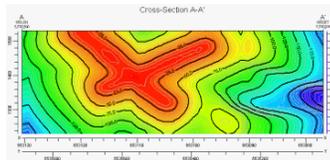
Use the Borehole Manager's **Fractures / Model** tool to interpolate a solid model or read an existing model representing fracture proximity and create a 3-dimensional isosurface or voxel diagram that illustrates that model. The values can be color-coded in a variety of ways. 3D striplogs can be appended.

### Fractures / Fence



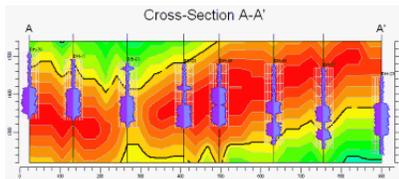
Use this tool to interpolate a solid model or read an existing model representing fracture proximity and create a 3-dimensional fence diagram that illustrates that model. You may request regular panel spacing, in a variety of configurations, or you can draw your own panels. The model's values can be color-coded in a variety of ways. 3D striplogs can be appended.

### Fractures / Profile



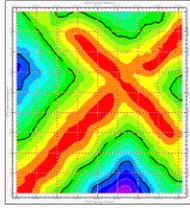
Use this tool to to interpolate a solid model or read an existing model representing fracture proximity and create a 2-dimensional vertical profile that illustrates that model, between any two points in the study area. The data values can be color-coded in a variety of ways. Striplogs can be appended. There is an option to create multiple, parallel profiles automatically.

### Fractures / Section



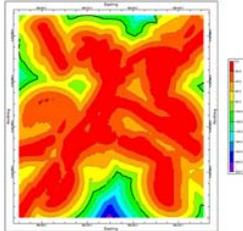
The **Fractures / Section** tool interpolates a solid model or reads an existing model representing fracture proximity and creates a 2-dimensional vertical multi-panel profile that illustrates the model. The panel endpoints can be placed anywhere in the project. The data values can be color-coded in a variety of ways. Striplogs can be appended.

## Fractures / Plan Map



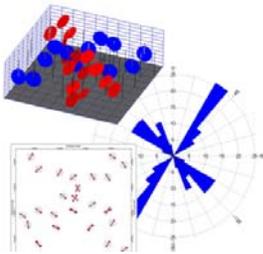
Use this tool to interpolate a solid model or read an existing model representing fracture proximity and slices it horizontally at a user-specified elevation. The resulting grid model (GRD) can be displayed as a 2-dimensional map in which the data values can be color-coded in a variety of ways

## Fractures / Surface Map



Use this tool to interpolate a solid model or read an existing model representing fracture proximity and extract the G values where they intersect a surface (GRD file). The resulting grid model (GRD file) can be displayed as a 2- or 3-dimensional map in which the data values can be color-coded in a variety of ways.

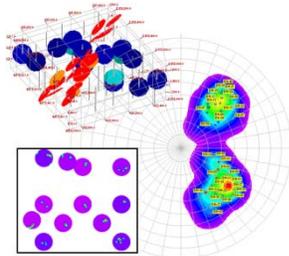
## Fractures / Rose Diagram and Rose Diagram Map



Use the **Fractures** menu's **Rose Diagram** and **Rose Diagram Map** tools to read 2D fracture orientations (azimuths) from the borehole database and generate a single rose diagram for the current borehole, or a rose diagram map for all boreholes.

See the description of Rose diagrams (page 232) for information about their structure.

## Fractures / Stereonet Diagram and Stereonet Diagram Map



Use the **Fractures** menu's **Stereonet** and **Stereonet Map** tools to read 3D fracture orientations (azimuths and inclinations) from the borehole database and generate a single stereonet diagram for the current borehole, or a stereonet diagram map for all boreholes.

See the description of Stereonet diagrams (page 233) for information about their structure.

## Exporting Fracture Data

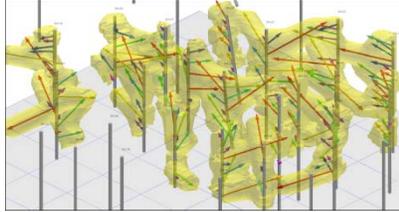
Use the Borehole Manager's **Fractures** / **Export** option to export the downhole depth/orientation/inclination data to the following:

**Export / ASCII file:** X, Y, elevation, direction, dip angle, radius, and aperture for all active boreholes will be written to an ASCII file.

**Export / Utilities Datagrid:** Exports ID, Depth, Easting, Northing, elevation, direction, dip angle, color, radius, aperture, and symbol to the RockWorks Utilities datasheet.

## Creating Solid Models of Downhole Vector Data

### Vectors / Model



Use the **Model** tool in the Borehole Manager's **Vectors** menu to convert directional downhole data into solid models that approximate the extents of the vectors. An example application is the generation of void geometries (cave models) based on downhole laser surveys.

The following operations are performed in order to generate a model that approximates cave geometries based on the vector data:

For each solid model node ...

For each borehole ...

For each vector ...

- Compute the endpoint coordinates.
- Define a line connecting the endpoints.
- Define a sphere whose center is defined by the line midpoint and whose diameter is equal to the line length.
- If the node resides outside of the sphere its g-value is set to "null" (-1.0E27).
- If the node resides inside of the sphere, its g-value is set to the distance to the closest line.

**Note:** In order for the node values to increase with distance to the closest line, it is necessary to negate the distance values (i.e. the node values should be multiplied by -1) as allowed within the Vector Modeling Options menu.

? [Help Contents: Borehole Manager/ Vector Tools](#)

# Chapter 14 - Laying Out Vertical Profiles, Sections & Fences

## Topics

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Drawing a Profile Line .....	203
Drawing a Multi-Panel Cross Section Trace.....	205
Drawing Fence Diagram Panels .....	206

## Overview

In the Options window of the RockWorks tools which build vertical profile, cross section or fence diagrams, RockWorks displays a tab where the borehole locations are illustrated. It is this Profile Selection Map, Section Selection Map, or Fence Selection Map tab you draw the section or fence panel line(s). The look of this window changes depending on the type of diagram being created, but the general operations are the same. If you are creating a profile, section, or fence from the RockWorks Utilities data window, the borehole locations may not be displayed.

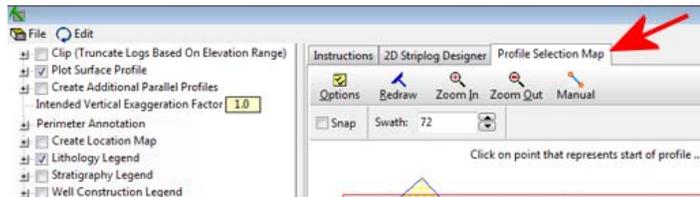
## Drawing a Profile Line

The Borehole Manager **Profile** tools are available within the **Lithology, Stratigraphy, I-Data, T-Data, P-Data, Fracture** and **Aquifers** menus. They are used to display a vertical slice from the inside of a solid or stratigraphic model to illustrate lithology distribution, stratigraphic or water level elevations, geochemical/geophysical values, and fracture proximities. Striplogs can be included in any of these profile diagrams.

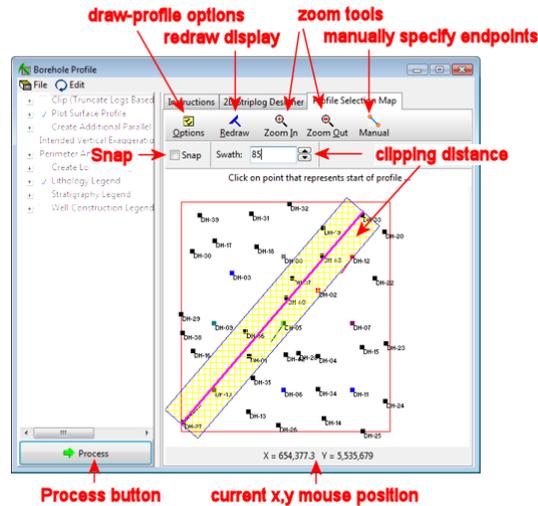
A **Profile** tool is also available within the RockWorks Utilities **Solid** menu, to slice an existing solid model containing any type of data.

In addition, log-only profiles are available using the **Striplogs / Multi-Log Profile** tool which displays multiple boreholes as if projected onto a vertical line of section.

When you select any of these menu options, you'll see the diagram-specific tree menu listing in the pane to the left – this is where you set up what the diagram should look like. Then, click on the **Profile Selection Map** tab to the right.



Here the program will display the well locations as a plan-view map, with boring name and symbol color tied to each well. Any previous line drawn for this project will also be displayed on the map.



1. To accept the existing profile cut, click the *Process* button at the bottom of the window.
2. Or, to draw a new profile line, along which the model will be sliced and/or onto which the logs will be projected, click on the map location to become the left edge of the profile and then click on the location to become the right edge of the profile. You do not need to refresh the screen between drawing lines.
 

The line can be oriented in any direction. You may redraw this line of section as many times as you like until you are pleased with its placement. Note that the prompt at the top of the window will read "Click on panel starting point" or "Click on panel ending point" to let you know what it's expecting.
3. For profiles containing logs, you can adjust the clipping distance or "swath", shown above by the cross-hatched area. This represents the distance to either side of the actual profile line that boreholes (or portions of boreholes, if the well is deviated) will be "grabbed" for projection onto the line. You can change the clipping distance by clicking the up- or down-arrows at the top of the window, or by typing an actual value into the *Swath* prompt.
4. To snap the profile endpoints to actual well locations, insert a check in the *Snap* check-box. After you select the profile endpoints, they will be repositioned to the nearest boreholes.
5. If you want to type in specific endpoint coordinates, you can do so: Click on the *Manual* button above the map. Type in the known X and Y coordinates for the beginning and ending points of the profile, and click the *Process* button. A profile line will be displayed between these coordinates.
6. If you want the program to create multiple, parallel profiles automatically, insert a check in the *Create Additional Parallel Profiles* checkbox in the main options list to the left. The *Options* button above the map can be used to define the multi-profile settings – the spacing, extents, orientation from the original line, and nature of the output graphic.
7. Click the *Process* button at the bottom of the window when you are ready to continue.

The program will create the diagram and display it in a RockPlot2D tab (page 249).

? Help Contents: Reference / Laying out Vertical Sections and Fences

? See also 2D Profile and Section Options, page 134.

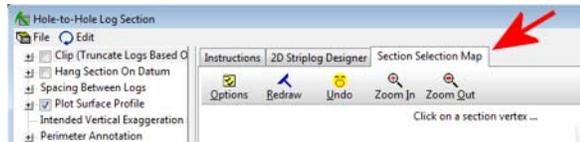
### Drawing a Multi-Panel Cross Section Trace

The Borehole Manager Section tools are available within the **Lithology, Stratigraphy, I-Data, T-Data, P-Data, Fracture** and **Aquifers** menus. They are used to display multiple, connected, vertical slices from the inside of a solid or stratigraphic model to illustrate lithology distribution, stratigraphic or water level elevations, geochemical/geophysical values, and fracture proximities. Striplogs can be included in any of these section diagrams.

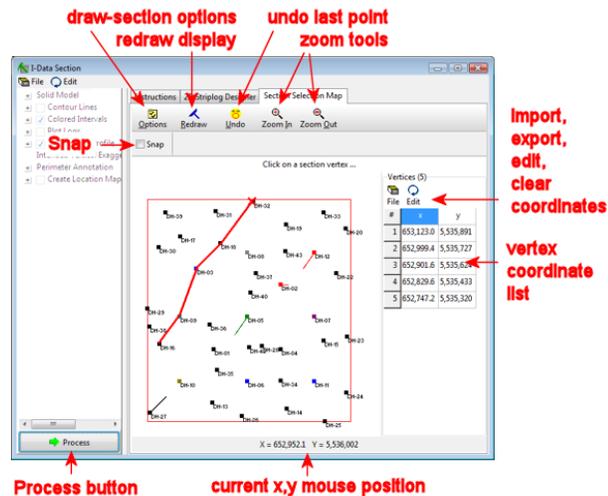
A **Section** tool is also available within the RockWorks Utilities **Solid** menu, to slice an existing solid model containing any type of data.

In addition, log-only sections are available using the **Striplogs / Multi-Log Section** tool.

When you select any of these menu options, you'll see the diagram-specific tree menu listing in the pane to the left – this is where you set up what the diagram should look like. Then, click on the **Section Selection Map** tab to the right.



Here the program will display the well locations as a plan-view map, with boring name and symbol color tied to each well. Any previous panels drawn for this project will also be displayed on the map.



1. To accept the current selection, click the *Process* button at the bottom of the window.
2. To redraw the section line, follow these steps:

Rockworks will remember any panel selections from previous sessions. If you wish to discard any existing selections and start well-picking from scratch, click on the **Clear** button. DON'T do this if you want to append to an existing section.

Click on the location to be represented along the left edge of the first panel of the section. If you are appending to an existing trace, pick the location for the next panel to be added to the existing list. The program will draw a line from the last endpoint to this one.

Pick the next endpoint, and the next and the next. Each selected panel point will be connected to the previous selection with a line.

3. To snap the panel endpoints to actual well locations, insert a check in the **Snap** checkbox at the top of the window. After you select the panel endpoint pairs, they will be repositioned to the nearest boreholes.

Section panels in interpolated surface or solid models can lie between boreholes - the slices can be placed anywhere within the model. However, if you choose to include striplogs in these section diagrams and if the panel endpoints don't lie at borehole locations, the program will simply project the closest log onto the panel.

Straight stratigraphy sections must be drawn borehole to borehole, and the program will automatically snap panel endpoints to well locations.

4. Click *Process* to accept the section trace.

The program will create the diagram and display it in a RockPlot2D tab (page 249).

Notes:

**Well Order:** In a section diagram, the order in which the panel endpoints are selected will make a big difference in the appearance of the diagram. The first panel you select, regardless of its position in the map, will be at the left edge of the cross section, and the last will be at the right edge.

**Mistakes?** Click the **Undo** button to remove the last-picked point. You can use this command repeatedly to remove panels in backward order. Or, click **Clear** to clear the display and start over.

? [Help Contents: Borehole Manager/ Laying Out Vertical Sections and Fences](#)

## Drawing Fence Diagram Panels

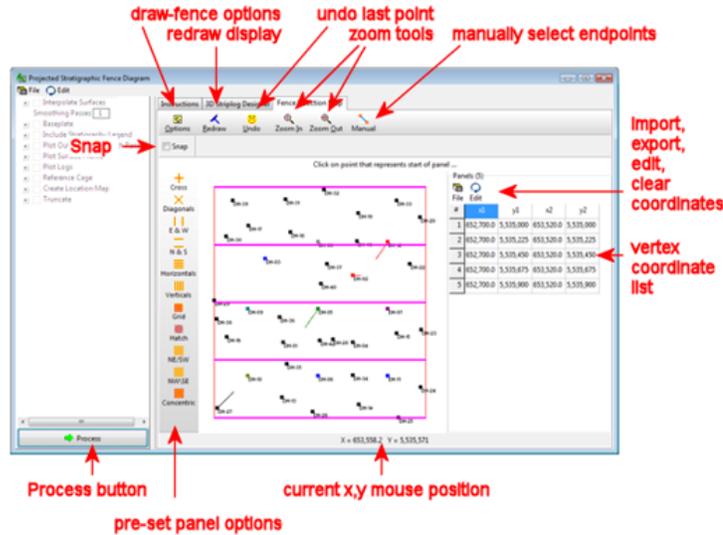
The Borehole Manager **Fence** tools are available within the **Lithology**, **Stratigraphy**, **I-Data**, **T-Data**, **P-Data**, **Fractures**, and **Aquifers** menus. They are used to display one or more vertical slices from the inside of a solid model to illustrate lithology distribution, stratigraphic or water level elevations, fracture proximity, or geochemical/geophysical values.

A **Fence** tool is also available within the RockWorks Utilities **Solid** menu, to slice an existing solid model containing any type of data.

When you select any of these menu options, you'll see the diagram-specific tree menu listing in the pane to the left – this is where you set up what the diagram should look like. Then, click on the **Fence Selection Map** tab to the right.

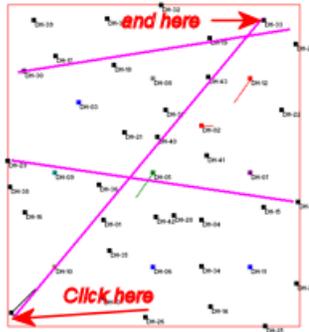


There you'll see the well locations displayed in a plan-view map, with boring name and symbol color tied to each well. Any previous panels drawn for this project will also be displayed on the map.

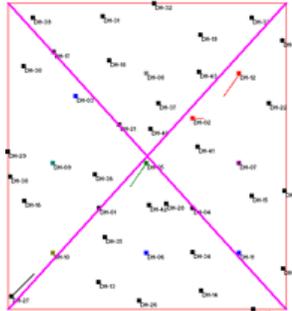


1. To accept any existing fence panel arrangement, click the *Process* button at the bottom of the window to proceed. The program will build the fence diagram and display it in a RockPlot3D tab.
2. To clear the current display to start over, click the **Clear** button at the top.
3. To draw a new fence panel or to add a new panel to the existing display, you have some options:

Manually draw the line: Simply left-click on the map location to become the one edge of the cut and then left-click on the location to become the other edge of the cut. The program will connect the points with a line. For projected fence diagrams, the slice endpoints do not need to correspond to borehole locations. For "straight" fence diagrams (**Stratigraphy** menu), the lines you draw will be snapped to the closest boreholes.



Pre-configured panels: Another option for fence panels is to select a pre-configured panel arrangement by choosing an option from the **Panels** menu or clicking the corresponding button. For example, for an automatic “X” panel layout that extends to the edge of the solid model, click on the  button.



As mentioned above, the slices do not need to conform to borehole locations for projected fence panels. They do for hole to hole fences (**Stratigraphy** menu) and the program will snap the drawn endpoints to the closest boreholes.

You can use any combination of hand-drawn and pre-configured panels that you wish.

4. To snap the panel endpoints to actual well locations, insert a check in the **Snap** checkbox at the bottom of the window. After you select the panel endpoint pairs, they will be repositioned to the nearest boreholes.

Lithology, modeled stratigraphy, I-data, T-Data, P-data, fracture, and aquifer fence panels can lie between boreholes - the slices can be placed anywhere within the model.

Straight stratigraphy fences must be drawn borehole to borehole, and the program will automatically snap panel endpoints to well locations.

Mistakes? Click the **Undo** button to remove the last-picked panel. You can use this command repeatedly to remove panels in backward order. Or, click the **Clear** button to clear the display and start over.

? Help Contents: Borehole Manager/ Laying Out Vertical Sections and Fences

# Chapter 15 - Grid Model Tools

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## Grid Model Tools - Overview

Within the Borehole Manager you can create grid models of stratigraphic surfaces using the Borehole Manager's **Stratigraphy** menu tools, and water level surfaces using the **Aquifer** menu tools. You can also perform "basic" gridding of XYZ data using the RockWorks Utilities **Map / Grid-Based Map** command. The program offers several gridding methods to do this interpolation of your data. Each operates differently, and each has strengths and differences. See "Gridding Methods", page 140.

The tools in the RockWorks Utilities **Grid** menu are used to summarize, manipulate, filter, and illustrate existing numeric grid models.

## Computing Grid Statistics

The **Grid** menu's **Statistics** utility is used to get a general summary of the contents of an existing grid (GRD) file. The computations are reported as a:

- Textual **report**, in which the summary of grid node values and computed statistics are displayed in a document in a text editor. Use this to confirm grid dimensions, view volumes, G value ranges and standard deviations.
- Plottable frequency **histogram** of the node values, reported as numbers or percent. This can be used to compare the G value distribution for models interpolated with different algorithms, and to look for anomalies.
- Plottable "**Krajewskigram**" or X,Y scattergram of original Z values (X-axis) versus computed node values (Y-axis). You can use this to gauge the accuracy of the grid model and view some error analysis.
- Computed grid **residuals**, representing the difference between observed XY values and computed grid values at the same locations.
- New grid **anomalies** model, created in batch from multiple grid models, to highlight areas where multiple variables show anomalous tendencies.
- **Standard deviations** of grid node values. This can be helpful in isolating anomalous areas.

- In addition, grid nodes can be **normalized** for comparing different models with unlike Z value ranges.

Notes: For the residuals computations and Krejowskigrams, you'll also need the original XYZ data from which the grid model was computed.

? Help Contents: RockWorks Utilities / Grid Model Tools / Computing Grid Statistics

## Performing Arithmetic Operations with Grid Models

The tools in the **Grid / Math** menu are used to perform a variety of mathematical operations on an existing grid file, storing the results in a new grid file. The resulting model can be illustrated as a 2D map or 3D surface.

**Grid & Grid:** This tool performs arithmetical operations with the grid node Z-values in two existing grid files. Example: Subtract an elevation model from another to generate a thickness (isopach) grid; then run **Grid / Stats / Report** for volume.

**Grid & Constant:** This tool performs arithmetical operations with the node Z-values in a single grid model and a constant, creating a new output grid model.

**Density Conversion:** Use this tool to multiply the grid cell volume (cell-width \* cell-height \* Z-value, thickness) by a constant (representing density per unit volume) to create a new "density" grid.

**Absolute Value:** Use this tool to convert the Z-values within an existing grid file to their absolute values, storing the new node values in a new grid file.

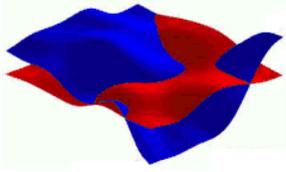
**Resample:** Use this tool to read an existing grid model and resample the nodes to the current project dimensions. Very handy if you need to make a grid model match another's extents and node spacing for filtering/math/comparison purposes.

! In order for the program to match up corresponding nodes in the two input grid files in the **Grid & Grid Math** option, they must have the same dimensions (X and Y coordinates and range) and numbers of nodes. You can use the **Grid / Statistics / Report** option to see a dimension summary. During gridding, you can manually establish the grid dimensions and node spacing by activating the Confirm Model Dimensions check-box in the Model Dimensions window. You can resample an existing grid model to different dimensions using the **Grid / Math / Resample** option.

! For the **Density Conversion** tool, the Z-values of the input grid must represent thickness, and the thickness units must be the same as the X and Y coordinate units in order to compute a meaningful volume. You can use the tools in the **Coords** menu to translate X and Y coordinates to different units. You can use the RockWorks **Edit / Columns / Thickness** command to compute the thickness between two selected data sheet columns. The thickness values can then be gridded using the **Map / Grid-Based Map** option.

? Help Contents: RockWorks Utilities/ Grid Model Tools / Mathematical Tools

## Filtering Grid Models



The tools in the **Grid / Filter** menu are used to read an existing grid file and alter the grid node Z values by imposing a filter of some kind. The resulting node values are stored in a new grid file. The resulting model can be illustrated as a 2D map or 3D surface.

The **Boolean Filter** transforms a real number grid file to a Boolean (true/false) file in which nodes are set to "1" if their Z-value falls within a user-specified range, and a "0" if the Z-values do not.

The **Limit Filter** is used to compare the nodes of one grid model with the corresponding nodes in another. Nodes whose Z values exceed or fall below those in the second grid can be re-assigned those node values. This is handy for constraining stratigraphy based on lower or upper layers.

The **Minimum Area Filter** is used to filter from Boolean or conventional grid models contiguous nodes whose areas fall below a threshold, setting them to zero, to eliminate exploration target areas that are too small.

The **Polygon Clip Filter** reads a user-created table listing polygon boundary coordinates, and sets a grid file's nodes that lie either inside or outside the polygon to a constant value or to the value of the corresponding node in another grid model. (See also page 59.)

The **Range Filter** deletes high or low Z-values from a grid file, reassigning them a user-specified constant.

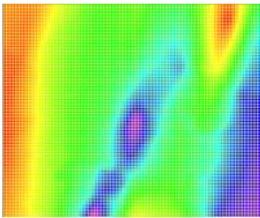
The **Rounding Filter** reads Z-values stored in a grid file and rounds them up or down to the user-declared rounding interval.

The **Smoothing Filter** reads an existing grid file and averages the Z-values based on a user declared "filter" size. The smoother can be run 1 or more times, to get rid of spurious "noise" within the grid model and bring out regional trends.

Notes: The Polygon table contains a button that will plot the polygon in a RockPlot2D window. If you save that image, it can then be plotted over your resulting map using RockPlot2D's **File / Append** command.

? [Help Contents: RockWorks Utilities/ Grid Model Tools / Grid Filtering](#)

## Editing Grid Models



The RockWorks Utilities **Grid / Edit** command is used to edit the node values stored in a RockWorks grid model, or to create from scratch a new grid with user declared dimensions and node values. This interactive editor color-contours node values, posts X,Y points if available, and allows editing of individual Z values or those within a polygon.

Notes: The Grid Editor is used to modify node "Z" values only. It cannot be used to modify the X,Y location coordinates of the nodes themselves. For moving grid nodes, see the **Resample** option in the **Grid / Math** menu.

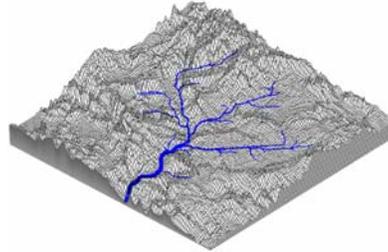
? [Help Contents: RockWorks Utilities/ Grid Model Tools / Grid Editor](#)

## Directional Analyses & Directional / Flow Maps

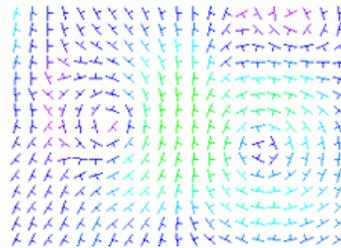
The RockWorks Utilities **Grid / Directional Analyses** tools are used to read an existing grid file and compute the changes in Z-values (e.g. elevations) between neighboring nodes to determine uphill or downhill direction and angle. A variety of map types and computations are available.

**Slope/Aspect Analysis:** Creates 3 output grid models: A slope grid which contains the change (or slope) between node Z-values, and represents the steepness of a structural face. An aspect grid which contains the direction of the slope, expressed in azimuth degrees. A second-derivative grid which contains the change in slope (the slope of the slope grid) to illustrate bends.

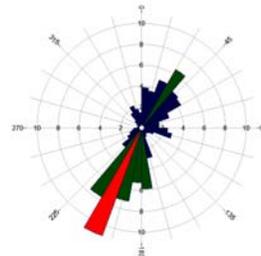
**Flow maps:** Illustrate flow pathways from high to low elevations, in 2D and 3D. Store flow vector segments in a datasheet, and compute upgradient areas



**Directional maps:** Illustrate the directionality of the elevation surface with upgradient or downgradient arrows, strike and dip symbols, slope contours, aspect contours, and second-derivative contours.



**Directional diagrams:** Summarize the directionality of the surface with a rose diagram or stereonet



**Movement Analysis:** Determines slope movement - the direction, inclination, distance, and velocity for X, Y, Z and time data (page 92).

? See also Arrow Maps in the **Linears** menu (page 231)

? Help Contents: RockWorks Utilities/ Grid Model Tools / Directional Analysis

## Trend Surface Analyses

Use the **Grid / Trend Surface Analysis** tools to determine regional trend for selected data in the main data sheet. This can help you to determine what trend order to select when creating a Trend Surface grid model, and it can help you to isolate regional anomalies by computing trend residuals. These tools are offered:

**Trend Surface Analysis / Report:** Performs a trend surface analysis on a selected Z-value column in the data sheet and lists the correlation and residuals for first through sixth order polynomials in a report which is loaded into a RockWare text window.

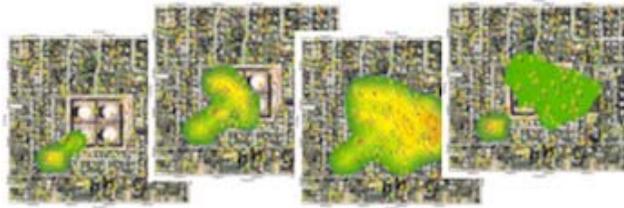
**Trend Surface Analysis / Residuals:** Performs a trend surface analysis on a selected z-value column and compute the residuals for a selected polynomial order, representing the difference between observed z-values and trend z-values. The residuals are stored in a data sheet column of the user's choice.

Notes: The trend surface report can be used to determine how well any of the trend surface models fit your data. The higher the correlation coefficient, the better the fit. This information can be helpful in determining whether there is much regional trend to your data. By isolating regional behavior, local anomalies can stand out.

This report can also be helpful if you are creating a trend surface map of your data, by providing correlation information. Use the residuals to determine where localized differences from the regional background may be.

- ? Help Contents: Reference / Gridding Reference / Trend Surface Gridding for information about creating trend surface maps, and examples of different polynomials.
- ? Help Contents: RockWorks Utilities/ Grid Model Tools / Trend Surface Analysis.

## Morphing Grid Models



The **Grid /Morph** command is used to generate a series of transitional grids / and/or contour-map images given two "end-member" grids. The user can specify the graphic format for the output maps, and they are then loaded into the RockWorks "picshow" application (page 247). This is a handy way to generate intermediate images between two models.

- ? Help Contents: RockWorks Utilities/ Grid Model Tools / Grid Morphing.

## Grid Import/Export Tools

### Importing Grid Models into RockWorks

The **Grid / Import** command is used to read an existing set of gridded data stored in one of the accepted formats and translate the data into a RockWorks grid file format. This tool also imports JPG or BMP images and translates them into a grid format.

**ASCII:** ASCII grid files consist of a list of space-delimited xyz values in which each line contains one node, also referred to as "Text" format.

**Bitmap:** RockWorks can import BMP or JPG images and store them as grid models. Be sure the input file, declared at the top of the window, has a ".bmp" extension if it's a BMP file, and a ".jpg" extension if it's a JPG file.

**Digital Elevation Model (DEM):** RockWorks can import Canadian Government, USGS 30-Meter, or USGS 3 Arc Second DEM formats.

**ESRI ASCIIGRID:** Imports a grid model from an ESRI® GIS program that has been saved in an ASCII format.

**GXF:** This represents GXF (Grid eXchange Files) output from the Geosoft program. This program does not import "compressed" GXF grid models.

**RockWorks7:** Binary files that were created by the last DOS version of RockWorks.

**Surfer:** Import Surfer ASCII or binary grid models.

? [Help Contents: RockWorks Utilities/ Grid Model Tools / Grid Import & Export](#)

### Exporting RockWorks Grid Models

Use **Grid / Export Grid** to export the data contained in a RockWorks grid model to another file format. It offers export to a variety of formats, with a variety of options:

**ASCII XYZ:** X and Y node locations and Z values are listed in three columns, with user-selected delimiter character, decimal precision, with or without a header.

**ASCII Matrix:** The Z-values only of the grid file are listed in rows and columns, with the number of entries corresponding to the numbers of nodes horizontally and vertically in the grid file. The Z-values are listed at the decimal precision you select.

**AutoCAD DXF Matrix:** ASCII files which can be read into any software application that reads files in a DXF format. They will appear as a three-dimensional mesh surface.

**Geosoft GXF:** GXF (Grid eXchange) are an ASCII grid format read by Geosoft.

**ESRI ASCIIGRID:** Export the RockWorks grid to an ASCII grid file that's importable into ESRI GIS programs for contouring and other spatial analysis.

**Ohio Automation ENZ:** X and Y node locations and Z values are listed in three columns in an ASCII format, with columns separated by commas. The node order is the same as that listed for the ASCII XYZ, above.

**RockWorks7:** A grid file format read by the RockWorks version 7 program for DOS.

**RockWare RTM:** The RockWare Terrain Model (RTM) is a binary grid file format originally designed as a method for shipping Digital Elevation Model (DEM) data.

**Surfer:** Choose from Surfer/6 binary or Surfer/7 and Surfer/8 ASCII and binary formats.

**VistaPro:** This is a binary grid format read by VistaPro, as DEM data.

? Help Contents: RockWorks Utilities/ Grid Model Tools / Grid Import & Export

## Importing LIDAR Data

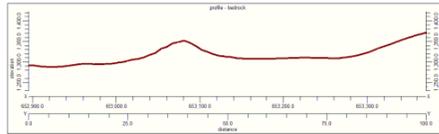
Use the **Grid / LIDAR XYZ -> Grid** tool to import XYZ files created from LIDAR (Light Detection And Ranging) equipment and generate a grid model that represents the Z values (typically surface elevation).

This is different from the process of gridding external XYZ data in the **Map / Grid-Based Map** option in these ways:

- Because of the huge number of points in a typical LIDAR file, the program does not load the points into memory (it's 100% file based).
- There is no choice for gridding algorithm - each grid node is assigned the Z-value for the last LIDAR point in that cell.

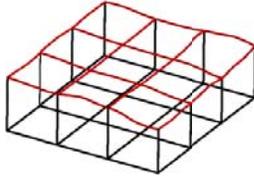
? Help Contents: RockWorks Utilities / Grid Model Tools / Importing LIDAR Data

## Grid Model Profiles & Fences



Use the **Grid / Grid -> Profile** tool to display the elevations in an existing grid model in a simple line profile drawing. You can specify the position of the vertical slice within the grid area interactively or by specifying endpoint coordinates.

Notes: This profile tool is also available as the “Plot Surface Profile” setting within the Borehole Manager Profile and Section tools in order to plot the ground surface as a line in these diagrams.



Use the **Grid / Grid -> Fence** tool to display the elevations in an existing grid model in a 3D line profile drawing. You can specify the position of the vertical slices within the grid area interactively or by specifying endpoint coordinates.

Notes: This profile tool is also available as the “Plot Surface Profile” tool within the Borehole Manager Fence tools in order to plot the ground surface as a trace in these diagrams.

? Help Contents: RockWorks Utilities / Grid Model Tools / Grid Fences & Profiles

## Grid Stratigraphic Tools

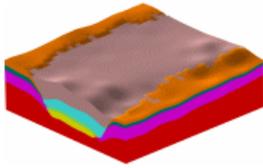
? Help Contents: RockWorks Utilities / Grid Model Tools / Grid Stratigraphic Tools

### Importing Stratigraphic Contacts from Grids into Stratigraphic Logs

Given a list of grid models, this program will define (or redefine) the contacts within existing stratigraphic logs based on the contents of a list of one or more stratigraphic surface models. Sample applications include: Interpolating elevations for missing contacts within borehole files (e.g. lost circulation intervals), estimating what a log might look like before the borehole is drilled (i.e. prediction).

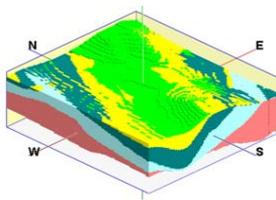
Caveats: Items within the datasheet "Unit" column must already exist within the project's Stratigraphy Types Table. This program only works with vertical boreholes.

### Manually Building 3D Stratigraphic Diagrams



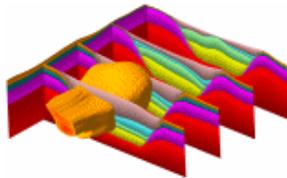
The **Grid / Grids -> Stratigraphic Model** tool is used to create a 3D stratigraphic model diagram based on a list of existing grid models that represent the top and base of each unit. These are grid models that must already exist on your computer. See also page 164.

### Manually Building 3D Stratigraphic Solid Models



The **Grid / Grids -> Solid** tool is used to create a 3D stratigraphic solid model (\*.MOD) based on a list of existing grid models that represent the top and base of each unit. This program is similar to **Grids -> Stratigraphic Model** except that this program creates a numeric *solid* model whereas the **Grids -> Stratigraphic Model** program just creates a diagram. See also page 165.

### Manually Building 3D Stratigraphic Fences



The **Grid / Grids -> Stratigraphic Fence** tool is used to create a stratigraphic fence diagram based on a list of existing grid models that represent the top and base of each unit. These are grid models that must already exist on your computer. See also page 165.

# Chapter 16 – Solid Model Tools

## Topics

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## Solid Menu Tools - Overview

The process of creating solid models is discussed in Chapters 10-13. Solid models are used to illustrate the 3-dimensional distribution of geochemistry, geophysical, lithology, or other measured values.

The tools in the RockWorks Utilities **Solid** menu discussed here are used to filter, extract, edit, and otherwise manipulate these solid models.

? See also: Chapters 10 – 13.

## Computing Solid Model Statistics

The RockWorks Utilities **Solid / Statistics** utility is used to get a general summary of the contents of an existing solid model file. The statistical summary can be displayed in several ways:

- As a **textual report**, in which the summary of node values and computed statistics are displayed in a document in a text editor. Example: Run this on two models to be sure they have the same dimensions for future mathematical operations.
- As a plottable **frequency histogram** of the node values, reported as numbers or percent. Be warned that histograms of high-density solid models may take a significant amount of time to create, or they may exceed the capacity of your computer system.
- As a plottable **scatterplot** of observed versus computed G values, representing model error. (We call these “Krajewskigrams” in honor of our associate who invented them.)
- As a listing of **predicted versus modeled values** in the data window.

? Help Contents: RockWorks Utilities/ Solid Model Tools / Solid Model Statistical Tools

## Performing Arithmetic Operations with Solid Models

The tools in the RockWorks Utilities **Solid / Math** option are used to perform arithmetic operations on the values stored in an existing solid model file, storing the results in a new solid model file. The following options are available:

**Model & Model:** This tool performs arithmetical operations with the node G-values in two existing solid model files.

**!** In order for the program to match up corresponding nodes in the two input models, they must have the same dimensions (X, Y, and Z coordinates and range) and numbers of nodes. If you aren't sure of the "size" of any solid model, use the **Solid / Statistics / Report** option to obtain a summary. If you need to change dimensions for either/both models you can use the **Resample** option, below.

**Model & Constant:** Performs arithmetical operations with the node G-values in a single solid model and a constant.

**Resample:** Reads an existing solid model and creates a new model based on the current project dimensions. You can use this tool to resize models that are to be filtered against or run through mathematical operations with each other.

**WARNING:** This resampling process is very slow. You may find it easier to remodel the original data using the new dimensions.

**?** Help Contents: RockWorks Utilities/ Solid Model Tools / Mathematical Tools

## Filtering Solid Models

The RockWorks Utilities **Solid / Filter** option used to filter the nodes contained within an existing solid model file.

The **Distance Filter** is used to filter an existing solid model file based on the nodes' distances from the XYZ control points. All nodes that lie beyond the distance cutoff will be set to null or a user-defined constant. This can be used to remove low-confidence areas from a model.

The **Grid Filter** adjusts the voxel values in a solid model based on their location above or below one reference grid model, or above, between, or below two reference grid models. This can be a handy way to assert stratigraphic surface or ground surface constraints on a solid model. Note that the input solid model and the input grid file must have the same dimensions and numbers of nodes in the X and Y directions in order for this filter to work. If you aren't sure, you can use the **Statistics** option in the **Grid** and **Solid** menus to view a summary of model dimensions and node spacings for grid and solid models, respectively.

The **Polygon Filter** reads a user-created table listing polygon boundary coordinates, and sets a solid model's nodes that lie either inside or outside a vertical projection of the polygon to a null value or a user-specified value.

The **Range Filter** deletes high or low G-values from a solid model file, reassigning them a user-specified constant.

The **Rounding Filter** reads G-values stored in a solid model file and rounds them up or down to the closest user-declared rounding interval.

The **Smoothing Filter** tool reads an existing solid model and averages the G-values based on a user declared "filter" size. The smoother can be run 1 or more times, to get rid of spurious "noise" within the model and bring out regional trends. Note that this tool pays no attention whatsoever to the original data from which the model was generated and makes no effort to honor the observed data values.

The **Tube Filter** reads an existing solid model and, given a list of xyz coordinates that represent the axes of tubes (e.g. mine workings, tunnels, etc.), sets the nodes that are either outside or inside the tubes to a null value.

? [Help Contents: RockWorks Utilities/ Solid Model Tools / Solid Model Filtering Tools](#)

## Creating and Manipulating Boolean Solid Models

The RockWorks Utilities **Solid / Boolean Operations** menu contains tools to transform a real number solid model file to a Boolean (true/false) file in which nodes are set to "1" if their G-value falls within a user-specified range, and a "0" if the G-values do not. In addition, there are tools to manipulate the resulting Boolean models.

The following options are available:

**Boolean Conversion:** This tool transforms a real number solid model file to a Boolean (true/false) file. In this process, the G-values of nodes are set to "1" if their original G-value falls within a user-specified range, and to a "0" if the G-values do not fall within the range. (Then, multiply this model back against the original to zero-out areas where your criteria aren't met.)

**Minimum Ore Zone Thickness:** This tool is used to specify a minimum thickness for any individual ore or material zone to be included in the output model and computations. This is a means of discarding non-economic areas from the totals.

**Minimum Total Ore Thickness:** This tool is used to specify a minimum thickness for the combined, total ore or material zones to be included in the output model and computations. This is also a means of discarding non-economic areas from the totals.

**Maximum Total Waste Thickness:** This tool is used to remove small pockets of "non-ore" material from surrounding "ore" blocks, translating them to "ore" classification and including them in the output solid model for future calculations.

**Stripping Ratio:** This tool is used filter a Boolean solid model based on the ratio between the thickness of the overburden ("waste") and the thickness of the zone of interest ("ore"). Several methods of computing the stripping ratio are offered, based on individual ore zones or total ore zones.

**Density Conversion:** This tool is used to enter a multiplier for individual Boolean voxels so that the program can compute total mass as well as total volume. The X, Y, and Z-values of the input model must be in the same units in order to compute a meaningful volume

Notes: The tools listed after Boolean Conversion can read ONLY BOOLEAN SOLID MODELS.

The computations can be constrained by a grid model representing surface elevations. Be sure the grid and solid models have the same XY dimensions and node spacings.

See also the **Solid / Convert / Ore Thickness to Grid** tool if you wish to convert the output Boolean model to a grid model for display as a 2D contour map.

Be sure that the conversion factor you enter for the Density Conversion tool matches the volume units that the program is using! If the program will be computing volume in cubic feet but your conversion constant represents weight per cubic inch, you would need to convert the constant to weight per cubic foot before entering it here.

? Help Contents: RockWorks Utilities/ Solid Model Tools / Boolean Model Tools

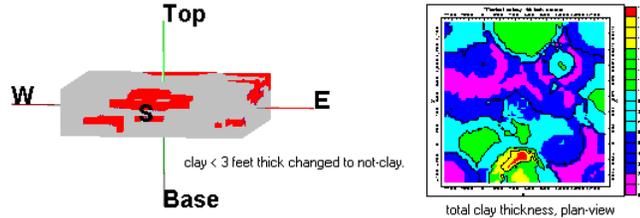
## Converting and Extracting Solid Model Data

The RockWorks Utilities **Solid / Convert** menu contains tools to convert certain solid model data to 2-dimensional grid model format, to extract 2-dimensional "layers" from solid models as grid files, and to insert 2-D grid model layers into solid models. These tools are available:

**Solid -> Grid:** Given a solid model, this program will create a grid model in which the z-value represents either the highest, lowest, average, or sum of corresponding value within the solid model (i.e. all nodes which fall within the same vertical region).

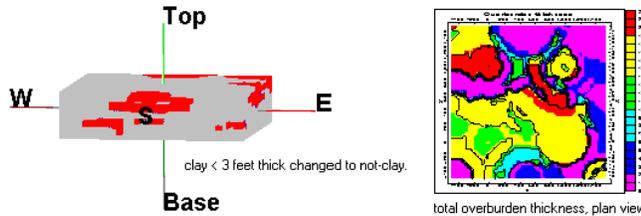
**Ore Thickness to Grid:** This translates a Boolean solid model file representing "ore" versus "not-ore" into a 2-dimensional grid file that represents total ore thickness, for display as a contour map, 3D surface, etc.

In this example, the solid model displays in dark clay zones that are > 3 feet thick (created in the **Solid / Boolean Ops / Minimum Ore Zone Thickness** tool). The contour map shows a plan view of the total clay thickness.



**Overburden Thickness to Grid:** This translates a Boolean solid model file representing "ore" versus "not-ore" into a 2-dimensional grid file that represents total overburden ("not-ore") thickness. The resulting grid file can be illustrated as a contour map, 3D surface, etc.

In this example, the solid model displays in dark clay zones that are > 3 feet thick (created in the **Solid / Boolean Ops / Minimum Ore Zone Thickness** tool). The contour map shows a plan view of the total thickness of the NOT-CLAY or "overburden".



**Extract Grid from Model:** This tool "pulls" out a 2-dimensional grid file from an existing real number or Boolean solid model file. The grid file can be extracted from any horizontal (constant Z) or vertical (constant Y or X) layer in the original solid model.

**Insert Grid into Model:** This tool inserts a 2-dimensional grid file "slice" into an existing real number or Boolean solid model file, replacing the existing node values with the grid's node values. The grid file can be inserted into any horizontal (constant Z) or vertical (constant Y or X) layer in the original solid model.

Notes:

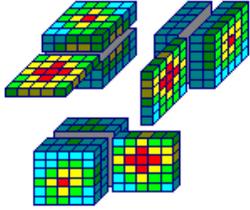
The **Ore Thickness to Grid** and **Overburden Thickness to Grid** tools read ONLY BOOLEAN SOLID MODELS.

See Editing Grid Models (page 211) for details about editing the extracted grid model.  
See Creating Grid-Based Maps (page 144) if you wish to illustrate the extracted grid file as a map.

- ? Help Contents: RockWorks Utilities/ Solid Model Tools / Converting, Extracting, Inserting Grid Models

## Editing Solid Models

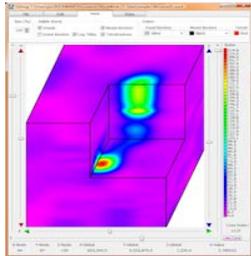
### Editing Solid Model Slices



The RockWorks Utilities **Solid / Edit / 2D** option is used to edit the contents of a real number or Boolean solid model file, one "slice" at a time. The slice you specify will be loaded into the Grid Editor for viewing and editing. When your work in the Grid Editor is complete, the edited slice will be re-inserted into the solid model. The modified solid model is saved on disk under a different file name.

- ? Help Contents: RockWorks Utilities/ Solid Model Tools / Editing Solid Models

### Using the Interactive 3D Solid Model Editor



The RockWorks Utilities **Solid / Edit / 3D** option is used to edit the contents of a real number or Boolean solid model file in an interactive 3D voxel editor window. Striplogs can be displayed for reference in editing the model voxels. You can adjust the tilt and skew, and drag controls to adjust the cutout dimensions to see inside the model. Editing can be done on single points or multiple points.

- ? Help Contents: RockWorks Utilities/ Solid Model Tools / Editing Solid Models

## Morphing Solid Models

The RockWorks Utilities **Solid / Morph** tool is used to read a list of existing solid model files (\*.MOD) and create a dynamic “movie” within RockPlot3D that shows time-based changes within these models. You can specify any number of intermediate, transitional models be generated between the existing models.

Notes: Be sure the solid model files have the same dimensions and number of nodes to morph successfully.

? Help Contents: RockWorks Utilities/ Solid Model Tools / Morphing Solid Models

## Initializing a Blank Solid Model

Use the **Solid / Initialize** tool to create a new solid model from scratch, at the dimensions and node spacing you declare. All model nodes will be initialized to a single, user-declared value.

? Help Contents: RockWorks Utilities/ Solid Model Tools

## Solid Model Import/Export Tools

### Importing Solid Models

The **Solid / Import** command is used to read an existing set of regularly-spaced XYZG data stored in an ASCII format and translate the data into a RockWorks solid model file format.

? Help Contents: RockWorks Utilities/ Solid Model Tools / Importing

### Exporting Solid Models

Use the **Solid / Export** command to export the data contained in a solid model file created within RockWorks. It offers model export to these different formats, with a variety of options:

**ASCII XYZG:** XYZ node locations and G values are listed in four columns, separated by the character of your choice, at the decimal precision you select, with or without a header.

**NOeSYS (T3D):** Exports XYZG data from the model to a NOeSYS ASCII format. RockWorks permits you to launch T3D automatically when the file export is completed.

**Slicer Dicer:** Exports XYZG data from the model to a Slicer Dicer format.

**Voxel Analyst:** Exports XYZG data to a Voxel Analyst format.

? Help Contents: RockWorks Utilities/ Solid Model Tools / Exporting

# Chapter 17 - Computing Volumes

## Topics

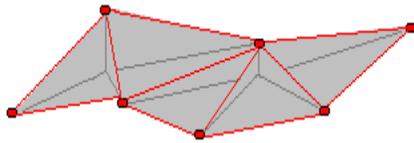
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## Volume Tools - Overview

RockWorks offers a number of tools for computing volumes of stockpiles, of formations in stratigraphic models, of specific material zones in solid lithology models, and of specific G value ranges in continuous solid models.

These tools can be found in both the RockWorks Utilities and in the Borehole Manager.

## RockWorks Utilities: EZ Volume of X, Y, Thickness Data



The RockWorks Utilities **Volumetrics / EZ Volume** calculator is used to compute the volume for a column of thickness values in the RockWorks Utilities datasheet and list the volume in a textual report.

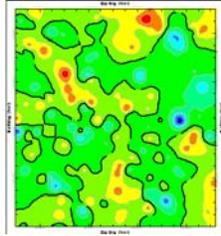
It uses a basic approach: Volumes are computed using a Delaunay triangulation method in which the samples are connected together in a network of triangles, a sample at each vertex. The volume of each triangle is computed, based on the thicknesses used as Z-values, and then the total volume added up.

This method tends to provide lower estimates of total volume than an orthogonal grid-based calculation. Optional volume-to-mass conversion is available.

Datasheet: RockWorks Utilities. This tool reads XYZ files where the Z value represents thickness. (See page 88.)

- ? Help Contents: RockWorks Utilities/ Volume Tools / Computing Volumes based on Thickness Values.

## RockWorks Utilities: Advanced Volume Computation of X, Y, Thickness Data



The RockWorks Utilities **Volumetrics / 2D (Grid Model)** option is used to compute formation volume, given a column of thickness values in the spreadsheet, with a variety of filtering parameters. The computations are grid-based, with the gridding algorithm user-selected.

Some of the advanced filtering operations include thickness, stripping ratio, up to 5 quantitative data column range restrictions, polygon areas, and distance.

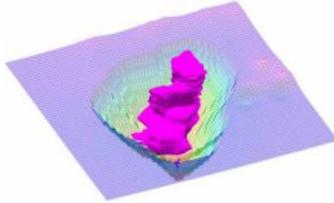
Finally, you have the options of:

- Storing the final thickness (or mass) model as a grid file on disk, and
- Displaying the volumetric (or mass) computations in a text report, and/or
- Displaying the final thickness (or mass) grid model as a 2-dimensional line or color-filled contour map, or labeled cell map, and/or
- Displaying the final thickness (or mass) grid model as a 3-dimensional profile or raised line or color-filled contour map.

Datasheet: RockWorks Utilities. This tool reads XYZ files where the Z value represents thickness. (See page 88.)

? [Help Contents: RockWorks Utilities/ Volume Tools](#)

## RockWorks Utilities: Extracting Solids



The RockWorks Utilities **Volume / Extract Solid** tool reads an existing solid model (such as soil chemistry or lithology type), determines the volume of a pit that would be required to extract the portions of the solid model that fall within a specified range (e.g. contaminated soil or a selected lithotype). The output is a report that lists the pit and contaminant volumes and the stripping ratios, a 2D diagram illustrating the pit elevations, and/or a 3D diagram showing the filtered solid and the pit elevations.

This program assumes you have already created a solid model that illustrates the distribution of the desired material. This can be created using the RockWorks Utilities **Solid / Model** tool (for XYZG data in the datasheet or external file) or using the Borehole Manager Model tools (**Lithology, Stratigraphy, I-Data, T-Data, P-Data** menus). You may also input solid models that have already been filtered for G value range or with a polygon filter (**Solid / Boolean Ops** or **Filter** tools).

The program also requires that you have an existing grid model of the surface elevations for the project. This will create more accurate computations and surface models.

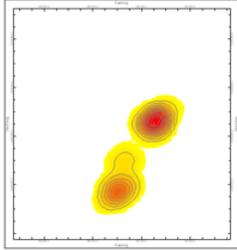
**Notes:**

This extraction process offers some options regarding maximum slope, and whether benches are desired and maximum bench height.

Use the Report Captions settings to fully customize your report to your units. See the help messages for examples.

? Help Contents: RockWorks Utilities/ Volume Tools / Extracting Solids.

## RockWorks Utilities: Computing Grade Thickness



The RockWorks Utilities **Volumetrics / Grade -> GT (Grade Thickness)** tool reads an existing solid model that contains grade values (e.g. percent eU308) this program will produce a GT (grade-thickness) grid and contour map in which the contours represent the grade multiplied by the thickness. In other words, high valued areas may represent either thick zones of lower-grade ore or thin zones of high-grade ore. The output includes a grid model and a 2D contour map or 3D surface map.

? Help Contents: RockWorks Utilities/ Volume Tools.

## Borehole Manager: Creating a Lithologic Volume Report

The Borehole Manager's **Lithology / Volumetrics** tool reads an existing lithologic solid model and compute volume, mass, number of nodes, and/or percent of each rock or soil type at user-declared elevation levels. Lithology solid models can be created in the Lithology / Model, Profile, Section, Fence, Surface Map, or Plan Map options.

Notes: If you select the Mass option, these computations are based on the Density Factors declared in the current Lithology Table which declare mass per cubic unit.

? Help Contents: Borehole Manager/ Lithology Tools / Computing Lithology Volumes.

## Borehole Manager: Creating a Stratigraphic Volume Report

Use the Borehole Manager's **Stratigraphy / Volumetrics** tools to compute volume, mass, number of nodes, and/or percent of each stratigraphic type in each user-defined elevation layer.

These computations can be done based on surface models or on a solid stratigraphic model. Stratigraphic solid models (.MOD) can be saved when you create a **Stratigraphy / Model**.

**Notes:**

The accuracy of the computations from the stratigraphy solid will be affected by the vertical spacing of the solid model nodes; the closer the spacing, the more accurate the volume computations. For this reason the surface-based computations may be more accurate (or, at least, consistent).

If you select the Mass option, these computations are based on the Density Factors declared in the current Stratigraphy Types Table which declare mass per cubic unit.

? Help Contents: Borehole Manager/ Stratigraphy Tools / Stratigraphy Volumes

## Borehole Manager: Creating Detailed Geochemistry Volume Reports and Diagrams

The Borehole Manager's **I-Data / Volumetrics** tool is designed to perform a variety of “what-if” filtering operations and volume computing operations on an existing solid model. The input model can represent precious metal assays, contaminant concentrations, or any measurable component for which you wish to compute volume.

This volume calculator specializes in models that are not stratified or homogeneous. You can filter the solid model for interbed thickness, material zone thickness, polygon areas, and distance from a borehole.

Output windows:

The final, filtered Boolean solid model file that represents the distribution of favorable materials can be displayed in RockPlot3D.

The final thickness or mass grid model can be displayed in RockPlot2D or 3D.

The detailed or summarized text report is displayed in a text window.

? See also: RockPlot3D for display of solid model or stratigraphy volume right in the 3D window. The **Solid / Statistics / Report** tool for a quick report of dimensions and volume of any solid model.

? Help Contents: Borehole Manager/ I-Data Tools / Creating Detailed I-Data Volume Reports and Diagrams.

# Chapter 18 – Hydrology/Hydrochemistry Tools

## Topics

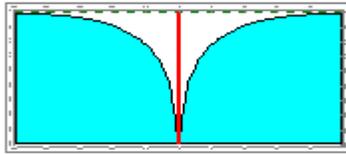
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## Overview

The RockWorks Utilities **Hydrology** and **Hydrochemistry** menus contain tools used for computing water level drawdown, creating water level and precipitation graphs, and hydrochemistry diagrams and calculations.

In earlier versions of RockWorks, these tools were lumped under the “Hydro” menu.

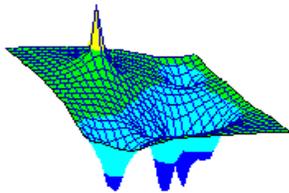
## Computing Drawdown for a Single Well



The RockWorks Utilities **Hydrology / Drawdown (1 Well)** utility is used to calculate water-level drawdown for a single well using the Theis non-equilibrium equation. Data for a single well is entered directly into the program dialog box; it is not read from the program datasheet.

? Help Contents: RockWorks Utilities / Hydrology Tools

## Computing a Drawdown Surface



The RockWorks Utilities **Hydrology / Drawdown Surface** utility is used to read a listing of drawdown data parameters from the datasheet and generate a potentiometric surface model based on pumping and/or injection wells using the Theis non-equilibrium equation.

? Help Contents: RockWorks Utilities / Hydrology Tools / Computing a Drawdown Surface

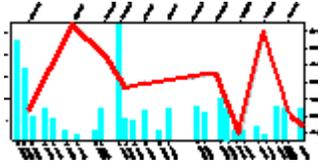
## Plotting 3D Flowlines



The RockWorks Utilities **Hydrology / Flowlines** command reads a particle path data file (as can be imported from ModPath data) and plots ModPath-style particle paths as 3-dimensional tubes.

- ? Help Contents: RockWorks Utilities / Hydrology Tools / Plotting Particle Paths as 3D Flowlines.

## Plotting Water Level versus Precipitation



The RockWorks Utilities **Hydrology / Hydrograph** command reads from the main datasheet listings of water level and precipitation measurements over time, and creates a HydroGraph diagram that illustrates their relationship.

- ? Help Contents: RockWorks Utilities / Hydrology Tools / Creating Hydrographs

## Computing Ion Balance

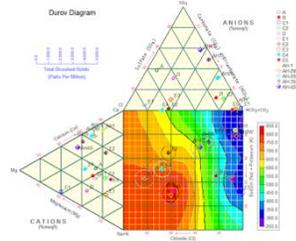
The RockWorks Utilities **Hydrochemistry / Ion Balance** tool reads a listing of ion concentrations from the datasheet and computes cation:anion ratio for each sample, in milli-equivalents per liter. RockWorks uses the following equation for the ion balance:

$$\left( \frac{\text{cations} - \text{anions}}{\text{cations} + \text{anions}} \right) \times 100$$

You may choose up to 4 additional cations and 4 additional anions in the computations.

- ? Help Contents: RockWorks Utilities / Hydrochemistry Tools / Computing Ion Balance

## Creating Durov Diagrams



The RockWorks Utilities **Hydrochemistry / Durov** command is used to read a listing of ion concentrations from the datasheet and create a Durov diagram for groundwater ion concentration analysis.

Durov diagrams consist of three parts: Two trilinear diagrams along the side and top, and one square grid in the middle. The trilinear diagrams illustrate the relative concentrations

of cations (left diagram) and anions (top diagram) in each sample. Each sample will be represented by a point in each trilinear diagram; unique symbols may be selected for each sample and can be referenced in a symbol index at the top of the diagram. Symbols may be accompanied by labels if desired. The square grid is designed to show both anion and cation groups.

Circles may be plotted around each point to illustrate total dissolved solids ("TDS") for the sample. The total dissolved solid computation will include all components listed in the data file ("standard" ions and additional ions). TDS concentrations and relative sample densities can also be represented with contours in the diagram.

Concentrations entered in the source data file in units of milligrams per liter are converted to milli-equivalents per liter for display on the diagram. You may choose up to 4 additional cations and up to 4 additional anions for the TDS computations.

? [Help Contents: RockWorks Utilities / Hydrochemistry Tools / Creating Durov Diagrams](#)

## Creating Piper Diagrams



The RockWorks Utilities **Hydrochemistry / Piper** command reads a listing of ion concentrations from the datasheet and creates a Piper diagram for groundwater ion concentration analysis.

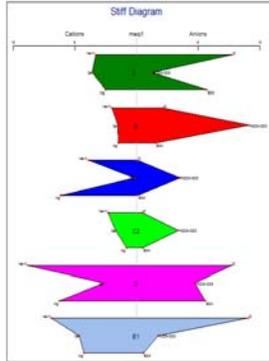
Piper diagrams consist of three parts: Two trilinear diagrams along the bottom and one diamond-shaped diagram in the middle. The trilinear diagrams illustrate the relative concentrations of cations (left diagram) and anions (right diagram) in each sample. Each sample will be represented by a point in each trilinear diagram; unique symbols may be selected for each sample and can be referenced in a symbol index at the top of the diagram. Symbols may be accompanied by labels if desired. The diamond field is designed to show both anion and cation groups.

Circles may be plotted around each point to illustrate total dissolved solids ("TDS") for the sample. The total dissolved solid computation will include all components listed in the data file ("standard" ions and additional ions).

Concentrations entered in the source data file in units of milligrams per liter are converted to milli-equivalents per liter for display on the diagram. You may choose up to 4 additional cations and up to 4 additional anions for the TDS computations.

? [Help Contents: RockWorks Utilities / Hydrochemistry Tools / Creating Piper Diagrams](#)

## Creating Stiff Diagrams



The RockWorks Utilities **Hydrochemistry / Stiff** command reads a listing of ion concentrations from the datasheet and creates a Stiff diagram for groundwater ion concentration analysis.

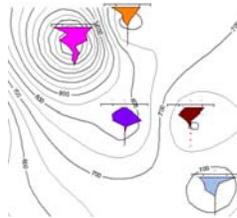
Stiff diagrams plot milli-equivalent concentrations of cations on the left side of the diagram and of anions on the right. Each ion is plotted as a point, and the points are connected to form a polygonal shape. The ions are plotted in a consistent order (Na+K across from Cl; Ca across from HCO<sub>3</sub> + CO<sub>3</sub>; Mg across from SO<sub>4</sub>) so that each polygon becomes that sample's "signature". Additional ions, if present, are plotted in the order that they are listed, below the standard ions.

You may choose up to 4 additional cations and anions for display in the Stiff polygons.

Use the Vertical Point Spacing and Polygons Per Page settings to control lengths of polygons. Use the Horizontal Scaling setting to determine widths of polygons; if you choose Automatic and there are multiple pages, be warned that each page may represent a different horizontal scale.

? [Help Contents: RockWorks Utilities / Hydrochemistry Tools / Creating Stiff Diagrams](#)

## Creating Stiff Diagram Maps



The RockWorks Utilities **Hydrochemistry / Stiff Map** option is used to create a map with a Stiff diagram illustrating ion concentrations at each sample point. See page 113 for more information.

## Computing Total Dissolved Solids

The RockWorks Utilities **Hydrochemistry / Total Dissolved Solids** command reads a listing of ion concentrations from the datasheet and computes total dissolved solids for each sample. Total dissolved solids represent the sum of all "declared" ions, as listed in the Data Input Columns, in the parts per million (or milligrams per liter) units read from the RockWorks Utilities datasheet.

You may choose up to 4 additional cations and anions in the computations.

? [Help Contents: RockWorks Utilities / Hydrochemistry Tools / Computing TDS](#)

# Chapter 19 - Directional Statistics Tools

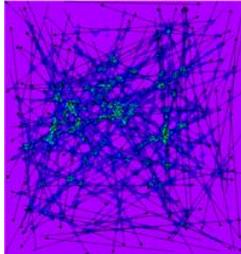
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## Overview

The RockWorks Utilities **Linears** and **Planes** menus contains tools used for performing analyses on and creating diagrams of directional (2D or 3D) data. These tools were previously lumped under the “Dirstat” menu.

## Creating Arrow Maps

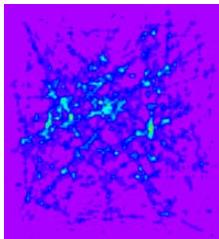


The RockWorks Utilities **Linears** / **Arrow Map** tool is used to read X1Y1X2Y2 data (page 92) and create a map in which lineations are represented with arrows plotted from the beginning X,Y coordinates to the ending coordinate pair. This graphic example illustrates an arrow map overlaying a lineation density contour map, discussed next.

Notes: See Creating Lineation Maps (below) for maps without arrowheads.

? Help Contents: RockWorks Utilities / Linear Feature Tools / Creating Arrow Maps

## Gridding and Mapping Lineations

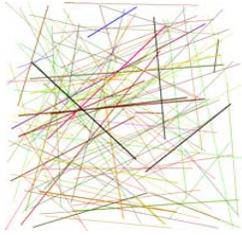


The RockWorks Utilities **Linears** / **Lineation Gridding** menu command is designed to read lineation data (in X1, Y1, X2, Y2 endpoint coordinate format), and create a grid file that models the lineation frequency, cumulative lengths, and/or intersections, with a variety of weighting options.

Notes: See Creating Lination Maps (below) for mapping the lineations themselves.

? Help Contents: RockWorks Utilities / Linear Feature Tools

## Creating Lination Maps

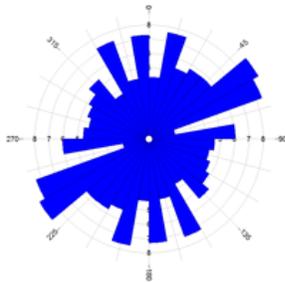


The RockWorks Utilities **Linears** / **Lination Map** utility creates a map of lineations from X1Y1X2Y2 line endpoint data (page 92).

Notes: See Creating Arrow Maps (earlier topic) for information about creating maps in which the lineations contain arrowheads.

? Help Contents: RockWorks Utilities / Linear Feature Tools / Creating Lination Maps

## Creating Rose Diagrams



The RockWorks Utilities **Linears** / **Rose Diagram** / **From Bearings** and **From Endpoints** utilities read either bearing data (page 91) or line endpoint data (page 92) and generate a directional diagram that depicts the orientations of the linear features. Full or half-rose diagrams are available. Line endpoint data can be interpreted as directional (1-direction) or oriented (2-directions).

? Help Contents: RockWorks Utilities / Linear Feature Tools / Creating Rose Diagrams

? See also: Creating Rose Diagrams & Rose Diagram Maps from fracture data (page 201)

## Other Lination Tools

### Computing Lination Bearing, Length, and Midpoint

The RockWorks Utilities **Linears** / **Lination Properties** command computes the bearing, length, and/or midpoint of lineations listed in the main datasheet as X1 Y1 X2 Y2 line endpoint coordinates (page 92).

? Help Contents: RockWorks Utilities / Linear Feature Tools

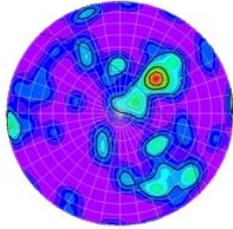
## Importing DXF Lineations into the Datasheet

The RockWorks Utilities **Linears / Import / DXF Lineations** utility is used to import lineation endpoint data from a DXF file, storing the endpoint coordinates in the main RockWorks data sheet.

Notes: "LINE" and "POLYLINE" entities only are read from the DXF file. "POLYLINE" entities will be broken down into their individual segments. See also [Importing Files into RockPlot2D](#) (page 253) for information about importing DXF images into the plotting window.

- ? Help Contents: RockWorks Utilities / Linear Feature Tools / Importing DXF Lineations into the RockWorks Datasheet

## Creating Stereonet Diagrams

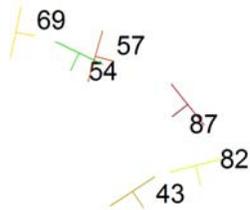


The RockWorks Utilities **Planes / Stereonet** utility reads planar, linear, or rake data from the data sheet (page 91), and displays the orientation of these features on a stereonet diagram using points and great circles. Optional gridding is available to display point density with line or color-filled contours.

Notes: Data can be listed as right-hand rule or dip direction. Equal area and Equal angle projections are available. Gridding can be using the Step Function or Spherical Gaussian methods. See the help messages for details about the stereonet statistics and more.

- ? Help Contents: RockWorks Utilities / Planar Feature Tools / Creating Stereonets
- ? See also: [Creating Stereonets and Stereonet Maps from downhole fracture data](#) (page 201).

## Creating Strike and Dip Maps



The RockWorks Utilities **Planes / Strike & Dip Map** utility is used to plot a strike and dip map based on X and Y coordinates, strike, dip, and color data from the data sheet (page 91).

- ? Help Contents: RockWorks Utilities / Planar Feature Tools
- ? See also [directional maps of slope/aspect grid models](#) (page 212).

## Other Planar Tools

? Help Contents: RockWorks Utilities / Planar Feature Tools

### Converting Strike Bearing to Dip Direction

The RockWorks Utilities **Planes / Strike -> Dip Direction** command is used to read from the datasheet a listing of azimuth bearings representing strike and translate them to dip direction. The output values will be stored in a designated column in the same datasheet. This permits you to change the format of your data from "right hand rule" to "dip direction."

### Computing the Orientation of a Single Plane Based on 3 Points

The RockWorks Utilities **Planes / 3-Points -> Planes / One Set** tool computes strike and dip based on three points and plots a surface as a contour map. The X,Y,Z points are typed into the program window (they are not read from the datasheet).

### Computing Plane Orientations Based on Three Points

Given a list of xyz coordinates for three points along a series of planes, the **Planes / 3-Point -> Planes / Multiple Sets** program computes the dip direction (or strike) and dip angle for planes that pass through these points. The output is stored within two new datasheet columns.

Datasheet: RockWorks Utilities, multiple sets of X1Y1Z1 X2Y2Z2 X3Y3Z3 data points.

### Computing Planar Intersections

The RockWorks Utilities **Planes / Beta Intersections** command reads a listing of planar orientations from the RockWorks data sheet (page 91) and calculate the lineations resulting from the intersections of all of the planes in the file. The linear values will be stored in an ASCII text file that can be displayed in the RockWorks text editor when completed.

The number of intersections that will be computed is:

$$\text{number} = n(n - 1) / 2 \quad \text{where } n \text{ is the number of individual planes in the input file.}$$

As the number of original planes increases, the number of resulting lineations increases dramatically. For example, a data set with 20 planes will result in 190 lineations, and 200 planes will produce 19,900 lineations!

Notes: A comparison: Beta Intersections reads a listing of individual planar strike and dip measurements from the data sheet and calculates the lineations that result from the intersection of each plane with each other plane in the data set. This can result in a tremendous number of computed lineations! Beta Pairs, on the other hand, reads strike and dip measurements for pairs of planes, and for each pair computes the single resulting lineation.

## Computing Planar Intersections - Planar Pairs

The RockWorks Utilities **Planes / Beta Pairs** tool is used to read the strike and dip of pairs of planes (page 92) and calculate the lineations resulting from their intersections. The bearing and plunge of these lineations are stored in new columns in the datasheet.

Notes: A comparison: Beta Intersections (previous) reads a listing of individual planar strike and dip measurements from the data sheet and calculates the lineations that result from the intersection of each plane with each other plane in the data set. This can result in a tremendous number of computed lineations! Beta Pairs, on the other hand, reads strike and dip measurements for pairs of planes, and for each pair computes the single resulting lineation.

## Rotating 3D Data

Use the RockWorks Utilities **Planes / Rotate Planes** command to rotate 3D features (planes or 3D lineations) by a specified amount, and to list the resulting strike and dip (or dip direction, dip angle) values in two new columns of your data sheet. The input data can be entered using the right-hand rule or as dip direction, dip angle.

## Converting Polylines to Planes

The **Planes / Import / Polylines -> Planes** program reads xyz polyline coordinates from an external ASCII file and computes the orientations of planes that pass through the polyline vertices. It is designed for applications in which the user has xyz coordinates that represent the intersections between fractures or contacts and surface topography. By computing the orientations of planes that pass through these points, it is possible to analyze and/or visualize the relative positions and orientations of these structures.

## Translating Coordinates – Converting Azimuth <-> Quadrant

The RockWorks Utilities **Coords** menu contains two tools for translating decimal-style azimuth bearings (i.e. 135) into quadrant-style bearings (i.e. S45E), and vice versa. The input data is read from the datasheet (strike and dip data, page 91) and the output coordinates are recorded there.

- ? Help Contents: RockWorks Utilities / Coordinate Conversion Tools / Converting Azimuth Data to Quadrant Format, Converting Quadrant Data to Azimuth Format.

**Notes**

# Chapter 20 - Statistical Tools and Graphs

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## Statistical Tools - Overview

The RockWorks Utilities **Stats** menu includes program for computing univariate, bivariate, and trivariate statistics as well as for creating a variety of statistical diagrams. Some of these tools are also available in the Borehole Manager for summarizing database records.

## Computing Univariate Statistics

### RockWorks Utilities

The RockWorks Utilities **Stats / Univariate** tool is used to calculate statistics for a single column of samples in the current datasheet. Data may be filtered out when an appropriate filter range is selected. Statistics include simple summaries (population, min, max, range, mean, etc.) as well as Mean + - 1, 2, 3, and 4 Standard Deviations.

Notes: This option is also available as a right-click option - simply right-click anywhere within a RockWorks Utilities datasheet, choose **Columns / Statistics** and you will see the statistical report in a text window.

- ? Help Contents: RockWorks Utilities / Statistical Tools / Creating a Statistical Report for a Column of Values

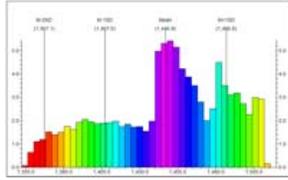
### Borehole Manager

The Borehole Manager's **I-Data / Stats, T-Data / Stats, and P-Data / Stats** tools are used to calculate statistics for a single track of samples in the current database. Spatial and G-value filters are available, as is resampling. Statistics include simple summaries (population, min, max, range, mean, etc.) as well as Mean + - 1, 2, 3, and 4 Standard Deviations.

- ? Help Contents: Borehole Manager / I-Data Tools or P-Data Tools

## Creating Frequency Histogram Plots

### RockWorks Utilities



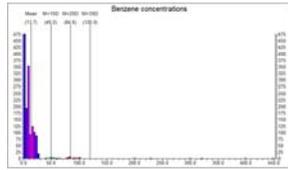
The RockWorks Utilities **Stats / Histogram** tool reads a single column of data from the datasheet and determines the frequency or percentage of the total number of measurements for that variable that falls in each user-defined grouping or "cell." These values are represented as a bar histogram plot.

It also contains a tool for creating multiple histogram plots of separate data columns and combining them into a single image.

Notes: The Multiple Histogram tool is a handy way to see quickly the distribution of numerous variables.

- ? Help Contents: RockWorks Utilities / Statistical Tools / Creating a Frequency Histogram for a Column of Values, Creating Multiple Frequency Histograms for Two or More Columns of Values.

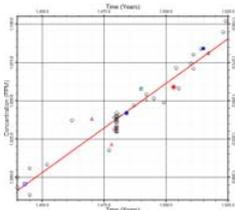
### Borehole Manager



The Borehole Manager **I-Data / Histogram, T-Data / Histogram, and P-Data / Histogram** options are used to read a single track of data from the database and determine the frequency or percentage of the total number of measurements for that variable that falls in each user-defined grouping or "cell." These values are represented as a bar histogram plot.

- ? Help Contents: Borehole Manager / I-Data Tools, T-Data Tools, or P-Data Tools

## Creating a Scattergram (X, Y) Plot for Two Variables

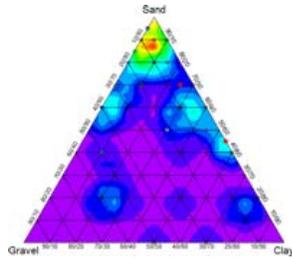


The RockWorks Utilities **Stats / Scattergram** tool is used to plot the data listed within a designated column in the datasheet against the data within another column.

Notes: Linear Regression and Polynomial Fit are available for interpolation.

- ? Help Contents: RockWorks Utilities / Statistical Tools

## Creating a Ternary Diagram for Three Variables

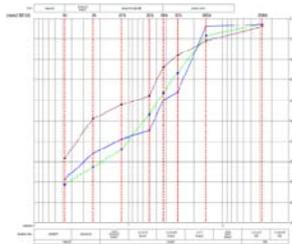


The RockWorks Utilities **Stats / Ternary** tool generates a trilinear diagram based on three columns of data. Optional contouring is available to show point density.

In addition, the Ternary program also includes options for plotting a variety of classification systems. These will plot a pre-defined diagram in the background with your data points and/or contours in the foreground. The currently available templates include Folk's (1954) siliclastic classification system, Schlee's (1973 - after Shepard) siliclastic classification system, Shepard's 1954 siliclastic classification system, and the USDA soil classification system.

- ? Help Contents: RockWorks Utilities / Statistical Tools / Creating Ternary (Tri-lateral) Diagrams.

## Creating a Sieve Diagram



The RockWorks Utilities **Stats / Sieve Diagram** tool is used to generate cumulative grain size distribution diagrams depicting grain size distributions for one or more samples. The program menu includes a variety of options that are designed to accommodate the plethora of classification systems and screen dimensions by allowing the user to specify the directionality of the horizontal and vertical scales as well as the border annotation. It also includes annotation options that allow the user to customize the diagram.

- ? Help Contents: RockWorks Utilities / Statistical Tools / Creating Sieve Diagrams

## Other Statistics Tools

- ? Help Contents: RockWorks Utilities / Statistical Tools / Generating Random Numbers

### Normalizing Data

The **Stats / Normalize** utility reads a single column of values from a RockWorks data sheet and normalizes the data values so that they range between two user-specified values. The resulting data are listed in a new data sheet column.

## Standardizing Data

The RockWorks Utilities **Stats / Standardize** utility reads a single column of values from a RockWorks data sheet and calculates the mean and the deviation of each sample value relative to the mean. The resulting data are stored in a new column in the data sheet. Once computed, display the standardized values as a contour map to show anomalous areas

## Generating Random Numbers

The RockWorks Utilities **Stats / Random** utility generates random numbers within a specified range or from a normal distribution. This utility can generate both positive and negative numbers with or without decimal values.

## Computing Point to Point Distances

The RockWorks Utilities **Stats / Point Distances** utility is used to read X,Y or X,Y,Z point locations from the datasheet and compute a variety of statistics regarding the distribution of the points.

# Chapter 21 - Survey Tools

## Topics

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## Survey Menu - Overview

The **Survey** menu contains a variety of tools designed to translate different kinds of survey data:

### Converting Bearing / Distance Data and Creating Maps

The RockWorks Utilities **Survey / Bearing/Distance** tools are used to convert survey data (page 90) to XYZ coordinates for display in a new datasheet, and/or to create a plottable map in 2D or 3D that illustrates the survey stations and/or transect lines with a variety of labeling options. The survey data must list one or more control points, and bearing, distance, and inclination to the survey stations.

- ? Help Contents: RockWorks Utilities / Survey Tools / Converting Survey Data to XYZ, Plotting 2D Survey Maps, Plotting 3D Survey Maps

### Converting Triangulation Data to XYZ

The RockWorks Utilities **Survey / Triangulation** tool is used to convert triangulation survey data (page 90) to XYZ coordinates for display in the current datasheet. This program requires that two or more stations have known X,Y, Z (elevation) coordinates from which other coordinates can be computed.

- ? Help Contents: RockWorks Utilities / Survey Tools / Converting Triangulation Data to XYZ Coordinates

### Setting Up X,Y Stations

The RockWorks Utilities **Survey / Setup XY Stations** tool is used to create a new set of X,Y coordinates based on a single user-entered coordinate, a known grid-based station arrangement, and a user-entered spacing.

- ? Help Contents: RockWorks Utilities / Survey Tools / Setting Up X,Y Stations

## Interpolating Points Along a Line

The **Survey / Interpolate Points Along a Line** tool creates a new set of X,Y coordinates based on beginning and ending coordinates of a line, and the point spacing along that line.

? Help Contents: RockWorks Utilities / Survey Tools / Interpolating Points Along a Line

## Computing Downhole Survey Coordinates

The **Survey / Drill Hole Survey** tool is used to read depths, bearings, and inclinations from the utilities datasheet, and compute XYZ coordinates at user-specified intervals down the borehole. It also offers 2D and 3D diagram views of the deviated borehole.

? Help Contents: RockWorks Utilities / Survey

## Chapter 22 –Accessory Image Tools

### Topics

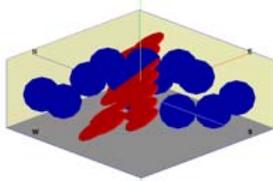
### 3D Utilities

The RockPlot3D plotting window, part of RockWorks, is used for display of surfaces, solids, fences, and other 3-dimensional images created in many Borehole Manager and RockWorks Utilities tools discussed in earlier chapters.

The **Grafix** menu (available from both the Borehole Manager and the RockWorks Utilities) contains additional tools for creating general-purpose 3D images which can be appended to other 3D images right within RockPlot3D (**File** / **Append**).

? Help Contents: Graphics Tools / 3D Utilities

### 3D Discs

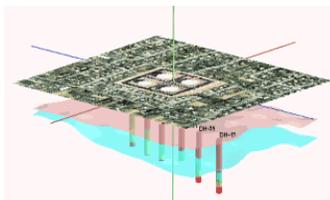


The **Discs** program plots 3D discs based on xyz coordinates, dip-direction, and dip amount, read from the datasheet (page 93). It is designed to display the relative orientations of planes in three-dimensions.

### 3D Bitmaps

Use the **Grafix** / **3D Utilities** / **Images** tools to apply 3-dimensional characteristics to bitmap images. This includes floating a bitmap horizontally at a specified elevation, draping an image over a surface, or displaying images as horizontal or vertical panels. A variety of bitmap images are supported: BMP, JPG, EMF/WMF, PCX, PNG, TGA, and TIFF. Where applicable, georeferencing can be done with an accompanying World File.

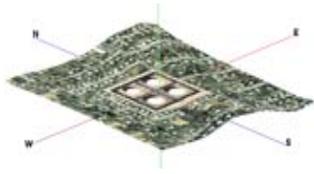
#### Float a bitmap at a particular elevation



The **Grafix** / **3D Utilities** / **Images** / **Float** tool reads an existing bitmap image and, given input user coordinates and an elevation, generates a flat, floating 3D image of the bitmap.

Notes: Be sure the X and Y coordinates you assign to the bitmap corners are in the same units as those in the project with which you'll be combining this image. Once the image is created, save it, then use **File** / **Append** to append this to an existing image.

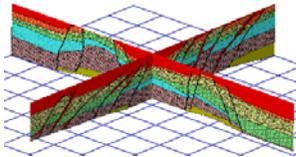
### Drape a bitmap over a surface



The **Grafix / 3D Utilities / Images / Drape** tool reads an existing bitmap image and, given an existing grid model, generates a 3D image of the bitmap that conforms with the grid surface.

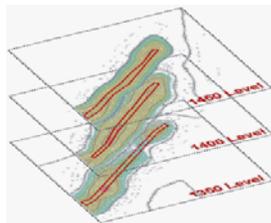
Save the draped bitmap view, then use **File / Append** to append this to an existing RockPlot3D view.

### Display bitmap images as vertical panels



The **Grafix / 3D Utilities / Images / Panels / Vertical** tool reads a list of bitmap images and their coordinates, and displays them as vertical image panels.

### Display bitmap images as horizontal panels

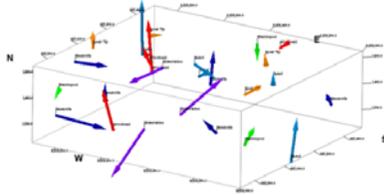


The **Grafix / 3D Utilities / Images / Panels / Horizontal** tool reads a list of bitmap images and their coordinates, and displays them as horizontal or inclined image panels.

### Display Bitmaps on a 3-Dimensional Cube

The **Grafix / 3D Utilities / Images / Cubes** program reads a list of images from the RockWorks Utilities datasheet and display them on a 3 dimensional cube for display in RockPlot3D. These can be used to create displays of building in 3D.

### 3D Oriented Objects



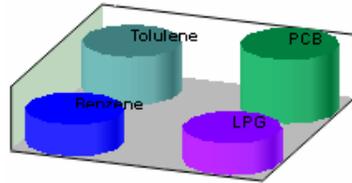
The **Grafix / 3D Utilities / Oriented Objects** tool reads location, bearing, inclination, and length information from the datasheet and draws 3-dimensional arrows at those locations for display in RockPlot3D. Use this to display fossils, archeological items, flow vectors or other oriented items in 3D space.

### 3D Perimeter

The **Grafix / 3D Utilities / Perimeter** option reads X and Y coordinate listings from the datasheet and plots fence-like perimeter edges for subsequent inclusion within other three-dimensional diagrams. During building of the perimeter “fence” you can specify its base and top elevation.

Once you’ve saved the perimeter image, use **File / Append** to append it to an existing RockPlot3D view.

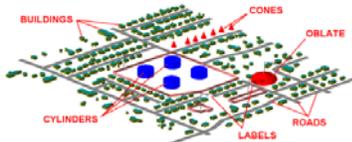
### 3D Storage Tanks



The **Grafix / 3D Utilities / Storage Tanks / Horizontal** and **Grafix / 3D Utilities / Storage Tanks / Vertical** tools read location, elevation, radius and color data from the datasheet (page 93) and draw 3-dimensional cylindrical tanks at those locations for display in RockPlot3D. Use these to display underground or surface tanks with your 3d images. The tanks can be oriented vertically or horizontally.

Once you’ve saved the tank image, use **File / Append** to append it to an existing RockPlot3D view.

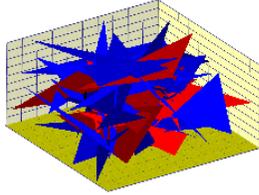
### 3D Surface Objects



The **Grafix / 3D Utilities / Surface Objects** tool is used to create simple 3D entities such as buildings, roads, cylinders, and walls that may be plotted along with other 3D diagrams in order to show relative positions of surface items. Data is read from an external ASCII file.

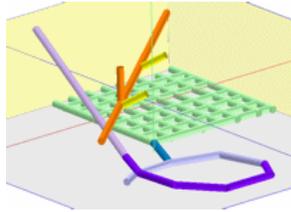
Once you've saved the image of the surface items, use **File / Append** to append it to an existing RockPlot3D view.

### 3D Triangles



The Triangles program is used to plot a series of colored triangles in 3D space. The input consists of a datasheet that lists the coordinates for each triangle vertex.

### 3D Tubes



The **Grafix / 3D Utilities / Tubes** option reads X1Y1Z1 X2Y2Z2 locations from the datasheet (page 93) and draws 3D tubes between these locations for display in RockPlot3D. Use this to display pipes, mine workings, structural diagrams in 3D space.

### Other Tools

The **Grafix** menu's **3D Utilities** also offers a stand-alone reference cage tool that's the same as the cage options listed within many of the program menus.

It also contains a stand-alone append-XML tool that functions just like the Append tool in RockPlot3D. (See page 266.)

### 2D Utilities

The **Grafix** menu's **2D Utilities** tools are stand-alone duplicates of those that exist within RockPlot2D:

**Append:** Combines two RK6 files.

**Append Raster Image:** Inserts a raster image into a RK6 file.

**Clip:** Clips a RK6 file within a rectangular region.

**Montage:** Combines multiple 2D images into a montage.

**Import:** Offers tools for importing AGL, DXF, and ESRI Shapefiles into RockPlot2D. (See also page 253.)

**Export:** Offers tools for exporting an existing RK6 file to a WMF, EMF, BMP, JPG, PNG, TIFF, or RockPlot3D format.

## Other Tools

? Help Contents: Graphics Tools / Misc Image Tools

### Creating an Animated GIF Image

The **Grafix / Images / Animated GIF** option is used to create an animated GIF file (suitable for inclusion within web pages) based on a list of images, such as the list generated by the **Grid / Morph** program.

### Appending RK6 Files and Raster Images

The **Grafix / Images / Append Raster Image** option is used to combine an existing RK6 file (from Rockplot2D) with a raster image that you georeference. The raster image can lie on top of or underneath the RK6 file's entities. The resulting image is saved under a new RK6 file name.

### Screen Digitizing from a Raster Image

The **Grafix / Images / Digitize From Bitmap** program is used to import a raster image (BMP, JPEG, WMF, EMF, PCX, PNG, and TIFF), calibrate it to global coordinates, and digitize points, lines, polylines, and polygons. As the items are selected, the global coordinates are stored within an editable data window along the right side of the screen. This data may then be copied into other applications.

See also: Digitizing data with an electronic digitizing tablet (page 98).

### Displaying a RockWorks PicShow

The **Grafix / Images / PicShow** option is used to read a list of names of bitmap images (BMP or JPG format) from the RockWorks Utilities data sheet, and display them in order, with an adjustable delay between frames. The PicShow can run once or be continually looped to repeat the display list.

### Raster to RockPlot2D

The **Grafix / Images / Raster -> RockPlot2D** tool can be used to add aerial photos to your maps or raster well logs or core pictures to your strip logs, cross sections and fence diagrams. This procedure supports BMP, JPEG, WMF, EMF, PCX, PNG, and TIFF formats. For very large images you may want to resize them to save disk space and for better viewing quality using the new Raster Conversion utility, below.

### Raster Conversion

The **Grafix / Images / Raster Conversion** tool is used to read bitmap images and resize and/or sharpen them. This would typically be done prior to displaying the images in RockPlot2D. This procedure supports BMP, JPEG, WMF, EMF, PCX, PNG, and TIFF formats.

## Rectifying Images

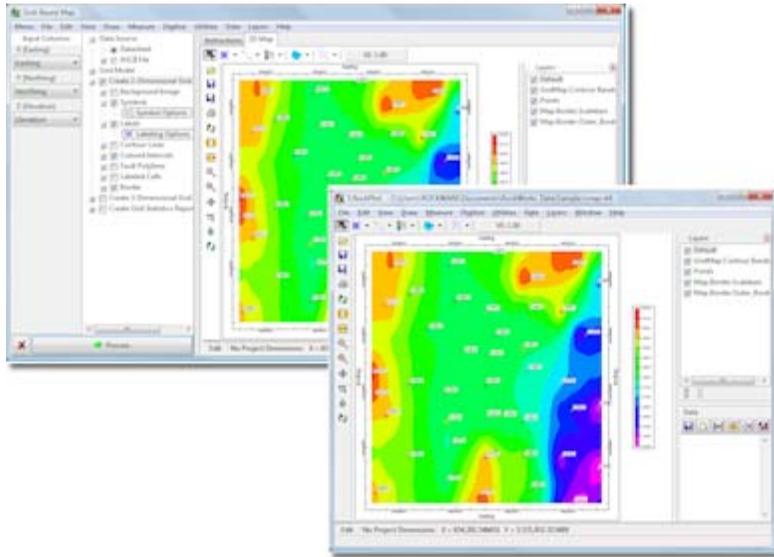
The **Grafix / Images / Rectify Image** tool reads a bitmap image and allows you to calibrate it to real world coordinates, rotate it to N-S and E-W orientation, clip it to project or user-defined coordinates, and display it in RockPlot2D or floating/draped in RockPlot3D. Extra large images can be resampled to lower resolution. Accompanying World files can be created.

## Chapter 23 – Displaying 2D Images - RockPlot2D

### Topics

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### RockPlot2D Overview

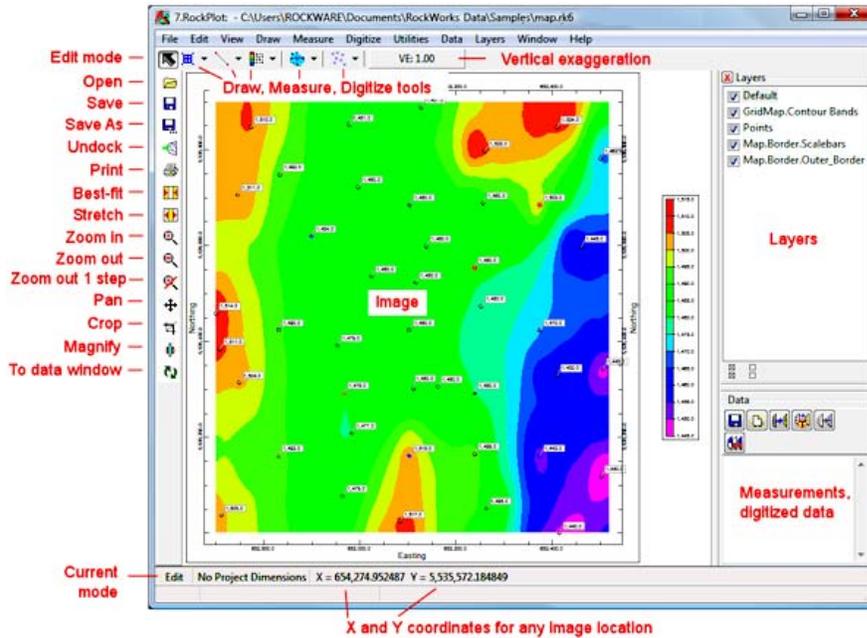


RockPlot2D is one of the plotting engines for RockWorks. It is used to display 2-dimensional maps and diagrams as they are being created, and for opening saved images at a later date. RockPlot2D contains its own set of menu and toolbar commands, which are discussed in this section.

- ! New to RockWorks15: RockPlot2D is embedded right into the program Options windows. However, you can still open a stand-alone RockPlot2D window (page Managing RockPlot2D Files). You can “undock” an image from an embedded window (page ). You can also configure the program to not embed the graphic windows (page 293).

- ? See also: RockPlot3D (page 265) for information about manipulating images in the RockWorks 3D plotting window, and ReportWorks (page 277) for information about the new page layout tool in RockWorks

## Quick Summary of RockPlot2D Tools



## Toolbar Summaries

**Left-hand toolbar:** File operations (Open, Save, Print), view operations (copy to new window, best fit, stretch, zoom, pan, magnify), and crop.

**Upper toolbar:** Edit-mode, draw points (circles, symbols, text), draw lines (lines, polylines, rectangles, polygons), draw miscellaneous items (scale bars, text tables, images, grids, legends [lithology, stratigraphy, well construction, color, symbol, line style, etc.]), measure tools (bearing, distance, perimeter, area), digitize tools (vertices, lines, polylines, polygons), vertical exaggeration.

**Data toolbar:** Save, clear, copy all text, copy only numeric text, append to image, create new image.

## Menu Summaries

**File menu:** Open, save, print, append RK6 files, set RockPlot2D options, import files, export files, close RockPlot2D, close RockWorks.

**Edit menu:** Undo, copy image, cut/copy/paste/delete individual items.

**View** menu: Stretch, best fit, zoom in, zoom out, pan, magnify, vertical exaggeration, set diagram extents, make all objects visible.

**Draw** menu: Draw circles, symbols, text, lines, polylines, rectangles, polygons, scale bars, text tables, legends (lithology, stratigraphy, well construction, color, index), new layer.

**Measure** menu: Bearing, distance, perimeter, area.

**Digitize** menu: Vertex (point), line, polyline, polygon.

**Utilities** menu: Annotate with border, rescale, clip image, coordinate conversion.

**Data** menu: Save contents of data pane, clear data, copy all/part of data, display data contents as graphic in new window or as overlay with current graphic.

**Window** menu: Tile RockPlot2D windows, access other Rockplot2D windows or main program.

## Managing RockPlot2D Files

This section discusses the process of opening and saving "RK6" files that are displayed in the RockPlot2D window.

? Help Contents: RockPlot2D / Managing RockPlot2D Files.

### Creating a New RockPlot2D Window

A new RockPlot2D tab or window is created automatically any time that a 2-dimensional map or diagram is created within RockWorks.

You can open a new, blank RockPlot2D window by clicking on the  button on the main RockWorks toolbar, or by selecting the **Window/RockPlot2D** menu option.

### Opening a RockPlot2D Plot File (RK6)

Use either of the following methods to open an existing 2D RockWorks graphic file, such as a map, cross section, or rose diagram, that has been saved as an "RK6" file in RockWorks2006, RockWorks14, or RockWorks15.

Method 1:

- Access the Project Manager along the left edge of the main RockWorks program window. (See page 107.)
- Expand the 2-D Diagrams heading.
- Double-click on the name of the RK6 file to be opened.

Method 2:

- Open a new RockPlot2D window (above).
- Use RockPlot2D's **File** menu / **Open** command.

If you need to open an older "RKW" file created in RockWorks2004, RockWorks2002, or "recent" versions of RockWorks99, use Method 2, and choose RKW in the Files of Type prompt. You will be warned, "This file needs to be updated to the current format. Do you

want to convert?" If you choose Yes, the program will allow you to type in a new name for the updated file.

## Saving RockPlot2D Files

Use the **File / Save** and **Save As** commands to save the current image under its existing name or under a new file name.

RockPlot2D always stores plot files in its own "RK6" format. If you need to export the image to a different graphic format, you can use the **File / Export** command.

## Combining 2D Plot Files

The RockPlot2D **File / Append** command is used to add the contents of a RockPlot2D file (\*.RK6) onto the end of a diagram displayed on the screen, thereby combining the two. This is a handy way to combine, for example, project contours with a reference base map. In order to preserve the existing plot file, the combined image will be loaded into a new RockPlot2D window.

Be sure that the two maps or diagrams must occupy the same coordinates in space in order for them to overlay correctly. You can use the coordinate display in the RockPlot2D toolbar to get an idea of the coordinate range of any diagram. Just move the mouse pointer around the RockPlot2D window and note the change in the coordinate listing. You can use the RockPlot2D **Utilities / Rescale** command to rescale a map to a different coordinate range. You can use the **Utilities / Degrees to UTM** or **UTM to Degrees** commands to convert between decimal longitude / latitude and UTM coordinates.

- ? See also: The ReportWorks program (page 277) for laying out pages with RK6 images.
- ? Help Contents: RockPlot2D / Managing RockPlot2D Files

## Copying RockPlot2D Files to a New Window

Use the RockPlot2D **Edit / Copy to New Window** command or toolbar button  to copy the contents of an embedded RockPlot2D window to a new, stand-alone window. This can be helpful if, for example, you want to keep a copy of a map handy while you adjust settings in the main options window and recreate the map again.

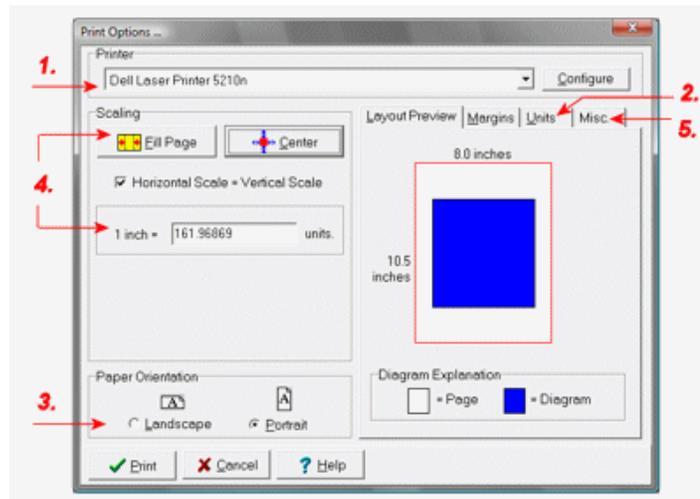
## Printing RockPlot2D Files

Use the RockPlot2D **File / Print Setup** and **File / Print** commands to output the map or diagram to your printer.

You should use the **Print Setup** command first to establish the type of printer you are using, and the paper size and orientation. (See your Windows documentation for information about installing printer drivers, and see your printer's documentation regarding specific printer settings.)

The **Print** command is used to send the graphic image to the printer.

When you select this command, you'll see a large Printer Scaling Options window.



1. Set up your printer: Choose a printer from the drop-down list, and configure the printer settings (paper size, etc.) using the Configure button.
2. Select your print units: Choose from diagram units per inch, centimeters, feet, or meters.
3. Select your paper orientation: Landscape or Portrait. You should see the Layout Preview update accordingly.
4. Set the diagram scaling: First, decide if the horizontal scale needs to equal the vertical scale. Then decide whether you need a specific scale or if it's ok just to fill the page. You can use the Center button to center the diagram on the paper.
5. Set the margins and pattern scaling (optional).

? Help Contents: RockPlot2D / Managing RockPlot2D Files

## Importing Files into RockPlot2D

Use the RockPlot2D **File** / **Import** tool to display other kinds of graphic files within RockPlot2D, save them in a RK6 format, combine them with existing RK6 maps, etc. These imports include

- AGL files
- DLG files
- DXF files
- ArcInfo E00 files
- ESRI Shapefiles
- Raster images (BMP, JPG, PNG, TIFF, TGA, EMF WMF)

? See Help Contents: RockPlot2D / Managing RockPlot2D Files / Importing Images

## Exporting RockPlot2D Files

The Rockplot2D **File** / **Export** command is used to save its 2D images in a graphic format other than its own "RK6" format. The following exports are offered:

- Bitmap (BMP) format
- JPEG format
- KMZ (Google Earth)
- PNG format
- TIFF format
- DXF format
- WMF format
- EMF format
- RockPlot3D
- ReportWorks

? [Help Contents: RockPlot2D / Managing RockPlot2D Files / Exporting RockPlot2D Images](#)

## Viewing RockPlot2D Files

RockPlot2D is the plotting engine for "flat" or 2-dimensional maps and diagrams within RockWorks, and these maps and diagrams are plotted automatically into a RockPlot2D tab in the Options window upon their completion.

Once the image is plotted on the screen, you may do any of the operations discussed in the topics below.

? [Help Contents: RockPlot2D / Viewing Plot Files](#)

## Changing the screen scaling of the image

To adjust the display of an image in the plot window, select one of the scaling options:



**Best Fit** - The **Best Fit** command (**View** menu) or toolbar button will fill the window as best it can with the current diagram while maintaining the currently-established vertical exaggeration.



**Stretch** - The **Stretch** toolbar button or **View** menu command is used to fill the current window with the diagram, regardless of the horizontal and vertical scaling used. The represented vertical exaggeration will be displayed in the VE item in the toolbar.

VE: 1.00

VE: You can use the **Vertical Exaggeration** button in the toolbar (and in the **View** menu) to stretch or compress the vertical axis of the screen image by a specific factor. To make the image taller, enter a value > 1. To make the image flatter, enter a value < 1.

? [See also: Printing RockPlot2D files \(page 252\) regarding print scaling.](#)

## Setting the Map or Diagram Extents

Use the **View / Set Diagram Extents** menu option to change the coordinate extents of the map or diagram displayed in the RockPlot2D window.

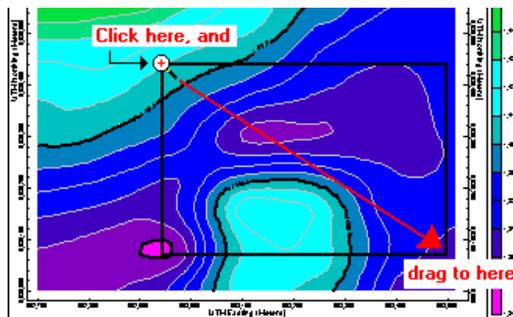
The **West, North, East, and South** prompts display the current edge coordinates in the RockPlot2D map or diagram. To change the coordinates, you have several options:

- You can type in new coordinates these to increase or decrease the extents along any axis.
- **Additional Margins (%)**: Use these settings to increase the image extents by a specific percent along all axes or individual axes. Once established, you must then click on the **Scan Extents** button (below) to scan the current coordinates and then add the requested margins.
- **Scan Extents**: Click this button to scan the current map or diagram to reset the extents. The extents will be set to the minimum and maximum coordinates of the objects in the image, plus any margin percent established.
- **Project Dimensions**: Click this button to reset the extents to those listed in the current project dimensions.

## Zooming in and out of the screen image

Follow these steps to enlarge/reduce the image display in the RockPlot2D window. (See also the Magnifier in the next topic.)

1. Use the **Zoom In** toolbar button  or menu command to enlarge a portion of the map or diagram plotted within RockPlot2D. Position the magnifying glass tool at one corner of the area to be enlarged. Depress the mouse button and drag the tool to the opposite corner.



Release the mouse button when you have reached the opposite corner of the area to be enlarged. When you release the mouse button, the program will redraw the selected area on the screen, maintaining the current vertical exaggeration. Y

2. Use the **Zoom Out** toolbar button  or **View** menu command to restore the active RockPlot2D window to its original zoomed-out view.
3. Use the **Undo Last Zoom** toolbar button  if you've zoomed in multiple times and want to go back to the previous view (not all the way out).

## Using the RockPlot2D Magnifier

Use the **Magnifier** button  (or type Ctrl+M) to magnify selected portions of the current screen display. Simply click on the button and a square or rectangular zoom-area will be visible somewhere within the plot.

Use your mouse to drag the zoom area around the window. Right-click on the zoom area to select the magnification amount. You can also resize the zoom area by grabbing and dragging a border or corner with your mouse. To disable the magnifier, click the Magnifier button again (or type Ctrl+M).

## Using the Pan tool to shift the current view

Use the **Pan** button  to shift your view of the current plot file if it's being viewed in a "zoomed in" state.

1. Simply click the **Pan** button, place your cursor within the image, and left-click, holding the mouse down. You'll see cross hairs at the cursor location.
2. Drag the image in the direction where it is to be repositioned, and release the mouse button.
3. To terminate **Pan** mode, click any other toolbar button.

## Making all RockPlot2D Objects Visible

All 2D graphic items can be rendered invisible in two different ways:

By accessing its Attributes window and removing the check in its **Visible** check-box (see Editing Graphics)

By making the layer in which the item resides invisible (see Working with Layers)

Select the **View / Make All Objects Visible** option to make all individual objects and all layers visible.

## Editing Tools

### Editing RockPlot2D Graphics

RockWorks-generated graphic images that are displayed in the RockPlot2D window contains graphic objects that can be selected, moved, resized, and edited.

**To select a RockPlot2D graphic item:**

1. Click the Edit button in the upper toolbar. 
2. Select an item using either of these methods:
 

Item-Clicking: Position the cursor on the item to be grabbed and click on it to select it. The selected item will be displayed with handles on each corner. The cursor will change shape to a pointer. You can select additional items by holding down the Shift key as you click on them. All selected items will appear with selection handles.

**Selection Rectangle:** Position the cursor in the graphic window and click and drag a rectangular "rubber-band" area, within which all items will be grabbed.

**To move a RockPlot2D graphic item:**

1. Select the graphic item as described above.
2. To move the item, simply click on it with your mouse, and drag it to its new location. You can also use your keyboard's arrow keys to move items in the specified directions.

**To resize a RockPlot2D graphic item:**

1. Select the graphic item as described above.
2. Position the cursor onto one of the item's handles, and watch for the cursor to change shape to  or . Click and drag the handle outward / inward to make the item larger / smaller. (You can also resize an item via its Attributes window, below.)

**To edit a RockPlot2D graphic item:**

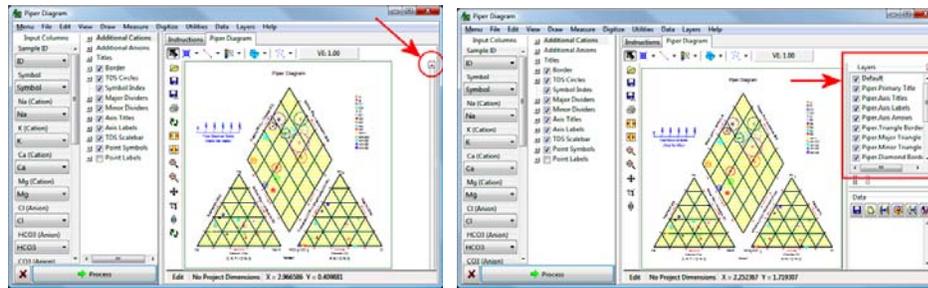
1. Select the graphic item as described above.
2. Right-click on the item, and choose **Properties** from the pop-up menu. The program will display the item's Attributes window. (You can also simply double-click on the item to access the Attributes window.)
3. Edit the attributes as you want (see details below), and click the OK button to apply the changes and close the window.

**?** Help Contents: RockPlot2D / Editing Tools for information about the graphic item Attributes windows:

- Circle Attributes
- Symbol Attributes
- Text Attributes
- Line Attributes
- Polyline Attributes
- Rectangle Attributes
- Polyfill (polygon) Attributes
- Scalebar Attributes
- Text table Attributes
- Pattern Legend Attributes (lithology, stratigraphy, and well construction)
- Color legend Attributes
- Raster image Attributes
- Grid Attributes
- Index Legend Attributes

## Working with RockPlot2D Layers

RockPlot2D allows you to organize the different items on a page into different "layers". These are groups of items that can be displayed or hidden with the click of a button. The layer pane sits along the right edge of the RockPlot2D window; to save real estate in embedded windows, the layer pane may be minimized – just click on the small "+" button to display it.



Opening RockPlot2D generates a single layer, named "Default Layer." Subsequent items that are drawn or inserted into the page are done so in that layer, until a new layer is created.

When RockWorks generates a map or diagram, there may be different layers created for the different image components, such as map contours, border annotation, and legends.

To **add a layer** to the current document, choose the **Draw / New Layer** menu item or right-click in the Layers pane and choose **Add**. The program will add a new layer entry into the layer pane, named **New Layer**. Be sure to highlight a particular layer prior to adding zitem(s) to your document; items are always added to the currently-highlighted layer. (See also "Moving Items," below.)

To **select a layer to be active**, click on its name in the Layers pane. It will be displayed as highlighted. Subsequent items that you add to your document will be added to that layer.

To **rename a layer**, right-click on the layer's name in the Layers pane, and choose **Edit**. Edit/type in a new name. This can help you to be more specific with layer items, such as "company legend items" rather than "New Layer2".

To **move an item to a different layer**, right on the item, and choose **Change Layer** from the pop-up menu. In the displayed window, choose the layer from the drop-down list, and click OK. Note that subsequent access of the item's Attributes settings will display the new layer name.

To **move multiple items to a different layer**, select all of those items (so that all are displayed with handles), right-click, and choose **Change Layer**. In the displayed window, select from the drop-down list the layer name to which the items are to be associated. Subsequent access of the items' Attributes windows will display the new layer name.

To **copy one or more items to another layer**, left click on the item(s), choose **Edit / Copy** (or type in Ctrl + C). Then click on the layer name to which the item(s) are to be pasted, in the Layers pane of the window, and select **Edit / Paste** (or type in Ctrl + V). The item(s) will be inserted into the document again, and associated with the specified layer.

To **display a layer's items**, insert a check-mark in the layer's check-box.

To **hide a layer's items from the display**, remove the check-mark from the layer's name.

## Undoing RockPlot2D Changes

Use the RockPlot2D **Edit / Undo** command - or type the keyboard shortcut of **Ctrl+Z** - to cancel or undo the last insertion or editing operation made to the current RockPlot2D graphic image. You can define the number of Undo levels that RockPlot will allow, in the **File / Options** menu.

## RockPlot2D Drawing Tools

Use the tools in the RockPlot2D **Draw** menu to add symbols, text, shapes, images, legends, and grids to the current image.

- ? Help Contents: RockPlot2D / Drawing Tools for step-by-step instructions about inserting the following items into a RockPlot2D image:

- Drawing Circles (**Draw / Point Types / Circles**)
- Drawing Symbols (**Draw / Point Types / Symbols**)
- Inserting Text (**Draw / Point Types / Text**)
- Drawing Lines (**Draw / Line Types / Lines**)
- Drawing Polylines (**Draw / Line Types / Polylines**)
- Drawing Rectangles (**Draw / Line Types / Rectangles**)
- Drawing Polygons (**Draw / Line Types / Polygons**)
- Inserting Color Legends (**Draw / Insert / Color Legend**)
- Inserting Gridlines (**Draw / Insert / Grid**)
- Inserting Images (**Draw / Insert / Image**)
- Inserting a Lithology Legend (**Draw / Insert / Lithology Legend**)
- Inserting Scalebars (**Draw / Insert / Scalebar**)
- Inserting a Stratigraphy Legend (**Draw / Insert / Stratigraphy Legend**)
- Inserting Text Tables (**Draw / Insert / Text Table**)
- Inserting a Well Construction Legend (**Draw / Insert / Well Construction Legend**)
- Inserting Miscellaneous Legends (**Draw / Insert / Index Legend**)

## RockPlot2D Measuring Tools

The RockPlot2D **Measure** menu contains four tools used to compute measurements. Computed measurements are displayed in the "RockPlot2D data window" that sits to the right of the graphic window. This information can be copied to the clipboard for pasting into other applications.

Examples: Measure hole to hole distances to determine good grid model node spacing. Measure fracture bearings off a map for display as a rose diagram.

- ? Help Contents: RockPlot2D / Measuring Tools for step-by-step instructions about computing the following measurements within the RockPlot2D window:

Measuring the area within a polygon (**Measure / Area**)

Measuring the bearing of a line (**Measure / Bearing**)

Measuring the distance between two points (**Measure / Distance**)

Measuring the perimeter length of a polygon (**Measure / Perimeter**)

## RockPlot2D Digitizing Tools

The RockPlot2D **Digitize** menu contains four tools used to capture map or diagram coordinates for points, lines, polylines, and polygons that are drawn by the user. Digitized coordinates are displayed in the "RockPlot2D data window" that sits to the right of the graphic window. This information can be copied to the clipboard for pasting into other applications. In addition, these digitized items can be appended to the underlying map or other graphic image.

Examples: Define a polygonal area on a map to be used to filter your grid or solid models. Digitize a fault trace polyline for use in gridding.

See Help Contents: RockPlot2D / Digitizing Tools for step-by-step instructions about digitizing the following items within the RockPlot2D window:

Digitizing points (**Digitize / Points**)

Digitizing lines (**Digitize / Lines**)

Digitizing polylines (**Digitize / Polylines**)

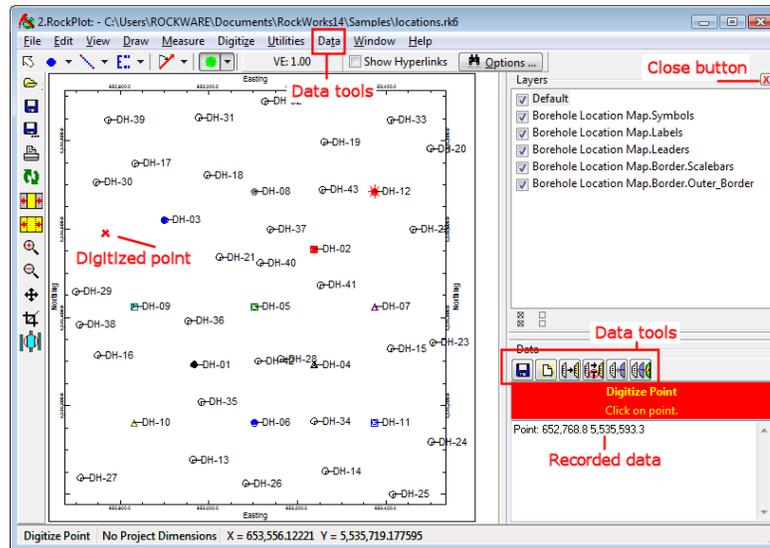
Digitizing polygons (**Digitize / Polygons**)

## Measurement and Digitizing Options

Use the Options command in the RockPlot2D **Measure** and **Digitize** menus to establish settings for the measurement and digitizing tools.

## The RockPlot2D Data Window

The RockPlot2D "Data Window" is displayed to the right of the RockPlot2D image window. It is used to display computed measurements and coordinates which result from the use of the **Measure** and **Digitize** menu tools. Each plot window that is open will have its own data window.



The RockPlot2D Data Window contains the following tools which can help you manage your measurements or digitized coordinates. These tools are available as buttons above the Data Window, or as commands in the **Data** menu.

 **Save:** Saves the contents of the data window in a text file.

 **Clear:** Clears all entries so that you can start a new data listing. You will NOT be warned that data will be lost.

 **Copy all Data:** Copies all data, including numbers and text labels, to the Windows clipboard for pasting elsewhere.

! Don't use Ctrl+C to copy the data displayed in the data window. That command is reserved for copying the current plot - the picture itself - to the clipboard.

 **Copy Numeric Data:** Copies numeric data only (computations and/or digitized coordinates) to the Windows clipboard for pasting elsewhere.

! Don't use Ctrl+C to copy the data displayed in the data window. That command is reserved for copying the current plot - the picture itself - to the clipboard.

 **New Graphic:** Creates a new plot window containing the graphic representation of the Digitized items (points, lines, polylines, and/or polygons) listed in the data window. The line style and color in which the lines are to be drawn should be established under **File** / **Options** prior to creating the new graphic.

 **Append Current Graphic:** Creates a new plot window containing the graphic representation of the digitized items (points, lines, polylines, and/or polygons) which are listed in the data window, overlaying the existing image in the current plot window. The line style and color in which the lines are to be drawn should be established under **File** / **Options** prior to creating the new graphic.

- ! You need to use the data tools shown above to store the data in the clipboard or record the data as graphic entities before closing the plot window, or you'll lose all of the data items. The data items are not stored in the graphic RK6 file.
- ! The **Measure** and **Digitize** items are held in temporary memory only. If you redraw the image (using **Zoom In**, **Zoom Out**, **Best Fit**, **Stretch**, or **Vertical Exaggeration**) the drawn items will disappear from the graphic display. Since they are recorded, however, in the **Data Window**, the **Copy all Data**, **Copy Numeric Data**, **New Graphic**, and **Append Current Graphic** tools are still available.
- ! The **Data Window** is not designed for you to edit the coordinates or measurements there. Thus, there is no **Paste** command for the **Data Window**. You may utilize either of two copy-data buttons, described below, for copying the data to the Windows clipboard for pasting elsewhere.
- ? See also the **Drawing Tools** (page 259) and **ReportWorks** (page 277) for an interactive page layout and drawing window.

## Manipulating RockPlot2D Files

### Locating the Closest Point

RockPlot2D has a nifty tool that allows you to search either the **Borehole Manager** or the **RockWorks Utilities** datasheet for the data that lies closest to a location you select on a map. With a map displayed in the **RockPlot2D** window, simply right-click on the locations for which you wish to retrieve data. As above, confirm the coordinates to be searched (they'll be populated automatically based on your right-click selection), specify the data window and columns if necessary:

The program will search for the requested information and display the data record closest to the selected point. This tool requires that you be running the program non-modal (see page 293).

- ? Help Contents: [RockPlot2D / Manipulating RockPlot2D Images / Locating Closest Point](#)

### Adding Border Annotations to RockPlot2D Images

The **RockPlot2D Utilities / Annotate** command is used to add axis tick marks and labels representing coordinate units to a two-dimensional map, such as a sample map or contour map. In order to preserve the existing plot file, the annotated map will be loaded into a new **RockPlot2D** window.

- ! **RockWorks** also permits you to include this annotation when the map or diagram is being created. If you wish to combine maps (via the **Append** command), you should combine the maps first, then annotate them.
- ? Help Contents: [RockPlot2D / Manipulating RockPlot2D Files / Adding Border Annotations](#)

## Rescaling 2D Plot files

The RockPlot2D **Utilities** / **Rescale** command is used to change map or diagram coordinates using one of two available schemes:

- Rescale by establishing a new X,Y origin coordinate and scaling the X and Y axes by a constant value.
- Rescale by establishing new boundary coordinates for one or more axes.

Note that these rescaling schemes change the actual coordinates that are stored for the lines, symbols, and such in a map or diagram. In order to preserve the existing plot file, both utilities create a new plot window for display of the rescaled map or diagram.

If you do not need to change the coordinates of the plot file but simply want to change the scale at which it is printed, this is done within RockPlot2D's **Print** utility itself. See [Printing RockPlot2D Files \(page 252\)](#) for more information. Or, if you want to change the scale at which it is viewed on the screen, there are zoom-in and zoom-out tools for this – see [Viewing RockPlot2D Files \(page 254\)](#).

? [Help Contents: RockPlot2D / Manipulating RockPlot2D Files / Rescaling 2D Plot Files](#)

## Clipping RockPlot2D Files

The RockPlot2D **Utilities** / **Clip** command is used to extract from an existing map or diagram all of the contents that lie within a user-declared rectangular area. The clipped image is displayed in a new RockPlot2D window.

This tool is also available using the Clip button  in the left-hand toolbar.

? [Help Contents: RockPlot2D / Manipulating RockPlot2D Files / Clipping](#)

## Converting Plot File Coordinates

The **Degrees to UTM** and **UTM to Degrees** commands in the RockPlot2D **Utilities** menu are used to convert plot file coordinates from longitude / latitude decimal degrees to Universal Transverse Mercator (UTM) meters or feet, and vice versa. The converted map is displayed in a new RockPlot2D window.

! These utilities convert graphic coordinates - the coordinates that are stored for each line, symbol, etc., in the plot file. If you wish instead to convert the original X,Y data coordinates that are listed in your datasheet, you can do so using the tools in the RockWorks **Utilities Coords** menu or the Borehole Manager's **Map** menu.

? [Help Contents: RockPlot2D / Manipulating RockPlot2D Files / Converting Diagram Coordinates.](#)

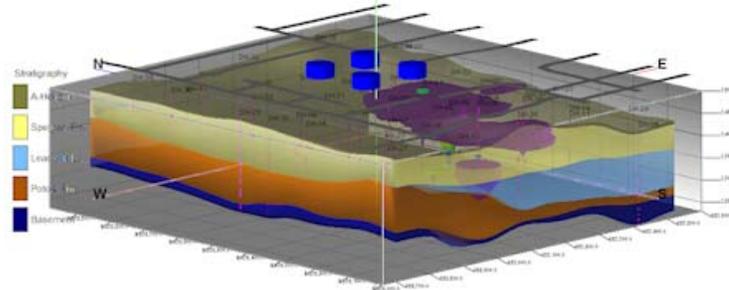
## Notes

# Chapter 24 - RockPlot3D

## Topics

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## RockPlot3D Overview



RockPlot3D is a true 3-dimensional display tool that is used by the RockWorks Borehole Manager and RockWorks Utilities for display of 3D objects, such as stratigraphic and water level surfaces, solid models, strip logs, and other items such as bitmaps and storage tanks. These items can be displayed individually, or in combination as shown above.

RockPlot3D permits interactive movement of the display (rotate, zoom, pan) and easy viewing and hiding of image objects.

## Managing RockPlot3D Files

This section discusses the process of opening, appending, printing and saving "R3DXML" files that are displayed in the RockPlot3D window.

? [Help Contents: RockPlot3D / Managing RockPlot3D Files](#)

### Creating a new RockPlot3D window

A new RockPlot3D window is created automatically any time that a 3-dimensional image is created within RockWorks. Multiple RockPlot3D windows may remain open at any time.

You can open a new, blank RockPlot3D window by clicking on the  button on the main RockWorks toolbar, or by selecting the **Window/RockPlot3D** menu option.

## Opening a RockPlot3D XML File

Use either of the following methods to open an existing 3D RockWorks graphic file, such as a stratigraphic model or 3D logs, that has been saved as an "R3DXML" file.

Method 1:

- Access the Project Manager along the left edge of the main RockWorks program window. (See page 107.)
- Expand the 3-D Diagrams heading.
- Double-click on the name of the file to be opened.

Method 2:

- Open a new RockPlot3D window (above).
- Use RockPlot3D's **File** menu / **Open** command.

## Appending Multiple RockPlot3D Views

RockPlot3D permits you to combine 3D views by appending the data objects in one R3DXML file to the end of an existing view. With a view displayed in the window, select the **File / Append** command and browse for the name of the other RockPlot3D view (previously saved as an R3DXML file) to be added.

The program will load the data items from the selected file and display them in the current view. The program will automatically update the view's dimensions if necessary to accommodate the new data elements.

- ! The view being appended should reside in the same folder as the original R3DXML file. If it does not, be warned that any files linked to the appended view (MOD files, images, etc.) will need to be located for the program the next time the saved, appended image is opened.

## Saving a RockPlot3D View

Use the **File / Save** or **Save As** commands to save a RockPlot3D view or changes made to an existing view. The default file name extension is R3DXML.

- ! RockPlot3D stores in the R3DXML file a list of the data items, as well as the status of the reference and data items: whether the item is "on" or "off", its transparency or color, and other characteristics. It also now embeds grid model data for surfaces and fence panels.
- ! RockPlot3D **does not** store in the R3DXML file the actual data contained in solid models, bitmap images, or other file-based items displayed in the current view whose names are shown in the Linked File List pane. Instead, it stores their file names. You need to be sure to keep all of these files together in the same folder.
- ? See also: Save a RockPlot3D view as a zip file (below) for information about zipping the R3DXML file and all linked files.
- ! RockPlot3D does not store any display information in the R3DXML file, such as last viewpoint, lighting, or vertical exaggeration.

## Zipping a RockPlot3D View and its Linked Files

Because RockPlot3D's "R3DXML" files can contain links to bitmap images, solid models, and other external files, it can be confusing to keep track of what files to send to co-workers for viewing, or what files you need to keep when you are house-cleaning. RockPlot3D offers a save option that stores the R3DXML and all linked files as a ZIP file: the **File / Zip All Linked Files** menu command.

RockPlot3D will create a ZIP-format file containing the R3DXML file and all linked solid models, bitmaps, color tables, and other linked files. (All linked file names are displayed in the "Linked File List" pane of the RockPlot3D window.) The default file name extension is ".ZIP".

- ! RockPlot3D cannot open a ZIP-format file. To later access the contents of the ZIP file, you will need to have a software program capable of extracting files from the ZIP archive.

## Printing a RockPlot3D View

Use the **File / Print** command to send the current view to your printer. You can choose from **Draft** quality (150 dots per inch or dpi), **Good** quality (300 dpi), or **Best** quality (600 dpi) output.

- ! The printing tool captures a bitmap image that's based on what's displayed in the 3D View, so be sure to adjust the image view to your satisfaction (rotation angle, zoomed-in state, vertical exaggeration, etc.)
- ! If you need printouts larger than a single page, we recommend that you export the image to a high resolution JPG or BMP image, and then print from a graphic application. (See Exporting RockPlot3D Images, page 267.)

The general shape of the image must be adjusted before selecting the **File / Print** command (see step #2). Unlike 2-dimensional (flat) images like contour maps, 3D images cannot be printed at a specific horizontal and vertical units-per-inch scale.

## Importing Images into RockPlot3D

While the RockPlot3D **File / Open** command is used to open existing RockPlot3D (.R3DXML) files, the **File / Import** command can be used to display 2D or 3D DXF files in an existing RockPlot3D window. The DXF file will be appended to any items already displayed. This tool imports DXF LINE, POLYLINE, LWPOLYLINE, 3DFACE, SOLID, and CIRCLE (filled) commands.

- ? See Help Contents: RockPlot3D / Importing Images into RockPlot3D

## Exporting RockPlot3D Images

The RockPlot3D program saves image information in an "R3DXML" file, with links to external bitmaps, solid models, etc. that are displayed in the image. (See Saving Files, page 266.)

RockPlot3D also offers export of the screen display as other image types via the **File / Export** menu command.

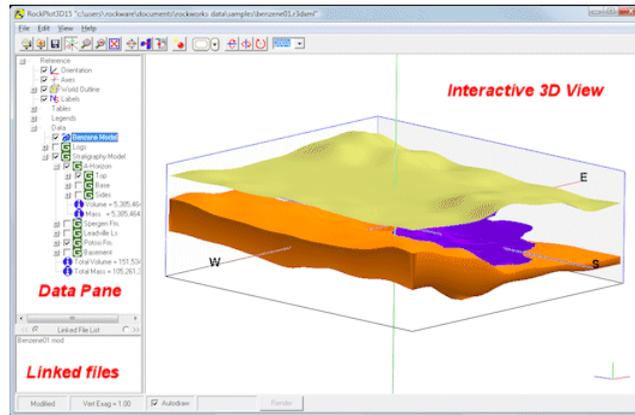
? See Help Contents: RockPlot3D / Exporting Images from RockPlot3D / ...

- Export RockPlot3D images to a Bitmap format.
- Export RockPlot3D images to a JPEG format.
- Export RockPlot3D images to a PNG format.
- Export RockPlot3D images to a TIFF format.
- Export a RockPlot3D animation to an AVI (animation) format.
- Export RockPlot3D images to ESRI 3D Shapefiles.
- Export RockPlot3D images to DXF.
- Export RockPlot3D images to Google Earth.

## Viewing RockPlot3D Files

RockPlot3D is the plotting engine for all surfaces, fence diagrams, solid models and other 3-dimensional objects within RockWorks, and these images are plotted automatically into a RockPlot3D window on the screen as they are generated.

What you'll see when RockPlot3D first opens is a window with three panes: Your image will be displayed in the larger pane, a listing of the standard reference items and the current data items are shown in another, and a list of any linked files are in the third. The program is originally set up with the image pane on the right, but you can swap them.



Once the image is plotted on the screen, you may do any of the following operations which are discussed in the Help topics below.

? Help Contents: RockPlot3D / Viewing RockPlot3D Files / ...

Swapping the position of the image and data panes

Changing the size of the 3D View pane

Rotating the 3D view 

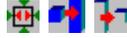
Zooming into/out of the view 

Moving the image in the 3D display (Pan) 

Spinning the 3D image 

Selecting a pre-set view (View / Above, Below, Plan View, Compass Points)

Selecting a custom view

Changing the 3D view dimensions and vertical exaggeration 

Changing the lighting of the 3D view 

Changing the 3D view background color 

Turning off screen redraw  Draw

## Manipulating RockPlot3D Images

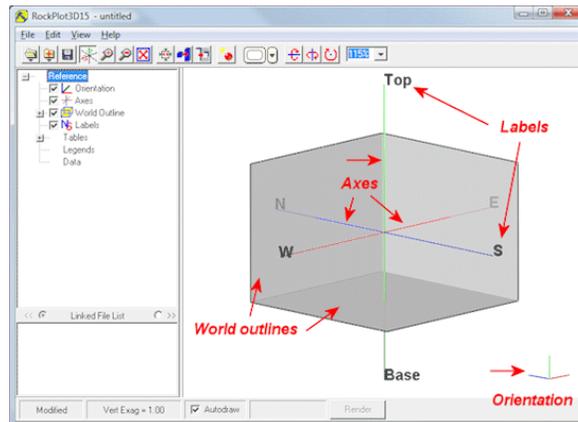
The RockPlot3D screen contains an image pane to the right, and a listing of the data items to the left. You can adjust interactively the view of the image in the 3D Image pane by following the instructions in Viewing RockPlot3D Files.

If you want to change the look of individual items in the Image view, that's possible, too, by accessing the item names in the data tree. This section discusses these tools. This discussion is split up into the Reference Items, which are available for all RockPlot3D images, and the Data Items which are specific to each image created by RockWorks.

? Help Contents: RockPlot3D / Manipulating RockPlot3D Images.

## Reference Items

RockPlot3D offers the following reference items used to orient yourself in the scene:



**Orientation marker:** Displayed in the lower-right corner of the 3D View, it shows the current orientation of the X-axis (red), the Y-axis (blue), and Z-axis or elevation (green). If you rotate the display, the orientation marker will be updated.

**Axes:** The X, Y, and Z (elevation) axes are plotted in the middle of the currently-defined scene dimensions.

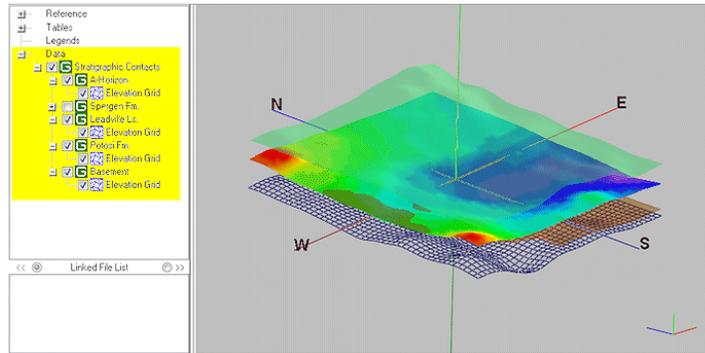
**World Outlines:** Expand this item in the data tree to access individual reference grids for the **Top**, **Base**, **West**, **North**, **East**, and **South** boundaries of the scene. Right-click on any item to adjust the color, fill, and opacity of the reference grids. Choose **View / Dimensions** to adjust the scene dimensions.

**Axis labels**, which note the Top, Base, West, North, East, and South directions.

? Help Contents: RockPlot3D / Manipulating RockPlot3D Images / Reference Items

## Data Items

The "Data Items" are the logs, surfaces, solids, or other entities that were created by RockWorks. They can be displayed individually or they can be displayed in groups.



Groups of items are shown with the Group symbol.  Simply click on the Group's "+" button to view the data items within. Expand any data item's "+" button to view its components.

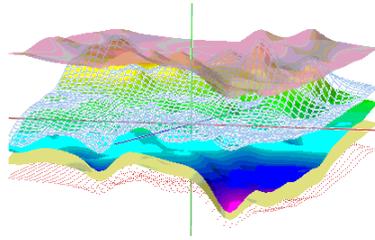
Each of the data types has characteristics you can modify right within RockPlot3D. Just double-click on the item in the Data pane to access the settings.

? Help Contents: RockPlot3D / Manipulating RockPlot3D Images / Data Items / ...

- Turning on/off the RockPlot3D Data Items
- Adding New Data Groups in RockPlot3D
- Dragging and Dropping RockPlot3D Data Items

## RockPlot3D Surface Settings

RockPlot3D can display 3-dimensional surfaces that are based on grid models. These might result from gridding X/Y/Elevation data in the RockWorks Utilities datasheet (**Map / Grid-Based Map**) or from modeling stratigraphic surfaces in the Borehole Manager (**Stratigraphy / Structural Elevations**). Surfaces can be displayed individually or in groups.



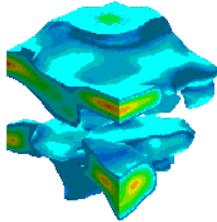
To access the surface settings, right-click on the surface item's name or icon  in the right pane, and choose **Options**. You can also double-click on the surface item to access the grid options.

The program will display a Grid Options window in which you can adjust the color scheme, surface style, opacity, smoothing, and data filter.

? Help Contents: RockPlot3D / Manipulating RockPlot3D Images / RockPlot3D Data Items / Surface Settings / ...

- Adjusting the surface color scheme
- Adjusting the surface style
- Adjusting the surface transparency
- Adjusting the surface smoothing
- Applying a Z-value filter

## RockPlot3D Isosurface Settings



RockPlot3D can display 3-dimensional isosurfaces that are based on solid models. These might result from modeling X,Y,Z,G data in the RockWorks Utilities datasheet (**Solid / Model**), or from modeling quantitative downhole data in the Borehole Manager (**I-Data / Model, P-Data / Model**, etc.).

To access the isosurface settings, right-click on the item's name or icon  in the right pane, and choose **Options**. You can also double-click on the isosurface item to access the options.

The program will display the Isosurface Options window in which you can adjust the color scheme, surface style, opacity, and smoothing. You can change the minimum G level enclosed in the isosurface "skin", and adjust the appearance of the model at the boundary edges. You can also insert horizontal and vertical slices.

? Help Contents: RockPlot3D / Manipulating RockPlot3D Images / RockPlot3D Data Items / Isosurface Settings / ...

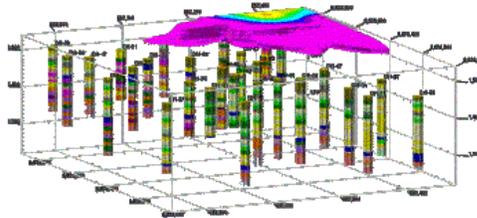
- Adjusting the isosurface color scheme
- Adjusting the isosurface style
- Adjusting the isosurface transparency

- Establishing the minimum iso-level
- Adjusting the isosurface smoothing
- Displaying the isosurface volume
- Adjusting the isosurface "cap" appearance
- Inserting solid model slices

? See also: RockPlot3D Solid Model Settings (page 272).

## RockPlot3D Morph Settings

The RockWorks Utilities **Solid / Morph** tool is used to read a list of existing solid model files (\*.MOD) and create a dynamic "movie" within RockPlot3D that shows time-based changes within these models. You can specify any number of intermediate, transitional models be generated between the existing models.



To access the morph settings, right-click on the item's name or icon  in the right pane, and choose **Options**. You can also double-click on the morph item to access the options.

The program will display the Morph Options window in which you can run the morphed sequence, export to an AVI file, and adjust isosurfaces' color scheme, surface style, and opacity. You can change the minimum G level enclosed in the isosurface "skin", and adjust the appearance of the model at the boundary edges.

? Help Contents: RockPlot3D / Manipulating RockPlot3D Images / RockPlot3D Data Items / Morphed Model Settings / ...

- Running the Morphed Solid Model Sequence
- Saving the Morphed Sequence as an AVI File
- Adjusting the isosurface color scheme
- Adjusting the isosurface style
- Adjusting the isosurface transparency
- Establishing the minimum iso-level
- Displaying the isosurface volume.
- Adjusting the isosurface "cap" appearance.

## RockPlot3D Voxel Model Settings

RockPlot3D can display solid models as isosurfaces or as "all voxels". The All Voxel display is typically used for display of lithology solid models or Boolean models that result from the RockWorks Utilities **Solid** menu filtering tools, but can also be used for I-Data (geochemistry) or P-Data (geophysical) models.

To access the solid model settings, right-click on the item's name or icon  in the right pane, and choose **Options**. You can also double-click on the solid model item to access the options.

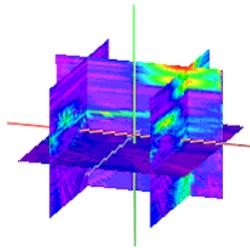
The program will display the Solid Model Options window in which you can adjust the color scheme, surface style, opacity, and smoothing. You can adjust the minimum and maximum G values displayed, and you can insert horizontal and vertical slices.

? Help Contents: RockPlot3D / Manipulating RockPlot3D Images / RockPlot3D Data Items / Solid Model Settings / ...

- Adjusting the solid model color scheme
- Adjusting the solid model style
- Adjusting the solid model transparency
- Adjusting the solid model smoothing
- Filtering G values from the display
- Displaying the RockPlot3D solid model volume
- Inserting solid model slices

? See also: RockPlot3D Isosurface Settings (page 271).

## RockPlot3D Slice Settings



RockPlot3D can display 3-dimensional solid models as isosurfaces or using all voxels. In addition, you can display horizontal and vertical slices within the solid model (see Isosurfaces / Inserting Slices or Solid Models / Inserting Slices in the Help messages).

Once created, these solid model slices then become data items of their own with their own. You can adjust the surface appearance, transparency, smoothing, and position.

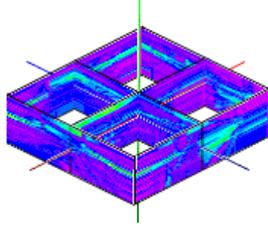
To access the slice settings, right-click on the slice's name or icon  in the right pane, and choose Options. You can also double-click on the slice item to access the options.

The program will display the Slice Options window.

? Help Contents: RockPlot3D / Manipulating RockPlot3D Images / RockPlot3D Data Items / Slice Settings / ...

- Adjusting the slice's surface style
- Adjusting the slice's color scheme
- Adjusting the slice's transparency
- Adjusting the slice's smoothing
- Adjusting the slice's position

## RockPlot3D Fence Panel Settings



RockPlot3D displays fence diagrams as vertical panels which are extracted from solid models. These might result from modeling I-data, T-Data, P-data, fracture, or lithology data in the Borehole Manager. Fence diagrams can also be generated using the RockWorks Utilities **Solid / Fence** tool.

**!** Stratigraphy and water level fence panels are drawn a little differently (not from solid models) and do not offer the same options as solid-model-based fences.

To access the vertical grid settings, expand the fence diagram group  and expand the fence panel's group (if necessary). Then, right-click on the vertical grid item's name or icon  in the right pane, and choose **Options**. You can also double-click on the vertical grid to access the options.

The program will display a Grid Options window in which you can adjust the color scheme, surface style, opacity, smoothing, and data filter.

**?** Help Contents: RockPlot3D / Manipulating RockPlot3D Images / RockPlot3D Data Items / Fence Panel Settings / ...

- Adjust the fence panel's color scheme
- Adjust the fence panel's surface appearance
- Adjust the fence panel's transparency
- Adjust the fence panel's smoothing
- Apply a fence panel G-value filter

### General RockPlot3D Data Items - Adjusting Transparency

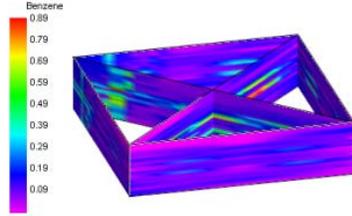
Some of the more complicated components of RockPlot3D displays (isosurfaces, grid surfaces, etc.) have lots of options for adjusting colors, filtering data, and more. These are discussed earlier in this section.

Some components of the displays are quite simple – they contain only a general transparency setting.

**?** See Help Contents: RockPlot3D / Manipulating RockPlot3D Images / Data Items / General RockPlot3D Data Items / How to...

- Adjust the transparency of a group of items.
- Adjust the transparency of individual items.

## RockPlot3D Legends



A “legend” is a key to colors and data values or data items that can be generated automatically by RockWorks or can be added interactively in RockPlot3D. The picture here shows a legend correlating colors with geochemical values in a fence diagram

- ? See Help Contents: RockPlot3D / Manipulating RockPlot3D Images / RockPlot3D Legends
- Adding a legend to an existing image
  - Adjusting the legend settings

## RockPlot3D Types Tables

RockWorks project databases store definitions of lithology materials, stratigraphic formations, and well construction materials in "Types Tables". Each time RockWorks creates any kind of 3D image, it reads these data Types and stores the material/formation names and other settings in the RockPlot3D view. This enables easy configuration of legend colors and names.

The Types Table information is stored under the Tables heading in the RockPlot3D data pane. You can edit the contents of these tables to change the appearance of the legends.

- ! The changes you make to the tables in RockPlot3D will not affect any models, surfaces, fence panels, or logs in the 3D display. Their colors were established upon diagram creation. You can adjust them manually using the settings described under RockPlot3D Data Items.

- ? See Help Contents: RockPlot3D / Manipulating RockPlot3D Images / RockPlot3D Tables
- Editing the RockPlot3D Lithology Table
  - Editing the RockPlot3D Stratigraphy Table
  - Editing the RockPlot3D Well Construction Table

## RockPlot3D Reference

### Troubleshooting File / Open

RockPlot3D stores the current 3D view in an "R3DXML" file\*. Some of the information in the view is recorded in the XML file itself; this includes all of the reference and data item names, whether the items are set to "on" or "off", their current attributes, surface and fence grid model data, and much more.

What is not stored in the R3DXML file, however, is the contents of any RockWorks-created solid models or bitmap images that may be displayed in the 3D view. In other words, a large solid model file (MOD) containing contaminant data is not stored in the R3DXML

file. Instead, its file name is stored in the R3DXML file, and then RockPlot3D loads the data itself from the linked file.

The names of files linked to the current view are displayed in the “linked file list” pane below the data pane of the RockPlot3D window. RockPlot3D assumes that all files referenced in the R3DXML are stored in the same folder as the XML file.

So, what this means is that if the R3DXML file and any linked solid model, bitmap, or other files get separated, you may see the following message when RockPlot3D tries to open that R3DXML file, or append that R3DXML file to another file:

*Filename* has been moved. Do you want to browse for this file?

1. Click the **Yes** option if you want to locate the missing file(s), and use the standard Windows to change folders and/or drives as necessary.

Click **No** if you prefer not to locate the missing file(s), and the scene will be loaded without those data elements.

## Troubleshooting OpenGL

RockPlot3D uses OpenGL to deliver the responsive, interactive scenes you see on the screen. You'll get the best performance from RockPlot3D on a computer that contains a video card with OpenGL support.

How do you know if you have a video card that supports OpenGL? The easiest way is to access the RockPlot3D **Help** menu, click on the **About** item, and then click on the **OpenGL Troubleshooting** tab that's displayed there. The window will display the driver that's installed on your system.

If there is a driver installed, its manufacturer and renderer and version will be listed. You should opt for the **Use Hardware Acceleration** setting if your computer contains a good card with a driver. You will be able to display and manipulate bigger images better.

If no driver is installed (typical of many laptops) you may see something like **Driver Vendor: Microsoft Corporation, Driver Renderer: GDI Generic**. In this situation, RockPlot3D will make use of RAM memory to provide the umph to drive the graphics. You should choose the **Use Software Acceleration** setting. For this to work effectively, we recommend that you have lots of RAM (more than 256 MB) and a faster processor (400 MHz or faster Pentium III CPU).

If the 3D images are slow to redraw on your computer, you can remove the checkmark from the Autodraw option along the bottom of the RockPlot3D window. The image will only be updated after rotation, stretch, view change, etc. when the **Render** button is clicked.

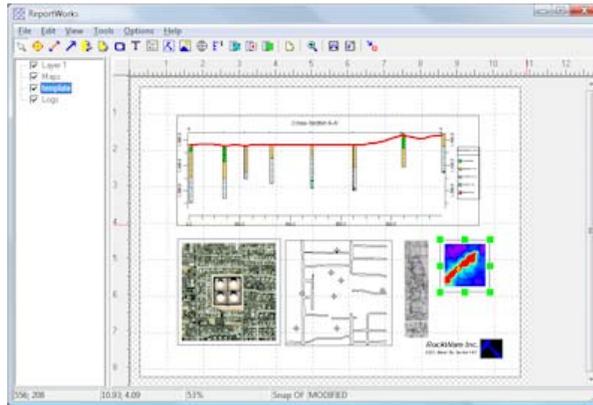
# Chapter 25 – ReportWorks

## Topics

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## ReportWorks Overview

The ReportWorks program is a new page layout tool that's shipped with RockWorks. It offers tools for laying out pages with RockWorks-generated graphics, imported graphics, text, shapes, and more. It's a really nice complement to all of the graphic options in the RockWorks program, allowing you to combine them for presentation and printing on a single page.



There are several ways you can access the ReportWorks program:

- If you are at the main RockWorks program window, click on the ReportWorks toolbar button  or select the **Window / Reportworks** menu option.
- If you are in RockPlot2D, choose the **File / Export / ReportWorks** command to place the current image in a new ReportWorks document.
- Outside the RockWorks program, you can use the Windows Start menu to locate the shortcut to the ReportWorks program in the RockWorks15 shortcut folder.

Once you have a ReportWorks window displayed, you can use the **File / Page Setup** menu command to set up your new page (size and orientation) and the **Tools** menu options to insert shapes, text, images, and more to the current page. Or, use the **File / Open** menu command to open an existing RW6 file.



Help Contents: Tutorial / ReportWorks Tutorial

## Managing ReportWorks Files

? Help Contents: ReportWorks / Managing Files

### Creating a New ReportWorks Document

Use the ReportWorks **File / New** menu option to create a new page layout document. Once the new document is created, use **File / Page Setup** option to define the page size and layout, and the **Tools** menu options to insert graphics and shapes.

### Opening Existing ReportWorks Images

Use either of the following methods to open an existing ReportWorks document which has been saved as an "RW6" file.

Method 1:

- Access the Project Manager along the left edge of the main RockWorks program window. (See page 107.)
- Expand the ReportWorks Diagrams heading.
- Double-click on the name of the file to be opened.

Method 2:

- Open a new ReportWorks window (above).
- Use the **File** menu / **Open** command to browse for the file to be opened.

! Note that if you are opening an older ReportWorks RWR file and it contains older RockPlot2D images (RKW rather than RK6), those images will be omitted. You will need to open the RKW files into the current version of RockPlot2D, update them to the new RK6 format, and re-insert them into the ReportWorks document.

! If the existing RW6 document contains linked images and those images are moved, you'll see a warning that they cannot be located. You can browse for these images to update their paths.

### Combining ReportWorks Documents

ReportWorks permits you to combine multiple RW6 files - this can be a handy way to append a standard company legend to your layouts. With an existing document displayed, select the **File / Append** command, and browse for the name of the RW6 file to be appended to the current view. The program will add the contents of that file to the current document.

! Be warned that if you have images in your ReportWorks documents, and if you share the documents across different projects, you might consider embedding the images so that file paths don't get messed up. See the discussion of embedding versus linking in the drawing tools topics.

## Saving ReportWorks Documents

Use the **File / Save** and **Save As** commands to save your ReportWorks documents.

ReportWorks always stores plot files in its own "RW6" format. If you need to export the image to a BMP, JPG, or PNG format, you can use the **Export** command.

## Printing ReportWorks Diagrams

You can output the image contained in a ReportWorks document to your printer using the **File / Print** command.



It is assumed that you've already established the page layout prior to designing and printing, since the page will be printed as it's displayed in the ReportWorks screen.

Your current printer's dialog box will be displayed. The options that are available will vary from depending on printer type. Typically, you would click the Properties or Options button to access your printer's settings, such as page size and orientation.

## Exporting ReportWorks Documents

The ReportWorks program saves plot files on disk in its own "RW6" format. If you want to save the plot in a BMP (Windows Bitmap), JPG (JPEG), or PNG (Portable Network Graphics) format you can do so with the **Export** command (**File** menu). The following information must be entered.

**File Name:** Click on the small open-file button to type in the name to assign the exported file.

**Color Depth:** Choose from the drop-down list box the color resolution you wish to use for the output raster image. As you increase the color resolution, the output file will increase in size. For good color depth, you should probably choose 24 bits/pixel.

! Changing the pixels per inch and/or colors per pixel does not change the printable size of the graphic but instead the resolution of the image and the size on disk of the output file.

**Resolution (DPI):** This setting defaults to 96 and will determine the resolution of the output graphic in dots or pixels per inch. As you increase the number of dots per inch, the disk size of the output file will increase. If you want to display the image on screen only, a resolution of 96 will probably be adequate. If you want to print the image at high resolution, you should increase the resolution to at least 150 pixels per inch. (We use 200 - 300 for publication quality graphics.)

**Compression:** (JPG and PNG only) These files can be created with varied compression; use the sliding bar to select the compression you wish to use (JPG) or choose Low/Medium/High for PNG. The greater the compression, the lower the quality of the output image and the smaller the disk size of the output file. The lower the compression, the higher the quality of the output image, and the larger the disk size of the output file.

## View and Layout Options

### Establishing the ReportWorks Page Layout

Use the **File / Print Setup** tool to establish the size and orientation of your ReportWorks page. This is an important first step in designing a report so that you know the page's dimensions.

You will see the Print Setup window for your default printer, as installed in Windows. Here you can select a different printer if necessary, and you can click the printer's Properties button to select the paper size, and portrait (vertical) or landscape (horizontal) orientation.

The ReportWorks page view will be updated based on the page dimensions and orientation.

If you view your page in Full Screen mode, the printable area of your paper will be shown in white, against a gray background. The printable dimensions of the sheet are determined by your printer's software, not by ReportWorks.

- ? See the **Tools** menu options for inserting graphic images and drawing shapes. See the **Options** menu for establishing the page units.
- ? Help Contents: ReportWorks / View and Layout Options / Establishing the ReportWorks Page Layout

### Establishing your ReportWorks Page Units

Use the **Options / Units** menu item to set your ReportWorks page units. This will determine the units displayed in the reference rulers, as well as the default units shown in scaling options.

From the pop-up menu, select either **Inches** or **Centimeters**. This is a "toggle" item; selecting either from the menu will establish it as default. The program will update the reference rulers with these units. These will also become the default scaling units for subsequent RockPlot images and geo-referenced raster images that you insert.

- ? Help Contents: ReportWorks / View and Layout Options / Establishing the ReportWorks Page Units

### Defining the ReportWorks Program Libraries

Use the **Options / Program Files** tool to establish the names of the pattern and symbol libraries to be used to draw patterns and symbols inserted into the page or those that are included in inserted RockPlot graphics. Neither RockWorks nor ReportWorks stores the actual pattern and symbol designs in the drawings, but instead links pattern and symbol numbers to a reference library; use this option to define which library to use.

- ? Help Contents: ReportWorks / Other Options / Defining the ReportWorks Program Libraries

## Drawing Tools

### Working with Layers

ReportWorks allows you to organize the different items on a page into different "layers". These are groups of items that can be displayed or hidden with the click of a button. For example, you might keep your static legend items (company logos, maybe a pattern index) in one layer, while document-specific RockPlot or bitmap images might be kept in a separate layer.

Opening the program or creating a new ReportWorks document generates a single layer, named "Layer 1." Subsequent items that are drawn or inserted into the page are done so in that layer, until a new layer is created.

**To add a layer** to the current document, choose the **Tools / New Layer** menu item or click on the New Layer button. The program will add a new layer entry into the data pane along the left side of the window. Be sure to highlight a particular layer prior to adding items to your document; items are always added to the currently-highlighted layer. (See also "Moving Items," below.)

**To select a layer to be active**, simply click on its name in the data pane. Subsequent items that you add to your document will be added to that layer.

**To rename a layer**, simply click on the layer in the data pane along the left side of the window, to highlight it. Then click on the layer's name so that you see the blinking cursor in the name's text. Edit/type in a new name. This can help you to be more specific with layer items, such as "company legend items" rather than "Layer2".

**To move items between layers**, double-click on the item in the drawing, and use the Layer prompt to select a different layer name.

**To display a layer's items**, insert a check-mark in the layer's check-box.

**To hide a layer's items** from the display, remove the check-mark from the layer's name.

? Help Contents: ReportWorks / Drawing Tools / Working with Layers

### Inserting a Symbol into a ReportWorks Page

Use the **Tools / Symbol** menu command or toolbar button  to insert a graphic symbol into an existing ReportWorks page. You can insert a symbol from the RockWare symbol library, or you can choose from some generic symbol shapes. Once the symbol is placed you can double-click on it (or right-click and choose Properties) to establish the symbol style, fill, outline, etc. The symbol can be resized by clicking on one of the corner handles and dragging larger or smaller. The symbol can be repositioned by clicking and holding anywhere on the symbol and dragging it to the new location.

? Help Contents: ReportWorks / Drawing Tools / Inserting a Symbol

## Drawing Lines, Polylines, Polygons, and Rectangles on a ReportWorks Page

Use the Reportworks **Tools** menu commands or toolbar buttons to draw straight lines, multi-segmented lines, closed polygons, and rectangles in an existing ReportWorks page. You can adjust the line style, thickness, and color, and the fill for polygons and rectangles.

Straight lines:  or choose the **Tools / Line** menu command.

Polylines:  or choose the **Tools / Polyline** menu command.

Polygons:  or choose the **Tools / Polygon** menu command.

Rectangles:  or choose the **Tools / Rectangle** menu command.

Double-click on the drawn item to view/adjust its settings, or right-click on it and choose Properties. Resize the item as you wish by clicking on one of the endpoint or vertex handles and dragging. Reposition the item as you wish by clicking and holding anywhere on the item and dragging it to the new location.

? Help Contents: ReportWorks / Drawing Tools / Inserting a Line / Polyline / Rectangle / Polygon

## Inserting Text into a ReportWorks Page

Use the **Text** or **Text Block** menu commands or toolbar buttons to insert either a single line of text or a text paragraph on an existing ReportWorks page. You can adjust the font type and size, color, and fill pattern/color.

Click on the Text toolbar button  or choose the **Tools / Text** menu command to insert a single line of text, such as a title or label.

Click on the  button or choose **Tools / Text Block** to insert text that can wrap into multiple lines or paragraph.

You can access the text options at any time by double-clicking on the text or by right-clicking and choosing Properties. Reposition the text label as you wish by clicking and holding anywhere on the text and dragging it to the new location.

? Help Contents: ReportWorks / Drawing Tools / Inserting Text / Multi-Line Text

## Inserting a RockPlot Map or Diagram (RK6 File) into a ReportWorks Page

Use the **RockPlot (RK6)** menu command or toolbar button  to insert into a ReportWorks page a map, cross-section, or other 2D diagram generated by RockPlot2D and saved as a RK6 file.

To insert the image, position the cursor in the page where the one corner of the image is to be placed, and click and hold the left mouse button to insert it. With the button still

pressed in, drag to the location of the diagonal corner point, and release the mouse button. As you drag, you'll see a "rubber band" image of the shape's outline

- You can adjust the diagram's scaling, clipping, outline, and fill pattern/color.
- You can access the image's options at any time by double-clicking on the image or by right-clicking and choosing Properties.
- You can resize the image block by first single-clicking on the image to see the boundary "handles." Then, click and hold on any of the handles on the corners or edges and drag to the new position. Release the mouse button when the boundary's edges are in the correct position.
- Reposition the image as you wish by clicking and holding anywhere on the text and dragging it to the new location.

! See the Bitmap tool for inserting more generic graphic images. The Bitmap tool can be a good option if the RK6 image is slow to redraw in the ReportWorks page, or if there are offset or scaling problems.

? Help Contents: ReportWorks / Drawing Tools / Inserting a RockPlot Map or Diagram

## Inserting a Raster Image into a ReportWorks Page

Use the **Raster** menu command or toolbar button  to insert into a ReportWorks page a BMP, JPG, PNG, TGA, TIFF, EMF, or WMF image. You can adjust the image's scaling and outline.

To insert the image, use your mouse to position the cursor in the page where the one corner of the image is to be placed, and click and hold the left mouse button to insert it. With the button still pressed in, drag to the location of the diagonal corner point, and release the mouse button. As you drag, you'll see a "rubber band" image of the shape's outline.

- You can access the image's options at any time by double-clicking on the image or by right-clicking and choosing Properties.
- You can resize the image block by first single-clicking on the image to see the boundary "handles." Then, click and hold on any of the handles on the corners or edges and drag to the new position. Release the mouse button when the boundary's edges are in the correct position. The raster image will be redrawn within the new boundary using the selected stretch or best-fit scaling you've selected.
- Reposition the image as you wish by clicking and holding anywhere on the text and dragging it to the new location.

? See the RockPlot (RK6) tool for inserting RockPlot-generated graphic images, and the Georaster tool for raster images with world coordinates.

? Help Contents: ReportWorks / Drawing Tools / Inserting a Raster Image

## Inserting a Geo-Referenced Raster Image into a ReportWorks Page

Use the **Georaster** menu command or toolbar button  to insert into a ReportWorks page a raster image that has an associated "world file" for geo-referencing its coordinates. You can adjust the image's scaling and outline.

To insert the image, use your mouse to position the cursor in the page where the one corner of the image is to be placed, and click and hold the left mouse button to insert it. With the button still pressed in, drag to the location of the diagonal corner point, and release the mouse button. As you drag, you'll see a "rubber band" image of the shape's outline.

- You can access the image's options at any time by double-clicking on the image or by right-clicking and choosing Properties.
- You can resize the image block by first single-clicking on the image to see the boundary "handles." Then, click and hold on any of the handles on the corners or edges and drag to the new position. Release the mouse button when the boundary's edges are in the correct position. The raster image will be redrawn within the new boundary using the scaling you've selected.
- Reposition the image as you wish by clicking and holding anywhere on the text and dragging it to the new location.

? See the Raster tool for inserting generic (non-geo-referenced) raster images.

? Help Contents: ReportWorks / Drawing Tools / Inserting a Geo-Referenced Raster Image

## Inserting a Scale Bar into a ReportWorks Page

Use the **Scalebar** menu command or toolbar button  to insert a scale bar on an existing ReportWorks page. You can adjust the style and scaling.

Double-click on the scale bar to access its options, or right-click and choose Properties.

You can resize the scale bar by first single-clicking on it to see its "handles." Then, click and hold on any of the handles on the corners or edges and drag to the new position. Release the mouse button when the rectangle edges are in the correct position. The program will automatically extend or shorten the bar and labels accordingly.

Reposition the entire scale bar as you wish by clicking and holding anywhere on it and dragging it to the new location.

? Help Contents: ReportWorks / Drawing Tools / Inserting a Scale Bar

# Chapter 26 – RockWorks Tables

## Topics

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Land Grid Tables.....	290

## Graphic Libraries

### Pattern Tables

#### Pattern Tables Overview

Patterns are repeating graphic units that can be associated with some kind of data item, such as lithology keywords in the Borehole Manager's Lithology tab, or formation names in the Stratigraphy tab. The actual pattern <-> data associations are made within the Lithology Types Table (for lithology), the Stratigraphy Types Table (for stratigraphy), and the Well Construction Types Table (for construction materials).

RockWorks is shipped with a large number of patterns already installed, in a "Pattern Table." The factory default Pattern Table is named "RW\_pat.pat". It is stored in the program's "System" folder. Unlike some of the other program tables (\*.TAB files), this table is binary rather than ASCII in format.

To access the Pattern Table, where you can view the current pattern set, open a new pattern set, or even access the Pattern Editor where you can modify existing patterns or create new patterns, follow these steps:

1. Access the Project Manager pane along the left edge of the program window.
2. Expand the Misc Tables heading.
3. Double-click on **Patterns** item.

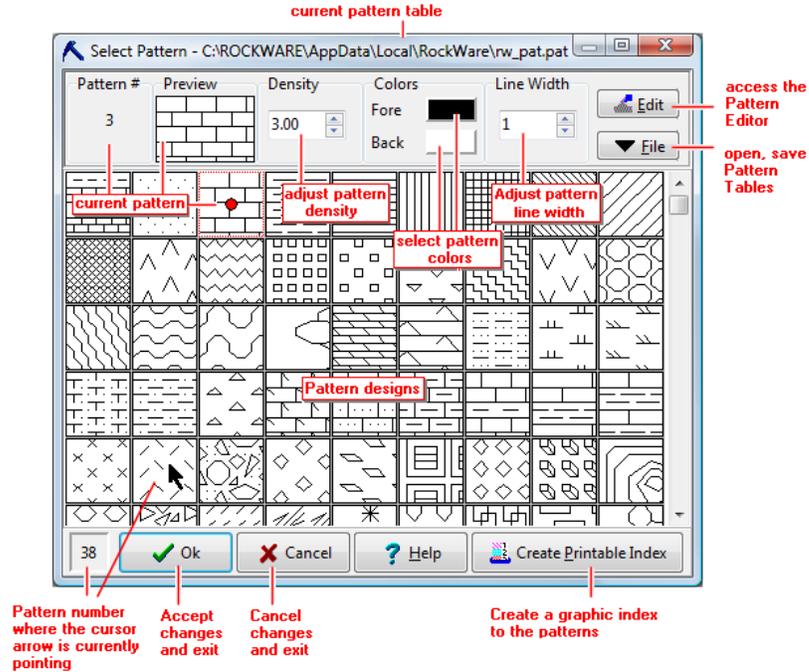
The program will display the default Pattern Table in the Select Pattern window. Here you can view and select patterns from the current pattern library. It also lets you access the Pattern Editor where you can edit existing pattern designs and create new patterns. See the topics below.

(The Pattern Table can also be accessed from several other places within the program, including the Stratigraphy / Lithology / Well Construction Types Tables.)

#### The Select Pattern Window

The Select Pattern window displays all of the pattern designs contained in the current Pattern Table. If you do a lot of modifications to this file, or like to maintain specific pattern libraries for different projects, you can save the Pattern Table under different file names and in different folders. The name of the current Table is displayed at the top of the Select Pattern window.

This window is used to view patterns, select pattern colors and density, open other Pattern Tables, and access the Pattern Editor.



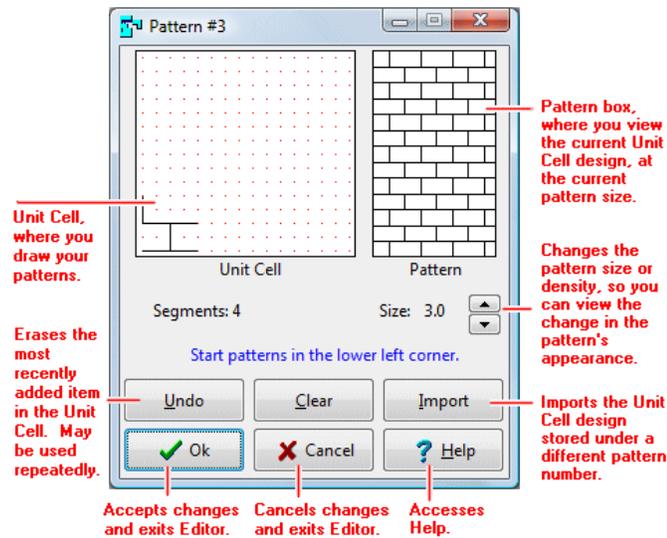
To view pattern samples that are not currently visible, drag the scroll bars up or down as appropriate.

? Help Contents: RockWorks Tables and Libraries / Pattern Tables

### Using the Pattern Editor

The Pattern Editor is a tool that permits you to edit an existing pattern design or create a new pattern design for use to illustrate rock types in logs, cross sections, etc. Pattern designs are stored in a RockWorks "Pattern Table."

The Pattern Editor is accessed from the Select Pattern window. The selected pattern design (or blank pattern) will be displayed in the Pattern Editor.



? Help Contents: RockWorks Tables and Libraries / Pattern Tables

## Symbol Tables

### Symbol Tables Overview

Symbols are small line drawings that can be associated with each record (row) in the RockWorks Utilities data window, representing a different sample site or drill hole location. The symbols will be used by the program to note the sample locations in point maps, ternary diagrams, stereonet, etc. Symbols will also be associated with each borehole in the Borehole Manager (shown on the Location tab).

RockWorks is shipped with an existing set of symbols already installed, in a "Symbol Table." The factory default symbol Table is named "RW\_sym.sym". It is installed in the program's main System folder. Unlike some of the other program tables (\*.TAB files), this table is binary rather than ASCII in format.

To access the Symbol Table, where you can view the current symbol set, open a new symbol library, or even access the Symbol Editor where you can modify existing symbols or create new ones, follow these steps:

1. Access the Project Manager pane along the left edge of the program window.
2. Expand the Misc Tables heading.
3. Double-click on **Symbols** item.

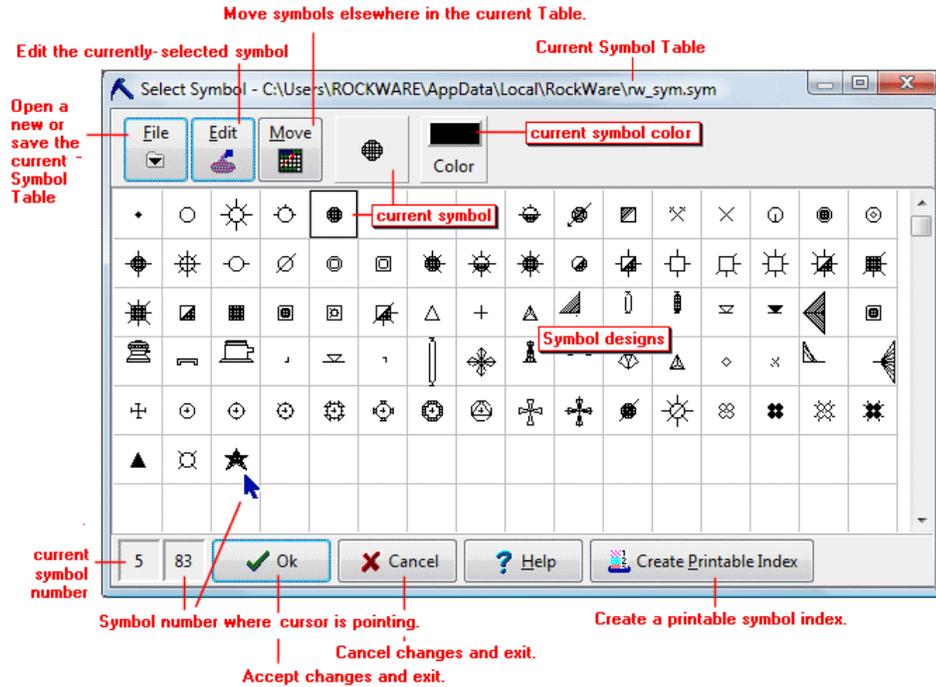
The program will display the default Symbol Table in the Select Symbol window.

Here you can view and select symbols from the current symbol library. It also lets you access the Symbol Editor where you can edit existing symbol designs and create new symbols. See the topics below.

\* The Symbol Table can also be accessed from within the RockWorks Utilities data sheet, by double-clicking on a graphic symbol cell. It can also be accessed by clicking on the picture of the symbol in the Borehole Manager Location tab.

### Using the Select Symbol Window

The Select Symbol window displays all of the symbol designs in the current Symbol Table. The factory default Table is "RW\_sym.sym" (in the program's main "System" folder. This window is used to view symbols, select symbol colors, open other Symbol Tables, and access the Symbol Editor.



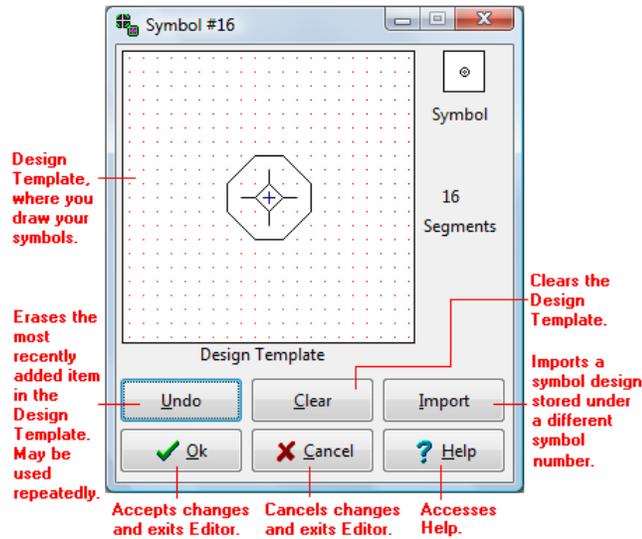
To view symbol samples that are not currently visible, drag the scroll bars up or down as necessary.

? Help Contents: RockWorks Tables and Libraries / Symbol Tables

### Using the Symbol Editor

The Symbol Editor is a tool that permits you to edit an existing symbol design or create a new symbol design for use to illustrate sample locations in maps, stereonet, etc. Symbol designs are stored in a RockWorks "Symbol Table."

The Symbol Editor is accessed from the Select Symbol window. The selected symbol design (or blank symbol) will be displayed in the Symbol Editor.



(\* The Select Symbol window can also be accessed by double-clicking in a symbol column in the RockWorks Utilities data sheet or by clicking on the symbol picture in the Borehole Manager Location tab.)

? Help Contents: RockWorks Tables and Libraries / Symbol Tables

## Diagram Legend Tables

**Color Index Tables:** A "Color Index Table" is used to plot a color legend inside a map/diagram legend box in the RockPlot2D program. Although many RockWorks color diagrams (maps, stratigraphic blocks, etc.) offer automatic color legends, it can be handy to include a custom color index in an overall diagram legend to emphasize anomalous areas, etc. Color Index legends can also be inserted into ReportWorks layouts.

**Line Style Index Tables:** These are used to plot a legend showing different line styles and captions in a map/diagram in the RockPlot2D and ReportWorks programs.

**Pattern Index Tables:** These are used to plot a legend showing different pattern designs and captions in a map or diagram in RockPlot2D and ReportWorks.

**Symbol Index Tables:** These are used to plot a legend showing different map symbol designs and captions inside a legend box in RockPlot2D and ReportWorks.

You can access the factory installed versions of these tables using the Project Manager – expand the Misc Tables heading and double-click on the Index item.

! The samples for these tables are in the RockWorks "System" folder. However, since these tables are generally project-specific, we recommend that you store your working tables in the project folder.

? Help Contents: RockWorks Tables and Libraries / Legend Index Tables

## Misc Project Tables

New to RockWorks15 is the ability to store a variety of project-specific lookup tables right in the project database. These include things like colorfill tables, contour line tables, point map scaling tables, polygon tables, and more.

? See page 59 for more information.

## Land Grid Tables

Land Grid Tables contain a listing of Jeffersonian-style locations, in Range, Township, Section (RTS) notation, and the longitude and latitude reference coordinates for the section corners. These tables are used by several tools in RockWorks:

Borehole Manager **Map** menu, **Adjust Coordinates / Jeffersonian** ->

**Easting/Northing**: This tool translates well locations from RTS format to the required Easting and Northing format.

RockWorks Utilities **Coords** menu, **Jeffersonian Points** -> **Cartesian** and **Jeffersonian Polygons** -> **Cartesian**: These tools translate RTS locations to X,Y coordinates in lon/lat or Easting/Northing format.

RockWorks Utilities **Map** menu, **Land Grid / Section Map** and **Lease Map**: These tools create section boundary maps and lease maps.

Where do these reference coordinates come from? RockWorks offers three options:

- One option is to purchase RTS land grid information from a commercial source. This requires that you import that data into the Land Grid Table. (See Importing Commercial Land Grid Data for details.)
- Another option is to create an idealized land grid, which requires only that you define a single known latitude and longitude coordinate for a corner of a Township and the number of townships to be listed. (See Interpolating Idealized Land Grid Data for details.)
- The third option uses RockWare's downloadable database of land grid information, called the "RockWare LandBase," which contains Range/Township/Section coordinates for many areas of the U.S. The LandBase data can be imported into a Land Grid Table or can be used directly for creating section maps and spotting wells and leases. Look for the link in the RockWorks **Help / Download** menu if you would like to download this dataset

! **IMPORTANT:** Although we ship a sample Land Grid Table with the program, you will need to create (import or interpolate) your own land grid table for your own projects  
See also: Land Grid Maps (page 115)

? Help Contents: RockWorks Tables and Libraries / Land Grid Tables

# Chapter 27 - Reference

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## Summary of RockWorks File Types

The following is a list of the file types used in RockWorks.

### User-Created Data Files

**ATD:** "ATD" files are user-created data files used in the RockWorks Utilities datasheet for storing row and column data. They can contain rows and columns of text, numeric values, symbols, color, line styles, and more. In RockWorks the column titles and column types are stored in a set of header lines at the top of the file. ATD files are ASCII Tab-delimited in format. File name extension = [.atd]. See RockWorks Utilities Datasheet Overview (page 85) and ATD File Structure Overview (in the Help messages Reference section) for more information.

**MDB:** This is a Microsoft Access-compatible database file that is generated by RockWorks automatically when you create a new project folder. It stores all of the borehole data for the project, many of the "type" libraries (lithology, stratigraphy, i-data, etc.), and the project dimensions. The database file name must match the folder name; for example the MDB file in the "Golden Project" folder will be named "Golden Project.mdb". File name extension = [.mdb]. The database will create support files, such as XML data "dictionaries" in the project folder. See Borehole Database (page 77) and the "Borehole Manager" section of the Help messages for more information.

**RCL:** "RCL" files are created by the user outside the RockWorks program in a text editor. These files contain a series of commands used to run RockWorks in a batch mode. "RCL" stands for "RockWare Command Language." See Using the RockWare Command Language (page 297) and RCL Format (Help Contents: Reference / RCL Scripting) for information.

### Program-Created Model Files

**GRD:** "Grid" files are created by RockWorks as the result of gridding X,Y,Z data in the RockWorks Utilities, or of gridding formation, thickness, water level or other spatial data in the Borehole Manager. Grid files can also be the result of filtering or importing existing grid files. Grid files are ASCII in format, with the file name extension [.grd]. See Gridding Reference and RockWorks Grid File Format in the Help message Reference.

**MOD:** "Solid Model" files are created by RockWorks as the result of modeling X,Y,Z,G data in the RockWorks Utilities, or of modeling lithology, I-Data, T-Data, P-Data, fracture, or vector data in the Borehole Manager. In addition, stratigraphic surface models can be stacked and

saved as a solid model file. They can also be the result of filtering or importing existing solid models. They are ASCII in format, with the file name extension [.mod]. See Solid Modeling Reference and RockWorks Solid Model Format in the Help message Reference section.

### Program-Created Plot Files

**RK6:** These "plot" files are created in the RockPlot2D window to store all RockWorks2D graphic images (2D maps and logs, rose and stereonet diagrams, etc.). They are binary in nature, and use the file name extension [.rk6]. See Managing RockPlot2D Files (page 251).

**R3DXML:** This is the format for files created in the RockPlot3D window to store the information in a 3-dimensional graphic image (3D surfaces and logs, solid models, fence panels, etc.). These are ASCII in format and contain links to solid models, bitmap images, etc. that may be displayed in the RockPlot3D view. The file name extension is [.r3dxml]. See Managing R3DXML Files (page 265). (These files are XML in format; the 6-character file name extension allows RockWare to register this file type within Windows.)

**RW6:** These are graphic files created by the ReportWorks program, storing the page layout of inserted RK6 images, bitmaps, text, shapes, and more. They are binary in format. The filename extension is [.rw6]. See Managing ReportWorks Files (page 278).

### Program Libraries

**PAT:** These are Pattern Tables that contain the designs for repeating graphic patterns used in logs, cross sections, lease maps, etc. RockWorks is shipped with a library of patterns in the default "rw\_pat.pat" table; you can save this file under a different name, delete patterns, add pattern designs, etc. via the Misc Tables listing accessed using the Project Manager along the left edge of the main RockWorks program window. Pattern files are binary in format, with the file name extension [.pat]. See Pattern Tables Overview (page 285).

**SYM:** These are Symbol Tables that contain the designs for graphic symbols used in maps, statistical diagrams, logs, etc. RockWorks is shipped with a library of symbols in the default "rw\_sym.sym" table; you can save this file under a different name, delete symbols, add symbol designs, etc. via the Misc Tables listing accessed in the Project Manager along the left edge of the main RockWorks program window. Symbol files are binary in format, with the file name extension [.sym]. See Symbol Tables (page 287).

**Rockware\_landbase:** These files contain Range/Township/Section coordinates for portions of the United States. These files are not installed with the program (they're large) but can be downloaded from the RockWare web site using the link in the RockWorks **Help / Download / RockWare Landbase** menu item. These data are used by the RockWorks Utilities **Map / Land Grid Maps** tools, **Coords / Jeffersonian Points & Polygons** tools, and the Borehole Manager **Map / Adjust Coordinates / Jeffersonian** tool.

### Importable Files

**BMP, JPG, PNG, TIFF, GIF, WMF, EMF, PCX, PCC, TGA, AFI, VST, ICO** (RockPlot2D, RockPlot3D, or as grid models), **DBase** (data), **DEM** (grid models), **DXF** (RockPlot2D, RockPlot3D, data), **GXF** (grid models), **Surfer/GRD** (grid models), **DLG** (RockPlot2D), **ESRI/e00** (RockPlot2D), **ESRI Shapefile/SHP** (into RockPlot2D), **TXT** (data), **Excel/XLS** (data), **LAS** (Log ASCII Standard) (data).

### Exported Files

RockWorks can export the following file types: **AVI** (RockPlot3D), **BMP, JPG, PNG, TIFF, GIF, WMF, EMF, PCX, PCC, TGA, AFI, VST, ICO** (RockPlot2D, RockPlot3D,

ReportWorks), **DBF** (from data), **DXF** (RockPlot2D, grid models), **ENZ** (from grid models), Surfer/**GRD** (grid models), ESRI Shapefile/**SHP** (RockPlot3D), **TXT** (data), Excel/**XLS** (data).

? Help Contents: Reference / File Formats

## Program Preferences

The **Tools / General Preferences** option is used to establish some general operational settings for the RockWorks program. This option is available from both the RockWorks Utilities and Borehole Manager, via the **Tools** menu.

**Skip Introductory Screen:** Insert a check in this box if you want to hide the introductory "welcome" screen that's displayed when you start up RockWorks. Changes will not take effect until the next time you start the program. This setting can also be adjusted on the startup screen itself.

**Project Manager:** These options define the display of the Project Manager pane, along the left edge of the program window.

**Load Last-Used ATD File into Utilities Datasheet On Startup:** Insert a check here if the program is to load into the Utilities data window, automatically on startup, the last datasheet with which you were working.

**Prompt for Project Folder:** If activated you will be prompted, each time the program is launched, for the name of the folder in which you wish to work. The prompt will default to the last folder in which you were working or, if you're new to the program, the tutorial samples folder. Note that you can change the current Project Folder at any time while you are working with the program simply by clicking in the Project Folder prompt below the main menu items.

**Reminders:** Insert a check-mark for the program to display a "Do-you-want-to-save?" reminder when you close a RockPlot2D graphics window and the image has not been saved. We recommend that you leave this setting on.

**Check for Newer Version On Startup:** Insert a check here to have RockWorks check whether there's a new version on the RockWare web site and display an alert if there is. If desired, you can save the latest installation program to your local computer. You can then run the installation program to re-install RockWorks.

**Show Help Messages on Startup** Check this box to display the RockWorks Help window automatically each time the program is launched. Should you disable this and then wish to access the Help system, simply select the Help / Contents option, the Help / Tutorial option, or the Help button in most options windows.

**Warn User If...** Use these settings to turn on a variety of warnings regarding data and memory availability.

**Main Menu Options:** Use these settings to define some overall program settings, such as windows size, toolbar displays, and Borehole Manager datasheet button/tab position.

**Secondary Menu Options:** Use these settings to define how the program Options windows will behave. This includes whether the Instructions tab is displayed, whether the program output is to be embedded into the windows, whether multiple windows can be open at the same time, etc. for the tree-style menus displayed in many of the program Options windows.

**New Project Defaults:** Use these options to define some of the new-project settings that will be used if you aren't using the RockWorks default MDB database setup.

**Data-Sheets:** These options can be used to adjust the font & decimals in the RockWorks Utilities datasheet.

**Diagram Scaling:** Use this option to define how the program will scale the items within graphic diagrams – using the project's map dimensions (XY), its entire extents (XYZ) or a user-defined value.

Tables: RockWorks tables are no longer listed in this menu. Instead, use the Project Manager pane along the left edge of the main program window to access the table listings.

## RockWorks Menu Settings

As you work in a project within RockWorks, most of the program settings - the thousands of check-boxes, file names, and other options that you establish in the program menus - are stored in two files on your computer.

**Project-Specific Settings:** These settings (which are the vast majority) are stored in a file named "menus.ini" in the "System" folder that is created inside each Project Folder. Examples of these settings would include gridding and contouring options, striplog setup, etc.

! The ability to store project-specific settings is new to RockWorks15.

**Global Settings:** These settings, which probably won't vary much from project to project (and which would be very annoying to change as you move to different projects) are stored in a file "GlobalSettings.ini" in the program's main System folder. Many of these settings are established in the **Tools / General Preferences** menu item, such as whether the Help window is displayed on program startup, or how wide the Project Manager pane should be.

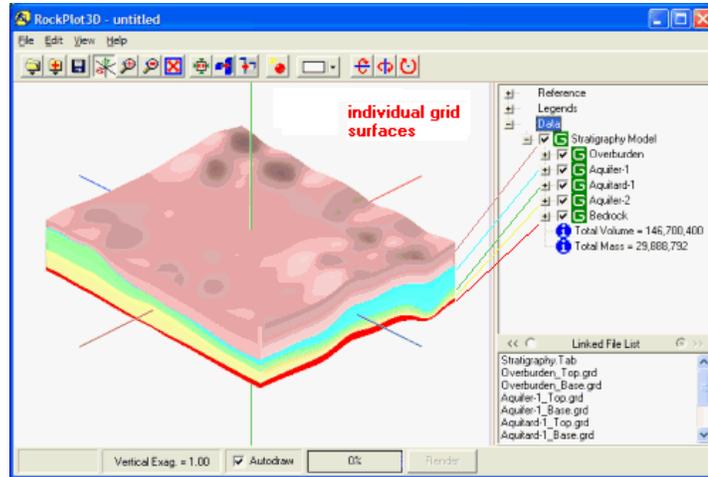
RockWorks contains some handy tools for managing these settings, listed below by functionality.

- **Creating a new project:** As you create a new project in RockWorks, you have the option of bringing in the project-specific menu settings from an existing project. (You can bring other project data in, as well.) This can be helpful if the data is similar and you want to start work in the new project based on where you left off in the old.
- **Making backups:** Use the **Tools / Export Menu Settings** option to store a copy of your current Global and/or Project settings (for all menus) in ".ini" file(s) - handy if you're fiddling around with settings and may want to go back to a previous configuration.
- **Restoring settings from backups:** Use the **Tools / Import Menu Settings** option to bring into the program a copy of the global and/or project settings (for all menus) previously saved.
- **Technical support and backups:** Export the settings for the current menu you're working in, using the **Menu / Save to RCL** option in the menu window itself. "RCL" stands for "RockWare Command Language" and can be used to run RockWorks using scripts. The **RCL** menu lists can also, however, be used by our support staff to trouble-shoot problems you're experiencing with the software. (RCL lists can be brought into the current menu using the Load from RCL option.)

- Sharing settings with a co-worker:
  - Use the **Save to RCL** and **Load from RCL** menu options to share settings for specific program options with co-workers.
  - Use the **Tools / Export Menu Settings** and **Import Menu Settings** to share all program settings with co-workers.

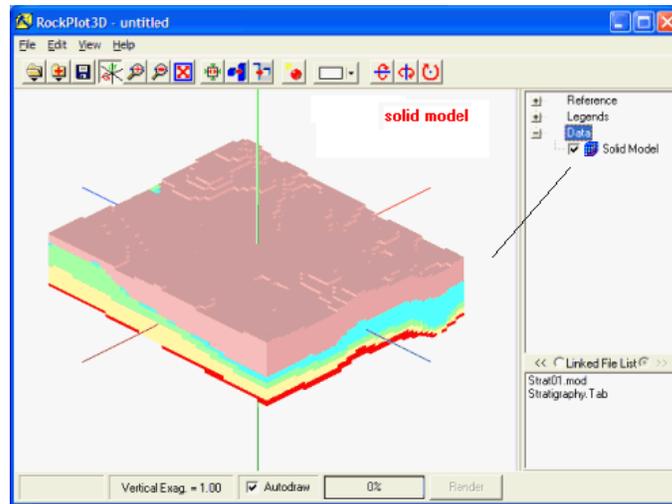
## Stratigraphy Model versus Stratigraphy Solids

When you use the Borehole Manager's **Stratigraphy / Model** tool to create a 3D display of all of your stratigraphic units, what RockWorks creates is a series of grid surfaces with sides for display in RockPlot3D. The benefits to this type of display and modeling are the nice looking surfaces, the ability to turn individual surfaces on and off in RockPlot3D, the ability to edit individual surfaces, and more.



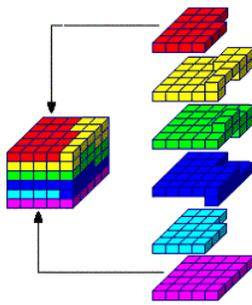
Stratigraphy Model: Stacked Grid Surfaces

RockWorks also offers the option of building a stratigraphic solid model of the stacked surfaces. This is done with the Save Model checkbox in the Stratigraphy / Model tool. These stratigraphic solids are true solid models that represent the 2-dimensional grids stacked on each other, depositionally, from the bottom up. Stratigraphic solids have three fixed dimensions: X (Easting), Y (Northing), and Z (elevation), with a variable G-value which represents stratigraphy type as an integer. These formation "G" values are declared in the Stratigraphy Types Table.



Stratigraphy Solid

Like geochemical or geophysical solid models, stratigraphic solid models are just files that contain listings of X, Y, Z, and G numbers. Unlike solid models which contain real number G values, stratigraphic models usually contain integer G values that correspond to the formations.



You might picture a stratigraphic solid as a stack of cubes. In the cartoon here, the 3-dimensional cells, or voxels, are color-coded based on their G-value or stratigraphy type. The model is constructed by “inserting” the 2-dimensional grid models of each stratigraphic layer (top AND base), from the bottom up.

The stratigraphic solid can be displayed in RockPlot3D by opening the MOD file using the Project Manager, and choosing All Voxels as the diagram type. When displayed in RockPlot3D, you can double-click on the Solid Model item to set the Color Scheme to the Stratigraphy Types Table from which the model was created. Stratigraphy solids have the same file structure as regular geochemistry / geophysical / fracture solid models.

With the introduction of RockPlot3D for visualizing multiple grid models as surfaces in 3D, users may not use stratigraphic solids as much as they did in RockWorks99.

? [Help Contents: Reference / Solid Model Reference / Stratigraphy Models v Stratigraphy Solids](#)

## 2-Dimensional Map Layers

RockWorks offers the following "layers" for two dimensional maps. A layer is activated if a check-mark is displayed in its check box. To access the layer's settings, expand its sub-topics by clicking on its "+" button.

**Background Image:** Displays an image in the background of the other map layers. BMP, JPG, EMF/WMF, PCX, PNG, and TIFF images are supported.

**Symbols:** Illustrates the sample sites in the main data sheet with map symbols.

**Labels:** Plots labels for the sample sites, usually used with the symbols layer.

**Contours:** Plots lines representing the distribution of "z-values" (elevation, geochemistry, etc.) in the study site.

**Colored intervals:** Plots solid color-filled regions representing the distribution of z-values in the study site.

**Fault Polylines:** (Available only for grid-based maps.) If the grid model from which the contours are being drawn contains faults, they can be displayed with lines in the resulting map.

**Labeled-Cells:** (Available only for grid-based maps.) Draws a grid of lines corresponding to the grid model nodes, and fills the cells with labels for the node values.

**Borders:** Plots border tick marks and coordinates labels, and axis titles.

**Triangulation Network:** (Available only for EZ maps, if contours or color filled intervals are selected.) Displays the network of triangles constructed by the program to build the map contours.

? [Help Contents: Reference / 2D Map Options](#)

## Running RockWorks from a Script

Almost all of the applications within RockWorks can be accessed, without displaying RockWorks menus, by placing special commands within an ASCII text file. This functionality is targeted toward users who wish to automate repetitive tasks, and developers who wish to run RockWorks in the background.

The "RCL" or "RockWare Command Language" scripts can be run by selecting the File / CompileRCL option, or via a command line parameter.

Use this tool to read a listing of program commands from a user-created "RCL" (RockWare Command Language) file and to perform the listed operations. This is a means of running RockWorks in "batch" mode to simplify repetitive tasks. The RCL file can also be launched via a command line, eliminating the need to view the menus at all. See the Help messages for more complete information.

## Troubleshooting

Please refer to the RockWorks Help Contents: Reference / Troubleshooting topic for possible answers to program error messages.

Please also visit our support forum: [www.rockware.com/forum/index.php](http://www.rockware.com/forum/index.php) for a searchable list of user discussions and questions.

email: [tech@rockware.com](mailto:tech@rockware.com)

tel: +303-278-3534

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