Cyclolog 2012 Manual

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1. INTRODUCTION

1.1. CYCLOLOG

CycloLog provides the petroleum geologist with a comprehensive suite of tools for displaying, analysing, interpreting and plotting wireline log data. CycloLog's particular speciality is in the stratigraphic interpretation of log data, and this version (CycloLog 2012) therefore incorporates important new functionality for constructing and plotting well correlation panels. Of CycloLog's many log-processing functions, those associated with spectral analysis remain unique to CycloLog, and provide the user with the means to apply the principles of climate stratigraphic analysis to his/her data. The more general user will find here a wealth of widely applicable functions that will greatly assist in the visualisation and interpretation of standard wireline log data.

1.2. WHAT'S NEW IN VERSION 2012

Compared with CycloLog version 2010, version 2012 contains more functions to come to a better result even faster. Some of the important new routines are summarized as follows:

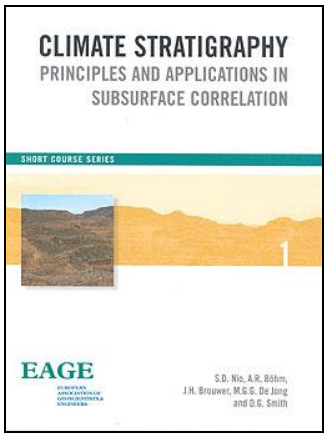
- Improved 2D cross plotting and manual clustering
- New Batch INPEFA function.
- Improvements to existing Dynamic INPEFA function.
- New Autosave feature.
- Draggable depth bar rescaling in log views.
- Unified scaling across all views.
- Toggleable value tooltips in logs.
- CLG file format change (any file opened and saved in 2012 can only be opened in 2012 or later).
- Many stability and bug fixes.

Furthermore, many existing routines have been improved and the user-friendly level has been increased.

1.3. THIS MANUAL

This Manual introduces the user-interface and all of the principle functions available in CycloLog. Familiarity with the Windows environment is assumed. This Manual is also the basis for the on-line Help system in CycloLog; the information in the manual is normally available through the Help system during a CycloLog session.

The Manual does not cover interpretative aspects; more information on interpretation and the new approach in stratigraphy is available in the EAGE Short Course – *Climate Stratigraphy, Principles and Applications in Subsurface Correlation*. The publication can be obtained from the EAGE website (http://www.eage.org/bookshop/main.phtml?action=details&id=267).



Please contact us if you need further guidance in the application of the methods available in CycloLog.

1.4. REQUEST FOR FEEDBACK

CycloLog is under continuous development, and we urge users to contact ENRES with any comments or suggestions for further improvements, or for improvements to this Manual.

1.5. BASIC CYCLOLOG CONCEPTS

CycloLog has incorporated new levels of functionality in the previous version. These functionalities have been maintained and improved in this new version CycloLog 2012. It is important for the user to be remembered to a small number of basic concepts, central to the way in which CycloLog handles wells and log data.

1.5.1. PROJECT

The project is the well or group of wells, with all their logs, that are held in a single CycloLog-format (*.clg) file. All the items in a Project can be worked on in a single CycloLog session.

1.5.2. DOMAIN

Standard well data exist in the Depth Domain; that is, the log values are recorded against increments of depth in either feet or meters. If a suitable time-depth curve can be defined, the depth scale can be converted into a scale of two-way travel time (TWT) measured in milliseconds. The log data can then be plotted against a vertical scale of TWT rather than depth; they are then said to be in the Seismic Domain.

Alternatively, there may be sufficient data available from detailed biostratigraphy, and/or from analysis of Milankovitch cyclicity, to define a relationship between depth and geological time. In this case, the data can be plotted against a vertical scale in geological time in millions of years – the Geologic Time Domain. CycloLog can convert between these domains, and can hold separate versions of the logs scaled against each of these different vertical scales.

Hence each Well in a CycloLog Project may have more than one Domain associated with it.

1.5.3. CYCLOLOG NATIVE DATA FORMAT

CycloLog imports data from LAS and other formats, in which log values are given at standard depth increments, normally 0.5 feet (0.1524 meters). However, the complex processing undertaken in CycloLog requires a much more efficient internal (binary) data format, in which CycloLog also stores all of its original and transformed log data whenever you save a session in a *.clg file. It is therefore not possible to read *.clg files in other applications.

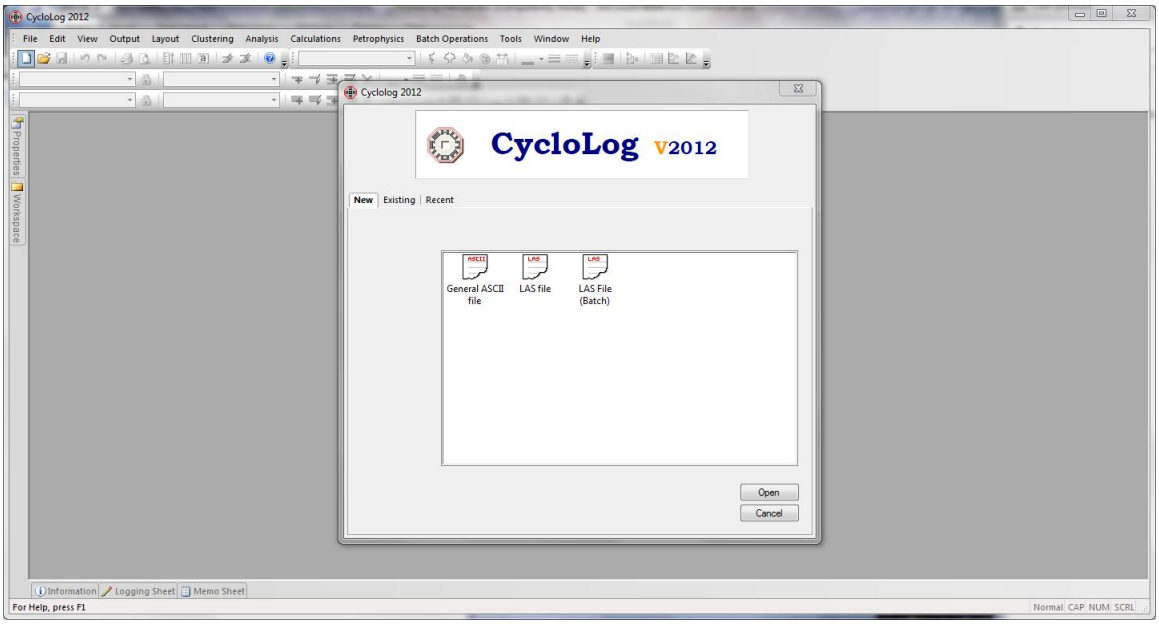
When CycloLog imports data from an external source such as a LAS file, it resamples the data at a user-defined depth increment. This need not be identical with the depth increment of the original data, in which case CycloLog interpolates the data using a linear function. This allows CycloLog to read from data with an irregular sampling interval, or from data from which lines are missing.

ENRES International
November 2009

2. THE CYCLOLOG WINDOW

2.1. TO OPEN CYCLOLOG

Open CycloLog 2012 by double-clicking on the CycloLog icon on your desktop. The main CycloLog window appears, together with a smaller window that allows you either to open an existing CycloLog project, or to create a new CycloLog project.



This section of the manual describes the functionality and behavior of these windows.

2.2. THE OPEN/NEW WINDOW

The Open/New window appears when you first open CycloLog, and also when you select File → Open or File → New. There are three tabs: New, Existing and Recent.

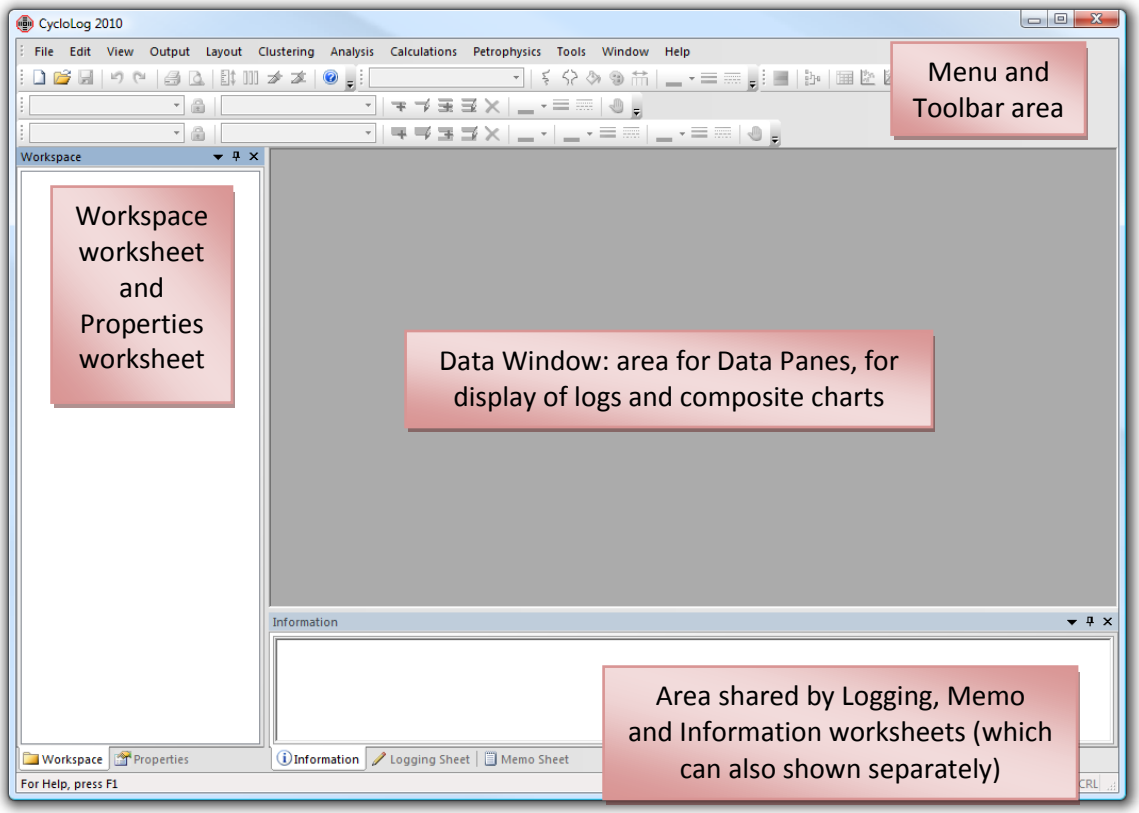
The New tab is for creating a new CycloLog project by importing new well data and converting them into CycloLog's binary format. Data can be imported either from LAS or more general ASCII format files: see the section on importing data of this Manual.

The Existing tab is for retrieving a project that already exists as a *.clg (CycloLog format) file. The tab leads to a standard Windows dialog box for navigating to the file.
On the Recent tab are listed the most recently modified projects (*.clg files); these can also be found near the bottom of the File menu on the main Menu Bar.

2.3. THE MAIN CYCLOLOG WINDOW

The CycloLog Window consists of the following components:

- The main Menu bar
- Toolbars
- The main Data Window
- The Workspace worksheet
- The Properties worksheet
- The Information, Logging and Memo worksheets
- Status Bar



The main **Menu Bar** and **Toolbars** are described in detail below.

The **Data Window** is the main window within which one or more panes of log data can be displayed, from one or more wells. Log data can be displayed in the depth domain or in the time domain. The Data Window and Data Panes have some important properties that are described in the section on the workspace and the data panes.

The various Worksheets provide information on a CycloLog session. The Workspace worksheet holds the tree structure showing the logs available in the current Project. The Worksheets can be arranged in a variety of different configurations or kept out of sight; they are described in more detail below.

The Properties worksheet offers a quick way of customizing visual layout parameters of active panes.

The **Status Bar** displays different information depending on the position of the cursor. If the cursor is held over one of the toolbar icons, the status bar displays the name of the relevant function. If the cursor is held over a pane displaying log data, the status bar displays the depth (in meters and feet) and the value of the log(s) at that depth.

The Status Bar can be opened and closed by clicking on View → Status Bar.

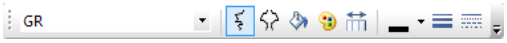
2.4. TOOLBARS

There are eight different toolbars, giving access to groups of commonly-used functions. The toolbars can be open or closed in any combination, and can be moved by dragging on the column of dots at the left-hand end of each. They can be arranged in whatever way you prefer at the top of the screen, or they can be detached to “float” anywhere in the Data Window.

The list of toolbars currently open can be seen by clicking View → Toolbars on the Menu Bar, or by right-clicking over the empty part of the main Menu Bar. Click on items on this list to open them if they are closed, or to close them if they are open. The toolbars are:

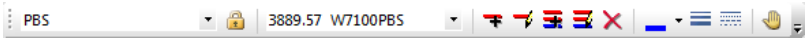
Standard Toolbar – The standard toolbar contains the most basic functions which are valid everywhere in the program.

Log Toolbar – some basic log-editing functions like style, color, horizontal scale etc.



Clustering Toolbar – for functions connected with Cluster Analysis.

Break Toolbar – Tools for managing and editing “breaks” (boundary picks).



Reservoir Toolbar – Tools for managing and editing “reservoirs”.

Format Toolbar – Includes tools for formatting and arranging objects on Correlation Panels.

Drawing Toolbar – Tools for inserting various drawing objects into Correlation Panels.

Align Toolbar – Tools for aligning objects in the correlation panel.

The more toolbars that are open, the less space is available in the Data Window for displaying logs, so it is useful to keep the number of open toolbars to a minimum.

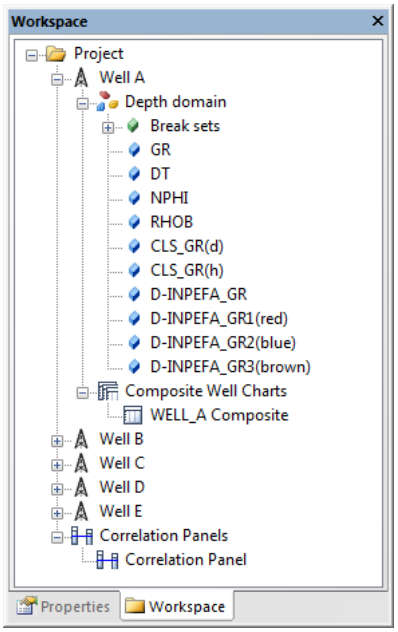
2.5. THE WORKSHEETS

The Worksheets provide access to the logs in a project, and also give information and status of well analysis. There are 5 Worksheets:

- Workspace worksheet
- Properties worksheet
- Information worksheet
- Logging worksheet
- Memo worksheet

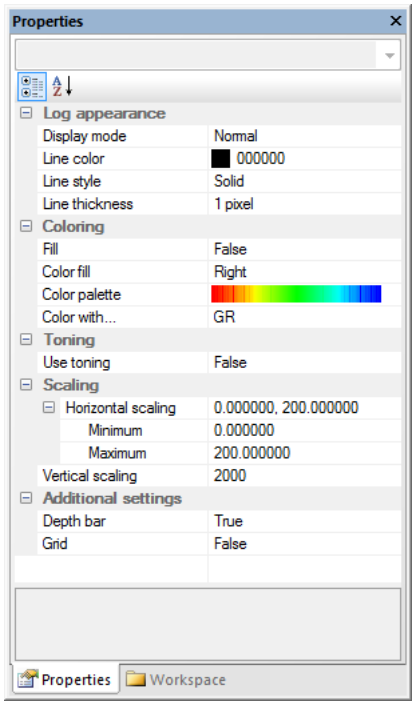
2.5.1. WORKSPACE WORKSHEET

The Workspace worksheet is the most important, as the various logs are opened from the list in this worksheet. The list of data available in the current project is shown in the Workspace in the form of a tree structure, which includes the logs available in each Domain (if there is more than one) and also the Composite Charts and Correlation Panels that have been created. Logs and charts are opened by double-clicking their names in the Workspace.
Also available in the Workspace are the different break sets and reservoir sets defined by the user. Double-clicking on a break set will open the Break Manager with the break set already selected for quick editing. Double-clicking on a reservoir set will display the same behavior as with the break set only in this case the Reservoir Manager is opened with the double-clicked reservoir set selected.



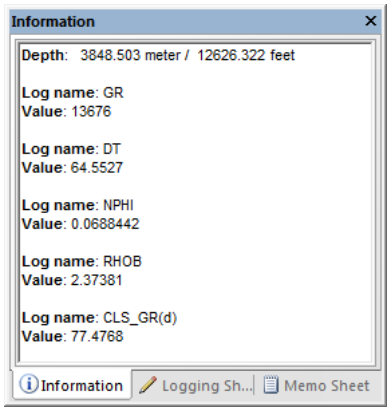
2.5.2. PROPERTIES WORKSHEET

If a pane is opened the layout of its content can be modified by using the options from the menu bar or using the context menu under the right mouse button. It is also possible to use the Properties worksheet to modify the layout. In the Properties worksheet all available layout options are grouped together. Changes in the Properties worksheet are immediately reflected in the open pane.



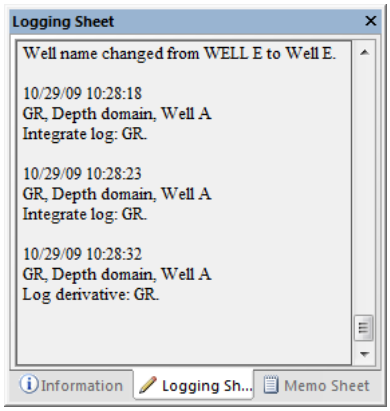
2.5.3. INFORMATION WORKSHEET

When a log data pane is open, the Information Worksheet shows the depth position of the cursor within the data pane, and the log name and log values of the log(s) within that pane.



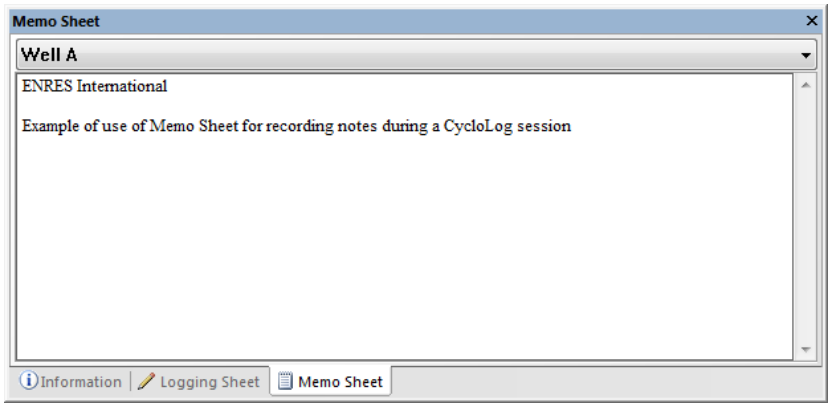
2.5.4. LOGGING WORKSHEET

The Logging Worksheet is a running log (date and time) of all major processes and analyses that have been carried out within the active project. It also records the parameters used for these analyses, which can be useful for future reference.



2.5.5. MEMO WORKSHEET

The Memo worksheet provides a space for the user to make notes in free format. A drop-down list at the top of the Memo sheet allows the user to select a well in cases where there is more than one well in the Project.



2.6. ORGANIZING THE WORKSHEETS

It is possible to display all five worksheets simultaneously, or none, or any combination of them. The layout of the worksheets (and of the toolbars) is saved from one session to the next. Each worksheet can be docked to the left, right, top or bottom of the main part of the Data Window (see illustrated examples below). Each can also be detached from the sides of the Data Window, to float anywhere within the window. To move a worksheet, click and drag on its title bar.

Worksheets can be closed, to save space – click on the close button ("**x**") on the title bar of the worksheet to be closed.

Worksheets can be opened again either from View → Toolbars on the Menu Bar, or by right-clicking on the empty part of the Menu Bar. Both actions open a list showing which of the Toolbars and Worksheets are open – click on the item to be opened if it is not already checked.

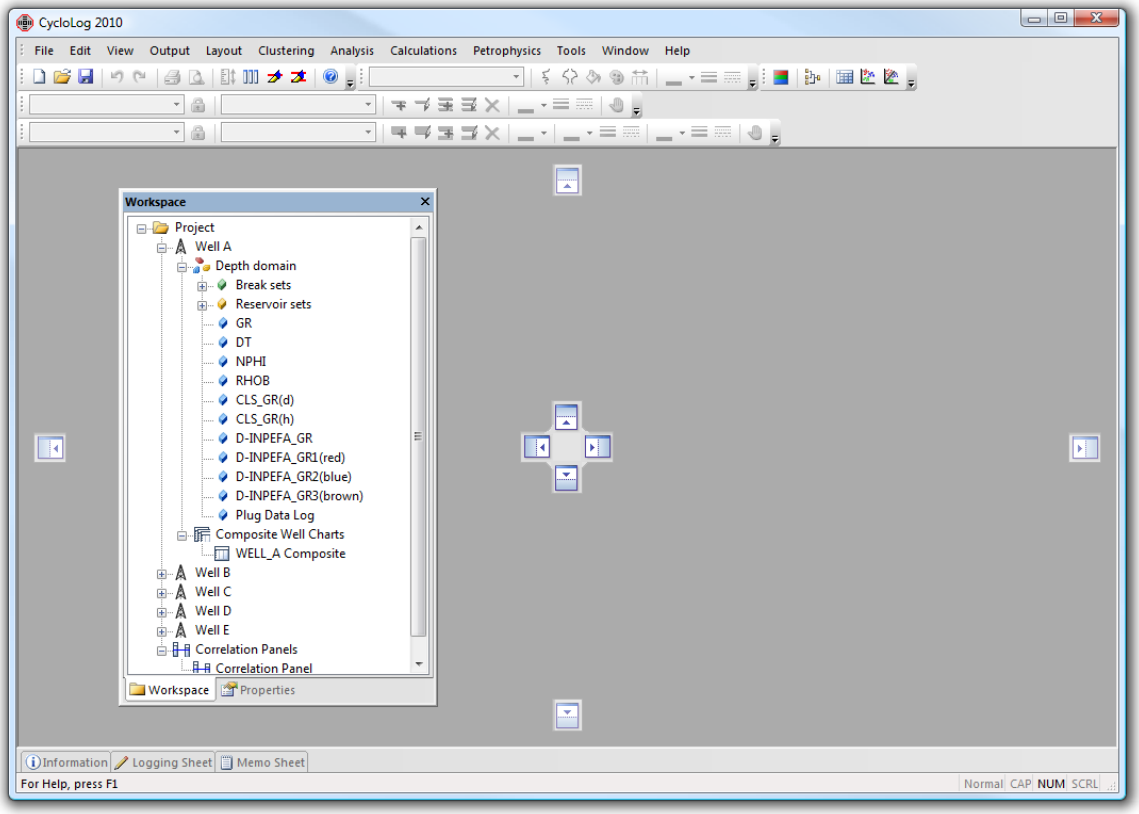
When first opened, the worksheets are fixed, and the pin symbol points downwards.

Clicking on the pin causes it to turn to the left, and the worksheet is now free to slide out of view until it is needed again.

While out of view, it is represented by a named tab at the appropriate side of the Data Window. To re-open the worksheet, move the cursor over the tab and the worksheet will slide back into view.

2.7. DOCKING THE WORKSHEETS

The layout of CycloLog is highly adoptable to the user's needs. The worksheets can be docked several ways creating a personal work area. If a worksheet is fixed and the pin in the caption of the worksheet is down, the workspace can be dragged across the working area when the left mouse button is pressed on the caption.
When a worksheet is being dragged, smart docking pointers appear. If the mouse pointer enters a docking pointer a preview is shown were the worksheet will be docked if the mouse button is released.



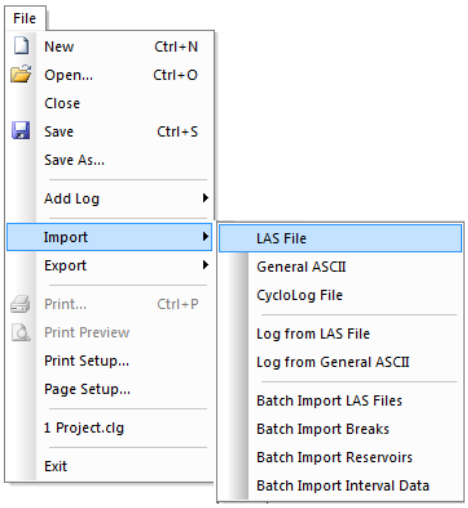
A further space-saving option is to stack two or more worksheets into the same window. To do this, the pins must first be turned to point down. Dragging the title-bar of one worksheet to the side or bottom of a second worksheet will “tile” the two within one window. Dragging the title bar of one to the title-bar of a second will overlay them in the same window, with tabs at the bottom to allow you to switch between them.

If all of the worksheets are fixed open, too little space will remain for displaying the logs, unless you are using two monitors. Once you have found a configuration that suits you, CycloLog will remember it for future sessions.

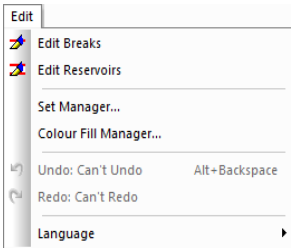
2.8. OVERVIEW OF MENU BAR FUNCTIONS

An illustrated overview of the functions that can be accessed from each item on the main Menu Bar.

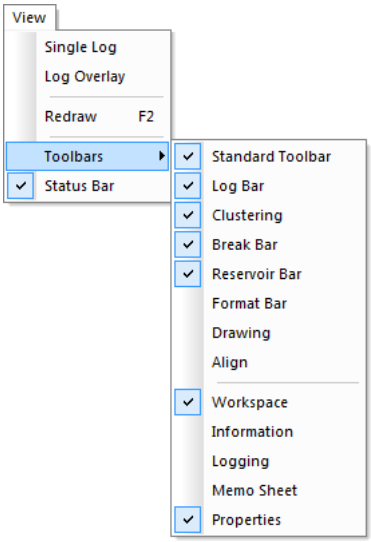
File menu, with Import sub-menu



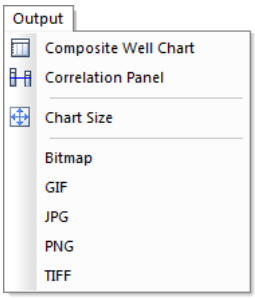
Edit menu



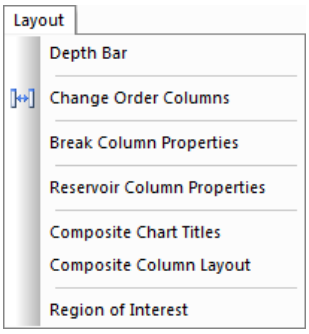
View Menu, with Toolbars sub-menu



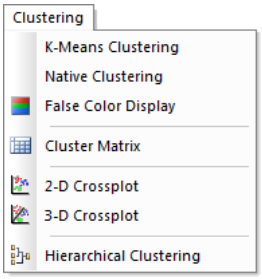
Output menu



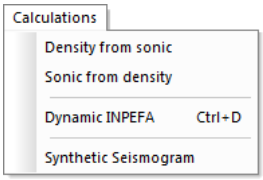
Layout menu



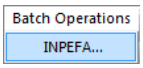
Clustering menu



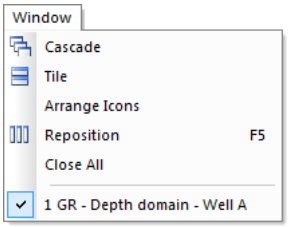
Calculations menu



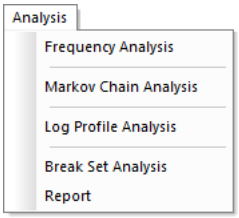
Batch Operations



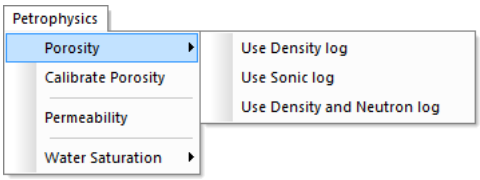
Window menu



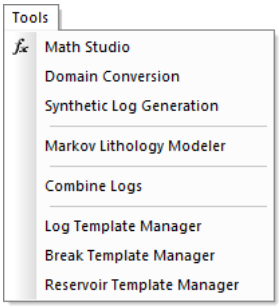
Analysis menu



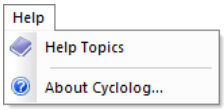
Petrophysics menu, with porosity sub-menu



Tools menu



Help menu



3. IMPORTING DATA

3.1. INTRODUCTION

CycloLog has its own internal data structure, designed for fast and efficient operation. Log data therefore have to be converted from an external source before they can be displayed or processed. This section describes how log data are imported into CycloLog.

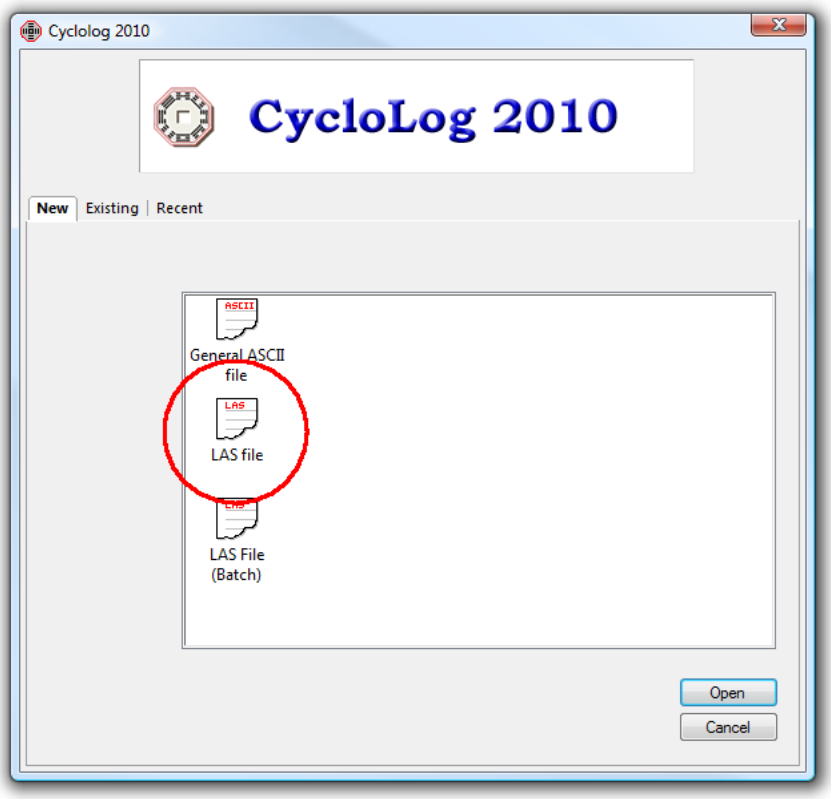
CycloLog can read files in LAS format, and this is the most efficient way of importing data. Alternatively, data can be read from an ASCII file in which the logs are tabulated in either space-delimited or tab-delimited format, with depth in the first column. Data available in spreadsheet format such as Excel should first be exported into such an ASCII file. ASCII files can have header data, as the import procedure allows any number of header lines to be skipped.

3.2. LAS FILE IMPORT

For importing LAS data into CycloLog, follow the following steps

3.2.1. FIND AND OPEN THE LAS FILE

Click File → New to see the CycloLog Opening Window.

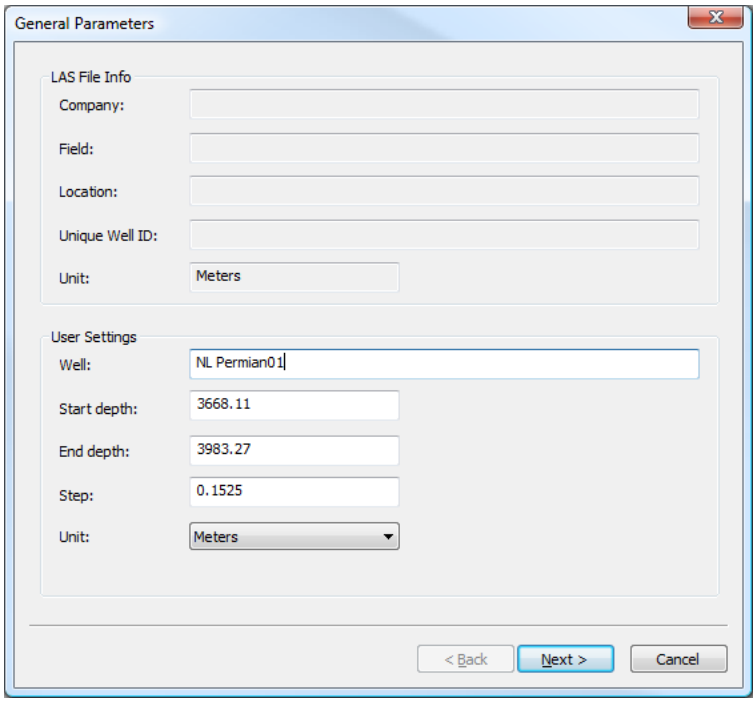


Select the NEW tab and double-click LAS file. Navigate to the required LAS file and double-click to open it.

CycloLog now reads the LAS file, then takes the user through several dialog boxes for selecting and controlling various aspects of the data. The dialog boxes appear in the following order, but you can use the Back and Next buttons at each stage to revise your settings.

3.2.2. GENERAL PARAMETERS DIALOG BOX

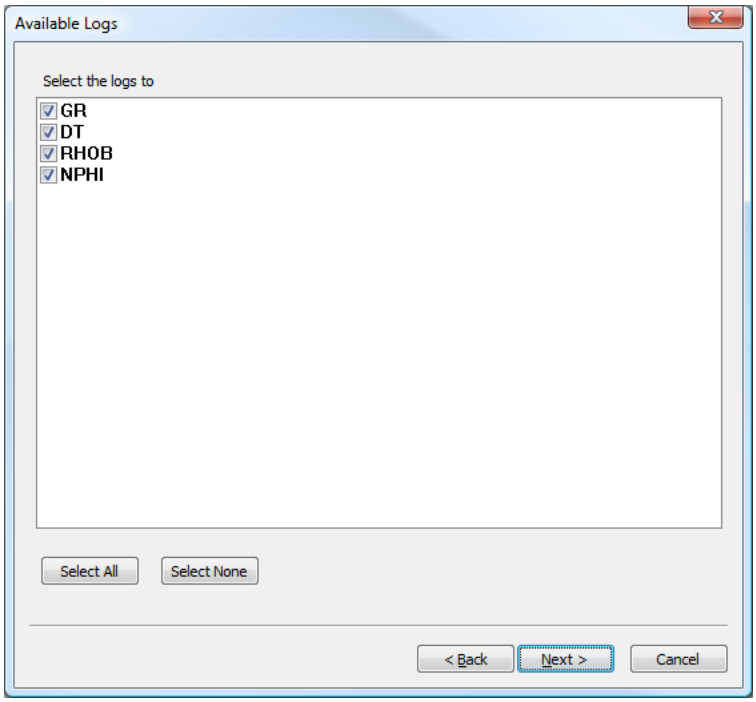
The parameters in the upper half of the box are reproduced as in the LAS file and cannot be changed by the user. The parameters in the User Settings area can be modified, including the name of the well as it is to appear within CycloLog, the depth interval selected, the depth step (normally 0.5 feet or 0.1524 meters), and the depth units. Note that the depth units can be converted from feet to meters or vice versa; the depth unit selected in this dialog box will be the depth units used for this well in CycloLog. Whatever depth step you select, CycloLog will resample the data at this interval, using linear interpolation where necessary.



Click Next to move to the next dialog box.

3.2.3. AVAILABLE LOGS DIALOG BOX

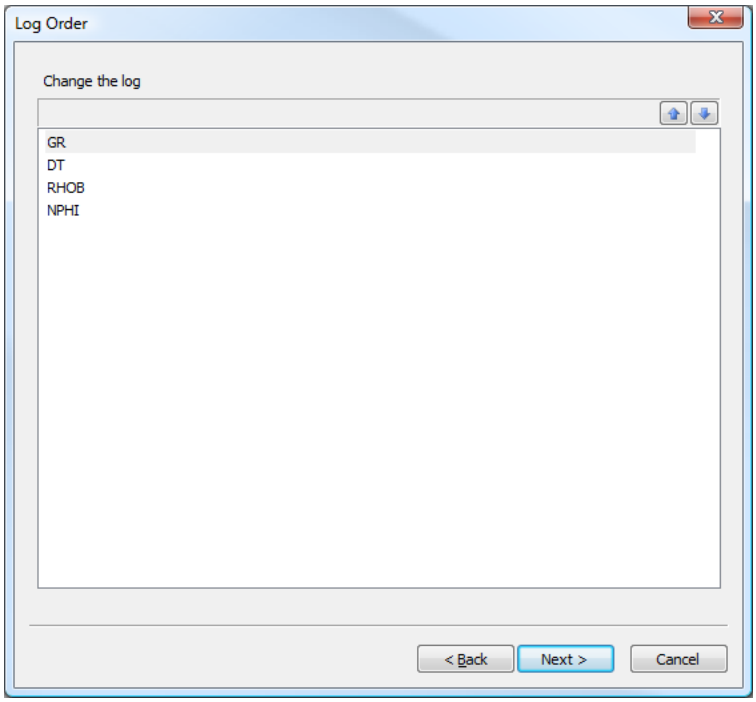
A list of all the logs read in from the LAS file is displayed. Check those logs that you want to use in CycloLog; using the Select All or Select None buttons if convenient.



Click Next to move to the next dialog box.

3.2.4. LOG ORDER DIALOG BOX

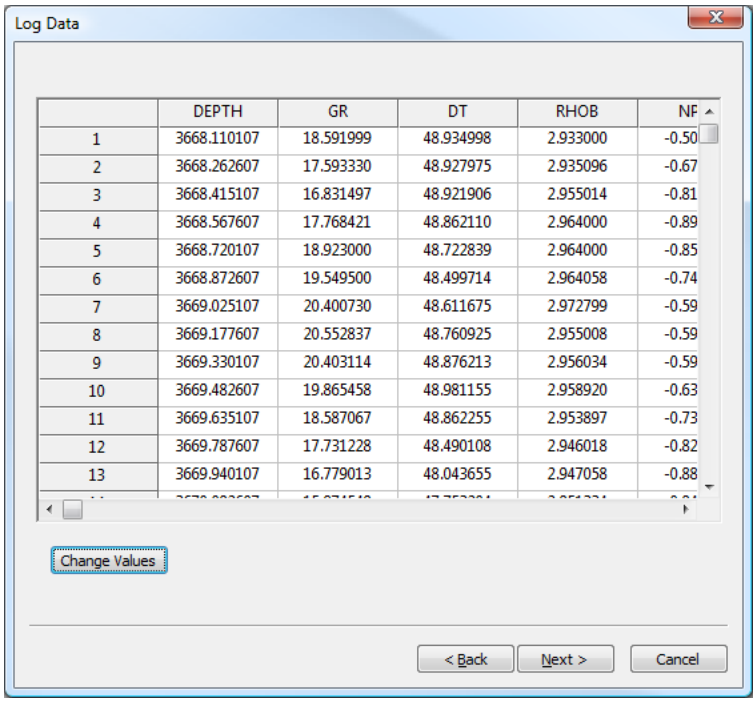
The selected logs are displayed in their original order (as in the LAS file). You can now change the order in which the logs will be listed in CycloLog if you wish (in a large project, it can be helpful if the logs are always in the same order). Click on a log to select it, then use the Up and Down arrows to move it up or down the list.



Click Next to move to the next dialog box.

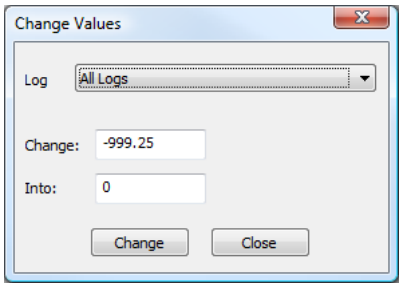
3.2.5. LOG DATA DIALOG BOX

CycloLog now displays all of the selected data in a table, which can be scrolled to check the data, or to look for null values. To change an individual value, click on that cell and type in the new value.

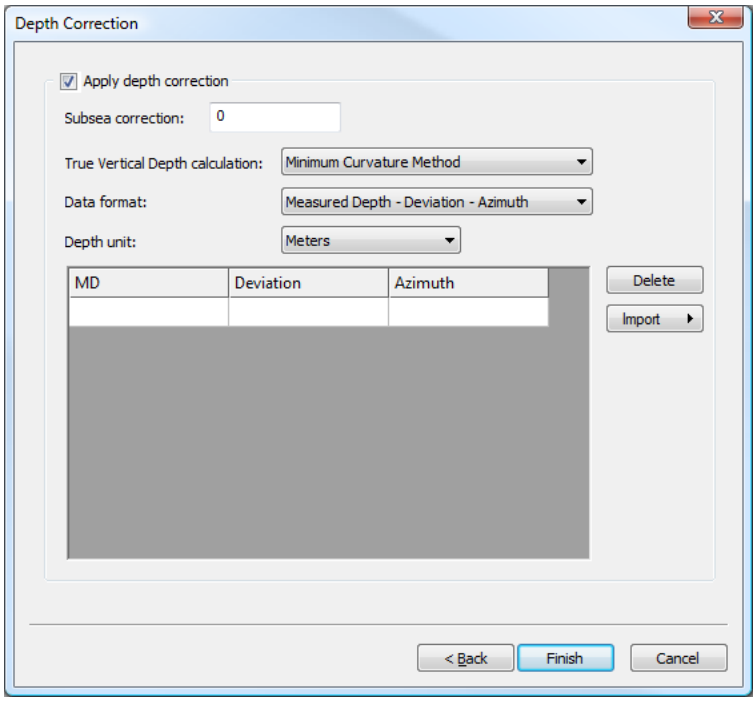


	DEPTH	GR	DT	RHOB	NP
1	3668.110107	18.591999	48.934998	2.933000	-0.50
2	3668.262607	17.593330	48.927975	2.935096	-0.67
3	3668.415107	16.831497	48.921906	2.955014	-0.81
4	3668.567607	17.768421	48.862110	2.964000	-0.89
5	3668.720107	18.923000	48.722839	2.964000	-0.85
6	3668.872607	19.549500	48.499714	2.964058	-0.74
7	3669.025107	20.400730	48.611675	2.972799	-0.59
8	3669.177607	20.552837	48.760925	2.955008	-0.59
9	3669.330107	20.403114	48.876213	2.956034	-0.59
10	3669.482607	19.865458	48.981155	2.958920	-0.63
11	3669.635107	18.587067	48.862255	2.953897	-0.73
12	3669.787607	17.731228	48.490108	2.946018	-0.82
13	3669.940107	16.779013	48.043655	2.947058	-0.88

For many CycloLog calculations (for example, computing INPEFA curves), instances of the standard null value of -999.25 can significantly influence the outcome, so it is convenient to eliminate all such values before converting the data into CycloLog format. To change all instances of a particular value, click the Change Values button. Select the log or logs in which you want to make this change (the default is All Logs). Then select the value that you want to change (the default is the null value specified in the LAS file) and the value you want this to change to (default = zero) and click the Change button.



3.2.6. DEPTH CORRECTION DIALOG BOX



In the final step you can apply a depth correction to the data in the LAS file. If you want to apply a depth correction to the data, check the Apply depth correction box to enable the controls used in the correction.

A subsea correction of the data can be done by filling in the correction value in the Subsea correction input field. SS (subsea) will be added to the domain name to indicate that a subsea correction has been performed on the data.

If a deviation survey is available you can use this survey to convert the measured depth data into true vertical depth data. CycloLog contains two methods for calculating the true vertical depth, the standard Minimum Curvature Method and the Tangential method. You will have to specify the deviation survey data format. This can be a measured depth – true vertical depth relationship or a measured depth – deviation – azimuth relationship. The data grid will change itself according to the data format you select. The units of the deviation data must be selected and need not be the same as the data in the data file. The deviation data will automatically converted into the correct units if the deviation units and the data file units are not the same. TVD will be added to the domain name to indicate that a true vertical depth correction has been applied to the data.

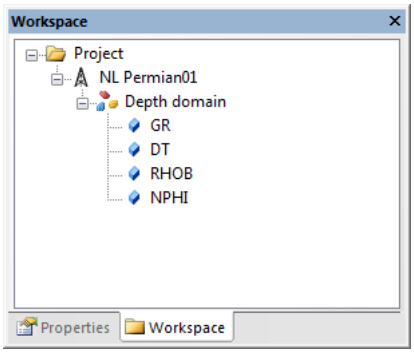
You can insert the deviation survey data in the data grid in several ways. First, you can type in the data manually. Second, you can load the deviation survey data from a file using the Import button, Import → File. This file must contain only the data and cannot contain any header files. To import data file with headers (in this case deviation data exported from Petrel) select Import → LAS file. Note that CycloLog can only import LAS File deviation data that were exported out of Petrel (i.e. the LAS file is a Petrel-based format).
Finally, you can copy data from the clipboard into the data grid by selecting
Import → Clipboard.

At this stage, you can still go back to the previous dialog boxes and make further changes if you wish. Otherwise, click the Finish button.

3.2.7. DATA CONVERTED TO CYCLOLOG FORMAT

CycloLog will now convert the data into its internal format, ready for display and analysis, using Measured Depth if no deviation survey was specified, and converting to True Vertical Depth if a deviation survey has been specified.

If the Workspace frame is not already visible, move the cursor over the Workspace tab to bring it into view. You can check that all the logs selected have been imported, under the Depth Domain heading in the tree structure.



3.2.8. SAVE THE NEW PROJECT AS A *.CLG FILE

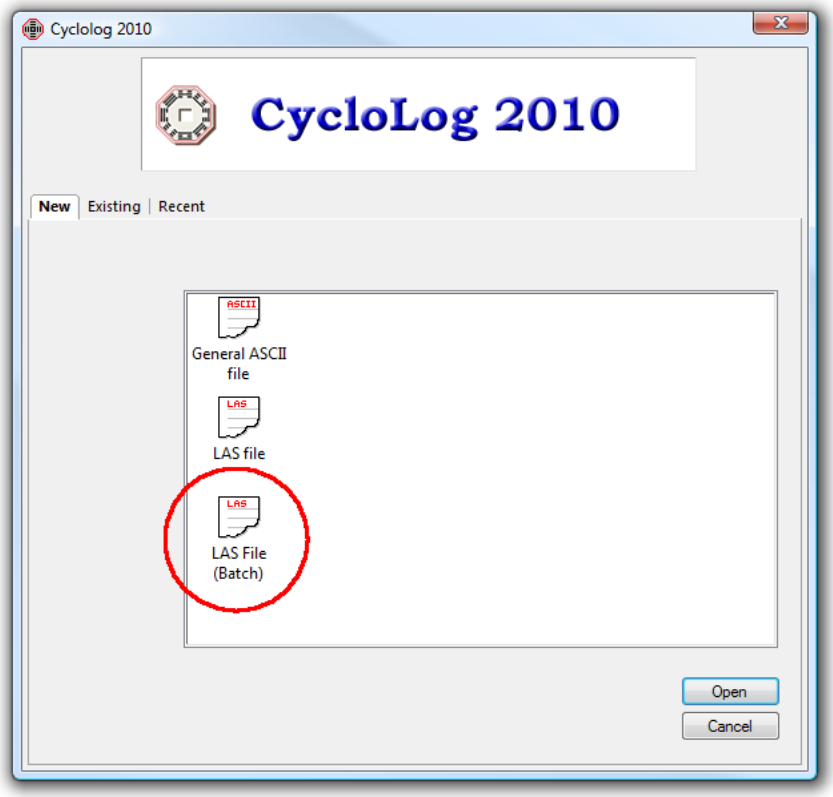
At this point you may wish to save the data as a *.clg file. Click File → Save (or Save As), select a folder and type in a name for the file.

3.3. BATCH LAS FILE IMPORT

Multiple LAS files can be loaded into CycloLog simultaneously. The LAS files are loaded using some standards settings as explained in the section on the Log Template Manager.

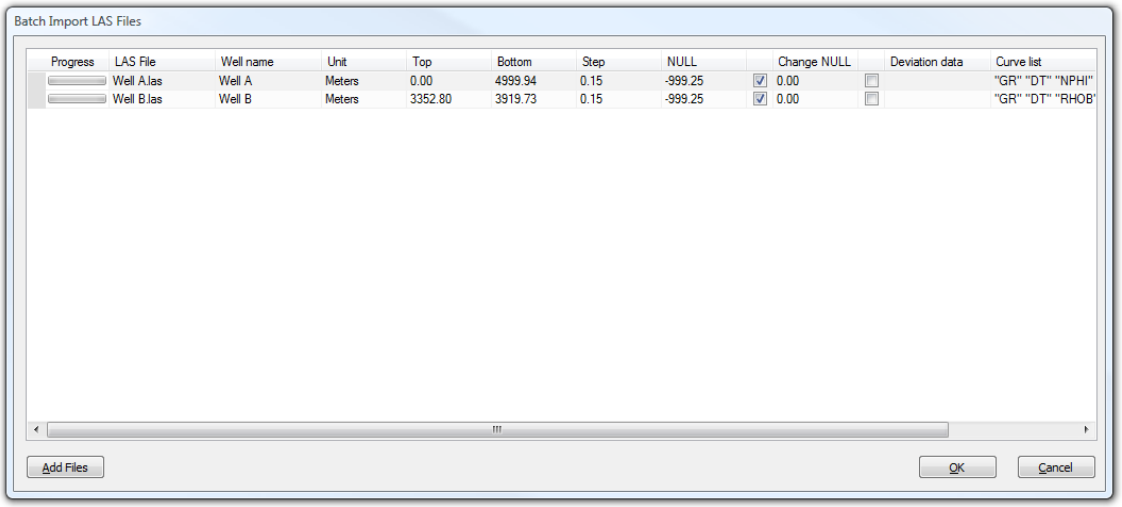
3.3.1. FIND AND OPEN THE LAS FILES

Click File → New to see the CycloLog Opening Window.



Select the NEW tab and double-click LAS File (Batch). Navigate to the required LAS files and open them using the Open button.

The following window is displayed and shows a list of all selected LAS files.

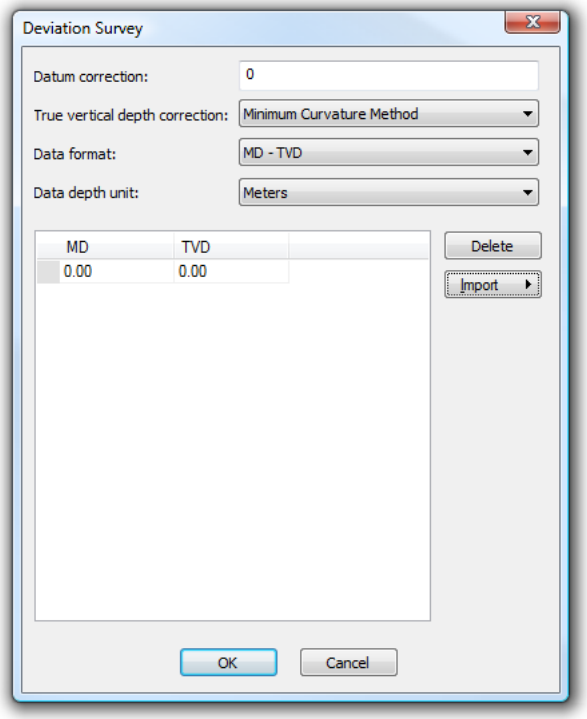


Extra LAS files can be added to the list by clicking on the Add Files button or by dropping a LAS file with the *.las file extension onto the window.

Information for each of the LAS files is shown in the grid rows. The input parameters can be changed by changing the shown values. When the unit is changed from meters into feet or from feet to meters, the top, bottom and step values change automatically. The top and bottom values can be changed to import a specific data interval. When the step size is changed the data will be resampled upon loading with the new step size.

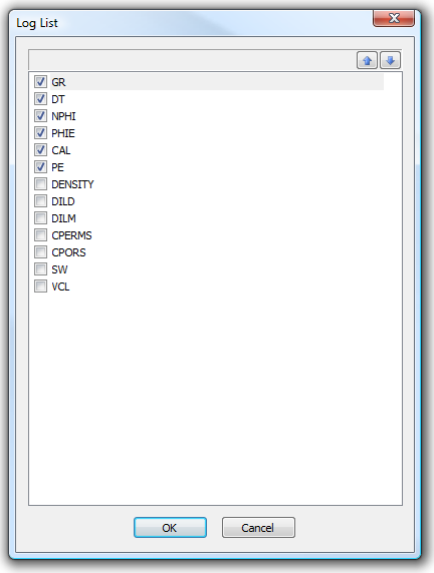
Null values can automatically be replaced by checking the box in front of the Change NULL column. When the box is checked, all NULL values in the data will be replaced by a new value. This option is always turned on by default.

If deviation data is available, this information can be used to transform the data from measured depth to true vertical depth. Deviation can be entered when the checkbox in front of the deviation data column is checked. When this box is checked, the button in the deviation button can be clicked to enter the deviation data.



The deviation can be entered manually or imported from a file or the clipboard. When data is imported the columns in the data must be identical to the columns in the data grid.

The last column in the grid is the curve list. In this list all the logs within the LAS file are shown and can be selected for loading into CycloLog. A first selection of logs to import is already performed using the information from the Log Template Manager. Logs defined in the Log Template Manager are automatically selected for import. The order or the logs is also changed into the order in which the logs are defined in the Log Template Manager.



Logs which are not recognized are not selected and appear after all recognized logs in the order they appear in the LAS file.

The order of the logs can be adjusted by selecting a log and move it up or down using the arrow buttons. It is also possible to drag the log to its new position.

When the OK button is clicked all the data is loaded into CycloLog.

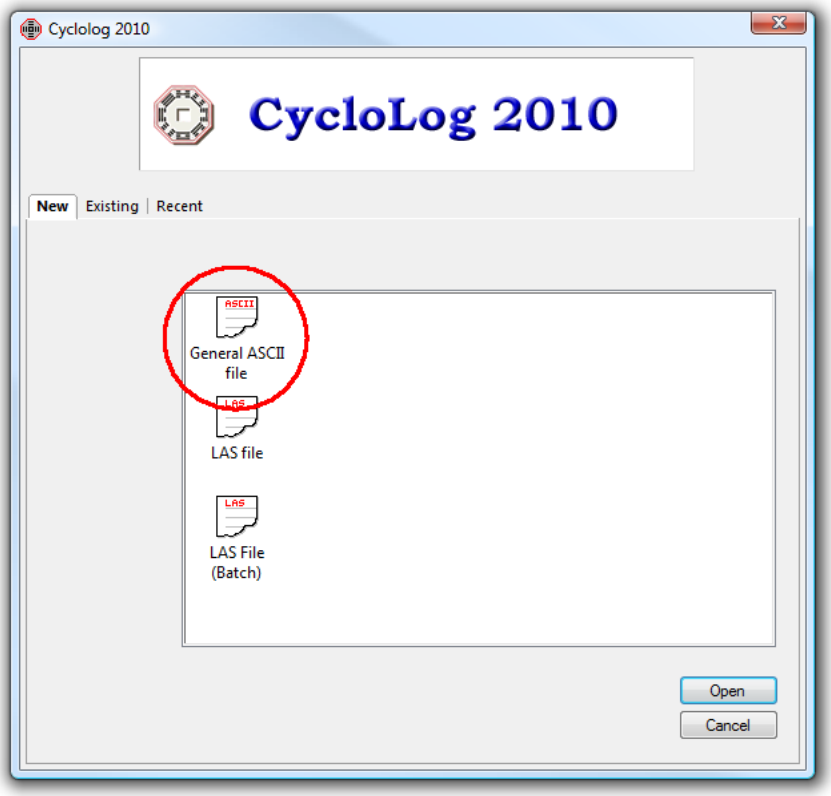
3.4. ASCII FILE IMPORT

Data can be imported into CycloLog from an ASCII (text) file. The file may contain any number of lines of header data, which will be ignored. The lines of data should have the depth at the beginning of the line, then the values for each log separated by either spaces or tabs.

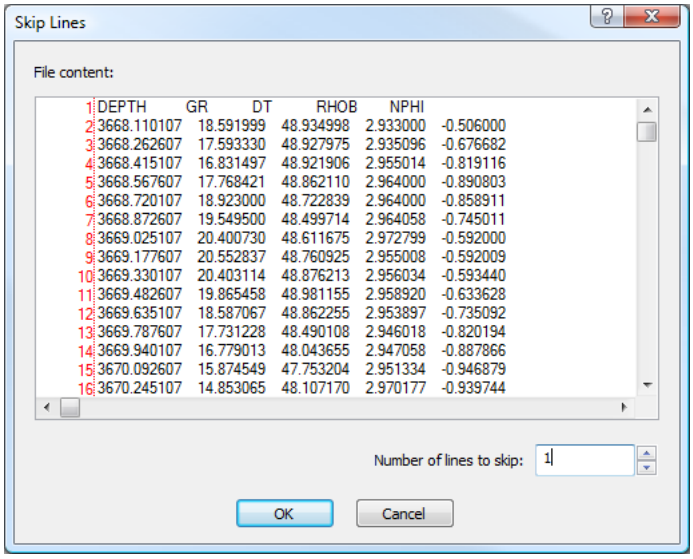
Note that LAS format data can also be imported and converted by this method; just skip the lines of header information as described below.

3.4.1. FIND AND OPEN THE ASCII FILE

1. Click File → New to see the CycloLog Opening Window.
2. Select the NEW tab and double-click General ASCII file.
3. Navigate to the required file and double-click to open it (Change Files of type to All files if the file extension is not *.asc).

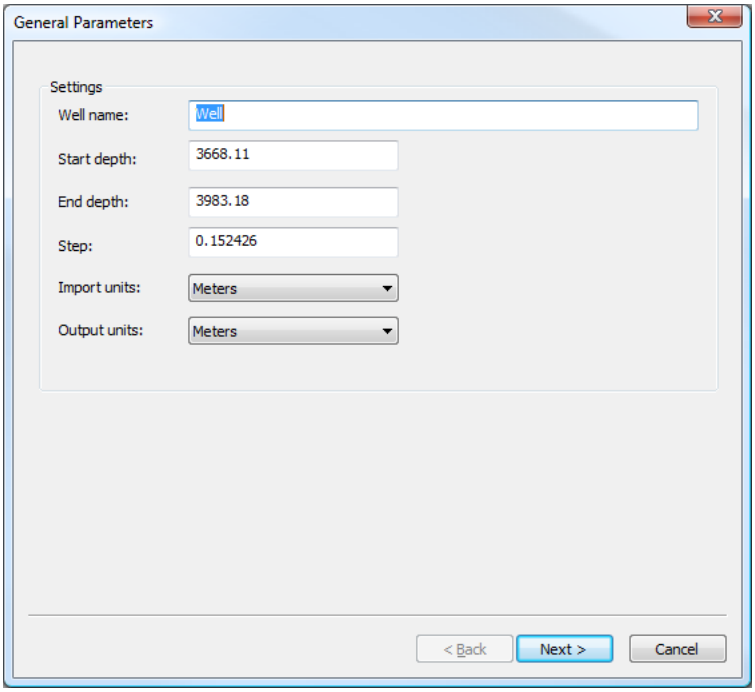


CycloLog now displays the top of the ASCII file. If the file includes any header lines before the start of the tabulated data, enter the number of header lines in Number of lines to skip and click OK. CycloLog reads the file, and displays the first of several dialog boxes for selecting and controlling various aspects of the data. The dialog boxes appear in the following order, but you can use the Back and Next buttons at each stage to revise your settings.



3.4.2. GENERAL PARAMETERS DIALOG BOX

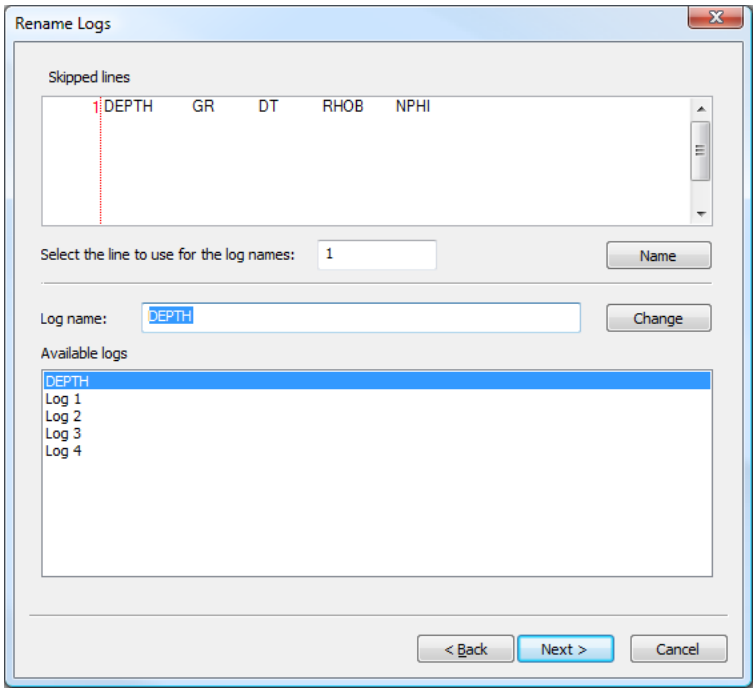
Enter the well name in the form in which you want it to appear within CycloLog. Select the correct Import Units (the depth units – Feet or Meters – in which the data are recorded in the ASCII file) and the Output Units in which you want the data to be stored in CycloLog. Then check the Start Depth and End Depth – you can change these if you want only part of the available depth interval. Step is the depth step and can be changed if you want a depth step different from the default value (CycloLog will resample the data to the required step value).



Click Next to move to the next dialog box.

3.4.3. RENAME LOG DIALOG BOX

This dialog box displays a list of all the logs, with the option to rename any or all of them. (By default, the logs are named Log 1, Log 2, etc.)



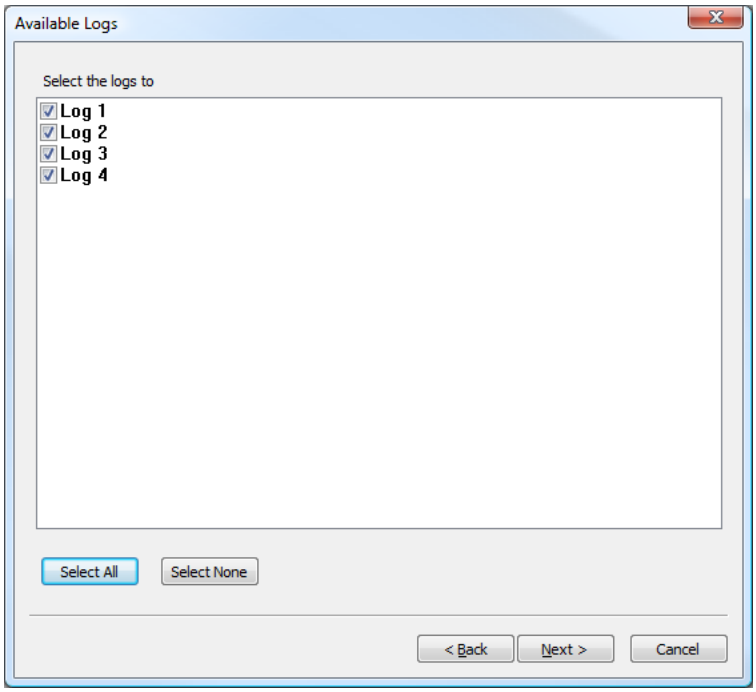
CycloLog offers two ways of renaming logs:

- To rename a log, click on its name in the list, type in the new name, and click Change.
- To rename all the logs at once, select a line from the skipped lines box which contains all the log names. When the Name button is clicked, the logs are renamed using the log names in the selected line.

When you have finished changing names, click Next to go to the next dialog box.

3.4.4. AVAILABLE LOGS DIALOG BOX

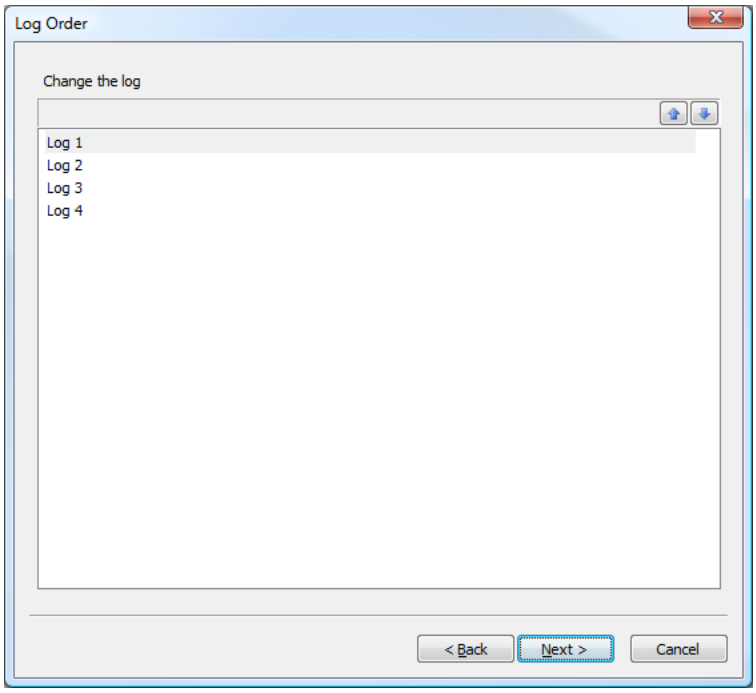
A list of all the logs read in from the ASCII file is displayed. Check those logs that you want to use in CycloLog; using the Select All or Select None buttons if convenient.



Click next to move to the next dialog box.

3.4.5. LOG ORDER DIALOG BOX

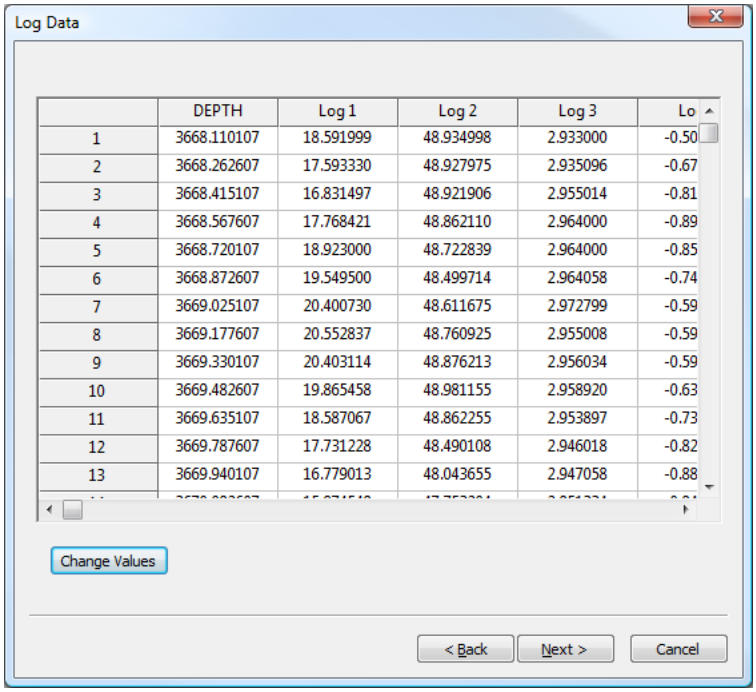
The selected logs are displayed in their original order (as in the LAS file). You can now change the order in which the logs will be listed in CycloLog if you wish (in a large project, it can be helpful if the logs are always in the same order). Click on a log to select it, then use the Up and Down arrows to move it up or down the list.



Click Next to move to the next dialog box.

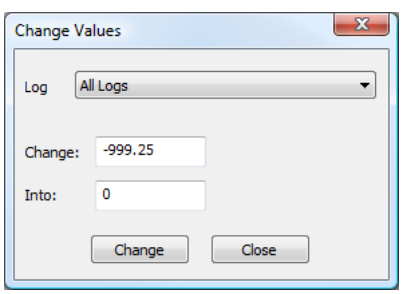
3.4.6. LOG DATA DIALOG BOX

CycloLog now displays all of the selected data in a table, which can be scrolled to check the data, or to look for null values. To change an individual value, click on that cell and type in the new value.



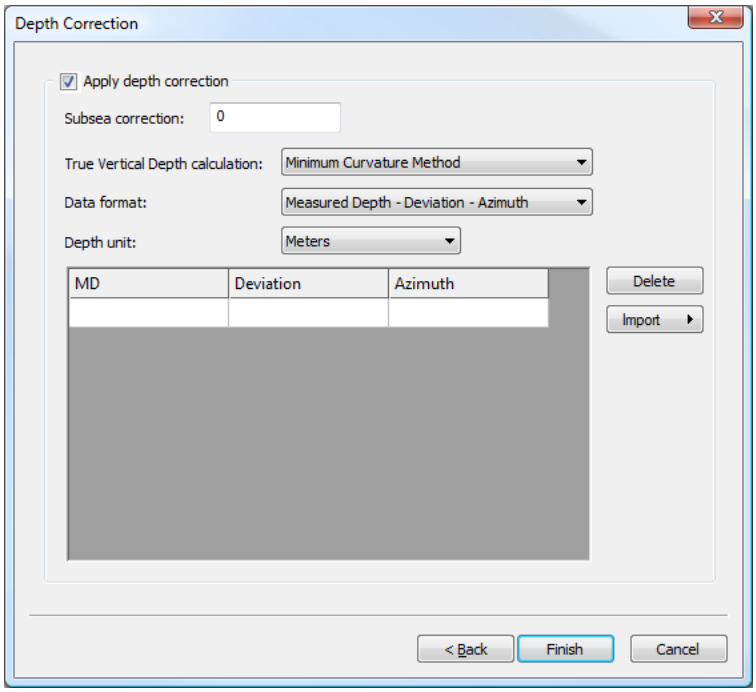
	DEPTH	Log 1	Log 2	Log 3	Lo
1	3668.110107	18.591999	48.934998	2.933000	-0.50
2	3668.262607	17.593330	48.927975	2.935096	-0.67
3	3668.415107	16.831497	48.921906	2.955014	-0.81
4	3668.567607	17.768421	48.862110	2.964000	-0.89
5	3668.720107	18.923000	48.722839	2.964000	-0.85
6	3668.872607	19.549500	48.499714	2.964058	-0.74
7	3669.025107	20.400730	48.611675	2.972799	-0.59
8	3669.177607	20.552837	48.760925	2.955008	-0.59
9	3669.330107	20.403114	48.876213	2.956034	-0.59
10	3669.482607	19.865458	48.981155	2.958920	-0.63
11	3669.635107	18.587067	48.862255	2.953897	-0.73
12	3669.787607	17.731228	48.490108	2.946018	-0.82
13	3669.940107	16.779013	48.043655	2.947058	-0.88

For many CycloLog calculations (for example, computing INPEFA curves), instances of the standard null value of -999 can significantly influence the outcome, so it is convenient to eliminate all such values before converting the data into CycloLog format. To change all instances of a particular value, click the Change Values button. Select the log or logs in which you want to make this change (the default is All Logs). Then select the value that you want to change (default = -999.25) and the value you want this to change to (default, zero) and click the Change button.



At this stage, you can still go back to the previous dialog boxes and make further changes if you wish. Otherwise, click the Finish button.

3.4.7. DEPTH CORRECTION DIALOG BOX



In the final step you can apply a depth correction to the data in the LAS file. If you want to apply a depth correction to the data, check the Apply depth correction box to enable the controls used in the correction.

A subsea correction of the data can be done by filling in the correction value in the Subsea correction input field. SS (subsea) will be added to the domain name to indicate that a subsea correction has been performed on the data.

If a deviation survey is available you can use this survey to convert the measured depth data into true vertical depth data. For calculating the true vertical depth, Cyclolog provides the standard Minimum Curvature Method. You will have to specify the deviation survey data format. This can be a measured depth – true vertical depth relationship or a measured depth – deviation – azimuth relationship. The data grid will change itself according to the data format you select. The units of the deviation data must be selected and need not be the same as the data in the data file. The deviation data will automatically converted into the correct units if the deviation units and the data file units are not the same. TVD will be added to the domain name to indicate that a true vertical depth correction has been applied to the data.

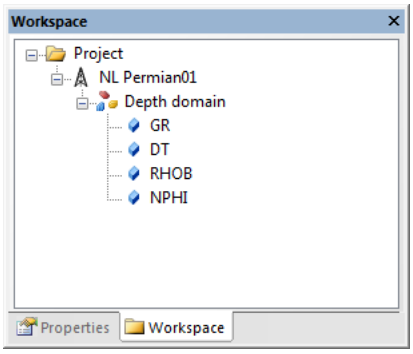
You can insert the deviation survey data in the data grid in several ways. First, you can type in the data manually. Second, you can load the deviation survey data from a file using the Import button, Import → File. This file must contain only the data and cannot contain any header files. To import data file with headers (in this case deviation data exported from Petrel) select Import → LAS file. Note that CycloLog can only import LAS File deviation data that were exported out of Petrel (i.e. the LAS file is a Petrel-based format).
Finally, you can copy data from the clipboard into the data grid by selecting
Import → Clipboard.

At this stage, you can still go back to the previous dialog boxes and make further changes if you wish. Otherwise, click the Finish button.

3.4.8. DATA CONVERTED TO CYCLOLOG FORMAT

CycloLog will now convert the data into its internal format, ready for display and analysis, using Measured Depth if no deviation survey was specified, and converting to True Vertical Depth if a deviation survey has been specified.

If the Workspace frame is not already visible, move the cursor over the Workspace tab to bring it into view. You can check that all the logs selected have been imported, under the Depth Domain heading in the tree structure.



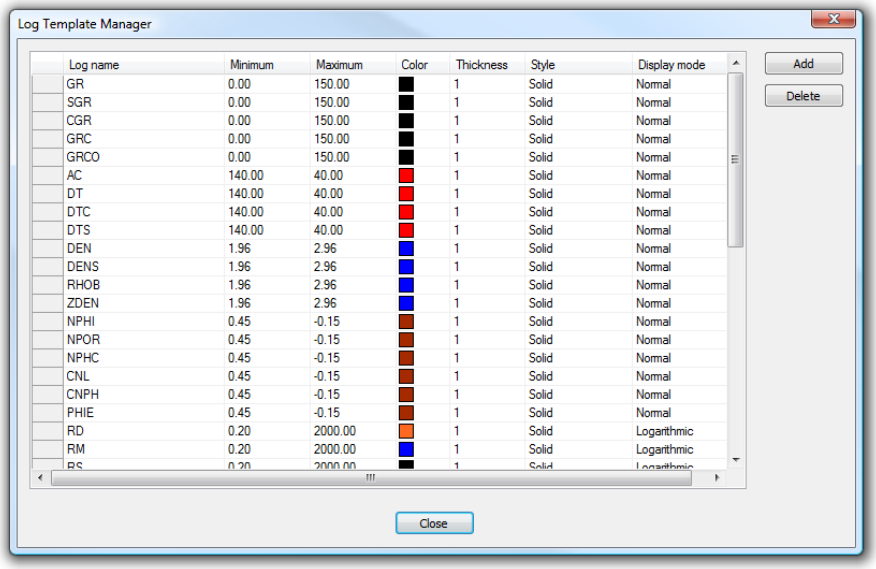
3.4.9. SAVE THE NEW PROJECT AS A *.CLG FILE

At this point you may wish to save the data as a .clg file. Click File → Save (or Save As), select a folder and type in a name for the file.

3.5. LOG TEMPLATE MANAGER

Closely working together with the batch LAS loading is the Log Template Manager. The information defined in the Log Template Manager is used to set initial layout styles for specific logs in the LAS file.

The Log Template Manager can be accessed by selecting the Log Template Manager option in the Tools menu.



Log name	Minimum	Maximum	Color	Thickness	Style	Display mode
GR	0.00	150.00		1	Solid	Normal
SGR	0.00	150.00		1	Solid	Normal
CGR	0.00	150.00		1	Solid	Normal
GRC	0.00	150.00		1	Solid	Normal
GRCO	0.00	150.00		1	Solid	Normal
AC	140.00	40.00		1	Solid	Normal
DT	140.00	40.00		1	Solid	Normal
DTC	140.00	40.00		1	Solid	Normal
DTS	140.00	40.00		1	Solid	Normal
DEN	1.96	2.96		1	Solid	Normal
DENS	1.96	2.96		1	Solid	Normal
RHOB	1.96	2.96		1	Solid	Normal
ZDEN	1.96	2.96		1	Solid	Normal
NPHI	0.45	-0.15		1	Solid	Normal
NPOR	0.45	-0.15		1	Solid	Normal
NPHC	0.45	-0.15		1	Solid	Normal
CNL	0.45	-0.15		1	Solid	Normal
CNPH	0.45	-0.15		1	Solid	Normal
PHIE	0.45	-0.15		1	Solid	Normal
RD	0.20	2000.00		1	Solid	Logarithmic
RM	0.20	2000.00		1	Solid	Logarithmic

In the first column the log name or mnemonic is defined. If an identical name is found in the data file the settings defined in the other columns are used for an initial layout.

The Minimum and Maximum column define the horizontal scaling of the log. The Color column defines the log color and the Thickness column defines the width in pixels of the log. In the Style column, the display style of the curve is defined. For example, whether the log must be drawn as a solid line or as a dotted line.

The last column defines the display mode of the log. Most logs are displayed using a linear scaling. For some logs, like resistivity logs, a logarithmic horizontal scaling is used.

A new definition can be added by clicking on the Add button. To remove a definition, select the row to delete and click on the Delete button.

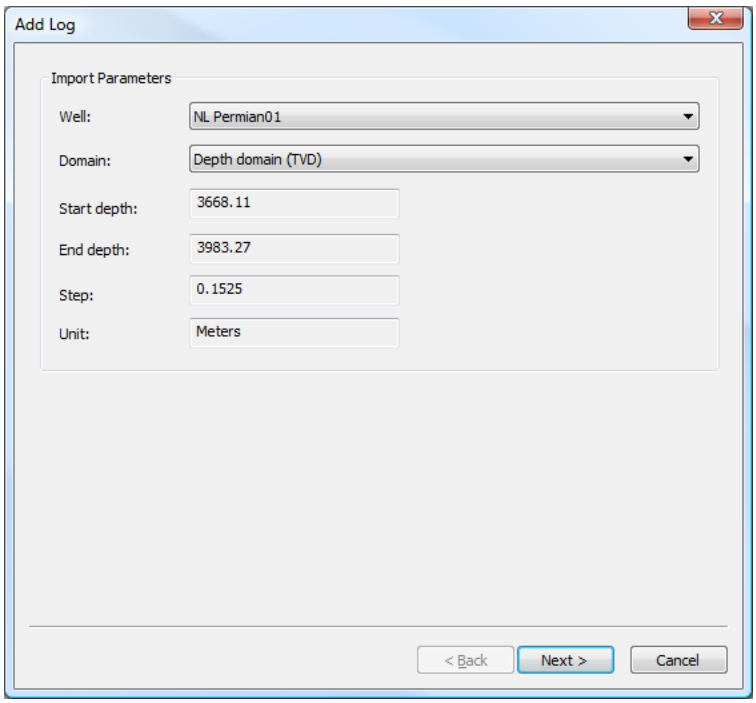
The order of the logs can be changed by dragging the definition to its new position. The order of the logs is important because the order of the logs in the Log Template Manager is used to order the logs in the CycloLog workspace.

3.6. TO ADD LOGS TO AN EXISTING PROJECT

Logs can be added to an existing project, either from the original source file or from a different source file (provided that it includes the depth interval covered by the project).

For importing more than one source file the previously described batch LAS loading can be used. This option can be found through the main menu bar. Click File → Import and select the Batch LAS Loading option.

It is also possible to load a single source file using the data loading wizard. From the main menu bar, click File → Import and select either Log from LAS file or Log from General ASCII, according to the type of source file. Navigate to the source file; when you click OK, the source file will be read, and the Add Log dialog box opens.



Notice that you cannot change the depth interval, the depth step, or the depth units, as the new log must be compatible with the logs already in the project. Check that the Well and Domain

are correct, then click Next, after which the procedure is the same as importing a new well from either a LAS file or an ASCII file (see previous sections).

3.7. TO OPEN MORE WELLS IN THE SAME PROJECT

More than one well may be included in a single Project. To add another well to a project, the project must be open first. The additional well can be imported from an existing CycloLog file, from a LAS file, or from a general ASCII file. If an existing CycloLog file having more than one well is imported, all the wells in that file will be imported.

To import a well into an existing project, open the project file and go to File → Import. Select from LAS File, General ASCII, or CycloLog File. For importing from LAS and ASCII files, the procedure is identical to that described in Section 3 of this Manual. For importing from an existing CycloLog file, click on the *.clg file that you wish to import, and the well (or wells) in that file will be added to your project, and will appear (with its/their logs) in the tree structure in your Workspace.

After importing the well, you may display its logs by following the same steps as described above. Note that you can display logs from different wells in the same project, but when scrolling any of the data panes, only logs from that well will scroll at the same time.

4. THE WORKSPACE AND DATA PANES

This section of the User Guide describes how to open existing CycloLog files, and it describes the appearance and function of the Data Window and Data Panes.

4.1. HOW TO OPEN WELLS

The following steps explain how to open wells for which a CycloLog file (file extension *.clg) already exists. You can:

Either, click File → Open (or, use the Open File icon on the Standard Toolbar) and navigate to the *.clg file that you want to open.

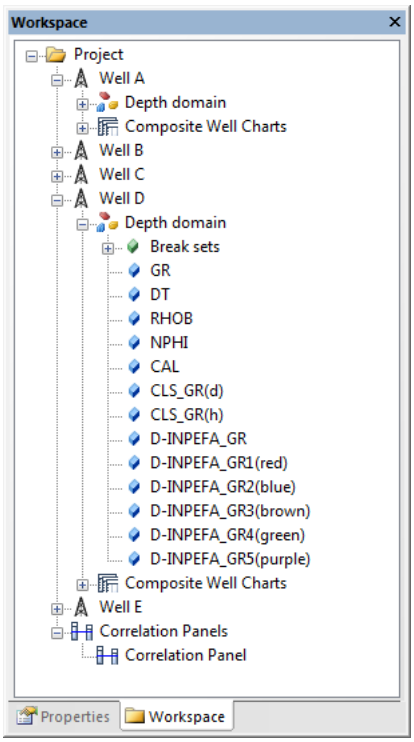
Or, click File → New to show the Opening Window.

From the three tabs, choose either Recent to select a file that that has recently been worked on, or Existing to navigate to a *.clg file in another folder. Select the well and click Open. (Recently

opened files are also available at the bottom of the File menu on the main Menu Bar.) The tree structure for that file (project) appears in the Workspace menu box.

4.2. THE WORKSPACE TREE STRUCTURE

The workspace worksheet contains a hierarchical structure of all the data used in the project.



The top level of the Workspace tree structure is the **Project**; one .clg file equals one project and the project cannot be renamed.

The next level in the tree is the **Well**. A project may contain more than one well. When constructing a correlation panel it is necessary for all wells in the panel to be in the same project (and hence in the same .clg file). Instructions for adding additional wells to an existing project are given in the section on importing data.

The third level in the Workspace tree structure is the **Domain**. One well may include more than one domain. The default is the Depth Domain, which is normally the domain into which the data are entered from a LAS or other file. Other possible domains are the Geologic Time Domain and the Seismic Domain – see Section 21 of this Guide.

The final level is the individual **Log**, of which there may be one or many. There is no distinction in the Workspace tree structure between logs that have been read into CycloLog from an external file, and those that have been created, or modified, within CycloLog. Logs can be renamed within the Workspace, and it is important to use names that will remind you of the origin and/or purpose of the logs. Also on this level you will find all the reservoir sets and the break sets.

4.2.1. TO OPEN LOGS

Open a log by double-clicking on its name in the Workspace tree structure. The log will be displayed in a Data-Pane. If other logs are already displayed, all data-panes will be re-sized to accommodate the new one. Large numbers of logs can, in theory, be displayed simultaneously, but in practice the number will be constrained by the width of the screen.

4.2.2. COMPOSITE WELL CHARTS AND CORRELATION PANELS

Two further types of display are listed in the Workspace tree structure:

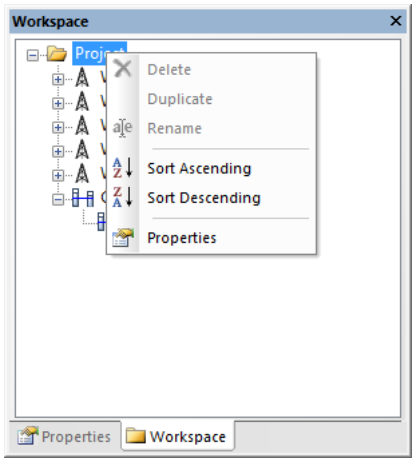
- **Composite Well Charts** are single-well graphical displays with multiple tracks. They appear at the same hierarchical level as the domain in the tree structure. They are described in detail in Section 22 of this Manual.
- **Correlation Panels** are multi-well graphical displays, comprising a number of Composite Well Charts linked by correlation lines. They are listed at the same level as wells in the tree structure. Correlation Panels are described in detail in Section 23 of this Manual.

4.2.3. CHANGING THE ORDER OF LOGS AND WELLS

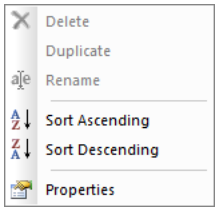
Some of the data in the tree structure in the Workspace can be dragged to a new position. This goes for the logs, wells, composite well charts and correlation panel. This allows for an easy reorganization of the data. Logs and composite chart can only be dragged within the same well. Cross well dragging is not supported.

4.3. THE WORKSPACE RIGHT-CLICK MENUS

Several additional actions can be performed on the objects within the Workspace. For the menus that control these actions, first single-click on the name of an object to select it, then right-click to open the menu.

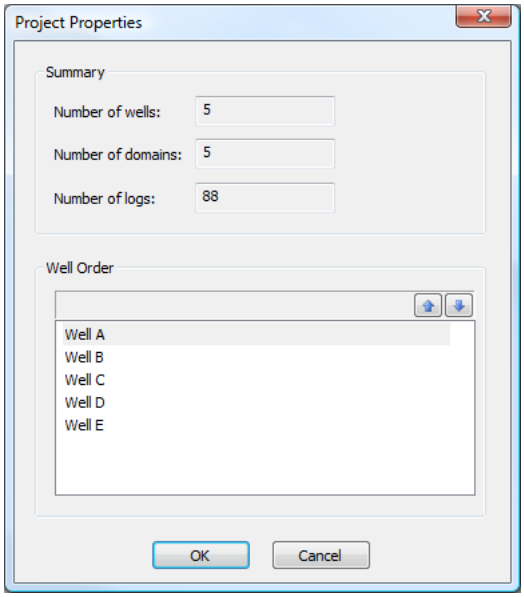


4.3.1. PROJECT RIGHT-CLICK MENU

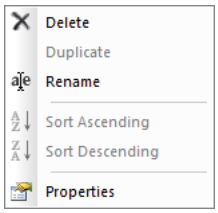


All the wells in the project can be sorted alphabetically using the Sort Ascending and the Sort Descending menu item.

The project properties gives you some information on the number of wells, domains and logs used in the project. In the Well Order list box, you can change the order of the wells in the project. Important wells can be shifted to the top of the tree structure while less important wells can be shifted to the end of the tree structure. To change the order of the wells, select a well and use the up and down arrows to move it up or down in the list.



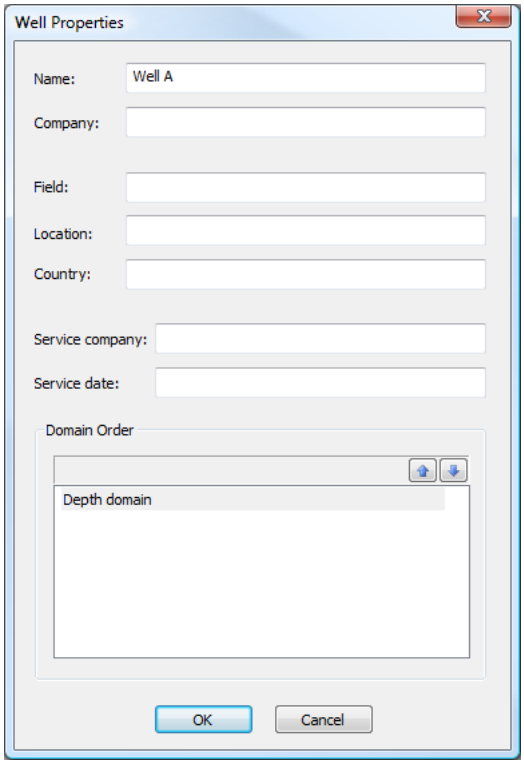
4.3.2. WELL RIGHT-CLICK MENU



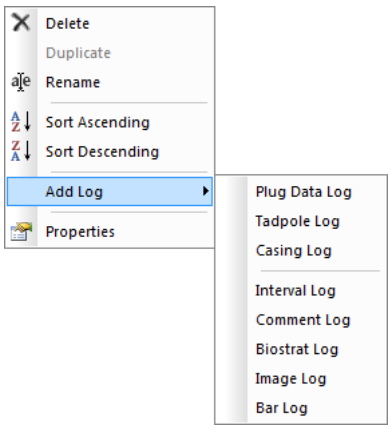
A well can be either deleted or renamed from the well right-click menu in the Workspace. If you select Delete you will be prompted to confirm the action before the well is deleted.

Selecting the Properties item on the well right-click menu opens a dialog box with basic information about the well. If you created the well from a LAS file, the Well Properties box will be populated with data from the LAS file. All of these items can however be edited if you wish to change them. If the original data came from an ASCII file, none of the fields will be populated, and you can add information to them if you wish.

The domains within the well appear in the Domain Order box. You can change the order in which the domains appear; select a domain and use the up and down arrows to move it up or down in the list.



4.3.3. DOMAIN RIGHT-CLICK MENU

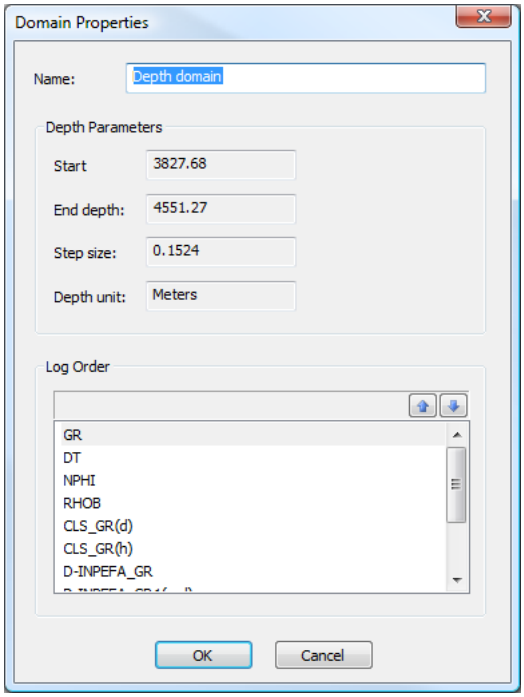


A domain can be either deleted or renamed from the well right-click menu in the Workspace. If you select Delete you will be prompted to confirm the action before the domain is deleted.

The logs in the domain can be sorted using the Sort Ascending or Sort Descending menu items.

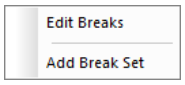
You can add special logs, like e.g. Interval, Biostratigraphic and Comment logs to a domain. Click Add Log and select the type of log to add. Further information on these special logs is given below, in Section 4.4.

Selecting the Properties item on the domain right-click menu opens a dialog box with basic information about the domain. The Depth Parameters information (Start depth, End depth, Step size, and Depth unit) cannot be changed.



The logs within the domain appear in the Log Order box. You can change the order in which the logs appear; select a log and use the up and down arrows to move it up or down in the list.

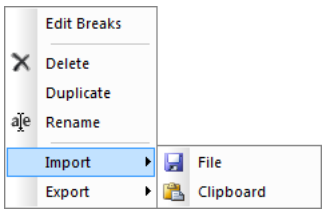
4.3.4. BREAK SETS RIGHT-CLICK MENU



The Break Manager can be started from the workspace by right-clicking on the Breaks Sets item in the workspace and selecting the Edit Breaks option. The Break Manager is initialized with the correct well and domain.

A new break set can be added to the domain by selecting the Add Break Set option.

4.3.5. BREAK SET RIGHT-CLICK MENU



In the break set right-click menu a lot of the functions available in the Break Manager are also present in the menu.

To edit the breaks click on the Edit Breaks menu item. The Break Manager is shown and it is already initialized with the correct well and domain.

To delete a break set, click on the Delete option. To create a duplicate of the break set, click on the Duplicate option. To rename the break set, click on the Rename option.

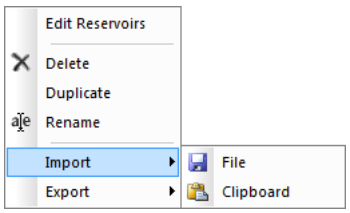
Using the import and export options, all breaks in a break set can be imported into CycloLog or exported from CycloLog.

4.3.6. RESERVOIR SETS RIGHT-CLICK MENU

The Reservoir Manager can be started from the workspace by right-clicking on the Reservoir Sets item in the workspace and selecting the Edit Reservoirs option. The Reservoir Manager is initialized with the correct well and domain.

A new reservoir set can be added to the domain by selecting the Add Reservoir Set option.

4.3.7. RESERVOIRS RIGHT-CLICK MENU



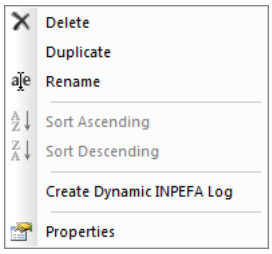
In the reservoir set right-click menu a lot of the functions available in the Reservoir Manager are also present in the menu.

To edit the reservoirs click on the Edit Reservoirs menu item. The Reservoir Manager is shown and it is already initialized with the correct well and domain.

To delete a reservoir set, click on the Delete option. To create a duplicate of the reservoir set, click on the Duplicate option. To rename the reservoir set, click on the Rename option.

Using the import and export options, all reservoirs in a reservoir set can be imported into CycloLog or exported from CycloLog.

4.3.8. LOG RIGHT-CLICK MENU



The log right-click menu in the workspace allows you to delete, duplicate or rename a log.

To delete a log, first select the log by single-clicking over it. Right-click to open the menu, then click Delete. You will be prompted to confirm the action before the log is deleted. Logs that are open may not be deleted; an error message is displayed and you must first close the log Data Pane.

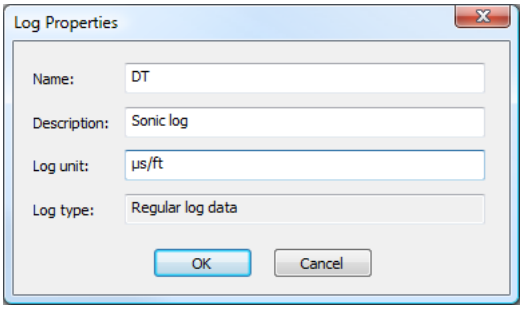
To duplicate a log, first select the log by single-clicking over it. Right-click to open the menu, then click Duplicate. A duplicate log is created, and is given the name "Duplicate of <log-name>". This name can be changed – see how to rename a log in the next paragraph. Further duplicates of the same log will be named "Duplicate of <log-name> - 1" etc. When modifying logs in any way, it is good practice to work on a duplicate rather than on the original log, so that the original, unmodified data are preserved.

To rename a log, first select the log by single-clicking over it. Right-click to open the menu, then click Rename. The existing name is highlighted, and you can type in the new name followed by Return. You can also rename a log by single-clicking on the name twice, with a pause between clicks. The name is highlighted as before and can be replaced with a new name.

If the log can be used as input for an INPEFA analysis, a menu item is added named Create Dynamic INPEFA curve. When this item is clicked, a dynamic INPEFA log is created and added to the workspace.

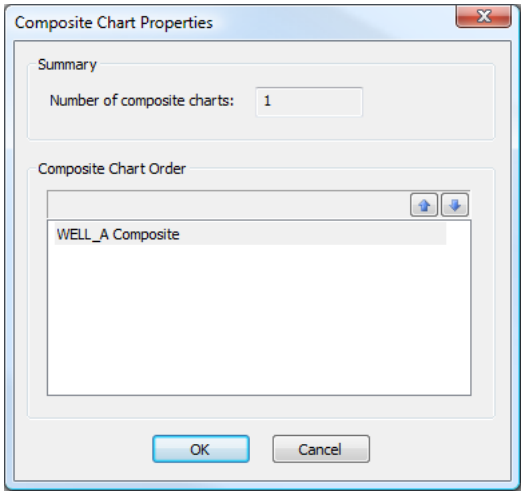
To open the Log Properties dialog box, first select the log by single-clicking over it. Right-click to open the menu, then click Properties. The Log Properties dialog box will be populated with information from the LAS file (if you created the well from a LAS file). You can change (or add)

the name of the log, its description, and the name of the log units. You cannot change the Log Type, which is internal to CycloLog.



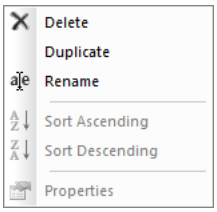
4.3.9. COMPOSITE WELL CHARTS RIGHT-CLICK MENU

The Properties option in the Composite Well Chart right-click menu in the workspace gives information on the composite well charts in a well. It shows the number of composite well chart created and the order of the composite well charts in the tree structure.



The composite well charts within the well appear in the Composite Chart Order box. You can change the order in which the composite charts appear; select a composite chart and use the up and down arrows to move it up or down in the list.

4.3.10. COMPOSITE CHART RIGHT-CLICK MENU



The composite chart right-click menu in the workspace allows you to delete, duplicate or rename a single composite chart.

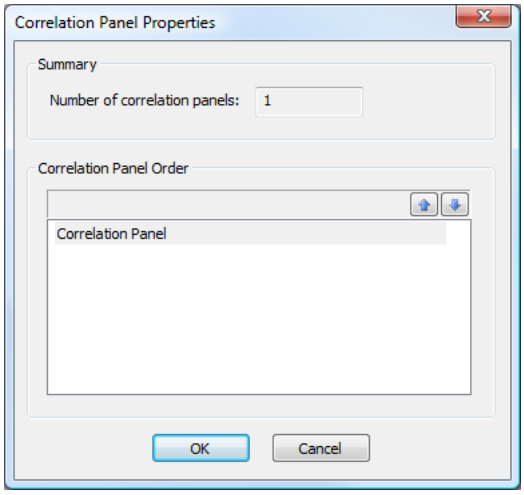
To delete a composite chart, first select the composite chart by single-clicking over it. Right-click to open the menu, then click Delete. You will be prompted to confirm the action before the composite chart is deleted. Composite charts that are open may not be deleted; an error message is displayed and you must first close the pane in which the composite chart is shown.

To duplicate a composite chart, first select the composite chart by single-clicking over it. Right-click to open the menu, then click Duplicate. A duplicate composite chart is created, and is given the name "<composite chart name> - 1". This name can be changed – see how to rename a composite chart in the next paragraph. Further duplicates of the same composite chart will be named "<composite chart name> - 2" etc.

To rename a composite chart, first select the composite chart by single-clicking over it. Right-click to open the menu, then click Rename. The existing name is highlighted, and you can type in the new name followed by Return. You can also rename a composite chart by single-clicking on the name twice, with a pause between clicks. The name is highlighted as before and can be replaced with a new name.

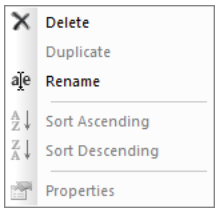
4.3.11. CORRELATION PANELS RIGHT-CLICK MENU

The Properties option in the Correlation Panels right-click menu in the workspace gives information on the correlation panels in the project. It shows the number of correlation panels created and the order of the correlation panels in the tree structure.



The correlation panels within the project appear in the Correlation Panel Order box. You can change the order in which the correlation panels appear; select a correlation panel and use the up and down arrows to move it up or down in the list.

4.3.12. CORRELATION PANEL RIGHT-CLICK MENU



The correlation panel chart right-click menu in the workspace allows you to delete or rename a correlation panel.

To delete a correlation panel, first select the correlation panel by single-clicking over it. Right-click to open the menu, then click Delete. You will be prompted to confirm the action before the correlation panel is deleted.

To rename a correlation panel, first select the correlation panel by single-clicking over it. Right-click to open the menu, then click Rename. The existing name is highlighted, and you can type in the new name followed by Return. You can also rename a correlation panel by single-clicking

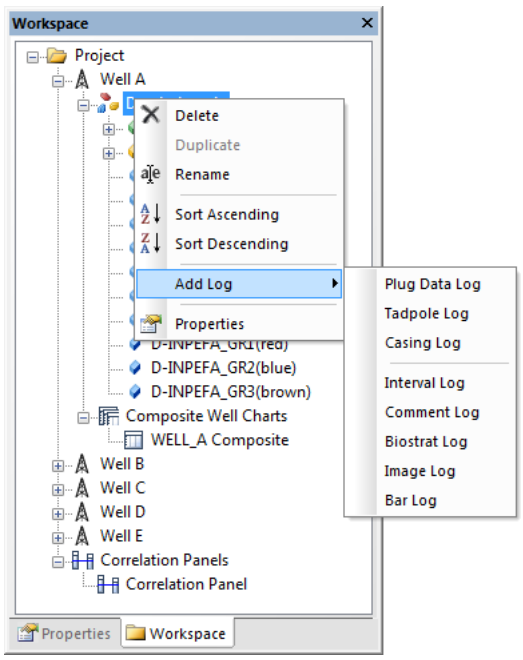
on the name twice, with a pause between clicks. The name is highlighted as before and can be replaced with a new name.

4.4. ADDING ADDITIONAL LOG TYPES

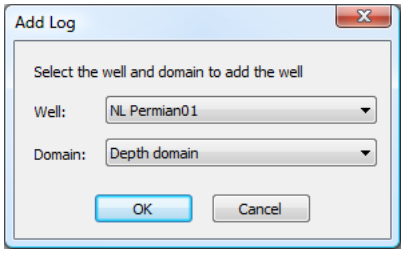
CycloLog contains a wide range of additional log types for showing different kinds of data. The kinds of data which can be shown are:

- Plug data – Show e.g. core porosity measurements.
- Tadpole data – Visualize the dip and strike of layers at specific depths.
- Casing data – Show the location of the casing shoes in the log.
- Interval data – Define intervals for showing e.g. biozones or paleoenvironments.
- Comment data – Add comments at specific depths in the log.
- Biostrat data – Show the biostrat appearances.
- Image – Include photos or core images in your composite charts.
- Bar – Show a constant value over an interval.

Additional log types can be added by the domain right-click menu in the workspace tree structure. The selected log type is added to the domain for which you have opened the right-click menu.



Additional log types can also be added by using the File menu on the menu bar. Select File → Add Log and select the type of log you want to add to your project. If you have selected the type of log you want to add, you are asked to which well and domain you want to add the selected log type.



After you have selected the well and the domain, click OK and the newly created log will be inserted in the Workspace tree structure.

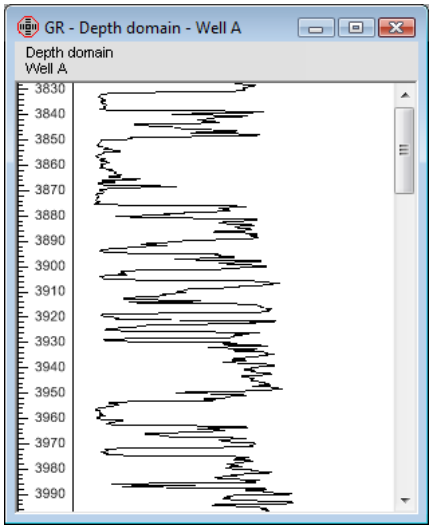
How to add data to these logs and how to work with them is explained in Section 6.

4.5. WORKING WITH DATA PANES

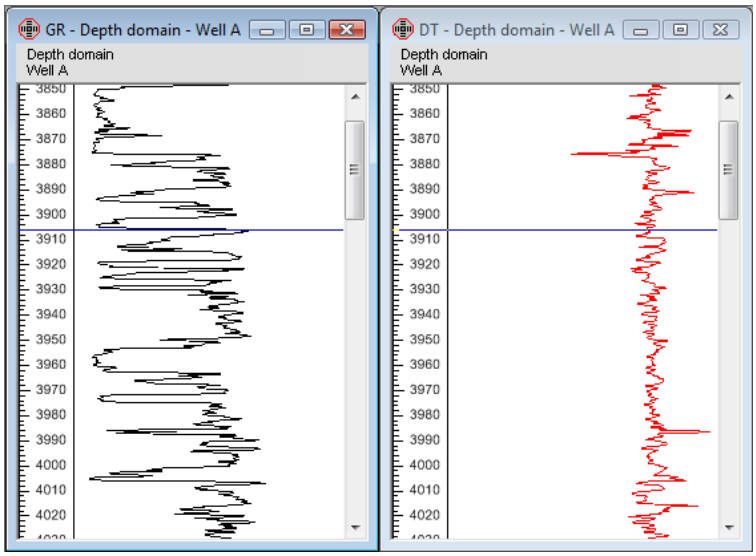
4.5.1. DATA PANE FEATURE

After double-clicking on the name of a log in the Workspace, the log is displayed in a separate pane within the data window. Several data panes will be open in a typical CycloLog session.

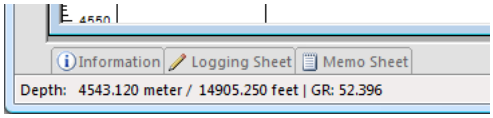
The pane headers contain information about the log, the domain and the well. All panes have a scrollbar. One data pane is the active pane (shown by the color of its title-bar). Any pane may be made active by clicking over it. The name of the active pane appears in the Log Toolbar. Scrolling the active pane will cause all other data panes for the same well and same domain to scroll simultaneously.



When the left mouse button is held down, a blue line appears across all the panes of the same well and same domain.



The Status Bar shows the depth and the log value(s) at that depth (these values are also shown in the Information Worksheet, if this is open).



4.5.2. RESIZING AND REPOSITIONING DATA PANES

Each Data Pane behaves like an individual window, except that they are synchronized to scroll in unison. Each pane can therefore be:

- maximized (to fill the entire screen - not usually very useful);
- minimized (in which case only its title-bar is visible, normally at the bottom of the data window and normally hidden by other data panes);
- resized manually (by dragging on the sides or corners of the window).

To reposition the data panes into their standard configuration, click Window → Reposition, click the Reposition icon on the Standard Toolbar, or select Reposition from the Data Pane right-click menu (see Section 5.1 for more on this menu).

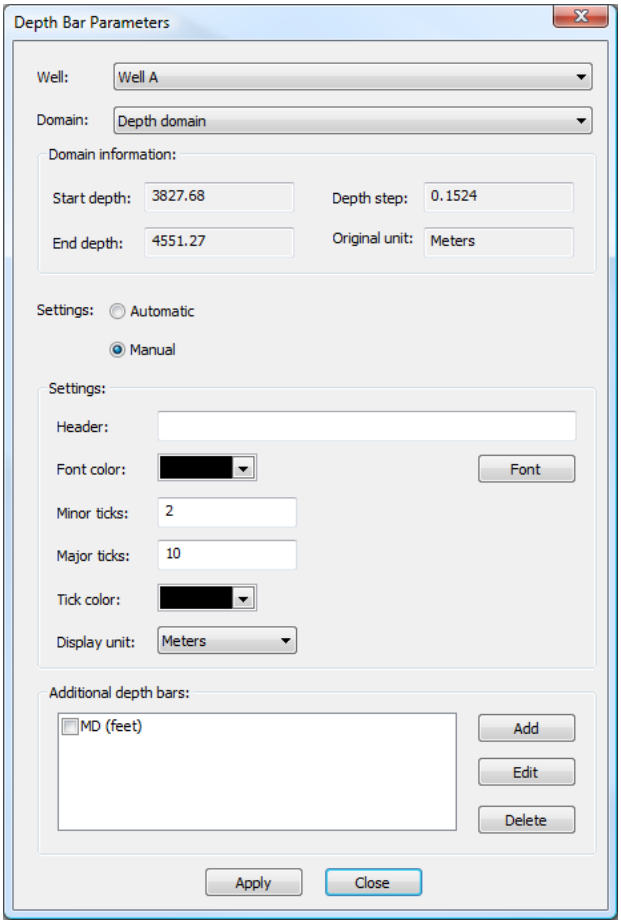
Data Panes can also be arranged in other standard Windows configurations; choose either Window → Tile or Window → Cascade from the main Menu Bar.

4.5.3. CLOSING DATA PANES

Data Panes are closed individually by clicking on the Close symbol at the top-right corner of each pane ("**x**"). To close all Data Panes, click Window → Close All.

4.6. CHANGING THE DEPTHBAR LAYOUT

CycloLog shows a depthbar in all data panes. The layout of the depthbar can be modified. Select Depthbar from the Layout menu on the main Menu Bar. The Depthbar Parameters dialog box opens:



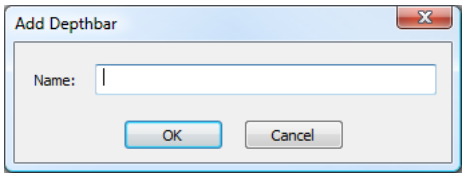
The dialog box shows the top and bottom depths, and the depth step, of the original data, for reference only. The current display units (feet or meters) are shown, and can be changed in the Settings area.

The depthbar settings can be set automatically by the program or manual by the user. When the automatic settings are selected the program will choose the minor and major tick distance. When the manual settings are selected, the user can choose the display character of the depthbar.

In the Header box you can enter the depthbar name which will be used in composite well charts as the header of the depthbar column. Besides the display units, the vertical depth (in display units) between the major and minor tick marks can be changed. Enter the required values if different from the default settings. The tick color can be changed using the Tick Color button. The font color used to display the annotations at the major ticks can be changed by clicking on the Font button. The color of the annotation can be changed using the Font Color button.

Extra depthbars can be added to the standard depthbar e.g. for displaying the depth in both meters and feet. To add an extra depthbar press the Add button in the Additional depthbars area.

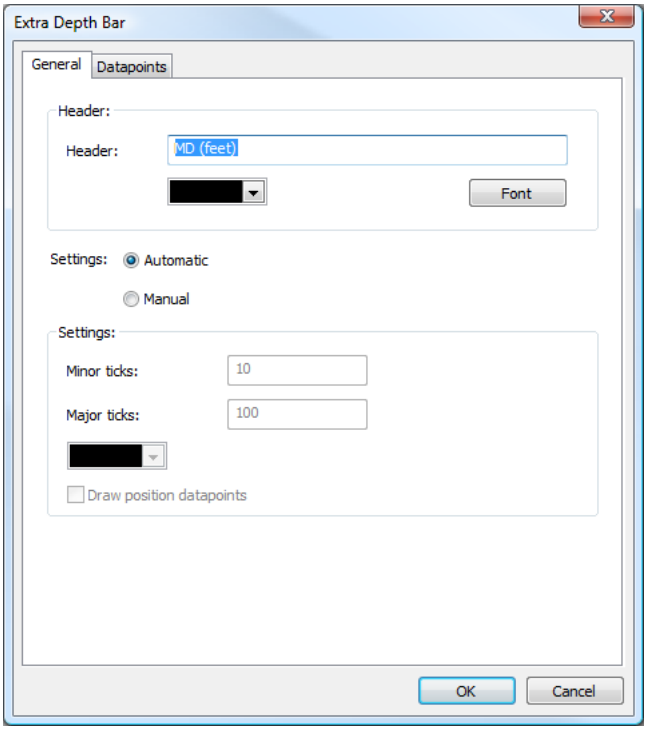
When you have clicked on the Add button a dialog appears in which you will have to define the name for the extra depthbar.



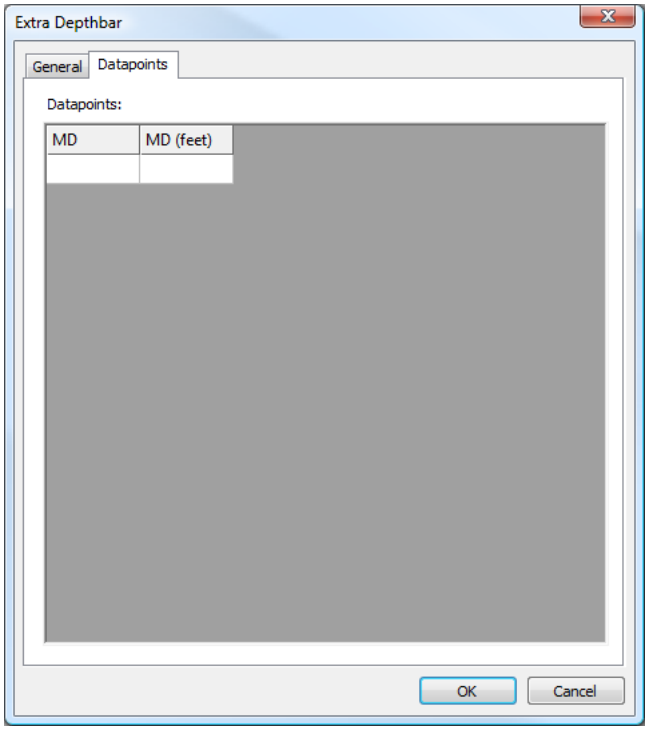
In the Extra Depthbar dialog two tabs are present for defining the extra depthbar. In the General tab the visual layout of the depthbar can be defined. In the Header section you can enter the name of the depthbar used in the header of composite charts. In this section you can also change the font type using the Font button and change the font color of the annotations using the color button.

If the automatic settings are selected the program will choose the settings for the minor and major tick distance. When the manual settings are selected, the user can select the settings for the minor and major tick distance.

In the Settings section you can define the minor and major tick distance. The color button can be used to set the color in which the ticks are drawn. If the Draw position datapoints is checked, a marker is draw in the depthbar at all the depths defined in the Datapoints tab.



The Datapoints tab contains a grid for defining the relation between the standard depthbar and the extra depthbar. In the first column you will have to enter the depths of the original depthbar. In the second column you will have to enter the corresponding depths of the extra depthbar. With an extra depthbar you can show both a depthbar in meters and a depthbar in feet next to each other.



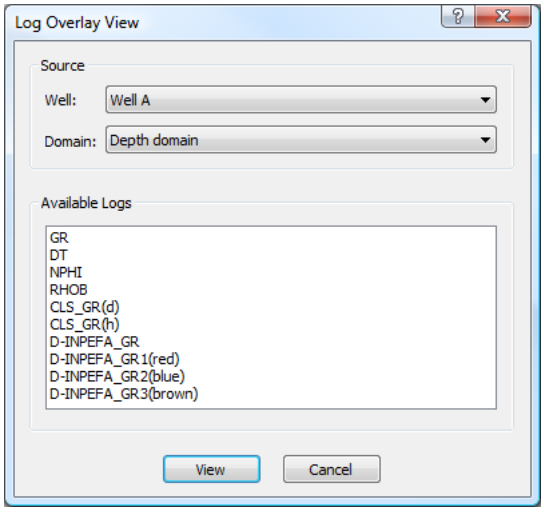
Clicking on the OK button will store the settings for the extra depthbar and close the Extra Depthbar dialog.

When you have finished making modifications, click the Apply button, then the Close button. CycloLog will make the changes to the depthbars in all data panes. If changes are made to a set of depthbars in a composite well chart, the changes will only affect the set in the composite well chart. Every composite well chart can have its own set of depthbars.

4.7. LOG OVERLAYS

Several (up to five) log curves can be overlaid in a single Data Pane. This can be useful for displaying logs that are often plotted together (e.g. neutron and density; caliper and gamma-ray), or for comparing the before and after effects of performing various transformations on data (e.g. filtering). Most curves can be selected for overlaying, processed data as well as original log data (an exception is the Markov Chain curve – see Section 18).

The log overlay function is accessed from the main Menu bar. Click View → Log Overlay. The Log Overlay View menu box appears. Click on the names of the logs that you wish to overlay (e.g. RHOB, NPHI) and click View.



See Section 5.5 for working with log overlay displays.

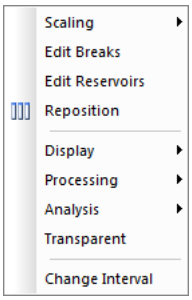
4.8. TRANSPARENT DATA PANES

The single log data panes and the composite chart can be made transparent during the interpretation process. If panes are transparent, they can be placed on top of each other to compare INPEFA shapes. Panes and composite chart can be made transparent by using the right-click menu within the pane. The Transparent option can be used to toggle the transparency on or off.

5. DISPLAYING AND EDITING LOGS

5.1. THE DATA PANE RIGHT-CLICK MENU

A number of functions for log display and log editing will be described in this section. All of these functions are accessible by right-clicking over the data pane showing the log to which you wish to apply the function.



Some of the more commonly used functions are also accessible from the toolbars, and this (if the relevant toolbar is displayed) is generally the faster option.

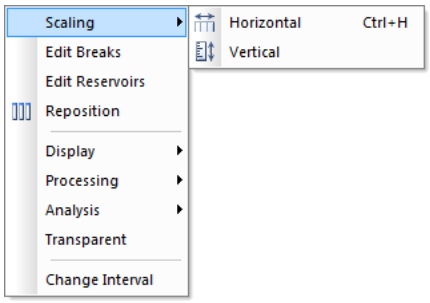
The following functions are mainly concerned with the display of the logs, and are described in this section of the manual.

- Vertical and horizontal scaling
- Repositioning of log panes
- Depthbar display
- Changing the log wiggle color
- Changing the log display from wiggle to mirror image
- Log overlays
- Log color bar coding
- Defining and editing breaks
- Changing the analysis interval (in case the log is a Dynamic INPEFA log)

Management of “breaks” is described later, in Section 7, and Analysis and Processing functions are described in Sections 10 to 19.

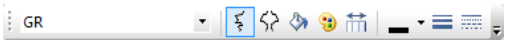
5.2. HORIZONTAL AND VERTICAL SCALING

Horizontal and vertical scaling are accessed from the Data Pane right-click Menu by selecting Scaling:



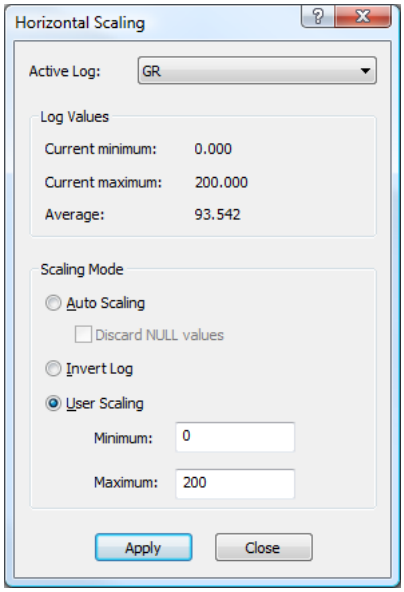
5.2.1. HORIZONTAL SCALING

Logs are displayed, by default, at a horizontal scale that extends from the minimum to the maximum value of the data. To change the horizontal scale, either select Scaling → Horizontal from the right-click Data Pane menu, or (short-cut) click the Horizontal Scaling icon on the Log Toolbar:



 : Horizontal scaling

CycloLog displays the following dialog box:



The default scaling mode is Auto Scaling, in which case the Minimum and Maximum values will be the minimum and maximum for the entire log. If you wish to change these values, click the User Scaling button, and type in your preferred values. For a log such as the Neutron Log, which is normally presented on an inverse scale, you can either use the Invert Log button, or you can type the minimum and maximum values in the "wrong" boxes; for example (for a neutron log) Minimum = 0.45, Maximum = -0.15.

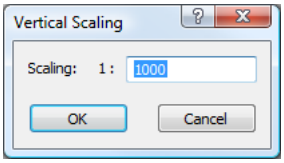
If the Data Pane is displaying two or more overlaid logs, choose the one you want from the Active Log drop-down list at the top of the dialog box.

5.2.2. VERTICAL SCALING

To change the vertical scale, either select Scaling → Vertical from the right-click Data Pane menu, or (short-cut) click the Vertical Scaling icon on the Standard Toolbar:

 : Vertical scaling

CycloLog displays the Vertical Scaling dialog box:



Enter the new vertical scale and click OK.

5.3. REPOSITION DATA PANES

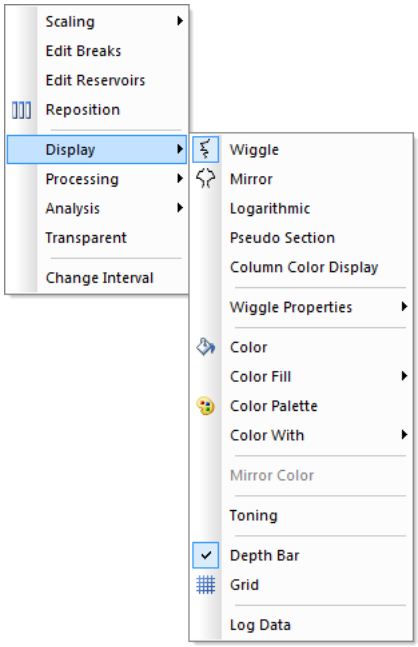
To reposition the log data panes so that they fill the available space in the data window, click the Reposition option on the data pane right-click menu, or use the shortcut icon on the Standard toolbar.

 : Reposition data panes

Repositioning can also be used to rearrange the order of the panes in the workspace. You can change the order by moving the panes roughly into the order in which you want to see the panes. If you select the Reposition command from the menu or the toolbar, CycloLog will check in which order you want the panes and rearranges the panes neatly in their new order in the workspace.

5.4. SINGLE LOG DISPLAY FUNCTIONS

Log display functions are accessed from the Data Pane right-click menu by selecting Display:



Note that some of these functions are not available for Data Panes in which two or more logs are overlaid (see Section 5.5 below for options with Log Overlay data panes).

5.4.1. CHANGE FROM WIGGLE TO MIRROR TRACE

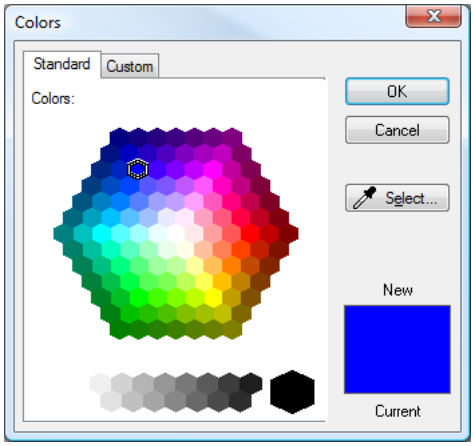
The default display is a simple "wiggle" trace. The alternative is a mirror trace, with two copies of the curve back-to-back in the same track; this can be useful for emphasizing patterns such as cyclicity.

To change from wiggle to mirror trace, click Mirror on the Display menu. To change back to a wiggle trace, click Wiggle on the Display menu. To color the space between the two mirror traces, select Color from the Display menu. To change the color, select Mirror Color from the Display menu, and select the color you want. To switch off the color, click Display → Color again. **Shortcuts: use the Normal (wiggle), Mirror, and Fill (color) icons on the Log Toolbar:**

 : Normal (wiggle) display

 : Mirror display

 : Fill color



5.4.2. CHANGE FROM LINEAR TO LOGARITHMIC SCALE

The default horizontal scale is linear; to change this to a logarithmic scale (for some induction logs, for example), click Logarithmic on the Display menu. If there is a check-mark next to Logarithmic, then the scale is already logarithmic; you can change it back to linear by clicking on Wiggle, either on the Display menu, or on the Log Toolbar.

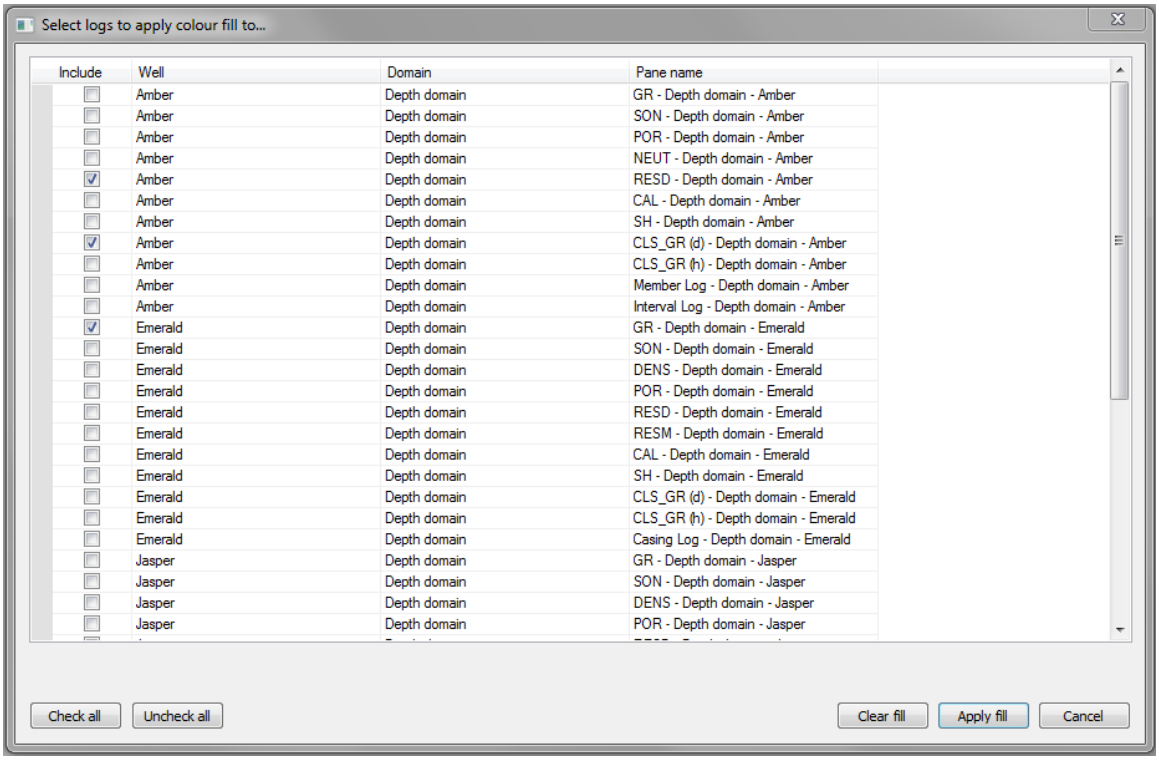
5.4.3. PSEUDO-SECTION DISPLAY

The Pseudo-section Display option is only relevant in the performance of seismic calculations – see Section 14.

5.4.4. COLUMN COLOUR FILL

The column color fill will fill the entire pane with the colouring of the log. The outline of the log in the pane will not be shown.

The user can additionally apply colour fills to a selection of logs in one pass, using the menu item Edit->Colour Fill Manager:



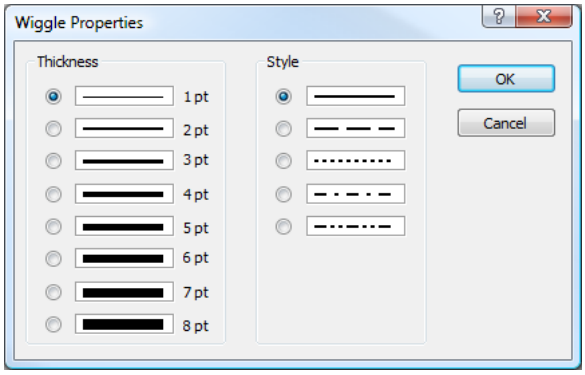
The user selects which log panes to apply the colour fill changes to, using the checkboxes on the left-hand side of the dialog.

Once the selection has been made, the user then chooses whether to apply a “Clear” (turn off colour fill) or “Apply” (turn on colour fill) operation by selecting the appropriate button.

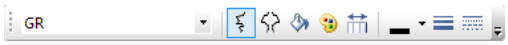
Note: colour fill selections persist only for the duration of the current Cyclolog session – they are not currently saved into the .clg file.

5.4.5. CHANGE WIGGLE COLOR AND STYLE

The color and line style of the wiggle trace can be changed. Go to Wiggle Properties on the Data Pane right-click menu, and select either Wiggle Color or Wiggle Style. Wiggle Color leads to a standard Windows color palette. Wiggle Style leads to a Wiggle Properties menu, where you can select line thickness (1 to 8 pixels) and line style (solid, dashed, dotted etc.).



Shortcuts are available for these functions: use the Wiggle Color, Wiggle Thickness, and Wiggle Style icons on the Log toolbar for faster editing of line color and style.



 : Wiggle color

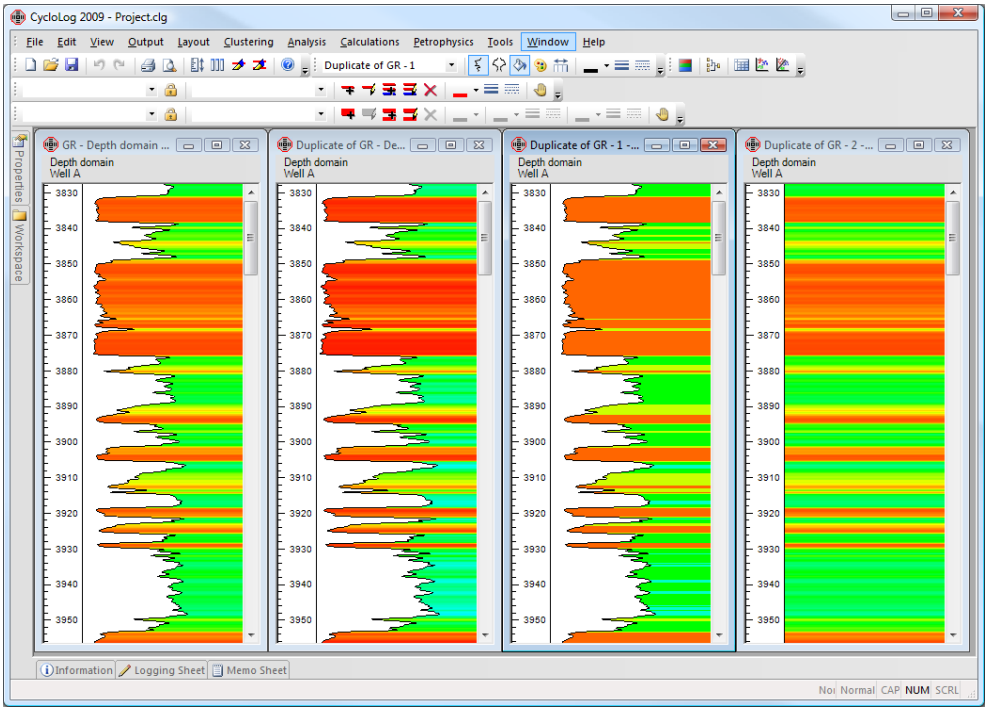
 : Wiggle thickness

 : Wiggle style

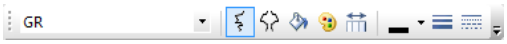
5.4.6. SCALED COLOR FILL

Scale-controlled color fill can be applied to a log wiggle trace for visual impact, and to suggest lithological or petrophysical variations in the data. The example shown uses a gamma-ray log, with colored subdivisions of the scale to suggest variation from sand (red and yellow – low GR values) to shale (green to blue - high GR values). By default, colors are assigned on a continuous scale from red (log minimum value) to violet (log maximum value). Alternatively, the color scale can be user-defined.

In the next image you examples of the default coloring of the logs. In the first two panes you can see the same continuous color scale but with a different horizontal scaling. The horizontal scale automatically adjusts to the horizontal scaling of the log. The third pane show a discrete color scale. The horizontal scaling is divided into a discrete number of intervals and each interval is assigned a color. The fourth pane shows a continuous color scale where the display mode is in the column color fill mode, the outline of the log is not shown, but the log value influences the coloring.



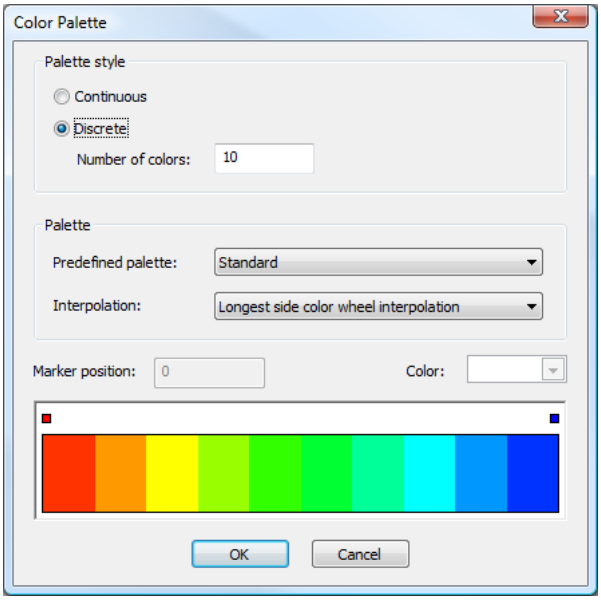
To fill a log with the default color scheme, right-click over the data pane and choose Display → Color from the menu. Shortcut: Choose the Fill icon on the Log Toolbar:



 : Fill color

 : Color palette

To change the color scheme, right-click over the data pane and choose Display → Color Palette from the menu. Shortcut: Choose the Color Palette icon on the Log Toolbar.



The color palette can be used to select between continuous and discrete color schemes, with any number of discrete colors. The standard palette (red to blue – illustrated) can be replaced by a red to black, green to black, or blue to black spectrum, or by a user-defined spectrum. The method of interpolation along the spectrum can also be changed. Marker points along the spectrum can be user-defined by double-clicking.

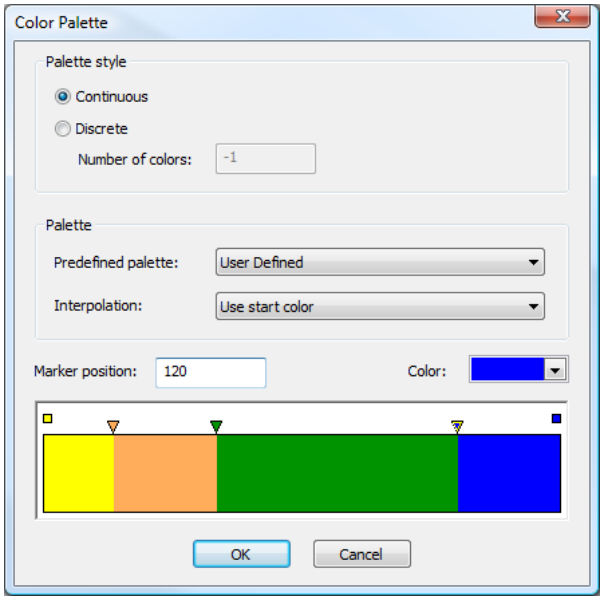
Some of the interpolation methods for interpolating colors between two given colors make use of the interpolations along the color wheel.

E.g. the standard color scheme runs from red to blue where the interpolation method uses the longest distance along the edge of the color wheel between red and blue. Available interpolation methods are:

- Linear interpolation – an interpolation along a straight line between defined colors.
- Use start color – The start color of an interval is used for the entire interval.

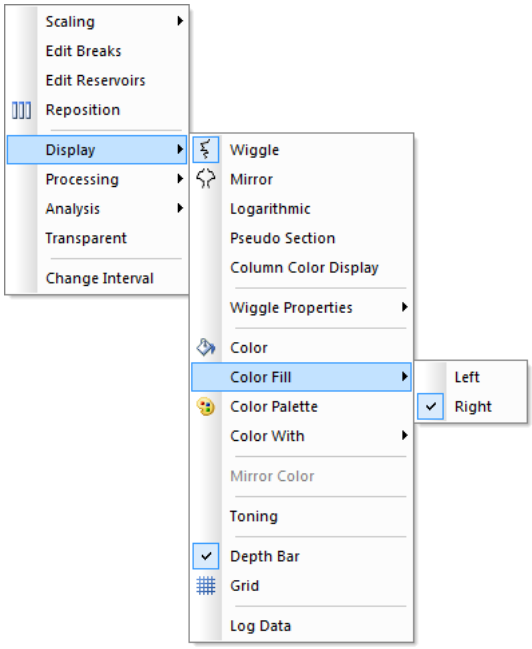
- Use middle color – The interpolated color between the start and end color of an interval is used for the entire interval.
- Use end color – The end color of an interval is used for the entire interval.
- Cosine interpolation – This method is similar to the linear interpolation but instead of using a straight line, the interpolation occurs along the first part of a cosine curve.
- Clockwise color wheel interpolation – Interpolation between given colors occurs clockwise along the color wheel.
- Anti-clockwise color wheel interpolation – Interpolation between given colors occurs anti-clockwise along the color wheel.
- Shortest side color wheel interpolation – Interpolation between given colors occurs along the shortest distance on the color wheel between the given colors.
- Longest side color wheel interpolation – Interpolation between given colors occurs along the longest distance on the color wheel between the given colors.

Combining the different settings you can define different kind of palettes. If you want to define a non-linear color scale you must make sure that the Palette Style is set to continuous, non-linear implies non equal intervals. Set the predefined palette to Used Defined and choose Use start color for the interpolation method. The start and end colors of your palette can be defined on the gradient. Select the start color by clicking on the small square at the beginning of the gradient. The Marker position box and the Color button are activated. Use the Color button to define the start color. Extra marker points (triangles) can be added to the gradient by double-clicking on the gradient. After a new marker point is added, the marker can be selected to adjust its position by dragging the marker along the gradient or by entering an absolute position in the Marker position box. The color of the selected marker can be changed with the Color button. Adding more markers to the gradient will create more color intervals.

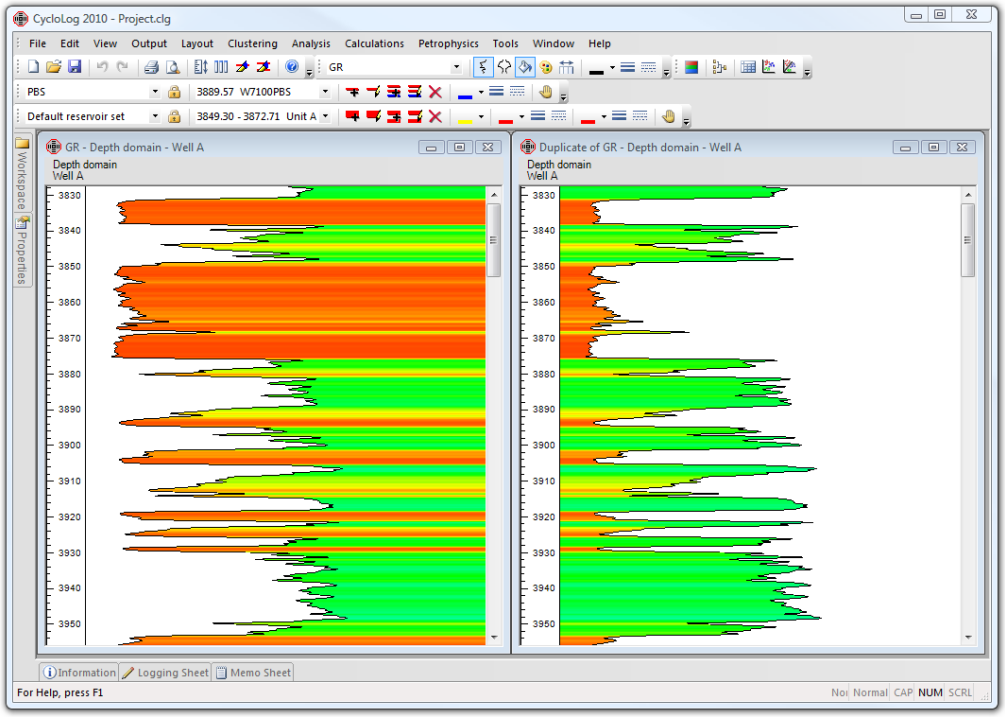


5.4.7. COLOR FILLING SIDE

Color filling can be performed on either side of the log. The color fill side can be accessed from the Data Pane right-click menu by selecting Display:

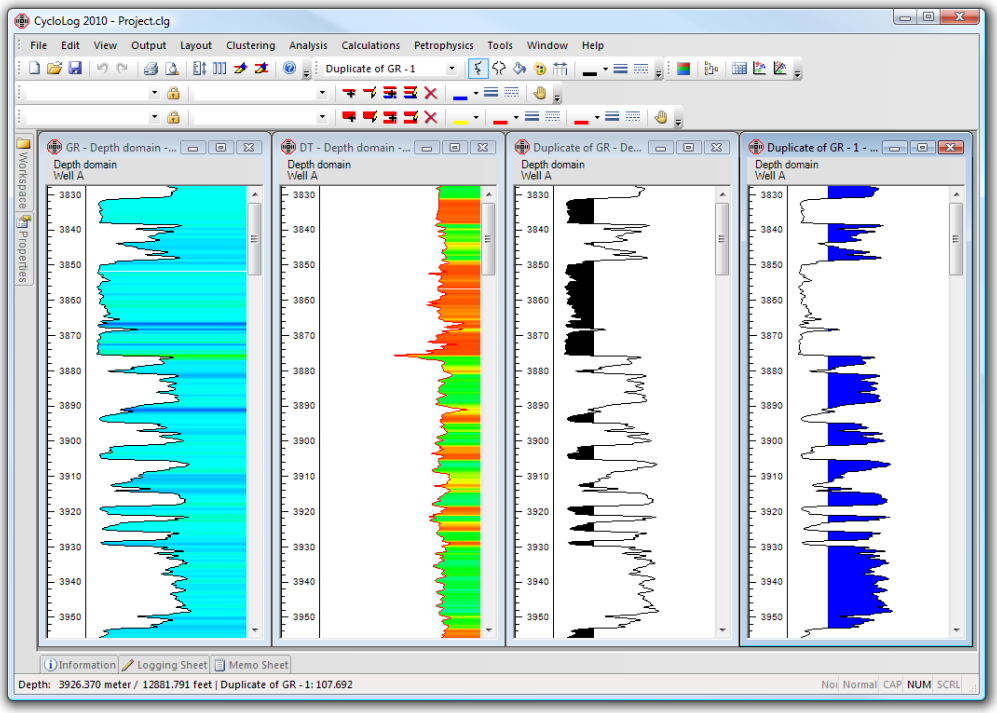


Selecting Left or Right will result in the color filling of the left or right side of the log. In the following example the GR curve is shows with a color fill on the left side of the curve and a color fill on the right side of the log.



5.4.8. COLOR WITH

A variation of the use of scale-controlled color fill is to color one log with the values of another. Combining information from two logs in one display sometimes gives insights that are not otherwise apparent. Right-click over the Data Pane showing the log to be colored (e.g. GR) and select Display → Color With. A menu of the available logs is shown; select the one to be used to control the color scheme (e.g. Sonic). If you want to change the color palette, the active pane must be the one with the log providing the color scheme, not the log to be colored.



In this image you can see four panes. In the first pane you can see the GR log which is colored with the color scale of the DT log. The second pane shows the DT log colored with the color scheme of the GR log. The third and fourth pane show the toning option.

5.4.9. TONING

Single-color tone can be added to a log display, either above or below a user-defined cutoff value. Right-click over the Data Pane, and select Display → Toning. Check the Draw Toning box, then specify positive or negative, the color to be used, and the cutoff value. Toning and Color Fill can be used in the same Data Pane.

5.4.10. DEPTHBAR DISPLAY

By default, each pane contains a depthbar. The depthbar display can optionally be switched off in one or more Data Panes, to make more space in the Data Window. Right-click over the Data Pane, and select Display → Depthbar.

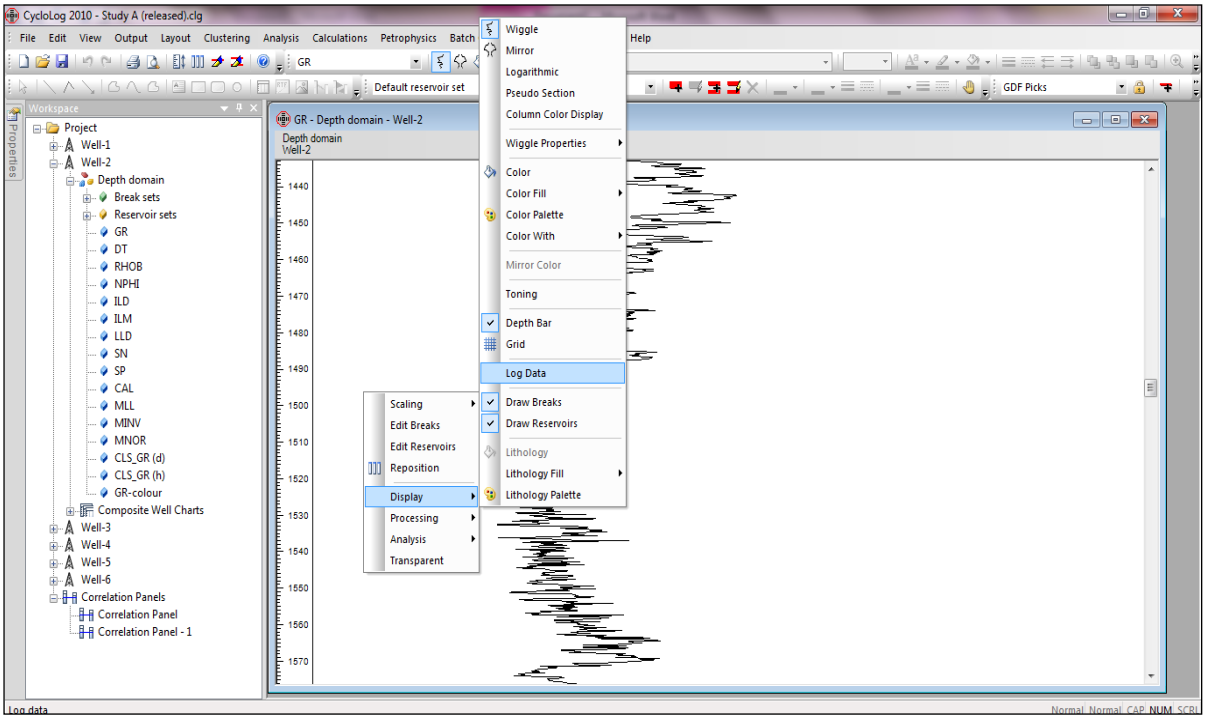
5.4.11. DISPLAY GRID

To display a scale grid in any Data Pane, right-click over the pane and select Display → Grid. Note that the Data Panes do not show the horizontal scale of the logs, although the depth

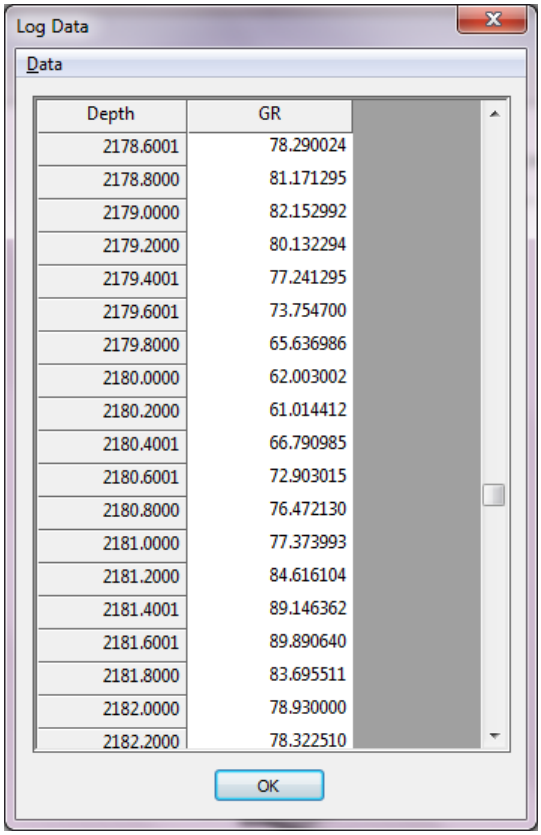
position of the cursor and the log value at that depth is shown in the Status Bar (and in the Information Worksheet, if open).

5.4.12. DISPLAY (AND EDIT) LOG DATA

To edit log data right-click on the log pane that requires editing of data and select Display → Log Data.

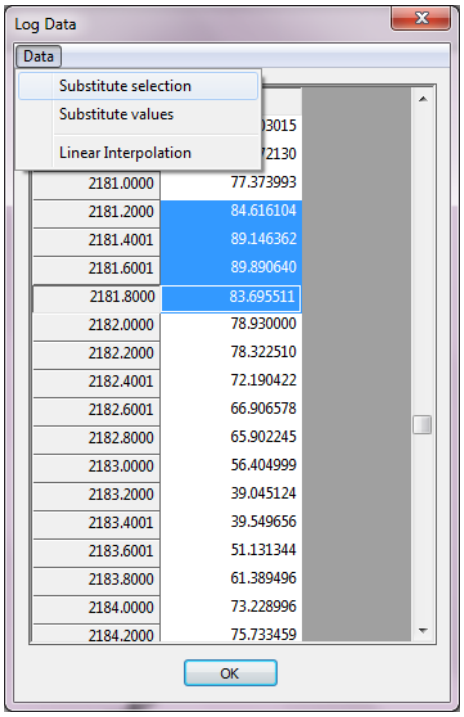


The following dialogue box opens displaying the log data:



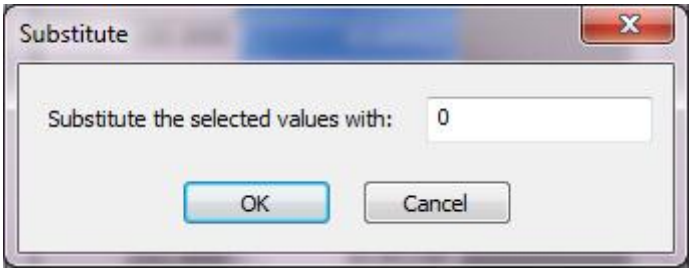
Depth	GR
2178.6001	78.290024
2178.8000	81.171295
2179.0000	82.152992
2179.2000	80.132294
2179.4001	77.241295
2179.6001	73.754700
2179.8000	65.636986
2180.0000	62.003002
2180.2000	61.014412
2180.4001	66.790985
2180.6001	72.903015
2180.8000	76.472130
2181.0000	77.373993
2181.2000	84.616104
2181.4001	89.146362
2181.6001	89.890640
2181.8000	83.695511
2182.0000	78.930000
2182.2000	78.322510

To change one or more values in the GR log, select data point(s) in the log and then click on the menu item Data → Substitute selection.

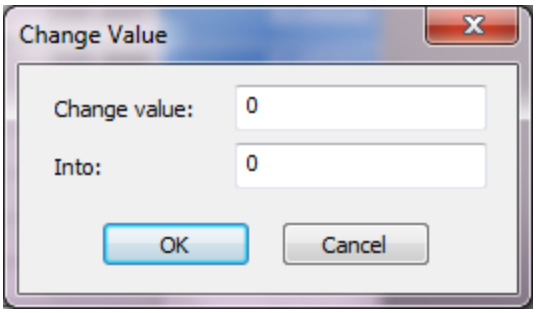


2181.0000	77.373993
2181.2000	84.616104
2181.4001	89.146362
2181.6001	89.890640
2181.8000	83.695511
2182.0000	78.930000
2182.2000	78.322510
2182.4001	72.190422
2182.6001	66.906578
2182.8000	65.902245
2183.0000	56.404999
2183.2000	39.045124
2183.4001	39.549656
2183.6001	51.131344
2183.8000	61.389496
2184.0000	73.228996
2184.2000	75.733459

To substitute the selected data point(s) enter a value:



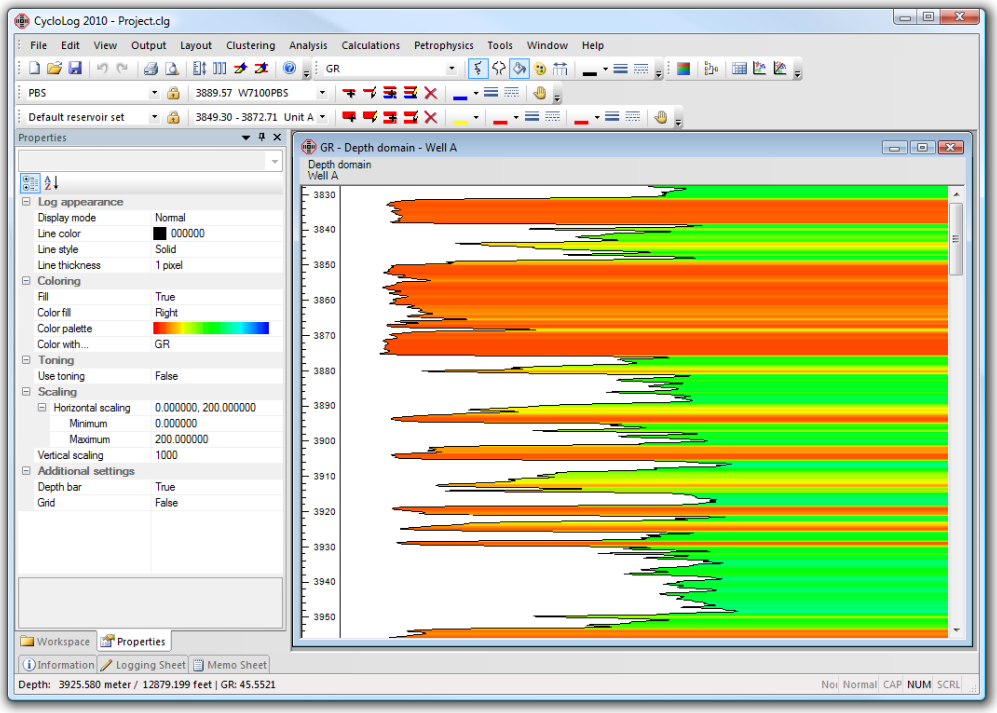
To change a certain log value into another value select Data → Substitute value. The following box appears where certain data values can be replaced.



Note that linear interpolation between data points is also possible. Therefore select the range of data where linear interpolation is desired.

5.4.13. DISPLAY FUNCTIONS USING THE PROPERTIES SHEET

All the before mentioned display functions can also be accessed from the property worksheet. In the image below a log is displayed together with the properties in the property worksheet.

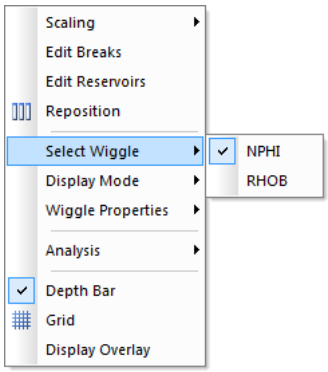


Any changes made in the property worksheet are immediately displayed in the pane.

5.5. LOG OVERLAY DISPLAY FUNCTIONS

5.5.1. THE RIGHT-CLICK OVERLAY DATA PANE MENU

Data Panes in which two or more logs are overlaid have a different Data Pane right-click menu:



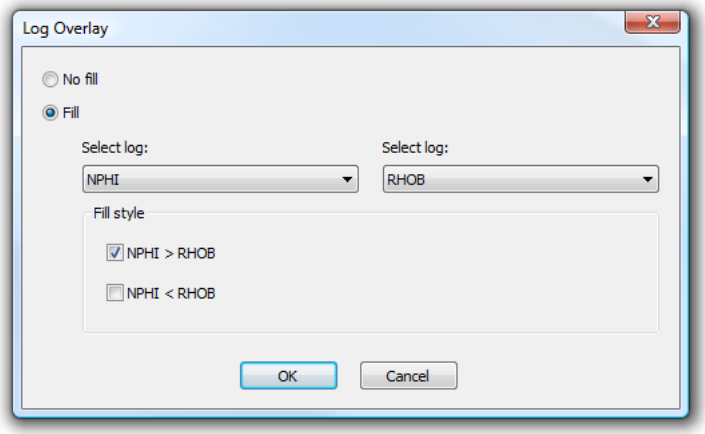
For actions affecting only one of the logs, you must first make sure that the log you want is the active log; Click Select Wiggle on the Data Pane right-click menu, and click on the log to be

made active. You can now change the color, thickness and line style of the active log, using either the right-click menu (Wiggle Properties), or the icons on the Log toolbar. Also you can change for each well individually if the display mode is linear or logarithmic. Changes made to the color and line style will also affect the same log if displayed in a single-log Data Pane.

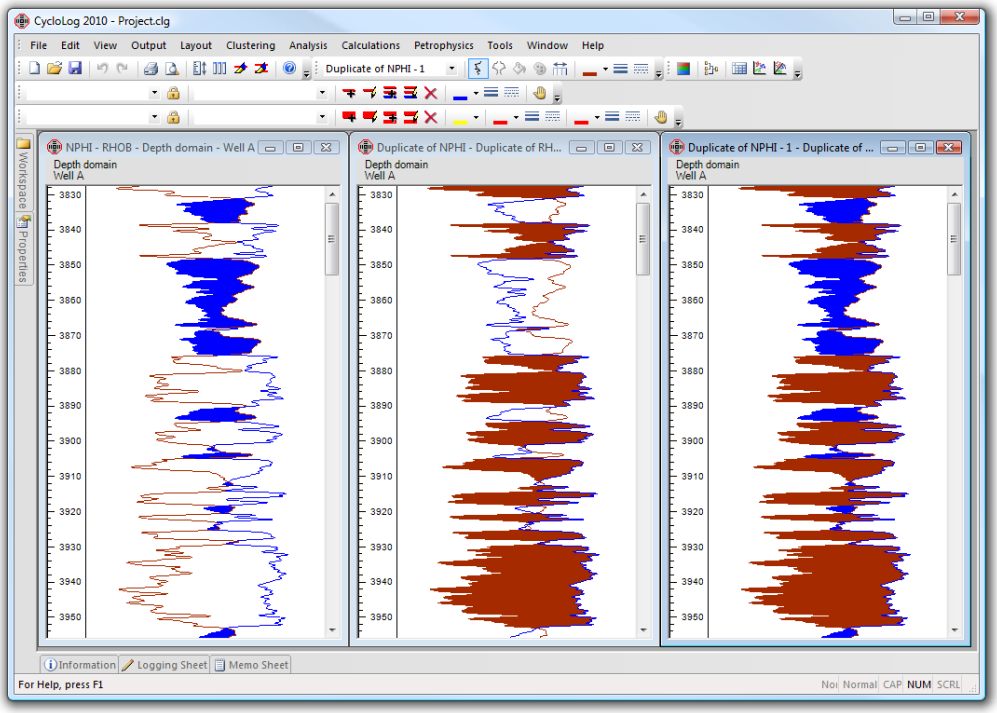
5.5.2. CHANGING THE OVERLAY DISPLAY

To adjust the horizontal scales of the logs in the Overlay Pane, select Scaling → Horizontal from the right-click menu. Select the log you want from the Active Log drop-down list at the top of the Horizontal Scaling dialog box, then make the changes you want as for a single log.

To color-fill the overlap between two overlaid logs (neutron-density, for example) go to the overlay Data Pane and right-click the mouse button. Click on Display Overlay in the Data Pane Menu.

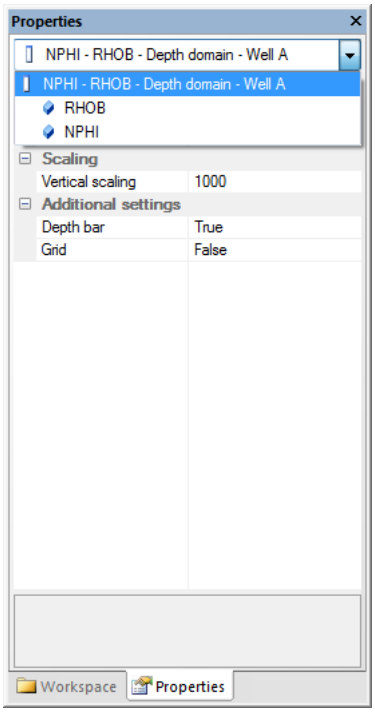


In the Log Overlay dialog box, click Fill, then select the logs you want to use to create the overlay. If two separate logs are chosen, the fill style area is activated. Here the user can choose which area must be filled. In the image below all fill possibilities are shown.



5.5.3. OVERLAY FUNCTIONS USING THE PROPERTIES SHEET

All display functions for the overlay view can be accessed from the properties sheet. To switch between the pane layout options and the logs the drop down box at the top of the properties sheet must be used.



Changes made in the properties sheet are immediately visible in the pane.

6. WORKING WITH ADDITIONAL LOG TYPES

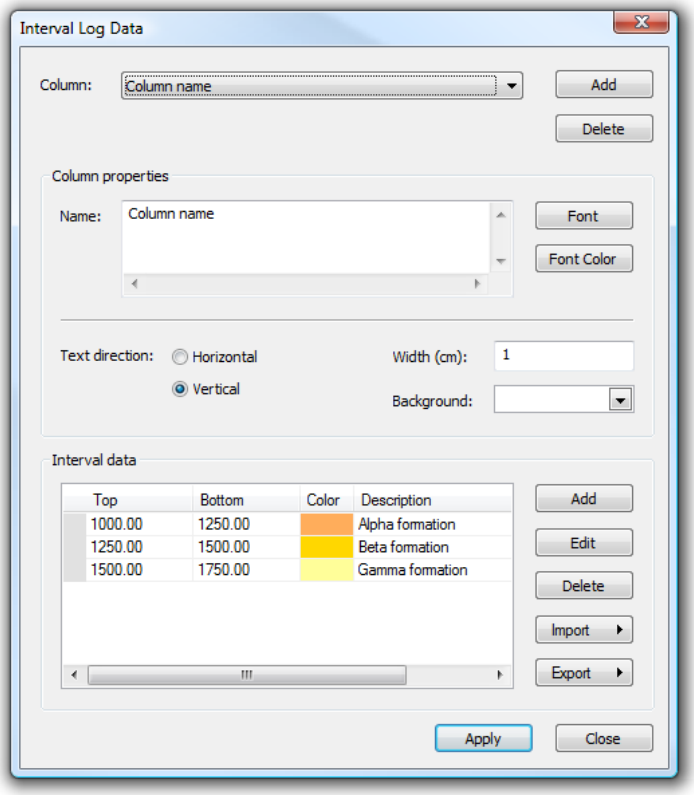
6.1. INTERVAL LOGS

Interval logs can be used to display the tops, bases and names of formations, chronostratigraphic units, biozones or any other kind of unit. Unlike the standard "break" in CycloLog, which is a picked horizon with a name and a single depth (see Section 7), intervals comprise a name associated with both a top depth and a bottom depth.

To create an interval log, right-click on the name of the domain to which you wish to add the new log, and select Interval Log. An interval log is added to the tree structure in the Workspace. Display the interval log in a pane by double-clicking on the interval log in the tree structure.

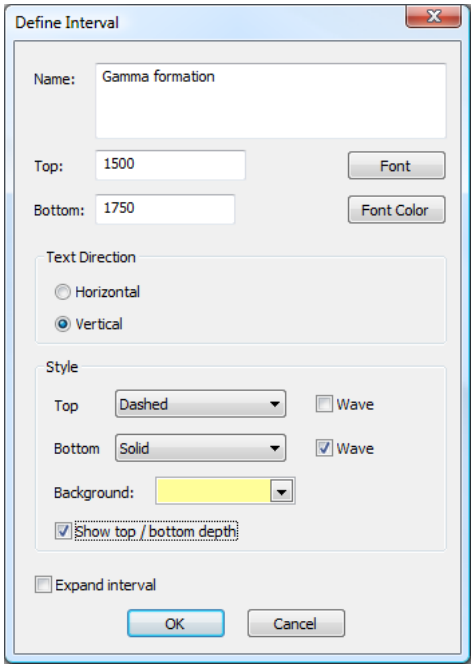
6.1.1. ADDING INTERVAL DATA

When the log is displayed in single pane, right-click on the pane to show the context menu and select the Log Data menu item. The Interval Log Data dialog box opens, in which you can set up one or more columns of interval information, specify the depth intervals in each, and format the text and background. The new log is added to the tree structure in the Workspace, with the name Interval Log (which can be changed).



To add a column to the Interval Log, click Add and give it a name in the Column Properties area of the dialog box. The name can be formatted using the Font and Font Color options; you can also specify the width of the column (default = 1cm), the direction of the text (horizontal or vertical), and a background color; the formatting can be different in each column.

To add intervals to a column, click the Add button in the Interval Data area. The Define interval dialog box opens, in which you can define the name of the new interval, its top and bottom depths, the direction of the text (horizontal or vertical) and the font and font color. You can also specify the style of the lines defining the top and bottom of the interval, and a background color. The option Show top/bottom depth annotates the interval boundary with its depth. The option to Expand interval is for cases where the interval is too small to accommodate its name.



The Define Interval dialog can also be shown by double-clicking on an interval in the data pane. The properties of the clicked interval are shown in the dialog.

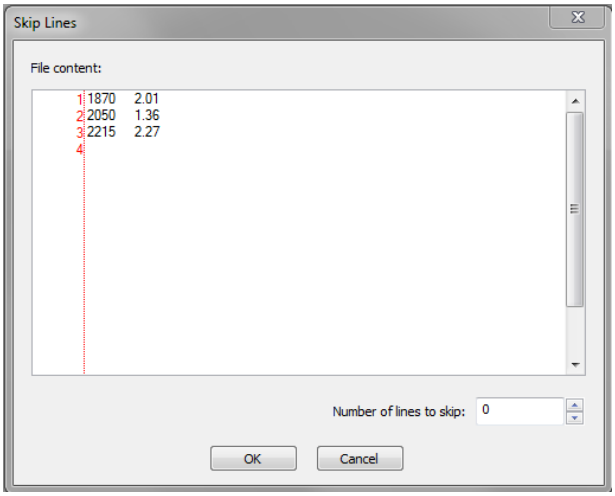
Alternatively, you can choose to import the interval data. To import a file, the file format must consist of tabulated data with the following three columns: 1) a top depth, 2) a bottom depth, and, 3) a description column. The colour and other Style properties can be edited manually.

6.1.2. BATCH IMPORT INTERVAL DATA

Cyclolog can import multiple intervals across multiple wells as a batch operation. To do this, select the menu File->Import->Batch Import Interval Data. This will prompt you for an ASCII text file, from which the interval data will be imported.

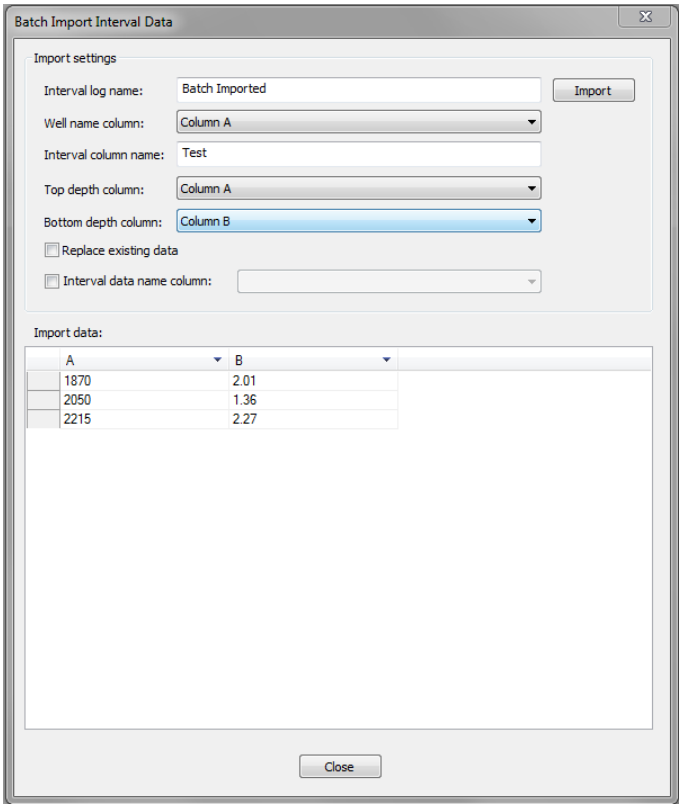
The file data must be in a tabulated data format file consisting of at least the following four columns: 1) well name; 2) Top depth; 3) bottom depth; and 4) Interval data (e.g. Formation name).

Once the file is selected, it will be read by Cyclolog, and the information will be presented to the user in a File Content dialog box:



This acts a preview for the user to determine that everything is as it should be. Some data files may additionally need a value to be placed in the line skip value box, depending upon the file's formatting.

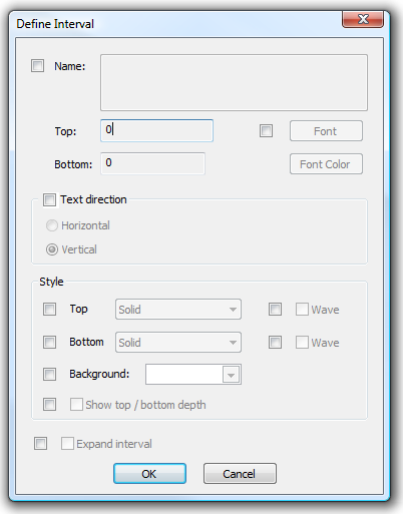
Once OK is clicked, the user will be presented with the batch import dialog:



Here, you can select which columns in the source data represent which value in Cyclolog. Once all values are set as expected, click Import to complete the process.

6.1.3. CHANGING MULTIPLE DATA INTERVALS

CycloLog has a function to change multiple intervals at the same time. When the log is displayed in single pane, right-click on the pane to show the context menu and select the Log Data menu item. Select multiple intervals and click on the Edit button.



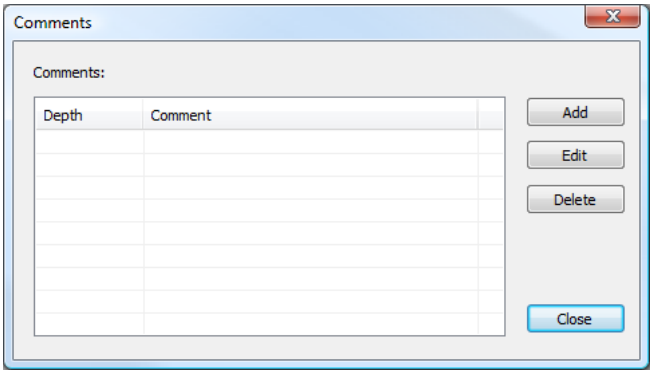
When a checkbox in front of a layout style is checked, the control becomes enabled. Once the control is enabled the value can be entered. When the OK button is clicked the entered layout options will be applied to all selected intervals.

6.2. COMMENT LOGS

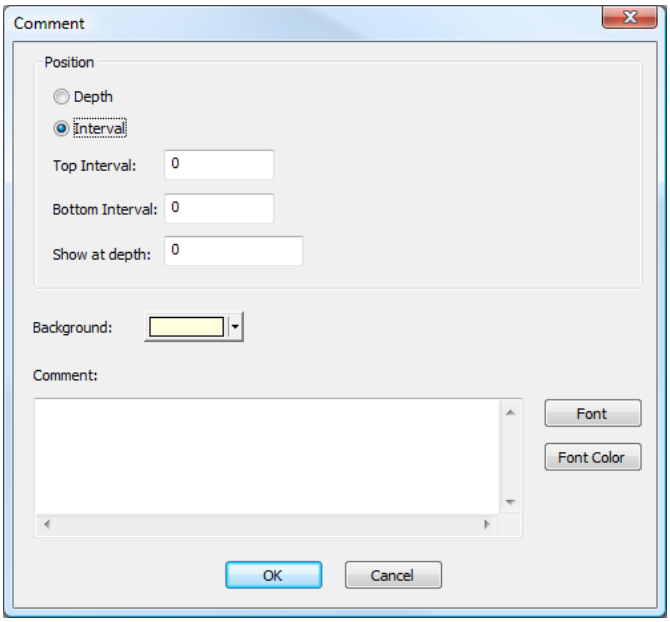
A comment log holds items of free-format text, each associated with a depth.

To create an interval log, right-click on the name of the domain to which you wish to add the new log, and select Comment Log. The new log is added to the tree structure in the Workspace, with the name Comment Log (which can be changed). Open the comment log in a pane by double-clicking on the interval log in the tree structure. Right-click on the pane to show the context menu and select the Log Data menu item.

The Comments dialog box shows any comments that have already been defined, with their depths. Click Add to add a comment, or select a comment and click Edit to edit an existing comment.



In the Comment dialog box, specify the depth to which the comment applies and the depth at which you want it to be shown (normally the same depth but you can specify a different depth if, for example, there is not sufficient space available at the first depth). If a depth is specified a marker is shown at that depth, if an interval is specified a marker is shown over the whole interval. Type in the text of the comment and specify the font, font color and background color.



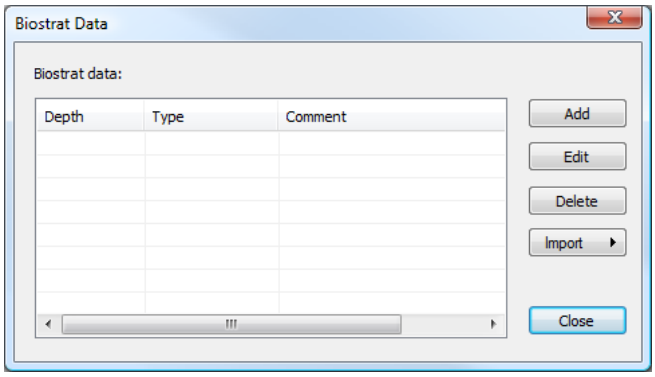
6.3. BIOSTRAT LOGS

A biostrat log holds items of biostratigraphic data, each associated with a depth.

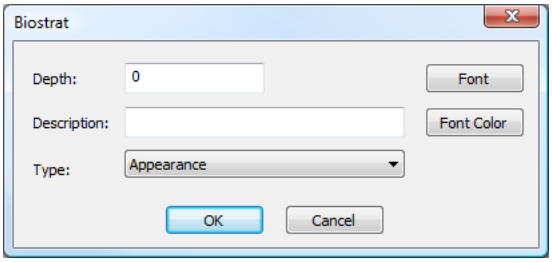
To create a biostrat log, right-click on the name of the domain to which you wish to add the new log, and select Biostrat Log. The new log is added to the tree structure in the Workspace, with the name Biostrat Log (which can be changed). Open the biostrat log in a pane by double-clicking on the interval log in the tree structure. Right-click on the pane to show the context menu and select the Log Data menu item.

In the main Biostrat Data dialog box, the depth, type and name of any biostratigraphic data already defined are listed. Add new items by clicking Add, or edit an existing item by selecting it and then clicking on Edit.

New data points can also be added by using the Import button to import data from an ASCII file or to import data from the clipboard. To import a file, the file must consist of tabulated data with the following two columns: 1) a depth and, 2) a comment (e.g. species name) column. The event type must be added manually in the Biostrat Data dialogue box.



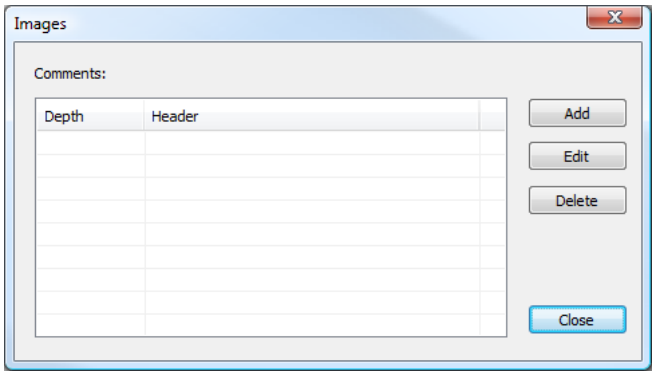
In the Biostrat dialog box, type in the depth and name of the biostratigraphic event, and select the type of event: the available options are First Appearance, ACME, Appearance, Last Appearance (each of which is shown with a different kind of arrow on the graphic log).



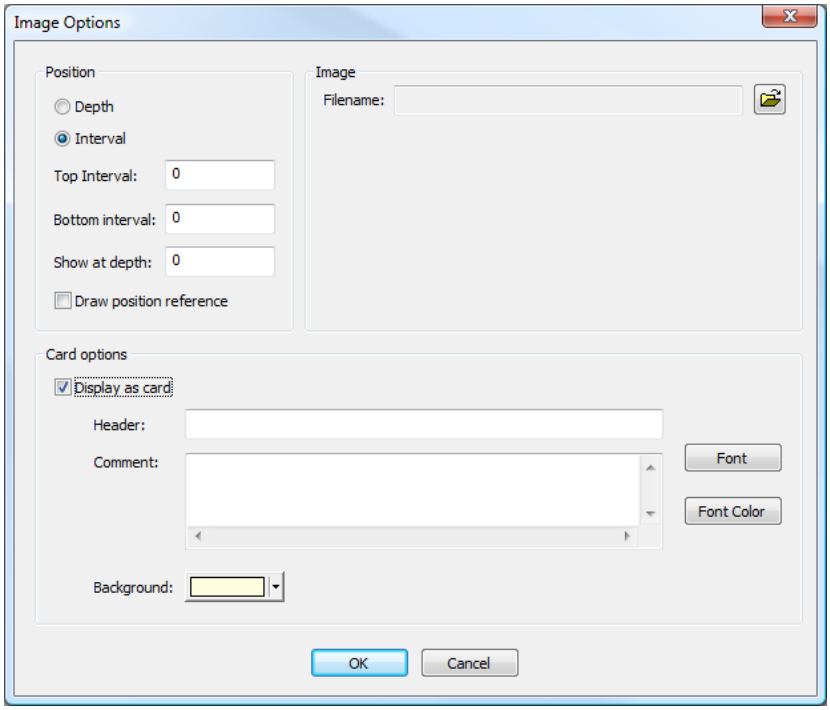
6.4. IMAGE LOGS

An image log can be used to display images, such as core photos, in a log, composite charts or correlation panels.

To create an image log, right-click on the name of the domain to which you wish to add the new log, and select Image Log. The new log is added to the tree structure in the Workspace, with the name Image Log (which can be changed). Open the image log in a pane by double-clicking on the interval log in the tree structure. Right-click on the pane to show the context menu and select the Log Data menu item.



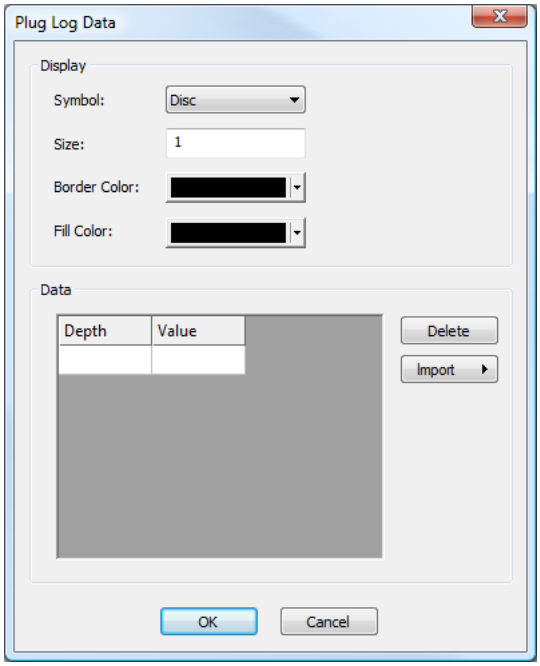
In the main Images dialog box, the depth and name of any image data already defined are listed. Add new items by clicking Add, or edit an existing item by selecting it and then clicking on Edit.



6.5. PLUG DATA LOGS

A plug data log can be used to display plug data, such as porosity or permeability measurements.

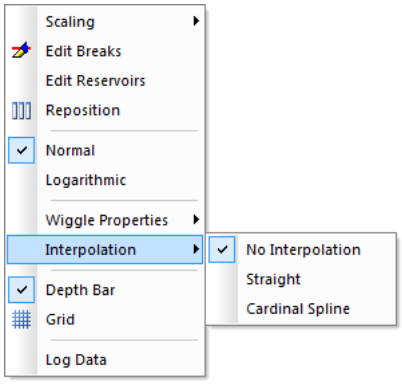
To create a plug data log, right-click on the name of the domain to which you wish to add the new log, and select Plug Data Log. The new log is added to the tree structure in the Workspace, with the name Plug Data Log (which can be changed). Open the plug data log in a pane by double-clicking on the interval log in the tree structure. Right-click on the pane to show the context menu and select the Log Data menu item.



In the Display section the visual styles for the plug data can be set. In the Symbol lists you will find several symbols which can be used for display. The Size defines the size of the symbol drawn. The Border Color and the Fill Color can be used to define the border of the symbol and the fill color of the symbol respectively.

In the Data section is a grid which holds all the plug data. New data points can be added by typing in new values, or using the Import button to import data from an ASCII file or to import data from the clipboard. The Delete button will delete all the data in the data grid.

If you right-click on the plug data pane you will find some additional visual options for drawing the data.

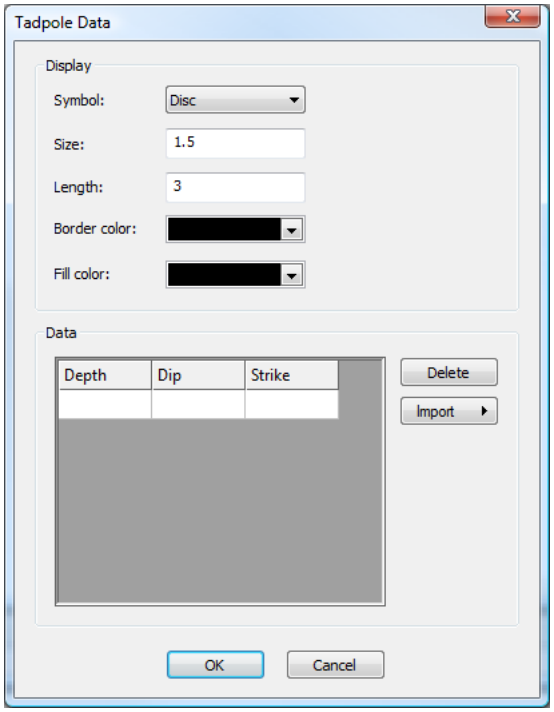


The plug data can be shown using a Normal or a Logarithmic horizontal scaling. The Interpolation option allows you to connect the data points with a line. The line can be drawn Straight which will draw a spiky line through the data points, or the line can be drawn using a Cardinal Spline which will draw a smooth curved line through the data points. Using the Wiggle Properties you can change the display properties of the interpolation line.

6.6. TADPOLE LOGS

A tadpole log can be used to display dipmeter data.

To create a tadpole data log, right-click on the name of the domain to which you wish to add the new log, and select Tadpole Log. The new log is added to the tree structure in the Workspace, with the name Tadpole Log (which can be changed). Open the tadpole log in a pane by double-clicking on the interval log in the tree structure. Right-click on the pane to show the context menu and then select **Scaling → Horizontal**. Depending on the dip meter data make sure that the data fall within the assigned horizontal scaling range. A rule of thumb is to set the minimum scaling at -90 and the maximum at 90. Right-click on the pane again and select the **Log Data** menu item.
Right-click on the pane to show the context menu and select the Log Data menu item.



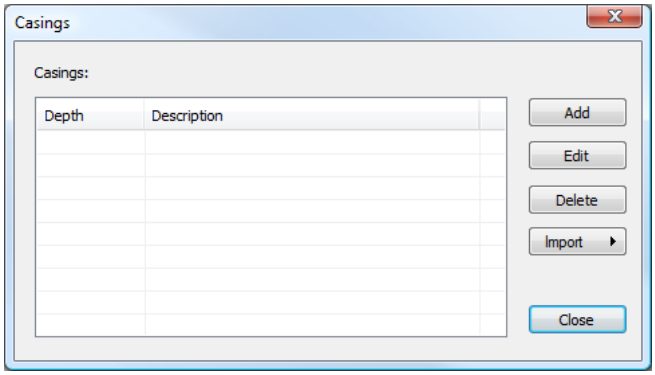
In the Display section the visual styles for the tadpoles can be set. In the Symbol lists you will find several symbols which can be used for display. The Size defines the size of the symbol drawn. The Length is used for the length of the tadpole tail. The Border Color and the Fill Color can be used to define the border of the symbol and the fill color of the symbol respectively.

In the Data section is a grid which holds all the tadpole data. New data points can be added by typing in new values, or using the Import button to import data from an ASCII file or to import data from the clipboard. The Delete button will delete all the data in the data grid.

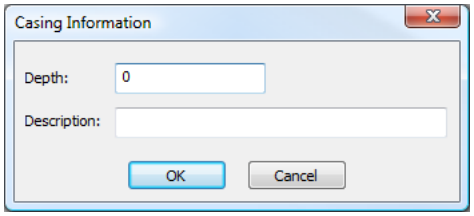
6.7. CASING SHOE LOGS

A casing shoe log will display all the casing shoes in a well.

To create a casing shoe log, right-click on the name of the domain to which you wish to add the new log, and select Casing Log. The new log is added to the tree structure in the Workspace, with the name Casing Log (which can be changed). Open the casing log in a pane by double-clicking on the shoe log in the tree structure. Right-click on the pane to show the context menu and select the Log Data menu item.

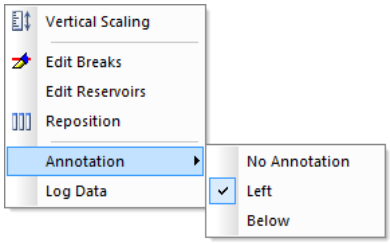


In the main Casings dialog box, the depth and description of any casing data already defined are listed. Add new items by clicking Add, or edit an existing item by selecting it and then clicking on Edit. New data points can also be added by using the Import button to import data from an ASCII file or to import data from the clipboard.



In the Casing information dialog box you can type in the depth of the casing shoe. The description value can be used to specify the size of the casing shoe.

Right-clicking in the casing show data pane shows additional display options.



The Annotation option can be used to place the description of the casing shoe relative to the casing shoe symbol. The description can be omitted by selecting the No Annotation option, can be drawn left of the casing shoe by selecting Left or can be draw below by selecting Below.

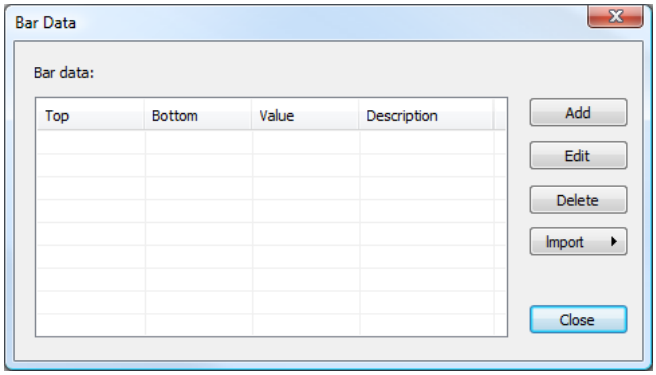
6.8. BAR LOGS

Using the bar log the user can display a value over an interval, equivalent to a bar chart.

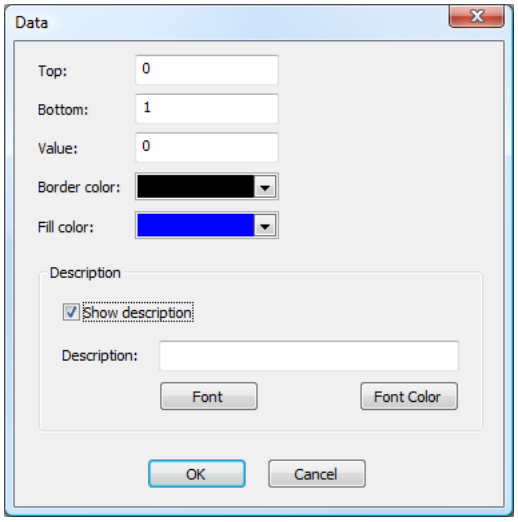
To create a bar log, right-click on the name of the domain to which you wish to add the new log, and select Bar Log. The new log is added to the tree structure in the Workspace, with the name Bar Log (which can be changed). Open the bar log in a pane by double-clicking on the bar log in the tree structure.

6.8.1. ADDING BAR DATA

When the bar log is displayed in a single pane, right-click on the pane to show the context menu and select the Log Data menu item.



In the main Bar Data dialog box, the depth and description of any bar interval data already defined are listed. Add new items by clicking Add, or edit an existing item by selecting it and then clicking on Edit. New data points can also be added by using the Import button to import data from an ASCII file or to import data from the clipboard. When the import option is uses, please make sure the data is tab delimited.



In the Top and Bottom boxes the top and bottom of the interval are defined. The Value is the horizontal value for the interval. Changing the border colour and the fill colour of a data interval will apply to all data intervals that have similar values in the Value box.

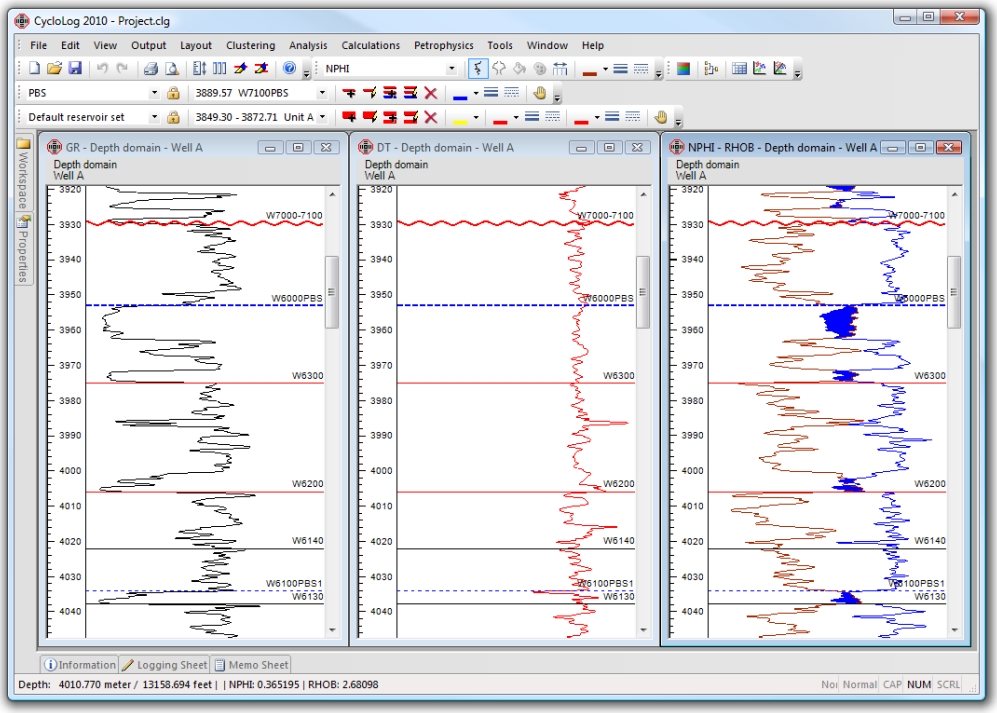
With the description option, it is possible to add a description inside the bar. The font and font color can be adjusted.

7. DEFINING AND EDITING BREAKS

7.1. INTRODUCTION

Horizons of interest in a well, such as the bases and tops of stratigraphic units, are defined in CycloLog as “breaks”. Breaks are organized into sets, so that one set can be used for picks made by the user, while another set could be used for biostratigraphic or formation tops.

Breaks are displayed on log Data Panes as horizontal lines, which appear on all log panes from the same well/domain. Individual breaks and sets of breaks can be selectively displayed or hidden, and the style of the line can be edited, to distinguish between different kinds of breaks.



Breaks can be defined interactively, or can be imported from an external source. Sets of breaks can be exported for use in another CycloLog project, or in a different software application.

This section of the manual describes how breaks are created, organized, edited, imported and exported. The various ways in which breaks can be displayed on well composite charts are

described in Section 22. The linking of breaks from one well to another in correlation panels is described in Section 23.

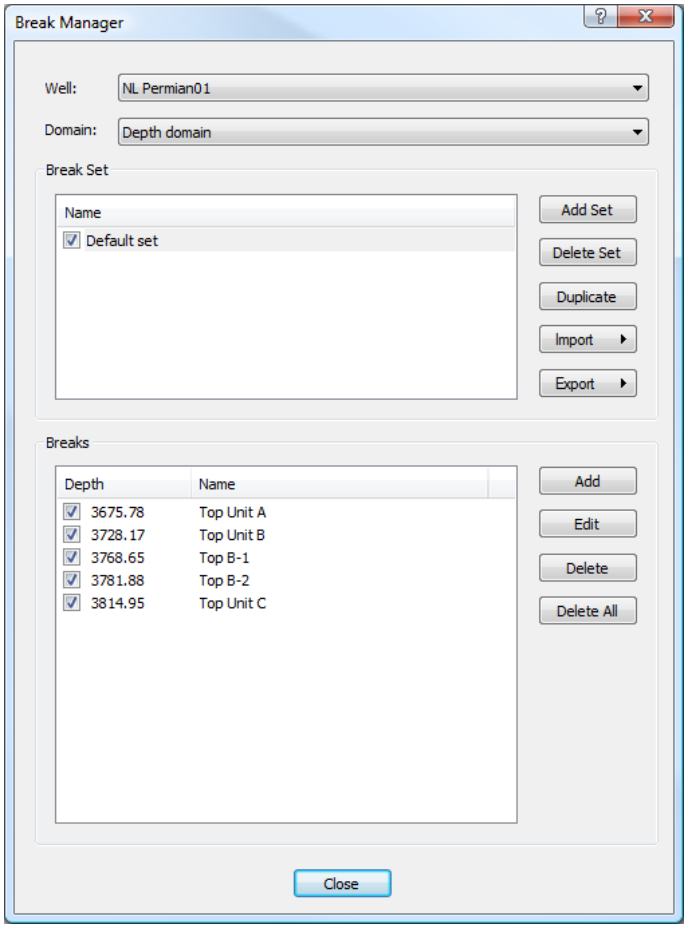
7.2. THE BREAK MANAGER

The Break Manager can be opened in several different ways:

- Click Edit → Edit Breaks on the main Menu bar
- Select the Edit Breaks icon on the Standard toolbar
- Select Edit Breaks on the right-click menu when the cursor is over a Data Pane.

 : Edit breaks

Because breaks are defined independently for each well in a project, and for each domain in a well, the Break Manager has boxes for selecting the well and domain. For projects with only one well and one domain, these boxes can be ignored. If the Break Manager is opened from within a pane using the right-click menu, the correct well and domain are already selected.



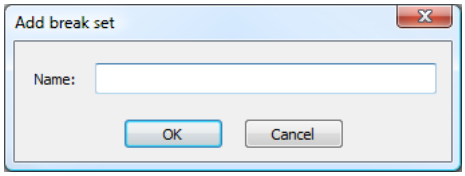
The Break Manager has two lists, one for displaying the sets of breaks defined for that well/domain and one for displaying the breaks in the selected break set. If no breaks have yet been defined or imported for a well/domain, the break set list will show only a single set of breaks, called Default Set. This can be renamed by right-clicking over the name, selecting the rename option and typing in the new name.

The buttons on the right of the Break Manager window operate various functions, which can also be accessed by right-clicking over the appropriate part of the Break Manager window.

7.3. ADDING AND DELETING BREAKS AND BREAK SETS

7.3.1. TO CREATE A NEW SET OF BREAKS

Click the Add Set button (or, right-click anywhere in the Break Set list of the Breaks Manager and click Add Break Set). You will be prompted for a name for the new set of breaks. A set's names must be unique within any one well/domain.



7.3.2. TO DELETE A BREAK SET

Put the cursor over the name of the set of breaks you wish to delete, and click the Delete Set button (or, right-click over the name of the set and select Delete). You are prompted if you really want to delete the set of breaks.

7.3.3. TO DUPLICATE A BREAK SET

Put the cursor over the name of the set of breaks you want to duplicate, and click the Duplicate button. A new set of breaks will be added to the break list with the name "Duplicate of <break set name>".

7.3.4. TO ADD A BREAK

Click on the name of the set of breaks to which you wish to add a break. Click Add (or, right-click anywhere in the Breaks list of the Break Manager and click Add) and type in the depth and name of the new break into the Edit Break dialog box. Break depths and names do not have to be unique; CycloLog will accept two or more breaks with identical depths and names within the same set. CycloLog will also accept a break with a depth but no name.

7.3.5. TO DELETE A BREAK

Put the cursor over the name of the break you wish to delete, and click the Remove button (or, right-click over the name of the break and select Delete). You are prompted if you really want to delete the break.

7.3.6. TO DELETE ALL BREAKS IN A BREAK SET

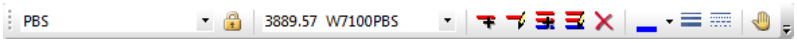
Select the set of breaks from which you want to remove all breaks. Click the Delete All button (or, right-click over the name of the set of breaks and select Delete All Breaks or, right-click anywhere in the breaks list and select Delete All). You are prompted if you really want to delete the breaks in the set of breaks.

7.3.7. TO MOVE A BREAK TO A DIFFERENT SET

A break can be moved to another set by dragging it to the name of the new set. Select the break you want to move in the break list. Hold the left mouse button down and drag the break to the set of breaks you want to move the break to in the Break Set list and release the left mouse button. You can select more than one break to move simultaneously to the new set of breaks by using the Ctrl or Shift button in combination with the left mouse button.

7.3.8. TOOLBAR SHORTCUTS

Add Break, Edit Break, Add Break Set, and Edit Break Set can also be accessed from icons on the Breaks toolbar. Note that the toolbar displays the name of the current break set, and the depth of the current break.



: Add break

: Edit break

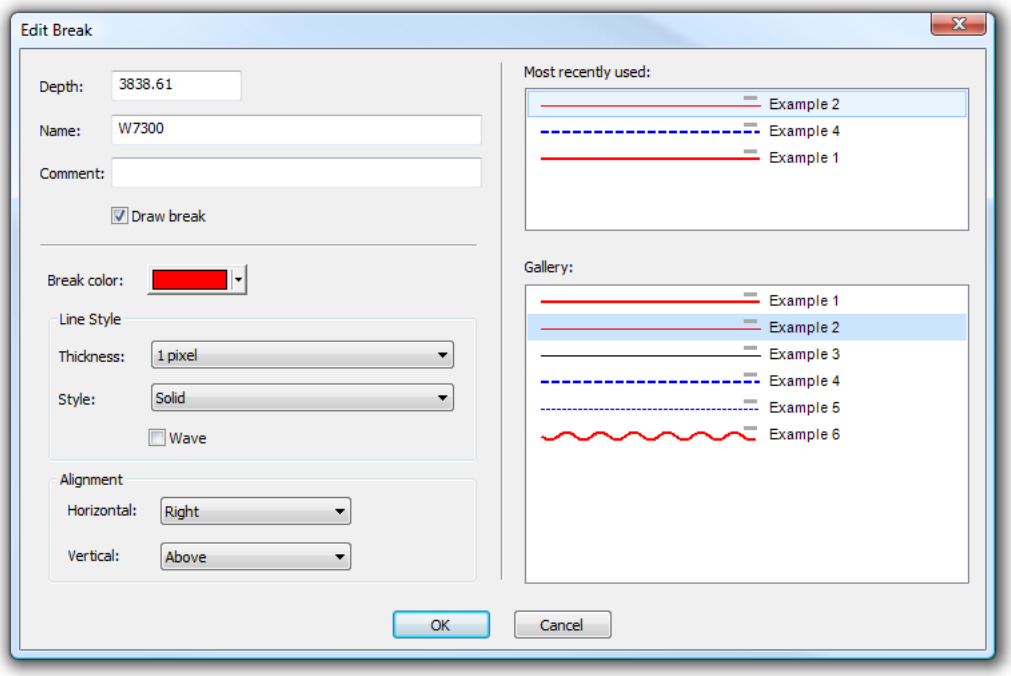
: Add break set

: Edit break set

: Delete the active break

7.4. BREAK PROPERTIES, AND EDITING BREAKS

Breaks each have a depth and a name. By default, the lines representing breaks on the screen are red, one pixel thick, and solid. These and other properties can be modified by the user through the Edit Breaks screen. This can be opened either by double-clicking with the cursor held over the break in the Data Pane (the cursor changes to a flash symbol -), or through the Breaks Manager. Open the Breaks Manager (Edit → Edit Breaks, or use the Edit Breaks icon on the Standard Toolbar) and either click on the name of the break to be edited, then click Edit, or double-click on the break name.



(If there are breaks from more than one set at the same depth, it may not be possible to access the one you want by double-clicking over it – check the boxes on the Break toolbar to see which is the current break set, and the current break.)

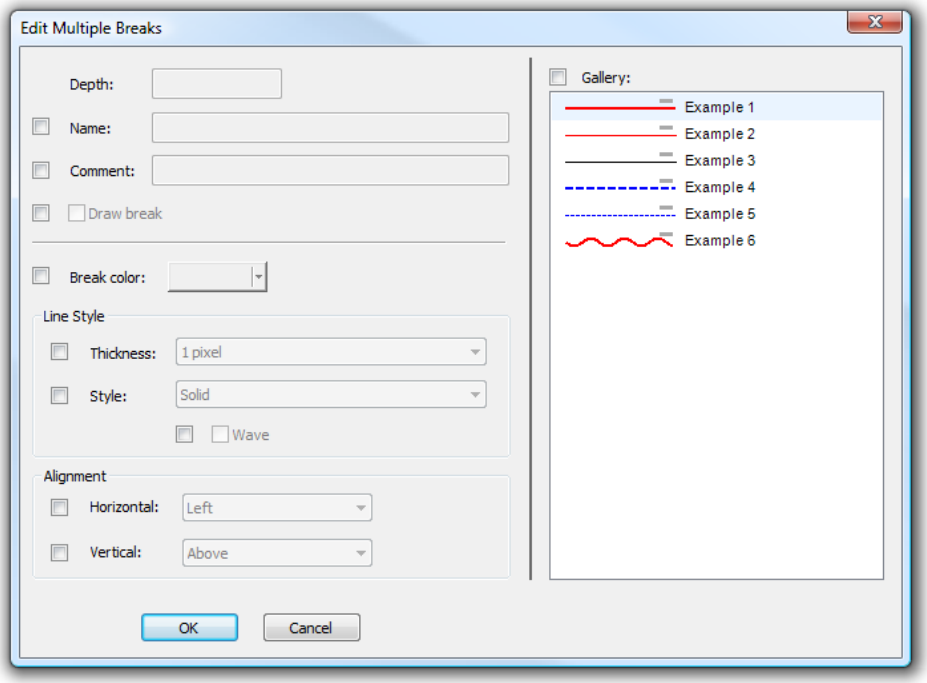
In the Edit Break dialog, you can make the following changes:

- Change the depth of the break
- Change the name of the break
- Check if the break is visible when drawing on screen
- Change the color of the break – a full color palette is available with the option to create custom colors

- Change the line thickness, from 1 pixel (the default) to 8 pixels
- Change the line style from solid (the default), to dashed, dotted, etc
- Change the break display from a straight line to a wave, to represent an unconformity (check the Wave box)
- Change the horizontal position of the break label, from the right-hand side of the pane (the default) to the centre or left of the pane
- Change the vertical position of the break label, from above the break line (the default), to below or over the line
- Add notes or descriptive information in free format in the Comments box.

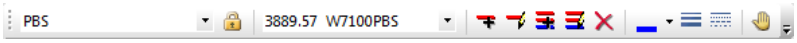
A gallery of the most commonly used break styles is present on the right side of the Edit Break window. If a style is selected from the library all the settings are immediately adjusted. The most recently used break styles are shown in the most recently used list for easy access.

When multiple breaks are selected in the Break Manager and the Edit button is clicked, the Edit Multiple Breaks window is shown.



By clicking on the checkbox in front of the layout style the control becomes enabled and can be changed. When the OK button is clicked, the layout style for all selected breaks is changed.

The break color, thickness and line-style can also be modified from the Break Toolbar; click on the break you want to modify, to make it the current break, then use the drop-down lists from the Toolbar to make your changes.



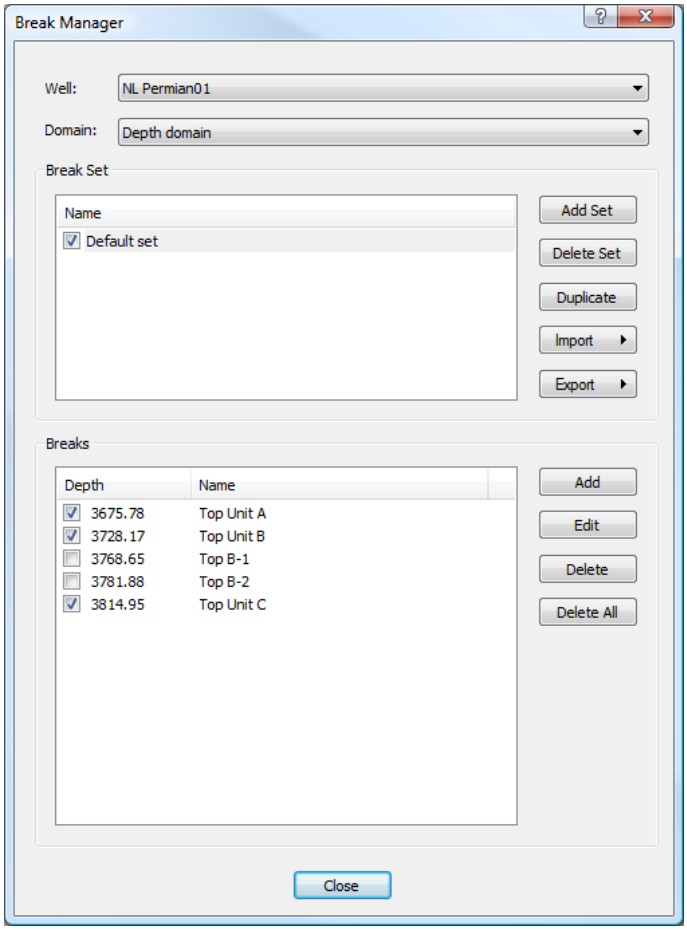
: Break line color

: Break line thickness

: Break line style

7.5. CONTROLLING THE DISPLAY OF BREAKS

To prevent a break, or an entire break set, from being displayed, click on the check-box beside the name of the break or break set. If a break or break set is not selected it is not drawn in all the panes, composite well charts and correlation panels.

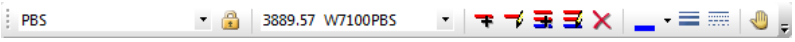


7.6. CREATING AND MOVING BREAKS ON-SCREEN

If you are picking key horizons on the screen, the easiest way to create a break is as follows:

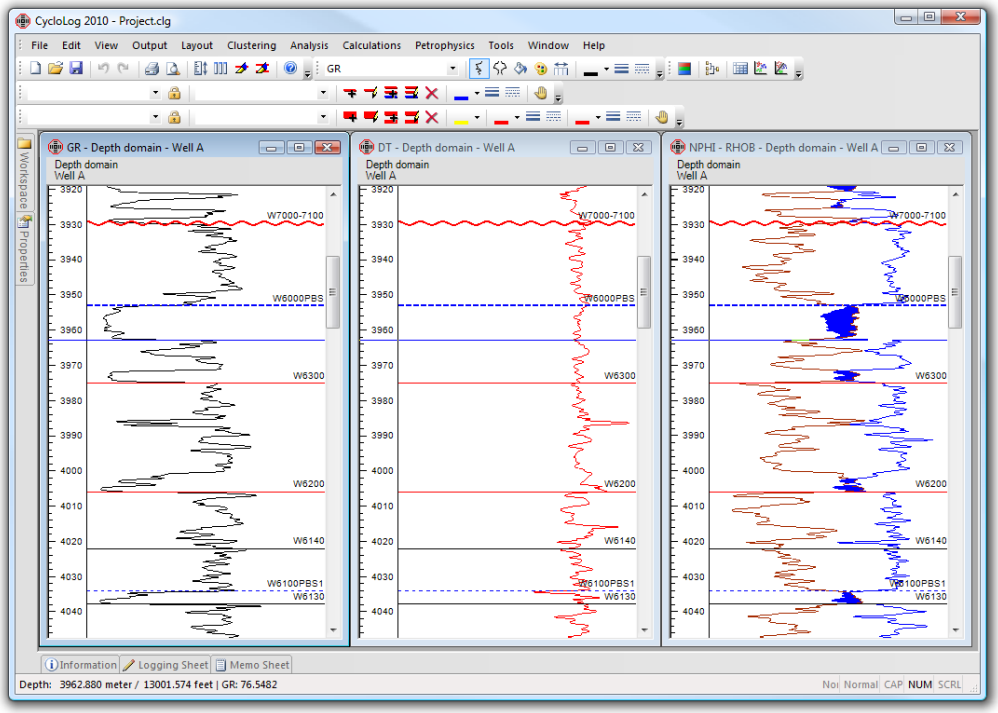
First check that you are adding the new break to the correct break set. For this, the Break Toolbar must be visible. (If it is not, right-click in the Menu Bar, in the empty space to the right of the menu names; click on Break Bar to display it.) The name of the current break set is displayed in the Break Toolbar. If the wrong break set is the current one, select the one you want from the drop-down list.

The break set can be locked by clicking on the lock on the Break bar. When a break set is locked, new breaks can only be added to the locked break set and only the breaks within the locked break set can be modified.



 : Lock break set

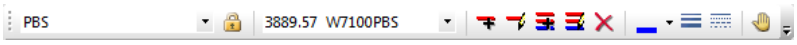
1. With the cursor over the relevant log Data Pane, hold down the left mouse button. The blue depth-line is displayed, and the depth (meters and feet) and the log value (or values) are displayed both on the status bar and in the Information worksheet (if this is open).
2. Move the depth-line up or down to the position at which you want to create a break.
3. Release the mouse button.
4. Hold down the CTRL button and left-click with the mouse.
5. The break is created and is displayed with a red line.



You can now give the break a name, and edit its properties, by double-clicking over the break to open the Edit Break box (see above).

A break can be moved interactively as follows:

1. On the Break Toolbar, click the hand icon.
2. The cursor will now change from a pointer to a hand when it is held over a break.
3. Position the cursor over the break you want to move, drag it to the new position and release the mouse button.



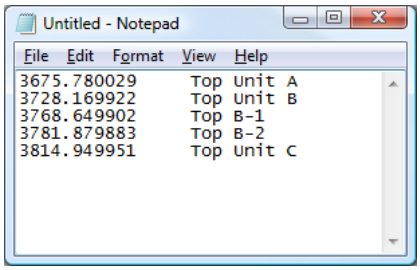
: Break repositioning tool

When you have finished moving breaks, click the hand icon on the Break Toolbar again to toggle back to the default mode.

7.7. IMPORTING AND EXPORTING BREAKS

Break definitions are stored with the relevant project, and saved in its *.clg file. However, for exchanging break data between projects, the definitions can be exported to an ASCII file with the extension *.brk or *.asc. Such files can then be imported into another project.

Two file formats are available; the default format contains not only the depth and name of each break, but also all of the formatting information (line color, style and thickness, etc.). This format is suitable for transferring breaks data from one CycloLog project to another, but is not convenient for exporting to applications such as spreadsheets. For this purpose, a simpler tabular format is available, in which only the depth and name of each break are held. Both formats are imported in exactly the same way. (See below for an example of the tabular format, displayed in the Notepad text editor. A list of breaks like this can be prepared in a text editor, and imported into CycloLog, using Import in the Break Manager.)



Exporting break data to other programs can also be done by using the clipboard. Breaks can be placed on the clipboard and e.g. be pasted in a spreadsheet program or a word processing program. Breaks can also be imported using the clipboard.

To export a set of breaks, open the Break Manager (Edit → Edit Breaks, or use the Edit Breaks icon on the Standard Toolbar). Click on the name of the break set that you wish to export. Click the Export button and select File. You will be prompted to select a folder and to specify a filename. If you wish to export the breaks in tabular format, select Tabular Data (*.asc) from the Save as Type drop-down list. Otherwise the breaks will be exported in *.brk format. If you want to copy a set of breaks into another program, select the break set, click on the Export button and select Clipboard. The set of breaks are now placed onto the clipboard and can be pasted in other programs.

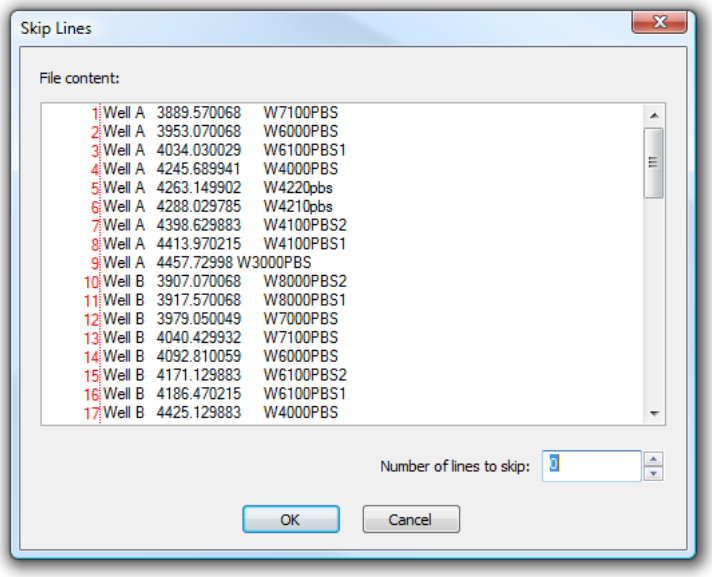
To import a set of breaks, open the Break Manager (Edit → Edit Breaks, or use the Edit Breaks icon on the Standard Toolbar). You can either add the new breaks to an existing set, or you can create a new empty break set using Add Set. Then select (left-click) the name of the break set

into which you wish to import the breaks, click the Import button and select File. (If you are importing breaks from tabular format, you will need to select All Files (*.*) from the drop-down Files of Type list.) The breaks will be added to the specified set in the Break Manager. To insert breaks from the clipboard, select the break set to which you want to add the breaks, click on the Import button and select Clipboard.

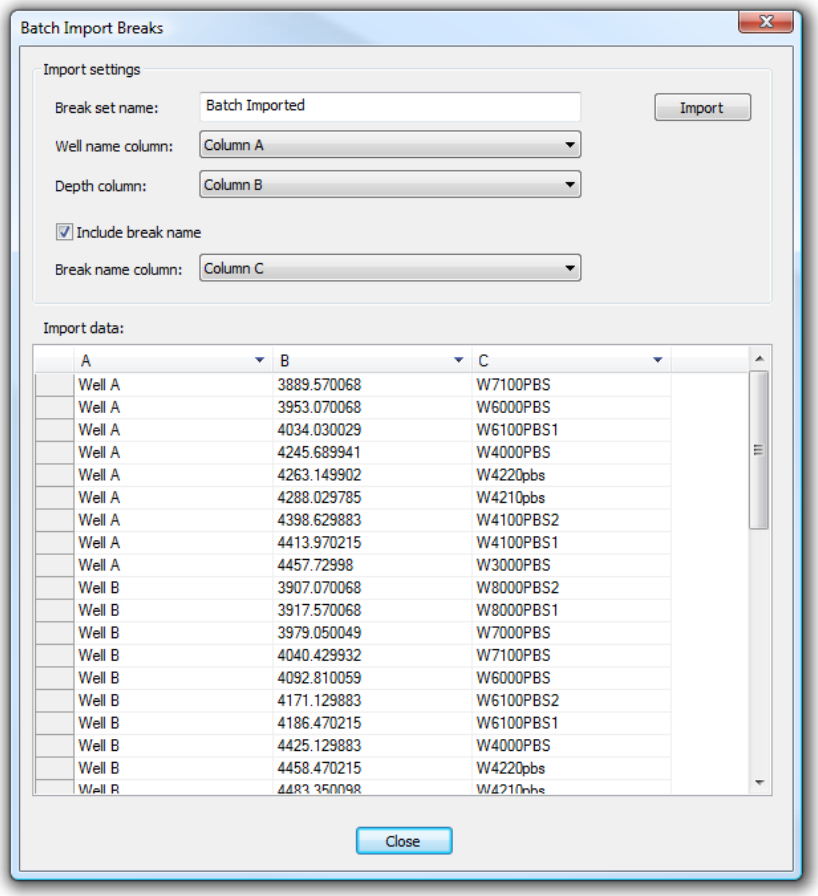
7.8. BATCH IMPORTING BREAKS

To import a large amount of breaks for several wells, for example obtained from a database, the batch loading of breaks can be used. This function can be found in the File menu under Import Batch Import Breaks.

The Open File window is shown for navigating to the data file containing all the breaks. The data file must at least contain the well names as they are used in CycloLog and the break depths. Once the file is opened the Skip Lines window is shown. If there are a few lines in the data file containing comments, the user can specify how many lines need to be skipped before the data begins. Click on the OK button to start the data loading.

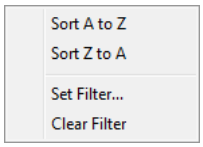


Once the data is loaded, the data is presented in the Batch Import Breaks window.

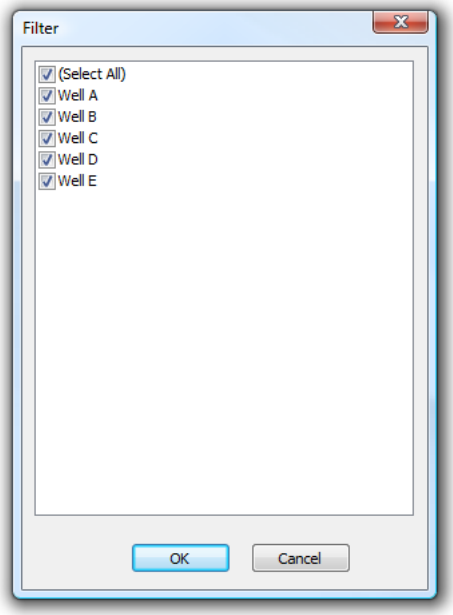


In this window break set name can be set in which the breaks are loaded. In the grid all the data from the data file is shown. It is possible that a lot more information is available in the data file than the well name, depth and break name. Also it is possible that the order of the data columns is not always the same. The user must define in which column the well name, depth and, if present, the reservoir names are. When the import button is clicked, the data is imported into CycloLog.

When the user clicks on the arrow in the column header, a menu appears.

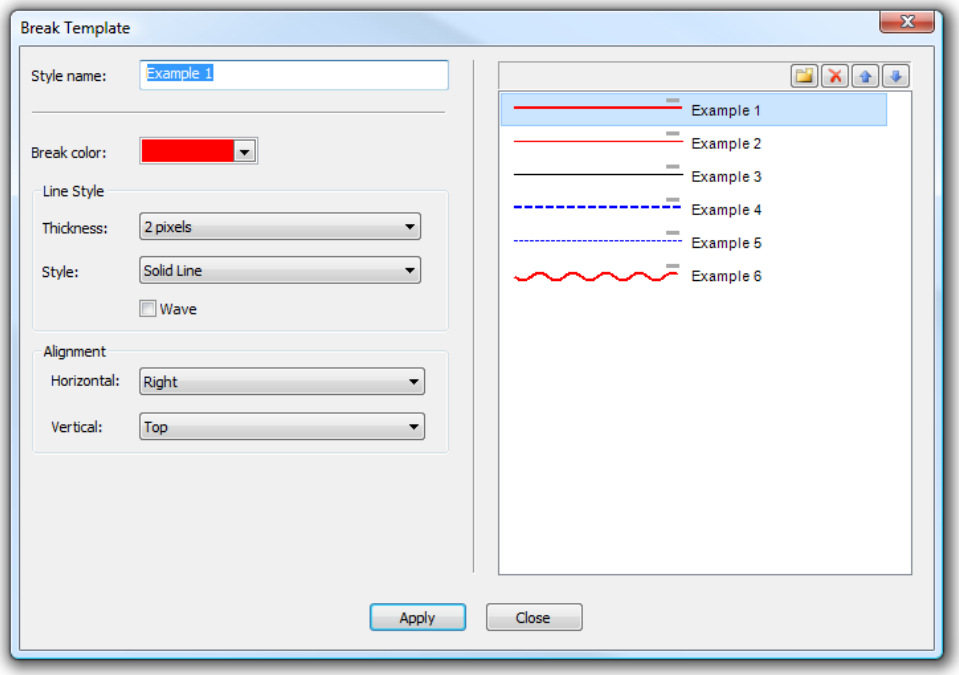


All the break data can be sorted alphabetically. Also, the user can define a filter to select for which wells the reservoirs must be imported or which breaks must be imported.



7.9. BREAK TEMPLATE MANAGER

When editing the break properties a number of predefined styles are displayed in the gallery. The user is able to modify these styles and add new styles to the gallery. The Break Template Manager can be found in the Tools menu.



On the left side all the layout options for a break are displayed. A style name can be assigned to the break style to identify the style in the library. This name is not used for other purposes. When the Apply button is clicked, the break style is updated with the new layout settings.

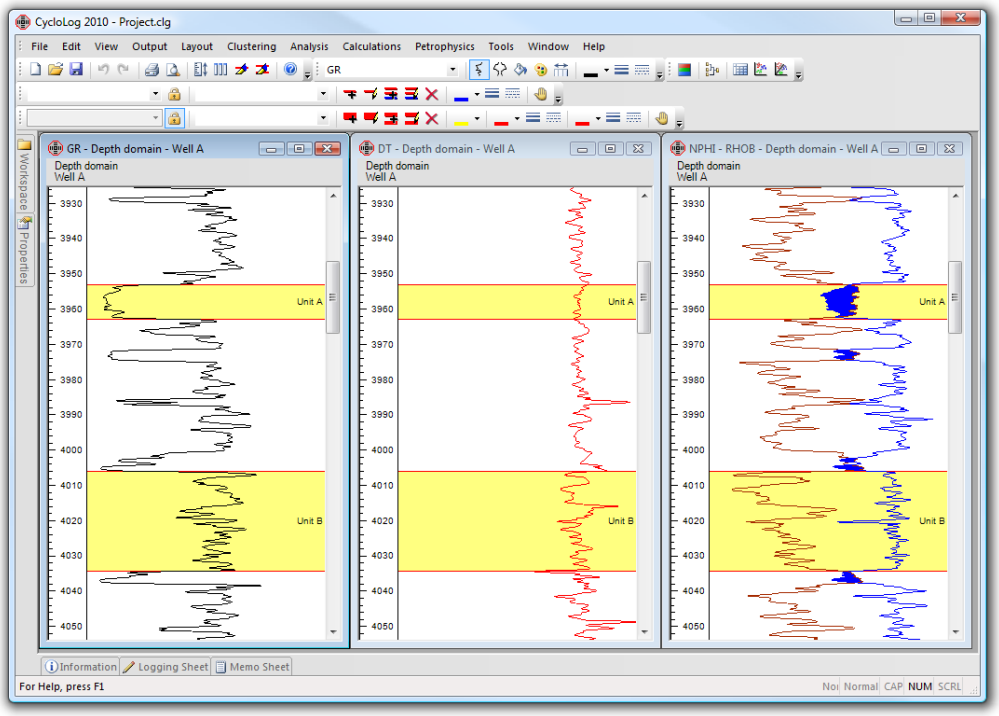
A new break style can be added to the gallery by clicking on the New button on the top of the breaks style list. When the Delete button is clicked, the active break style is deleted. The Up and Down button can be used to change the order of the break styles in the list.

8. DEFINING AND EDITING RESERVOIRS

8.1. INTRODUCTION

Interesting intervals in a well, such as reservoirs, are defined in CycloLog as “reservoirs”. Reservoirs are organized into sets, so that one set can be used for picked reservoirs, while another set could be used for any other type of interpretation.

Reservoirs are displayed on log Data Panes as colored interval in the background, which appear on all log panes from the same well/domain. Individual reservoirs and sets of reservoirs can be selectively displayed or hidden, and the style of the reservoir can be edited, to distinguish between different kinds of reservoirs.



Reservoirs can be defined interactively, or can be imported from an external source. Sets of reservoirs can be exported for use in another CycloLog project, or in a different software application.

This section of the manual describes how reservoirs are created, organized, edited, imported and exported. The various ways in which reservoirs can be displayed on well composite charts are described in Section 22. The linking of reservoirs from one well to another in correlation panels is described in Section 23.

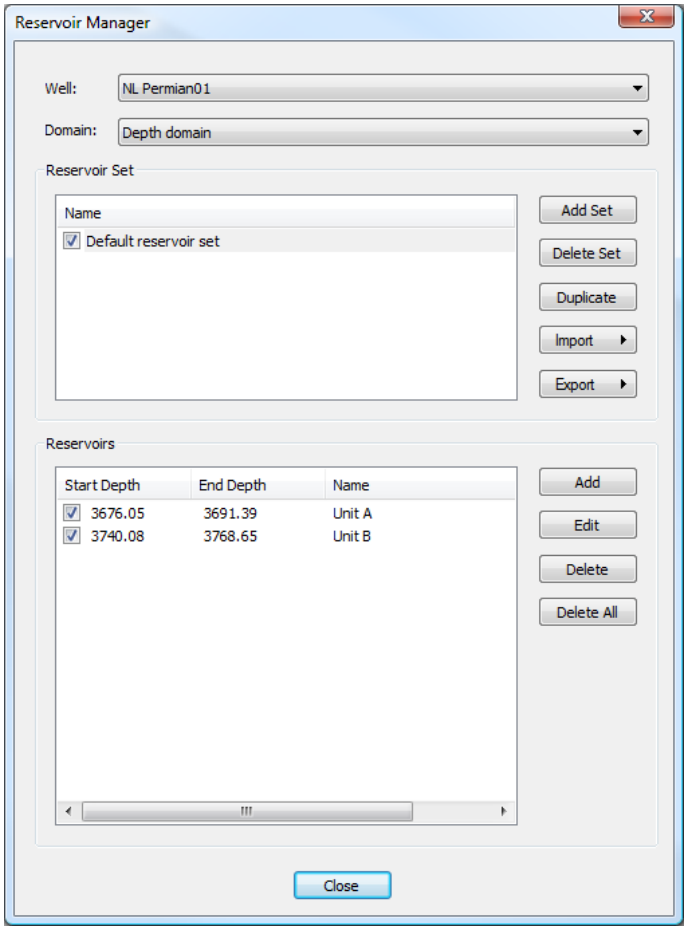
8.2. THE RESERVOIR MANAGER

The Reservoir Manager can be opened in several different ways:

- Click Edit → Edit Reservoirs on the main Menu bar
- Select the Edit Reservoirs icon on the Standard toolbar
- Select Edit Reservoirs on the right-click menu when the cursor is over a Data Pane.

 : Edit reservoirs

Because reservoirs are defined independently for each well in a project, and for each domain in a well, the Reservoir Manager has boxes for selecting the well and domain. For projects with only one well and one domain, these boxes can be ignored. If the Reservoir Manager is opened from within a pane using the right-click menu, the correct well and domain are already selected.



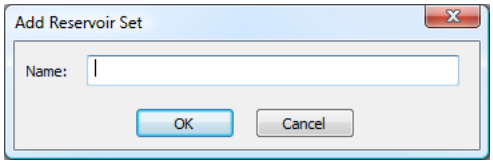
The Reservoir Manager has two lists, one for displaying the sets of reservoirs defined for that well/domain and one for displaying the reservoirs in the selected reservoir set. If no reservoirs have yet been defined or imported for a well/domain, the reservoir set list will show only a single set of reservoirs, called Default reservoir set. This can be renamed by right-clicking over the name, selecting the rename option and typing in the new name.

The buttons on the right of the Reservoir Manager window operate various functions, which can also be accessed by right-clicking over the appropriate part of the Reservoir Manager window.

8.3. ADDING AND DELETING RESERVOIRS AND RESERVOIR SETS

8.3.1. TO CREATE A NEW SET OF RESERVOIRS

Click the Add Set button (or, right-click anywhere in the Reservoir Set list of the Reservoir Manager and click Add Reservoir Set). You will be prompted for a name for the new set of reservoirs. A set's names must be unique within any one well/domain.



8.3.2. TO DELETE A RESERVOIR SET

Put the cursor over the name of the set of reservoirs you wish to delete, and click the Delete Set button (or, right-click over the name of the set and select Delete). You are prompted if you really want to delete the set of reservoirs.

8.3.3. TO DUPLICATE A RESERVOIR SET

Put the cursor over the name of the set of reservoirs you want to duplicate, and click the Duplicate button. A new set of reservoirs will be added to the reservoir set list with the name "Duplicate of <reservoir set name>".

8.3.4. TO ADD A RESERVOIR

Click on the name of the set of reservoirs to which you wish to add a reservoir. Click Add (or, right-click anywhere in the Reservoirs list of the Reservoir Manager and click Add) and type in the start depth, the end depth and name of the new reservoir into the Edit Reservoir dialog box. Reservoir depths and names do not have to be unique; CycloLog will accept two or more reservoirs with identical depths intervals and names within the same set. CycloLog will also accept a reservoir with a depth interval but no name.

8.3.5. TO DELETE A RESERVOIR

Put the cursor over the name of the reservoir you wish to delete, and click the Remove button (or, right-click over the name of the reservoir and select Delete). You are prompted if you really want to delete the reservoir.

8.3.6. TO DELETE ALL RESERVOIR IN A BREAK SET

Select the set of reservoirs from which you want to remove all reservoirs. Click the Delete All button (or, right-click over the name of the set of reservoirs and select Delete All Reservoirs or, right-click anywhere in the reservoirs list and select Delete All). You are prompted if you really want to delete the reservoirs in the set of reservoirs.

8.3.7. TO MOVE A RESERVOIR TO A DIFFERENT SET

A reservoir can be moved to another set by dragging it to the name of the new set. Select the reservoir you want to move in the reservoir list. Hold the left mouse button down and drag the reservoir to the set of reservoirs you want to move the reservoir to in the Reservoir Set list and release the left mouse button. You can select more than one reservoir to move simultaneously to the new set of reservoirs by using the Ctrl or Shift button in combination with the left mouse button.

8.3.8. TOOLBAR SHORTCUTS

Add Reservoir, Edit Reservoir, Add Reservoir Set, Edit Reservoir Set, and Delete Reservoir can also be accessed from icons on the Reservoir toolbar. Note that the toolbar displays the name of the current reservoir set, and the depth interval of the current reservoir.

: Add reservoir

: Edit reservoir

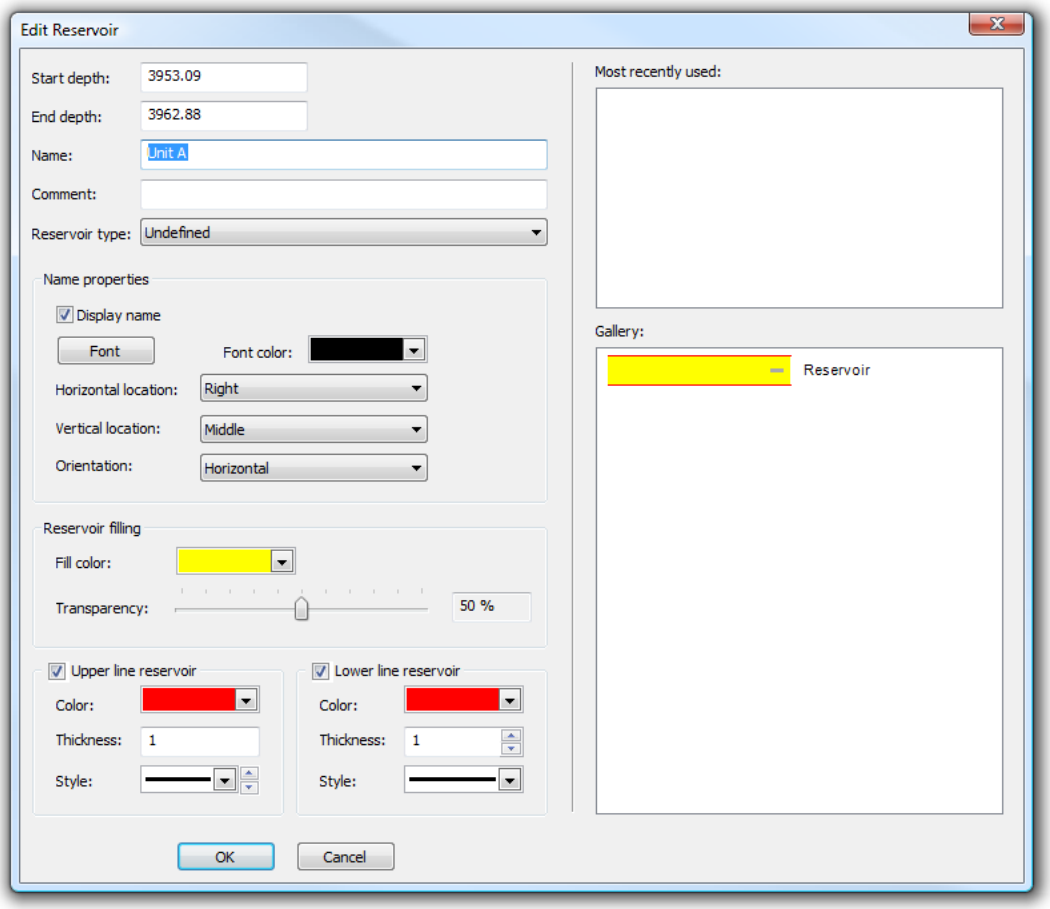
: Add reservoir set

: Edit reservoir set

: Delete the active reservoir

8.4. RESERVOIR PROPERTIES, AND EDITING RESERVOIRS

Reservoirs each have a depth interval and a name. By default, the colored intervals representing reservoirs on the screen are yellow with boundaries that are red, one pixel thick, and solid. These and other properties can be modified by the user through the Edit Reservoir screen. This can be opened either by double-clicking with the cursor held over the depth interval of the reservoir in the Data Pane, or through the Reservoir Manager. Open the Reservoir Manager (Edit → Edit Reservoirs, or use the Edit Reservoirs icon on the Standard Toolbar) and either click on the name of the reservoir to be edited, then click Edit, or double-click on the reservoir name. If the mouse cursor in the Data Pane is in break mode (the cursor changes to a flash symbol -), double-clicking on the reservoir interval will open the Edit Break screen. Double-clicking in the Data pane on the reservoir interval when the mouse button is the normal pointer will open the Edit Reservoir screen.



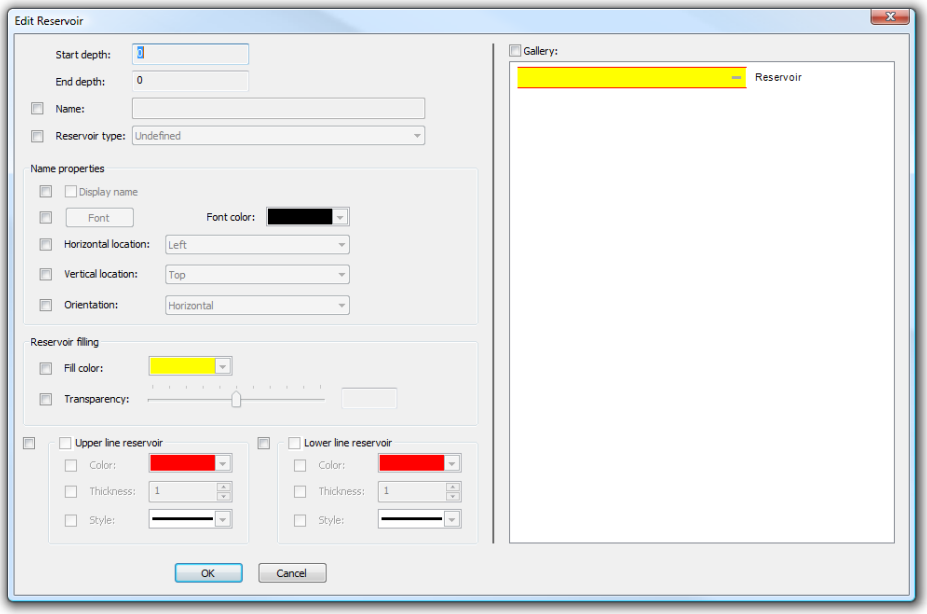
(If there are reservoirs from more than one set over the same interval, it may not be possible to access the one you want by double-clicking over it – check the boxes on the Reservoir toolbar to see which is the current reservoir set, and the current reservoir.)

In the Edit Reservoir dialog, you can make the following changes:

- Change the start and end depth of the reservoir
- Change the name of the reservoir
- Change the reservoir comment
- Turn drawing of the reservoir name in the reservoir on or off
- Change the font and color for the reservoir name
- Change the horizontal position of the reservoir label, from the right-hand side of the pane (the default) to the centre or left of the pane
- Change the vertical position of the reservoir label, from the middle (the default) to the top or the bottom of the reservoir interval
- Change the orientation of the reservoir name between horizontal or vertical
- Change the fill color of the reservoir – a full color palette is available with the option to create custom colors
- Change the transparency for the filling of the reservoir
- Change the top and bottom line thickness, from 1 pixel (the default) to 8 pixels
- Change the top and bottom line style from solid (the default), to dashed, dotted, etc

A gallery of the most commonly used reservoir styles is present on the right side of the Edit Reservoir window. If a style is selected from the library all the settings are immediately adjusted. The most recently used reservoir styles are shown in the most recently used list for easy access.

When multiple reservoirs are selected in the Reservoir Manager and the Edit button is clicked, the Edit Multiple Reservoirs window is shown.



By clicking on the checkbox in front of the layout style the control becomes enabled and can be changed. When the OK button is clicked, the layout style for all selected reservoirs is changed.

The reservoir fill color, thickness and line-style for the top and bottom of the interval can also be modified from the Reservoir Toolbar; click on the reservoir you want to modify, to make it the current reservoir, then use the drop-down lists from the Toolbar to make your changes.

: Reservoir fill color

: Reservoir top line color

: Reservoir top line thickness

: Reservoir top line style

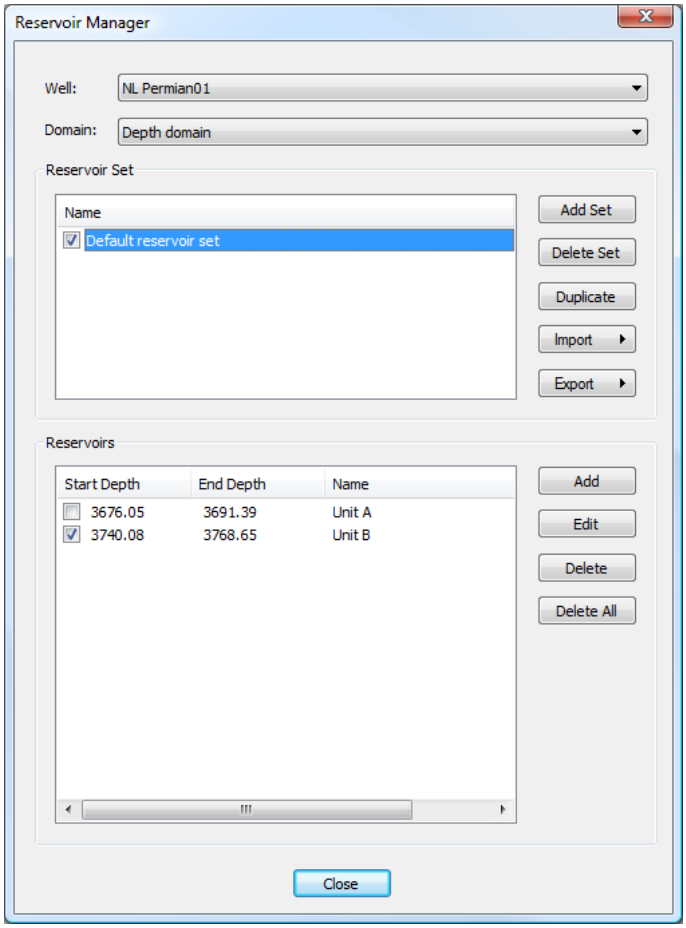
: Reservoir bottom line color

: Reservoir bottom line thickness

: Reservoir bottom line style

8.5. CONTROLLING THE DISPLAY OF RESERVOIRS

To prevent a reservoir, or an entire reservoir set, from being displayed, click on the check-box beside the name of the reservoir or reservoir set. If a reservoir or reservoir set is not selected it is not drawn in all the panes, composite well charts and correlation panels.



8.6. CREATING AND MOVING RESERVOIRS ON-SCREEN

If you are picking reservoir intervals on the screen, the easiest way to create a reservoir is as follows:

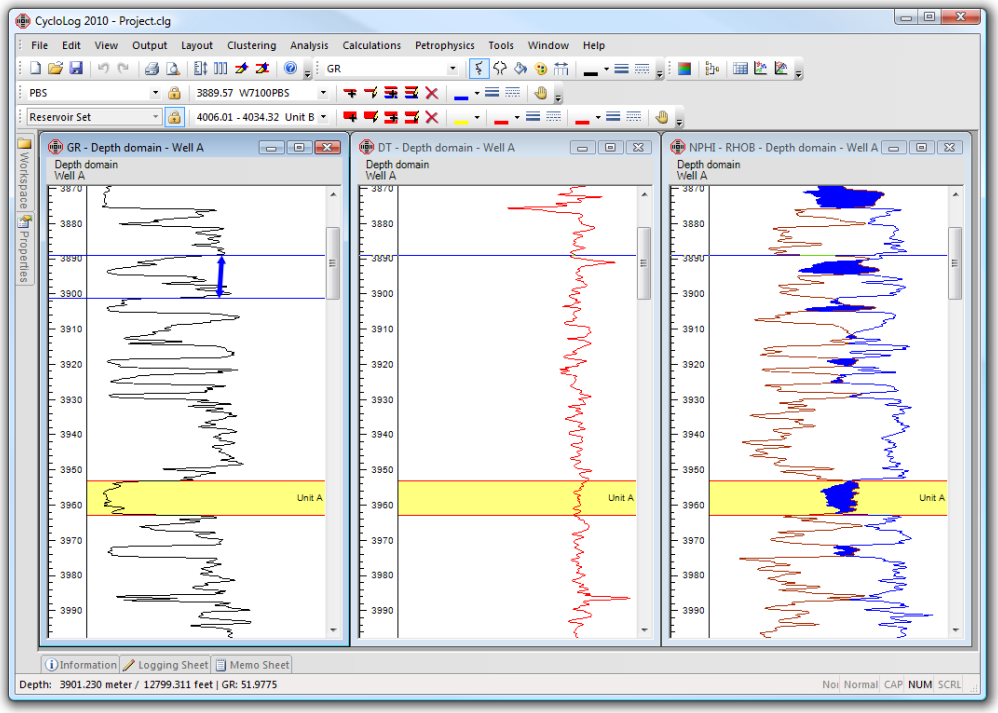
First check that you are adding the new reservoir to the correct reservoir set. For this, the Reservoir Toolbar must be visible. (If it is not, right-click in the Menu Bar, in the empty space to the right of the menu names; click on Reservoir Bar to display it.) The name of the current

reservoir set is displayed in the Reservoir Toolbar. If the wrong reservoir set is the current one, select the one you want from the drop-down list.

The reservoir set can be locked by clicking on the lock on the Reservoir bar. When a reservoir set is locked, new reservoirs can only be added to the locked reservoir set and only the reservoirs within the locked reservoir set can be modified.

 : Lock reservoir set

1. With the cursor over the relevant log Data Pane, hold down the left mouse button. The blue depth-line is displayed, and the depth (meters and feet) and the log value (or values) are displayed both on the status bar and in the Information worksheet (if this is open).
2. Move the depth-line up or down to the position at which you want to start the reservoir interval.
3. Hold down the SHIFT button and move the cursor to the end of the reservoir. A blue arrow is drawn from the start to the end of the reservoir interval
4. Release the left mouse button.
5. The reservoir is created and is displayed as a yellow interval.

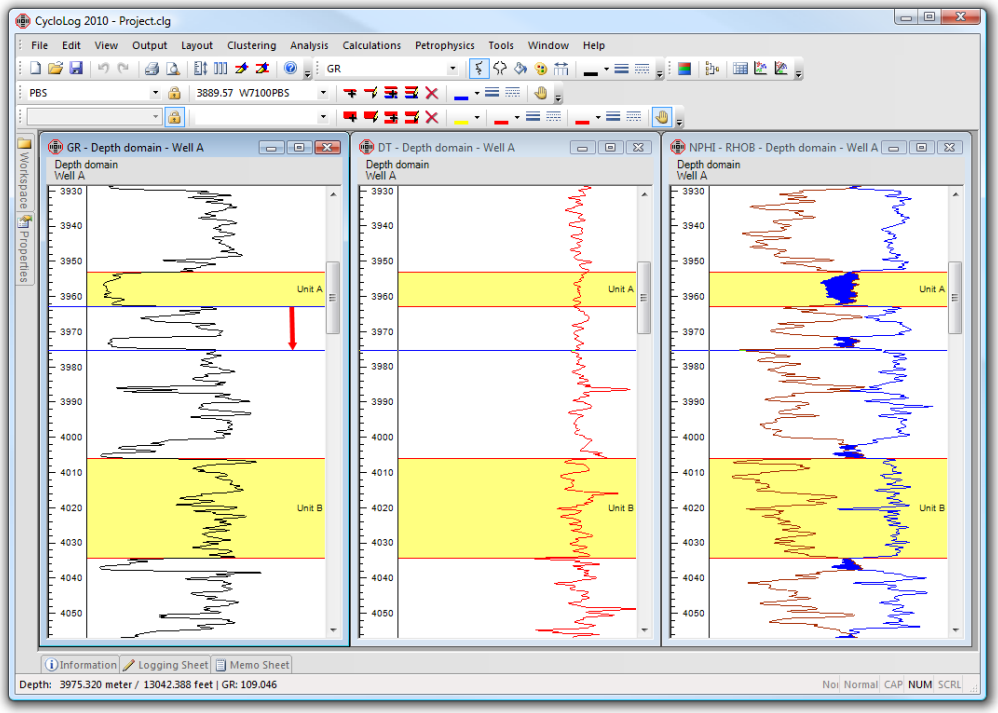


You can now give the reservoir a name, and edit its properties, by double-clicking over the reservoir to open the Edit Reservoir box (see above).

A reservoir can be moved interactively as follows:

1. On the Reservoir Toolbar, click the hand icon.
2. The cursor will now change from a pointer to a hand when it is held over the start or end depth of an interval.
3. Position the cursor over the side of the interval you want to move, drag it to the new position and release the mouse button. A red arrow is draw to show from the old position to the new position.

: Break repositioning tool

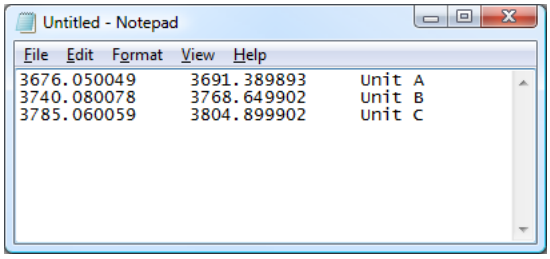


When you have finished moving reservoirs, click the hand icon on the Reservoir Toolbar again to toggle back to the default mode.

8.7. IMPORTING AND EXPORTING RESERVOIRS

Reservoir definitions are stored with the relevant project, and saved in its *.clg file. However, for exchanging reservoir data between projects, the definitions can be exported to an ASCII file with the extension *.res or *.asc. Such files can then be imported into another project.

Two file formats are available; the default format contains not only the start depth, end depth and name of each reservoir, but also all of the formatting information (line colors, styles and thicknesses, etc.). This format is suitable for transferring reservoir data from one CycloLog project to another, but is not convenient for exporting to applications such as spreadsheets. For this purpose, a simpler tabular format is available, in which only the start depth, end depth and name of each reservoir are held. Both formats are imported in exactly the same way. (See below for an example of the tabular format, displayed in the Notepad text editor. A list of reservoirs like this can be prepared in a text editor, and imported into CycloLog, using Import in the Reservoir Manager.)



Exporting reservoir data to other programs can also be done by using the clipboard. Reservoirs can be placed on the clipboard and e.g. be pasted in a spreadsheet program or a word processing program. Reservoirs can also be imported using the clipboard.

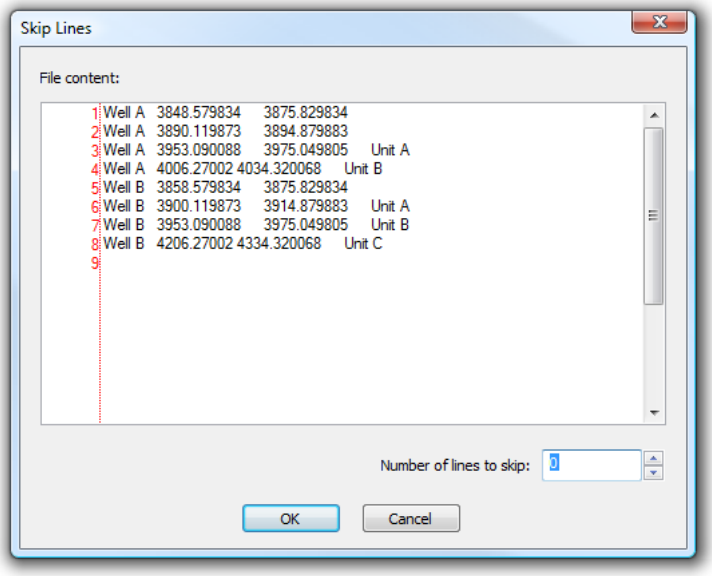
To export a set of reservoirs, open the Reservoir Manager (Edit → Edit Reservoirs, or use the Edit Reservoirs icon on the Standard Toolbar). Click on the name of the reservoir set that you wish to export. Click the Export button and select File. You will be prompted to select a folder and to specify a filename. If you wish to export the reservoirs in tabular format, select Tabular Data (*.asc) from the Save as Type drop-down list. Otherwise the reservoirs will be exported in *.res format. If you want to copy a set of reservoirs into another program, select the reservoir set, click on the Export button and select Clipboard. The set of reservoirs are now placed onto the clipboard and can be pasted in other programs.

To import a set of reservoirs, open the Reservoir Manager (Edit → Edit Reservoirs, or use the Edit Reservoirs icon on the Standard Toolbar). You can either add the new reservoirs to an existing set, or you can create a new empty reservoir set using Add Set. Then select (left-click) the name of the reservoir set into which you wish to import the reservoir, click the Import button and select File. (If you are importing reservoirs from tabular format, you will need to select All Files (*.*) from the drop-down Files of Type list.) The reservoirs will be added to the specified set in the Reservoir Manager. To insert reservoirs from the clipboard, select the reservoir set to which you want to add the reservoirs, click on the Import button and select Clipboard.

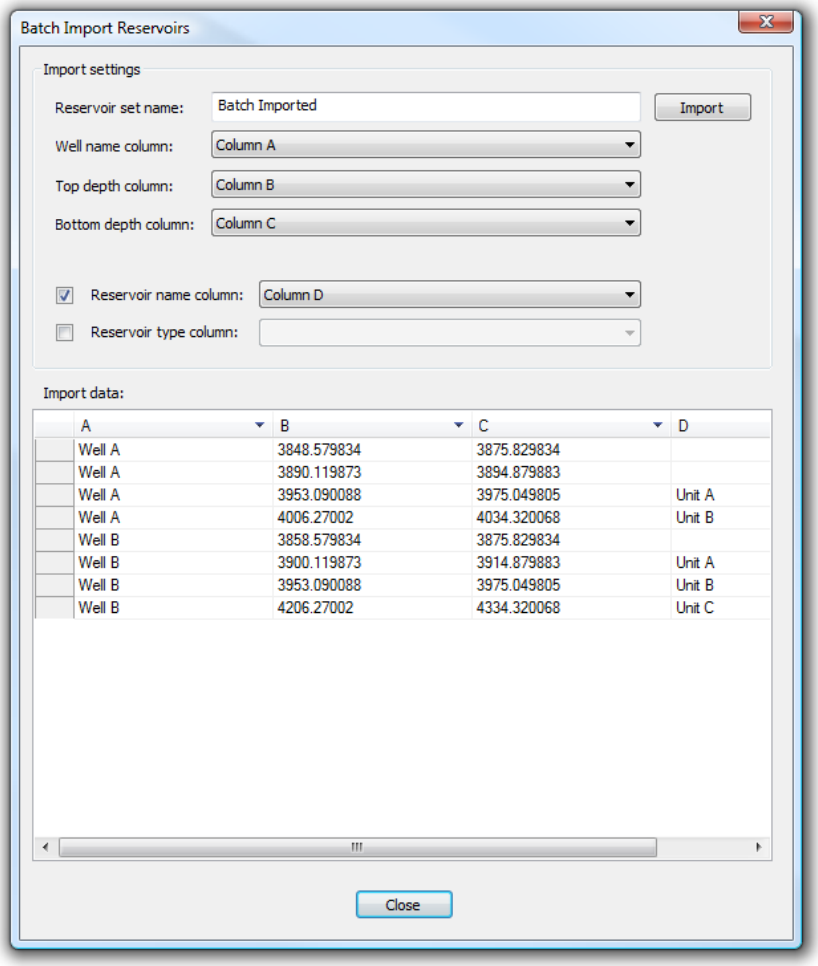
8.8. BATCH IMPORTING RESERVOIRS

To import a large amount of reservoirs for several wells, for example obtained from a database, the batch loading of reservoirs can be used. This function can be found in the File menu under Import Batch Import Reservoirs.

The Open File window is shown for navigating to the data file containing all the breaks. The data file must at least contain the well names as they are used in CycloLog and the top and bottom of the reservoir interval. Once the file is opened the Skip Lines window is shown. If there are a few lines in the data file containing comments, the user can specify how many lines need to be skipped before the data begins. Click on the OK button to start the data loading.

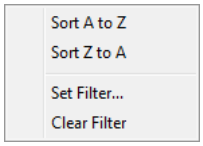


Once the data is loaded, the data is presented in the Batch Import Reservoirs window.

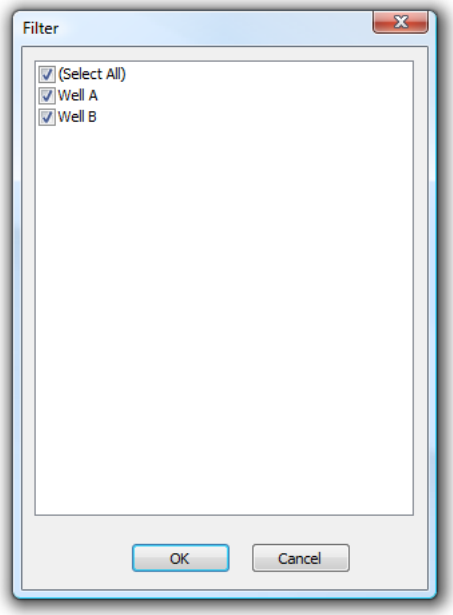


In this window reservoir set name can be set in which the reservoirs are loaded. In the grid all the data from the data file is shown. It is possible that a lot more information is available in the data file than the well name, top depth, bottom depth and reservoir name. Also it is possible that the order of the data columns is not always the same. The user must define in which column the well name, top depth, end depth and, if present, the reservoir names are. When the import button is clicked, the data is imported into CycloLog.

When the user clicks on the arrow in the column header, a menu appears.

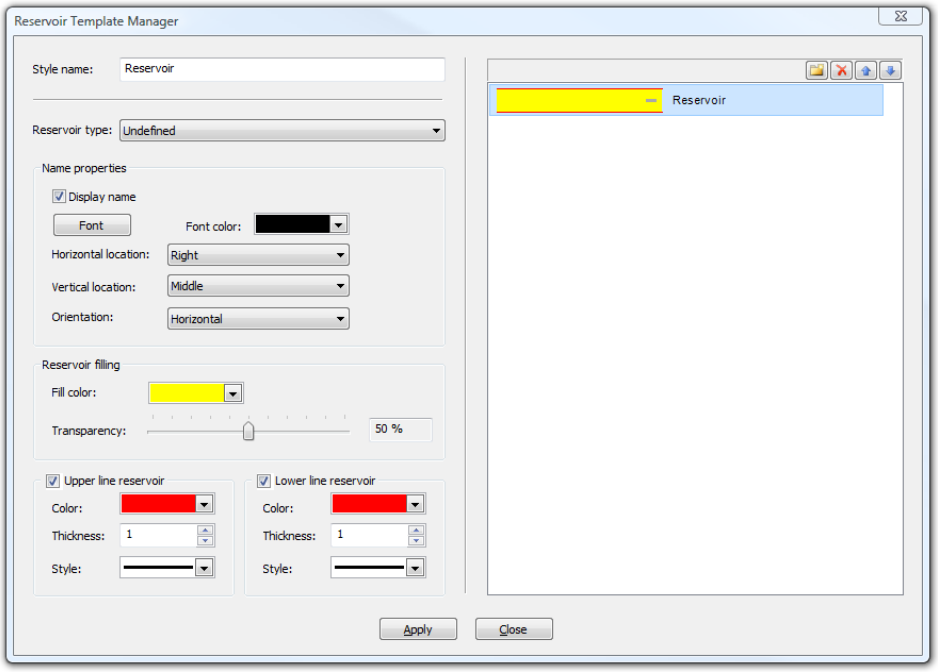


All the break data can be sorted alphabetically. Also, the user can define a filter to select for which wells the reservoirs must be imported or which breaks must be imported.



8.9. RESERVOIR TEMPLATE MANAGER

When editing the reservoir properties a number of predefined styles are displayed in the gallery. The user is able to modify these styles and add new styles to the gallery. The Reservoir Template Manager can be found in the Tools menu.

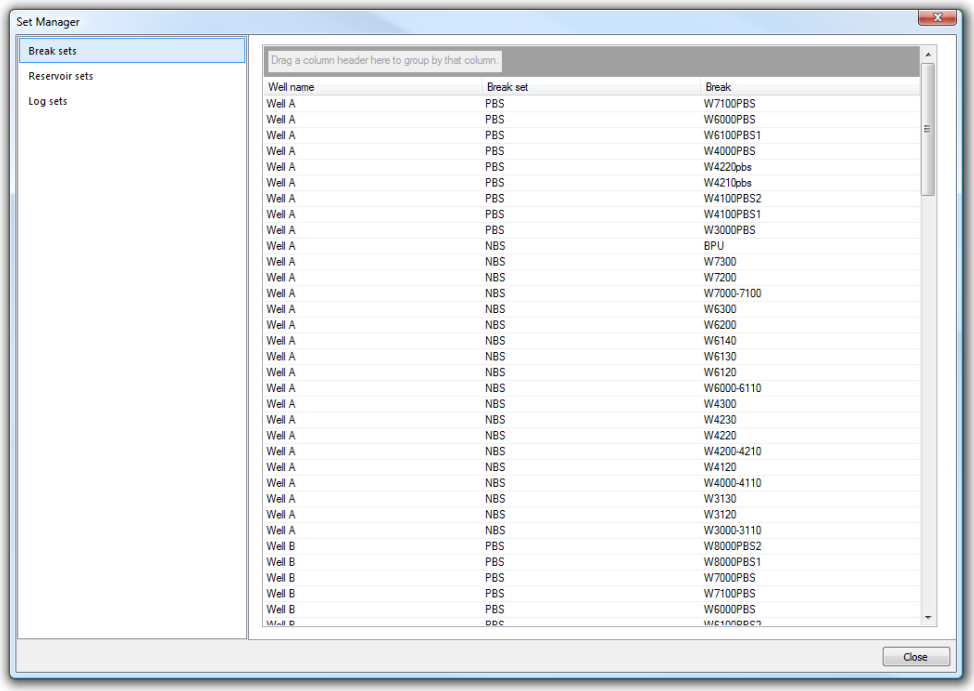


On the left side all the layout options for a reservoir are displayed. A style name can be assigned to the reservoir style to identify the style in the library. This name is not used for other purposes. When the Apply button is clicked, the reservoir style is updated with the new layout settings.

A new reservoir style can be added to the gallery by clicking on the New button on the top of the reservoir style list. When the Delete button is clicked, the active reservoir style is deleted. The Up and Down button can be used to change the order of the reservoir styles in the list.

9. SET MANAGER

The Set Manager is a powerful manager to change lots of parameters simultaneously along multiple wells. The Set Manager can be found in the Edit menu.



Well name	Break set	Break
Well A	PBS	W7100PBS
Well A	PBS	W6000PBS
Well A	PBS	W6100PBS1
Well A	PBS	W4000PBS
Well A	PBS	W4220pbs
Well A	PBS	W4210pbs
Well A	PBS	W4100PBS2
Well A	PBS	W4100PBS1
Well A	PBS	W3000PBS
Well A	NBS	BPU
Well A	NBS	W7300
Well A	NBS	W7200
Well A	NBS	W7000-7100
Well A	NBS	W6300
Well A	NBS	W6200
Well A	NBS	W6140
Well A	NBS	W6130
Well A	NBS	W6120
Well A	NBS	W6000-6110
Well A	NBS	W4300
Well A	NBS	W4230
Well A	NBS	W4220
Well A	NBS	W4200-4210
Well A	NBS	W4120
Well A	NBS	W4000-4110
Well A	NBS	W3130
Well A	NBS	W3120
Well A	NBS	W3000-3110
Well B	PBS	W8000PBS2
Well B	PBS	W8000PBS1
Well B	PBS	W7000PBS
Well B	PBS	W7100PBS
Well B	PBS	W6000PBS

Operations can be performed on several sets:

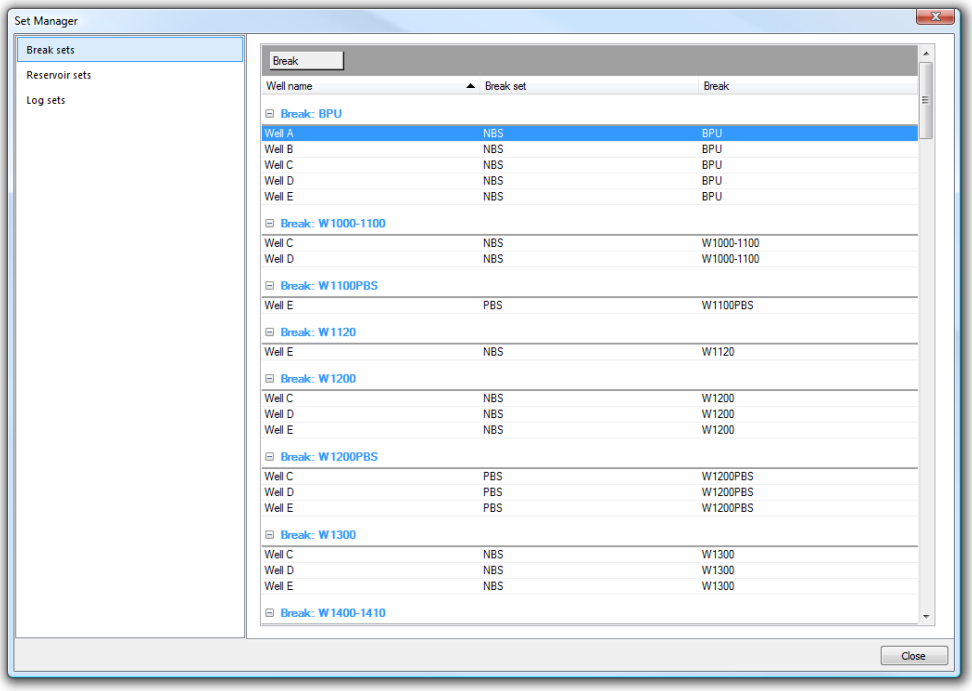
- Break sets
- Reservoir sets
- Log sets

The size of the Set Manager can be adjusted by dragging the border to a new size.

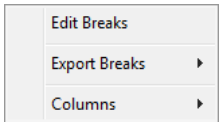
9.1. BREAK SETS

When the break set option is selected, all breaks in the project file are shown in the list. The list can be sorted by dragging the column name to the dark gray area on the top. To sort the breaks by well, drag the well column header to the gray area. To sort the breaks by break name, drag

the break column header to the gray area. It is also possible to sort the data using more sort criteria by adding columns to the gray sort area. To remove a sort criterion drag the column away from the gray sort area and release it.



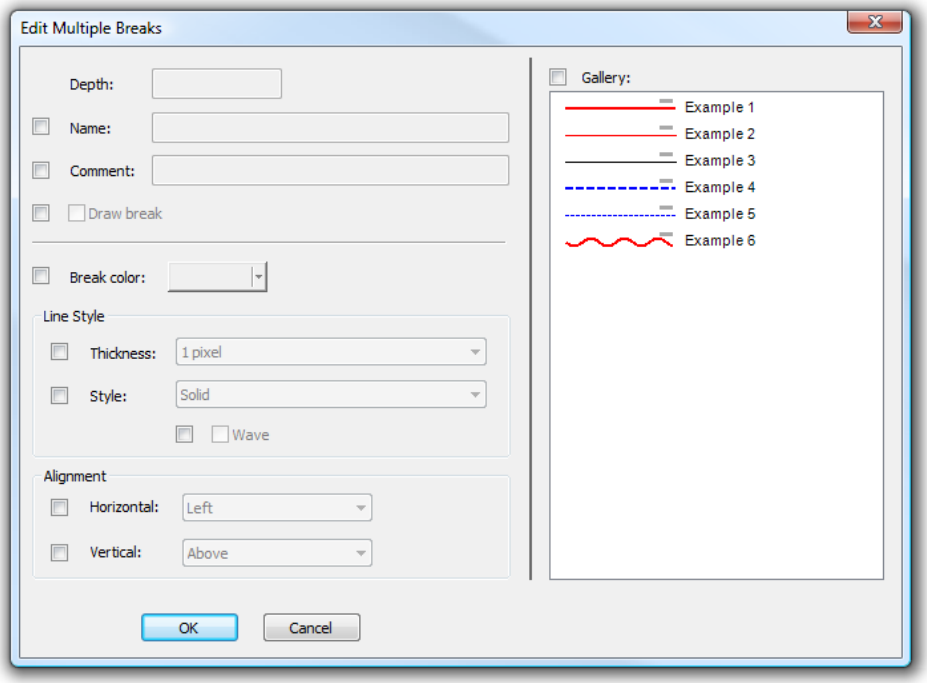
Selected breaks can be edited or exported using the right mouse button context menu.



Additional columns can be added to the grid by selecting the columns from the Columns sub menu in the right mouse button context menu.

9.1.1. EDIT BREAKS

When the breaks are sorted, they can be selected for changing of the layout parameters. When breaks are selected, the user can edit the selected breaks by choosing the Edit Breaks option in the right mouse button menu.



By clicking on the checkbox in front of the layout style the control becomes enabled and can be changed. When the OK button is clicked, the layout style for all selected breaks is changed. Using the Set Manager, breaks can be changed for different wells, which is not possible with the Break Manager.

9.1.2. EXPORT BREAKS

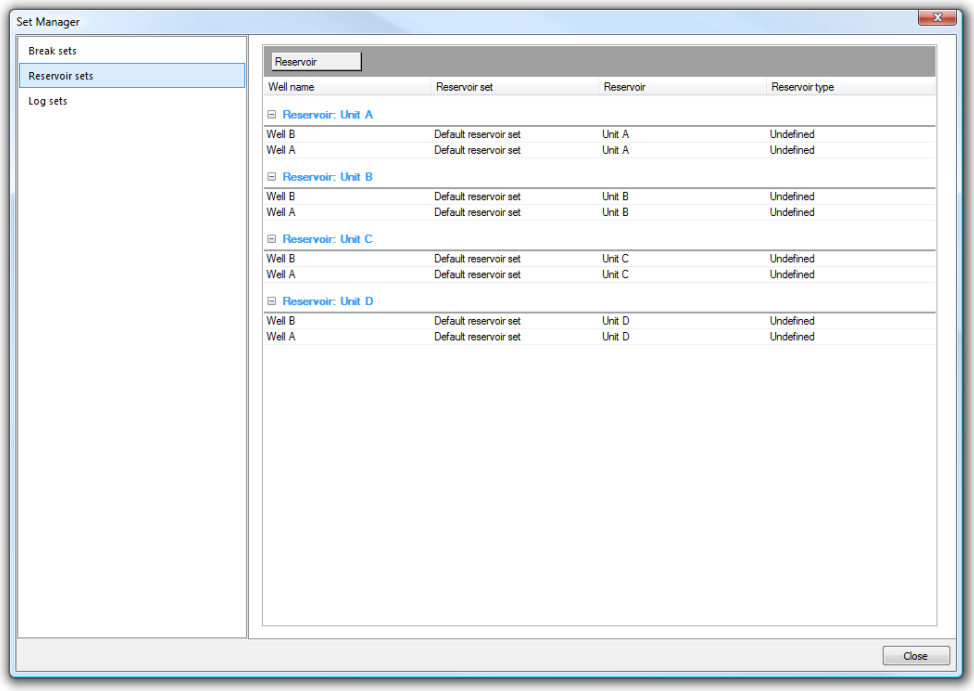
The selected breaks can be exported to a file or to the clipboard. The export options can be found in the right mouse button context menu.

Data is exported in the order of the columns in the set manager. Also, only visible columns will be exported. The use can configure which columns are shown by right- in the manager window and selecting the Columns menu. Columns can be reordered by dragging them with the mouse.

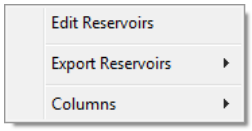
9.2. RESERVOIR SETS

When the reservoir set option is selected, all reservoirs in the project file are shown in the list. The list can be sorted by dragging the column name to the dark gray area on the top. To sort the reservoirs by well, drag the well column header to the gray area. To sort the reservoirs by reservoir name, drag the well name column header to the gray area. It is also possible to sort

the data using more sort criteria by adding columns to the gray sort area. To remove a sort criterion drag the column away from the gray sort area and release it.



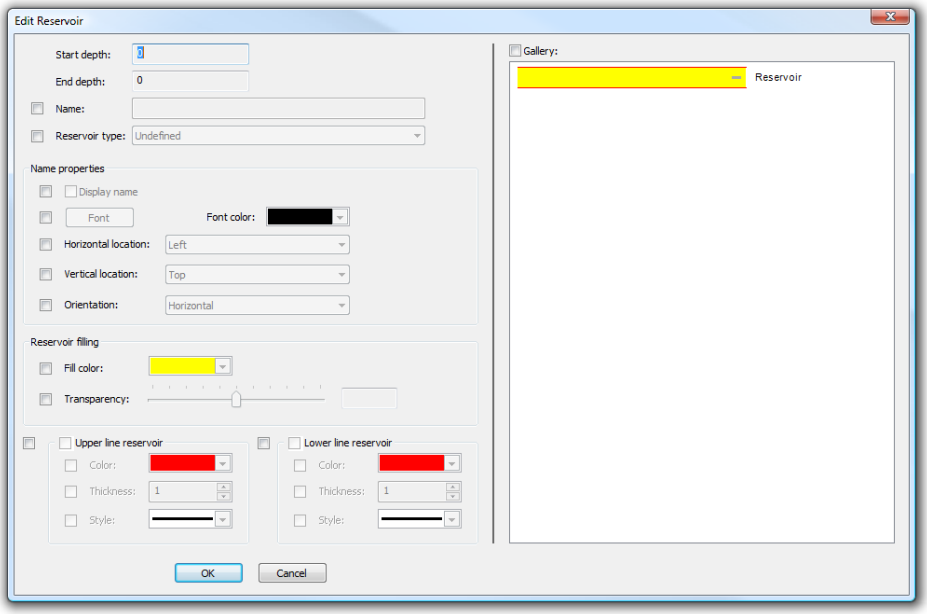
Selected reservoirs can be edited or exported using the right mouse button context menu.



Additional columns can be added to the grid by selecting the columns from the Columns sub menu in the right mouse button context menu.

9.2.1. EDIT RESERVOIRS

When the reservoirs are sorted, they can be selected for changing of the layout parameters. When reservoirs are selected, the user can edit the selected reservoirs by choosing the Edit Reservoirs option in the right mouse button menu.



By clicking on the checkbox in front of the layout style the control becomes enabled and can be changed. When the OK button is clicked, the layout style for all selected reservoirs is changed. Using the Set Manager, reservoirs can be changed for different wells, which is not possible with the Reservoir Manager.

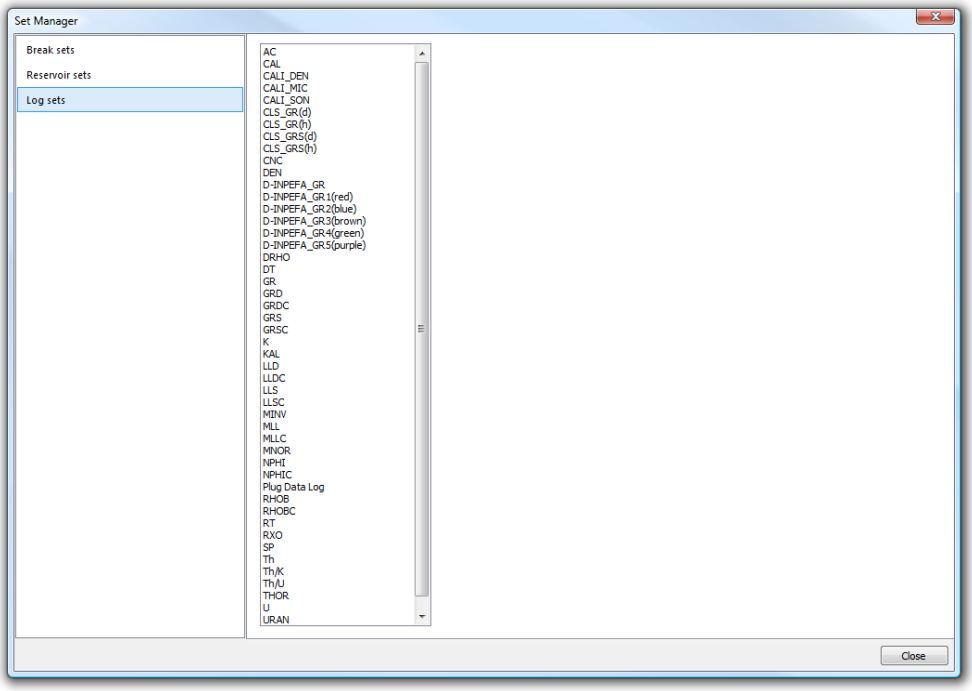
9.2.2. EXPORT RESERVOIRS

The selected reservoirs can be exported to a file or to the clipboard. The export options can be found in the right mouse button context menu.

Data is exported in the order of the columns in the set manager. Also, only visible columns will be exported. The use can configure which columns are shown by right-clicking in the manager window and selecting the Columns menu. Columns can be reordered by dragging them with the mouse.

9.3. LOG SETS

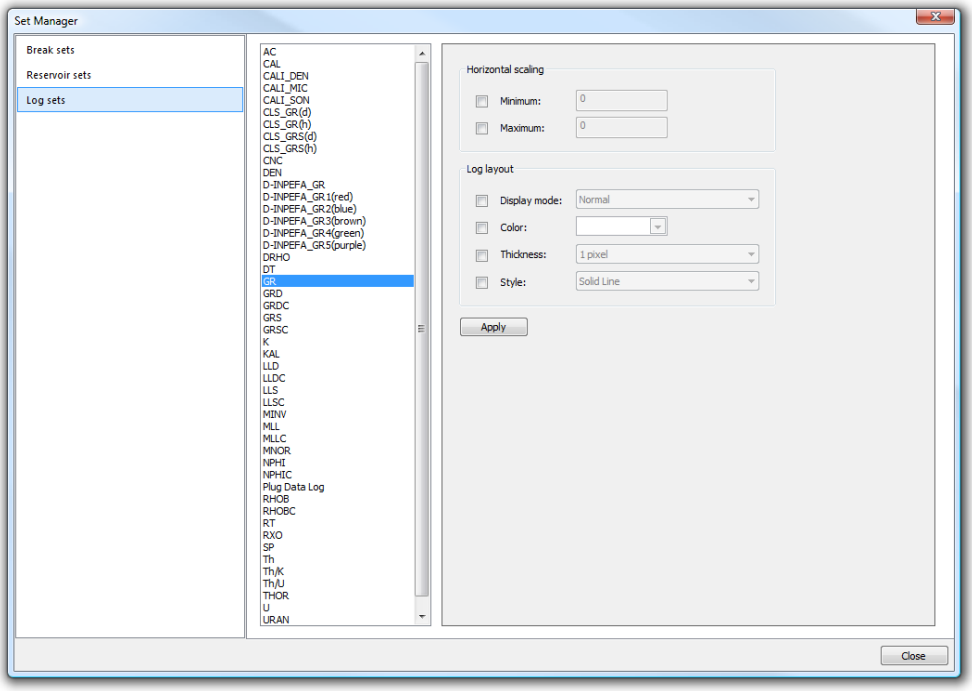
The log sets option groups all logs in the project according to their well name. For example, the GR item in the log set list represents all GR curves in the project.



The user is presented an alphabetical list with all logs sets. When an item in the list is selected, on the right side appears an area with options for the user to modify log properties or log data properties.

9.3.1. NORMAL LOGS

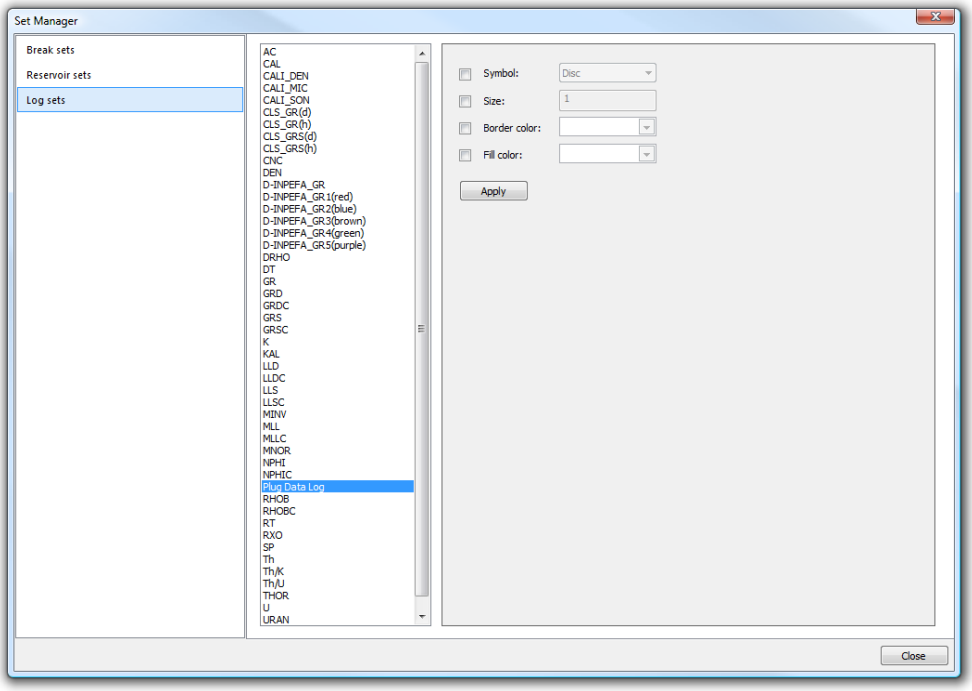
If a normal data log is selected in the log set list, an area is shown where the user can change the log display styles like the log color, line thickness or line style. It is also possible to change the horizontal scaling.



A layout property is activated when the checkbox in front of the control is checked. When the Apply button is clicked, the changed property is applied to all logs in all wells.

9.3.2. PLUG DATA LOGS

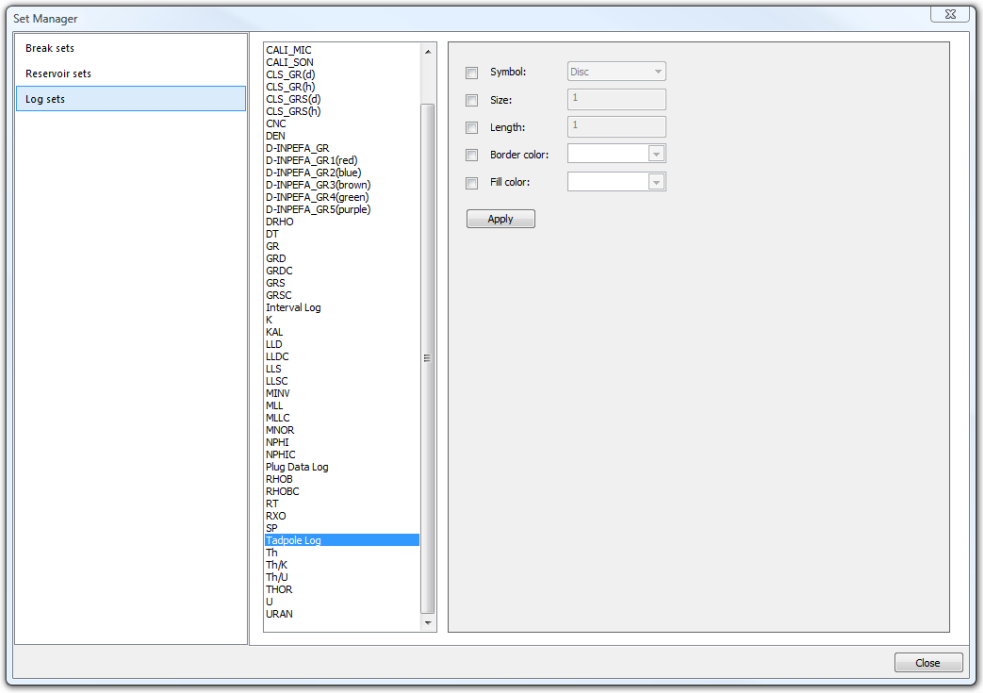
If a plug data log is selected in the log set list, an area is shown where the user can change the plug data display styles like the display symbol and colors.



A layout property is activated when the checkbox in front of the control is checked. When the Apply button is clicked, the changed property is applied to all logs in all wells.

9.3.3. TADPOLE LOGS

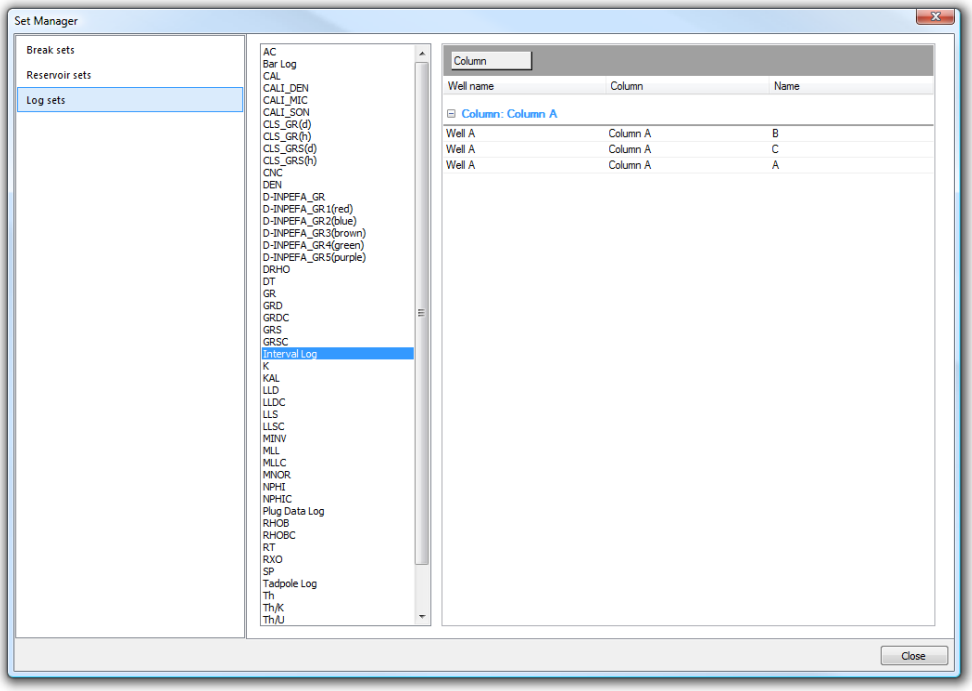
If a tadpole data log is selected in the log set list, an area is shown where the user can change the tadpole data display styles like the display symbol, size and colors.



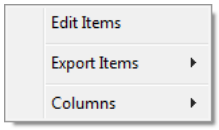
A layout property is activated when the checkbox in front of the control is checked. When the Apply button is clicked, the changed property is applied to all logs in all wells.

9.3.4. INTERVAL LOGS

If an interval log is selected in the log set list, an area is shown with all the intervals in the project of all the logs with the same name.



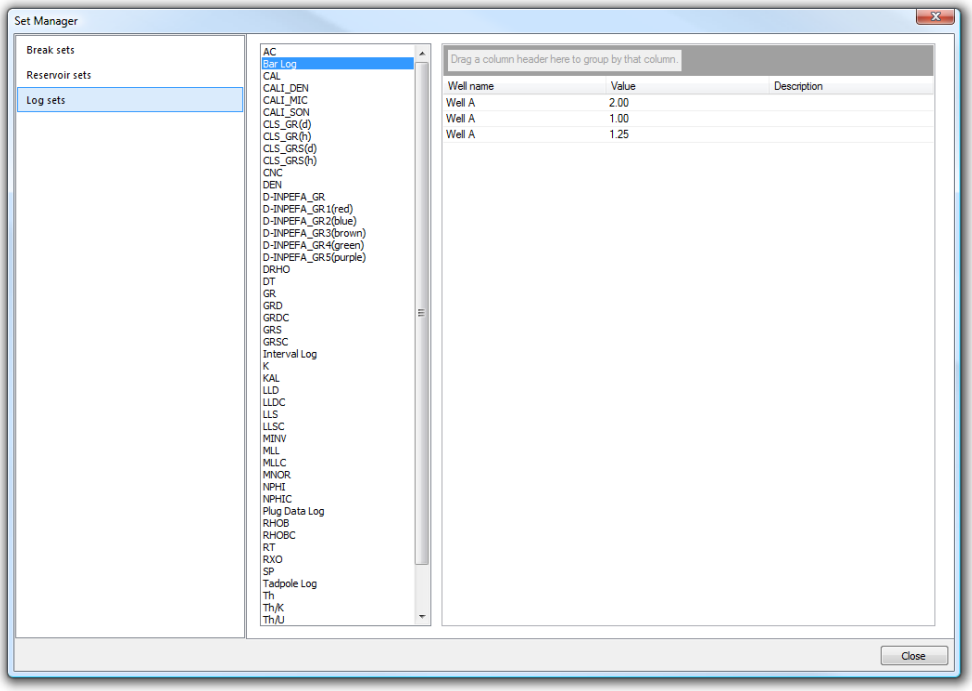
The list can be sorted by dragging the column name to the dark gray area on the top. To sort the intervals by column name, drag the column name column header to the gray area. It is also possible to sort the data using more sort criteria by adding columns to the gray sort area. To remove a sort criterion drag the column away from the gray sort area and release it. Selected intervals can be edited or exported using the right mouse button context menu.



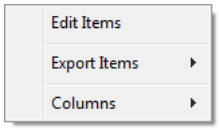
Additional columns can be added to the grid by selecting the columns from the Columns sub menu in the right mouse button context menu.

9.3.5. BAR LOGS

If a bar log is selected in the log set list, an area is shown with all the bar log data in the project of all the logs with the same name.



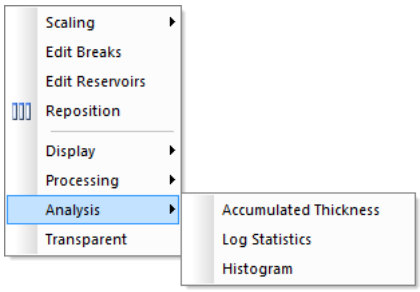
The list can be sorted by dragging the well name to the dark gray area on the top. To sort the intervals by well name, drag the well name column header to the gray area. It is also possible to sort the data using more sort criteria by adding columns to the gray sort area. To remove a sort criterion drag the column away from the gray sort area and release it. Selected data intervals can be edited or exported using the right mouse button context menu.



Additional columns can be added to the grid by selecting the columns from the Columns sub menu in the right mouse button context menu.

10. LOG STATISTICAL ANALYSIS

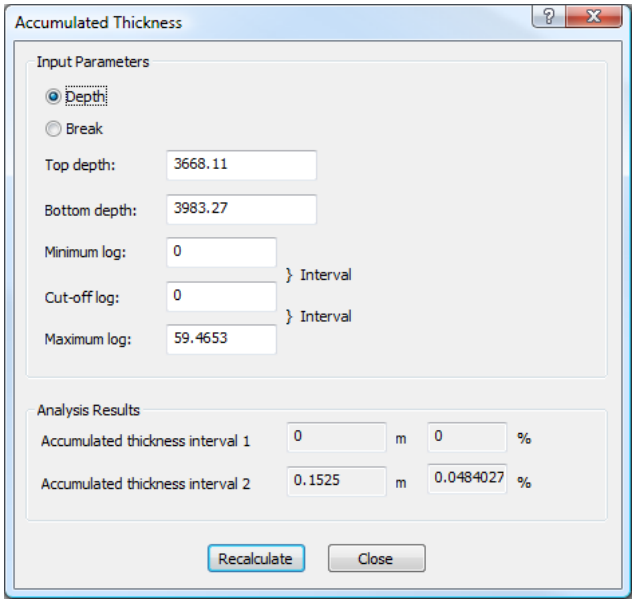
The analysis functions in CycloLog allow the user to carry out some basic statistical calculations on the log data. The three available Log Analysis functions are accessed by right-clicking over the relevant data pane and selecting Analysis:



10.1. ACCUMULATED THICKNESS

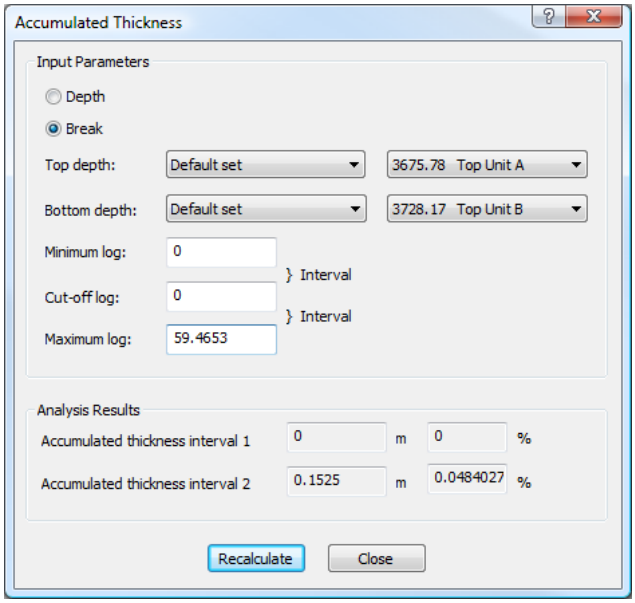
This function is used to calculate the total thickness of section within which the log value lies in a given range – Net Sand is a typical application of this.

Right-click the mouse button on the Data Pane for which you want to make the analysis. Select “Analysis” and click on “Accumulated Thickness”.



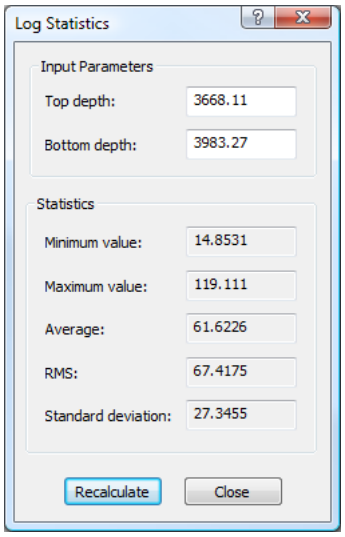
Define the thickness interval in which you want to perform the calculation (default is the total depth interval for the project). Specify the log minimum, cutoff and maximum values, and click Recalculate. The net thickness of section with values in the interval from minimum to cutoff appears in Accumulated Thickness Interval 1, in depth units and as a percentage of the total. The net thickness of section with values in the interval from cutoff to maximum appears in Accumulated Thickness Interval 2, in depth units and as a percentage of the total.

Instead of defining the intervals manually, you can use breaks from an interpretation as boundaries for your calculation. Select the Break option in the Input Parameters section. The top depth and bottom depth input boxes change into lists containing defined break sets and breaks. Select the top depth break and bottom depth break and press Recalculate to perform the calculation.



10.2. LOG STATISTICS

The Log Statistics function gives basic statistical data about all or part of a log interval. To open the Log Statistics box, click Display → Log Statistics.

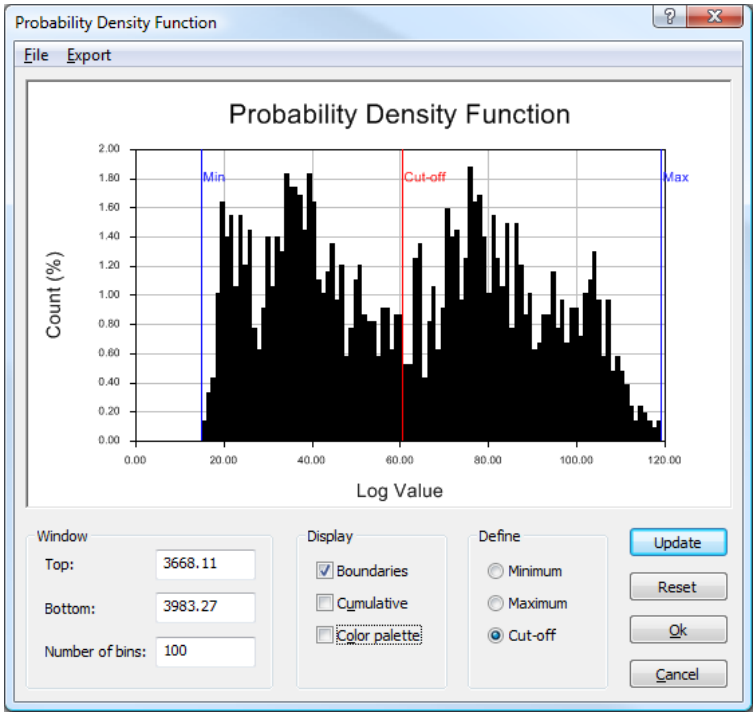


Use the Top Depth and Bottom Depth boxes to specify the interval you are interested in – the default is the full depth interval available in the project. Click Recalculate to display the statistics for the new interval.

10.3. HISTOGRAM

The Histogram function is useful for defining minimum and maximum log values for rescaling logs, for identifying distinct populations within the data, and for planning cluster analysis. It displays the frequency of occurrence of values in the selected interval of the log (also called the probability density function).

Right-click the mouse button on the Data Pane for which you want to make the analysis. Select Analysis → Histogram.



If you want a histogram for less than the total available interval, select the interval you want by typing its top and bottom depths into the dialog box. You can also specify the number of bins (default = 100). Click Update to recalculate the histogram.

To define minimum, maximum and cutoff values (e.g. for Accumulated Depth calculations), select Boundaries and the type of boundary you want to define. Then place the cursor on the graph at the value you want to select, and left-click. Repeat for the other boundaries. Click Update and the graph will be rescaled to lie between the new minimum and maximum values. The Reset button will change the minimum and maximum value back to the values they were when the histogram window was opened. If you now click OK, these values will also be applied

to the horizontal scale of the log in its Data Pane; they will also be the new default values when you open the Accumulated Depth window.

If you have defined a set of colors for Color Fill of the log (see above, section 5.4.6), you can view their distribution on the histogram by checking the Color palette display option. (If you have not created a user-defined color scheme, the default scheme will be shown.)

There is also an option to show the cumulative version of the histogram – check the Cumulative display box.

11. BASIC LOG PROCESSING ROUTINES

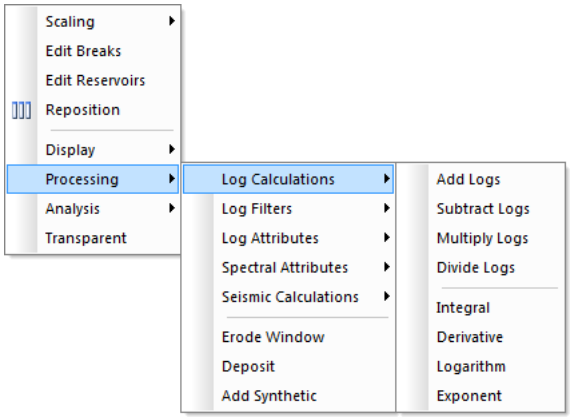
11.1. INTRODUCTION TO LOG PROCESSING

CycloLog has many different kinds of functions that change the original log patterns through mathematical, statistical or spectral calculations. The changed log curves are called ***log transforms***. As the many available functions fall into several different categories according to their application, we deal with them in several sections of the Manual. This section deals with arithmetical log calculations, log filters, and some functions to delete and interpolate portions of logs.

Most log processing functions work by transforming the current log from its present form into something else. Although log processing functions can be Undone and Redone, you will probably want to save some at least of the transformed logs. **Therefore, it is important to perform Log Processing on copies of the log, keeping the original for reference.** Make copies by right-clicking over the name of the log in the Workspace tree structure, and selecting Duplicate. Giving the duplicate log an appropriate name will help you to remember what you have done to it. Right-click over the duplicate log name in the Workspace tree structure, and choose Rename; type in the new name and press Return.

11.2. LOG CALCULATIONS

A number of basic mathematical functions are available in Log Calculations. Mathematical operations can be performed for each log Data Pane. The basic mathematical operations available appear in the log data pane right-click menu; select Processing → Log Calculations:

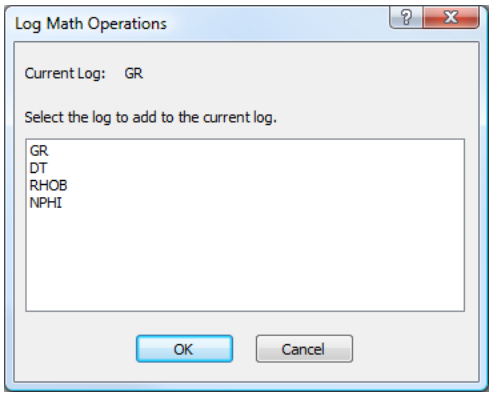


All Log Calculation operations can be undone (and redone) using any of the following actions:

- Edit → Undo (Redo); the menu shows the name of the last action
- Undo (Redo) icon on the Standard Toolbar
- ALT + backspace

Several successive actions can be undone/redone (the number is more or less unlimited), and CycloLog maintains a separate record of actions for each Data Pane. This information is retained, both when you Save the project, and also if you close and then re-open the data pane without saving the project.

For the following four arithmetical operations, clicking on the menu item opens a list of the available logs – select the one that you want to use to modify the active log.



Multiply Logs – Multiplies the data values displayed in the active pane by the depth-equivalent values from the selected curve.

Divide Logs – Divides the data values displayed in the active pane by the depth-equivalent values from the selected curve.

Add Logs – Adds the data values displayed in the active pane to the depth-equivalent values from the selected curve.
Subtract Logs – Subtracts the data values in the selected curve from those displayed in the active pane.

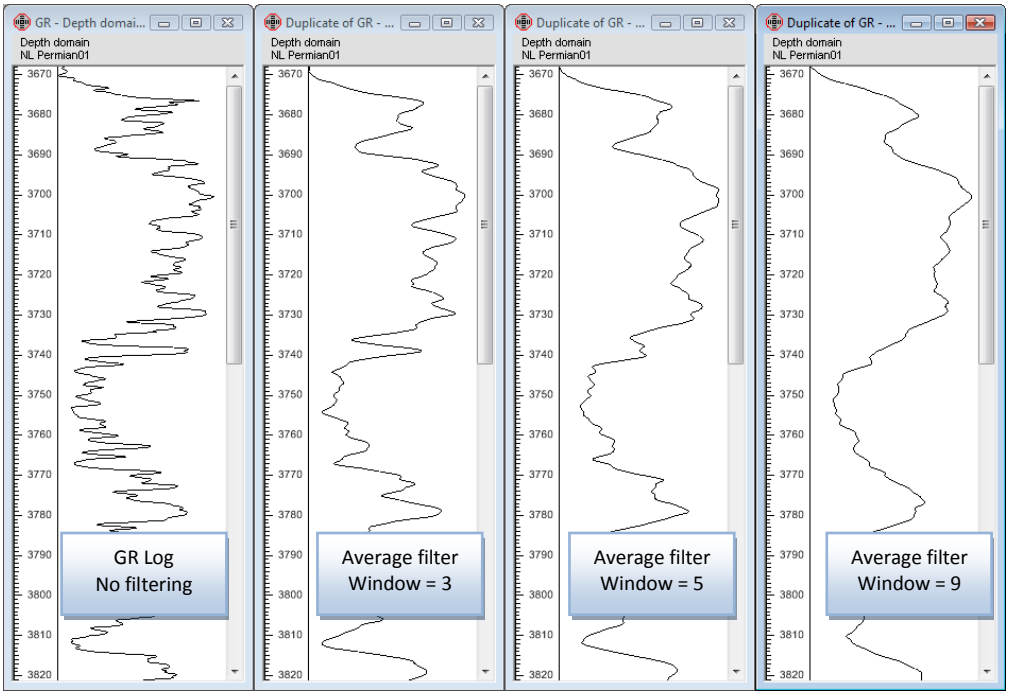
The other four available mathematical operations need no additional input, and are performed immediately on clicking their name on the right-click menu:

Derivative – Calculates the derivative (i.e. the slope, or rate of change) of the data, replacing the existing data values by the value of the derivative at each point. There is no window-length and hence there are no user-defined options.
Integral – Calculates the integral (i.e. the area under the curve) of the data, replacing the existing data values by the value of the integral at each point.
Logarithm – Replaces each value in the data by its logarithm (to base 10).
Exponent – Replaces each value in the data by its exponent (inverse logarithm).

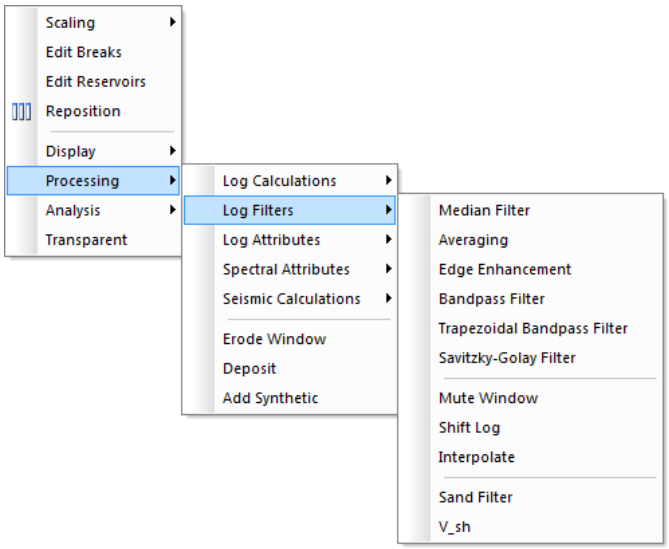
11.3. LOG FILTERS

11.3.1. EFFECTS OF FILTERING LOGS

Log filters modify the data by replacing each value with some function of the adjacent values. The effect is to smooth the log. In the example illustrated you can see four panes, a GR log has been filtered using an Average Filter with window lengths of 3m, 5m and 9m, to show the progressive removal of shorter wavelengths of “noise”.



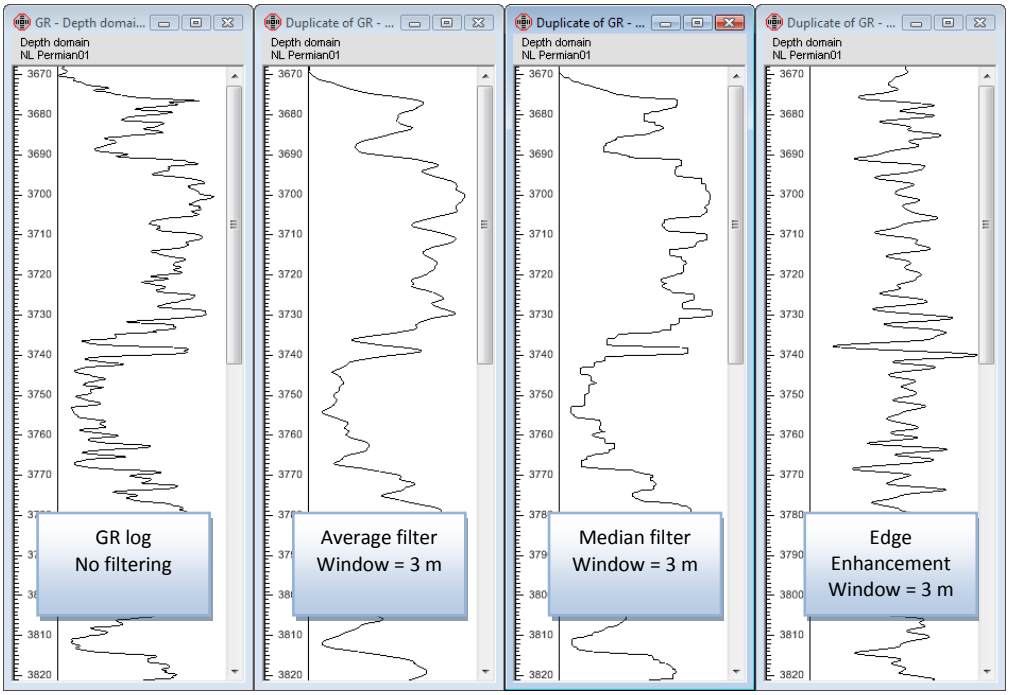
The various available filtering operations are access from the Data Pane right-click menu:



11.3.2. MEDIAN FILTER

Replaces a log value with the median of the values above and below it, within a window whose length is specified by the user. The effect is to smooth out the higher frequency (shorter wavelength) variation present in the data, preserving the lower frequencies (longer wavelengths). Median filtering generates a more "boxy" curve than averaging. In the example

illustrated you can see four panes, a GR log has been filtered using a Median Filter with window lengths of 3m, 5m and 9m, to show the progressive removal of longer wavelengths of “noise”.



Put the cursor in the pane in which you wish to perform a Median Filter analysis. Right-click the mouse button and select Processing → Log Filters → Median Filter. Enter the required window length in the Median Filter dialog box and click OK.

11.3.3. AVERAGING FILTERS

Replaces a log value with the average (mean) of the values above and below it, within a window whose length is specified by the user. The effect is to smooth out the higher frequency (shorter wavelength) variation present in the data, preserving the lower frequencies (longer wavelengths). Averaging generates a smoother curve than median filtering.

Put the cursor in the pane in which you wish to perform an Averaging Filter analysis. Right-click the mouse button and select Processing → Log Filters → Averaging. Enter the required window length in the Averaging dialog box and click OK.

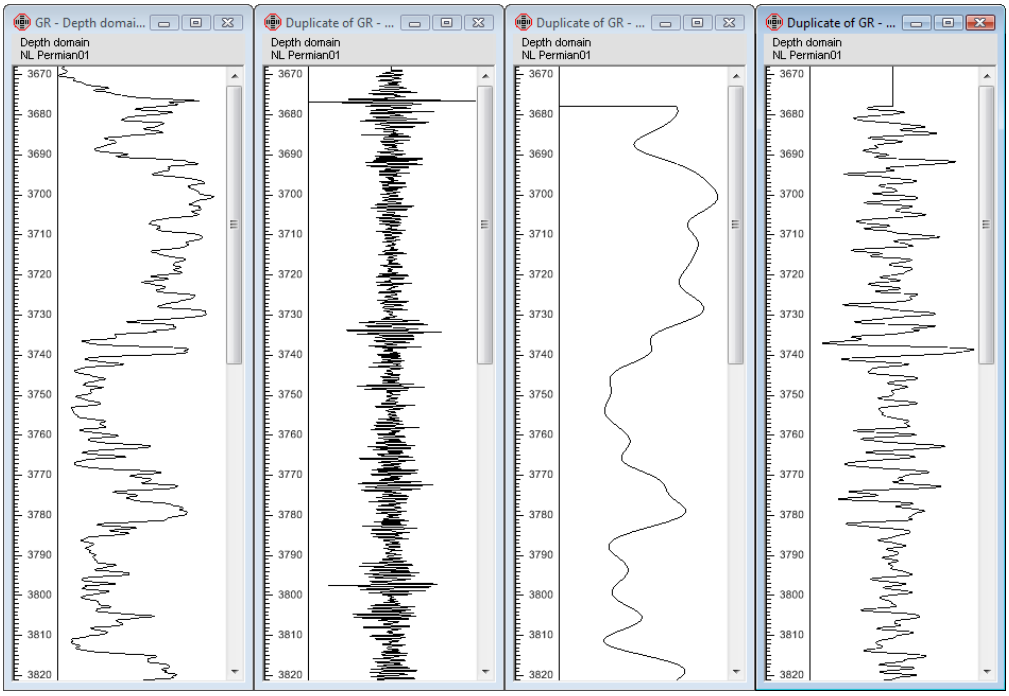
11.3.4. EDGE ENHANCEMENT FILTERS

Replaces each data value with the difference between successive data points within the user-defined window size relative to a midline (equal to no difference). The primary effect is to enhance the extreme values of the data, but Edge Enhancement also has the effect of filtering out the longer wavelengths.

Put the cursor in the pane in which you wish to perform an Edge Enhancement. Right-click the mouse button and select Processing → Log Filters → Edge Enhancement. Enter the required window length in the Edge Enhancement dialog box and click OK.

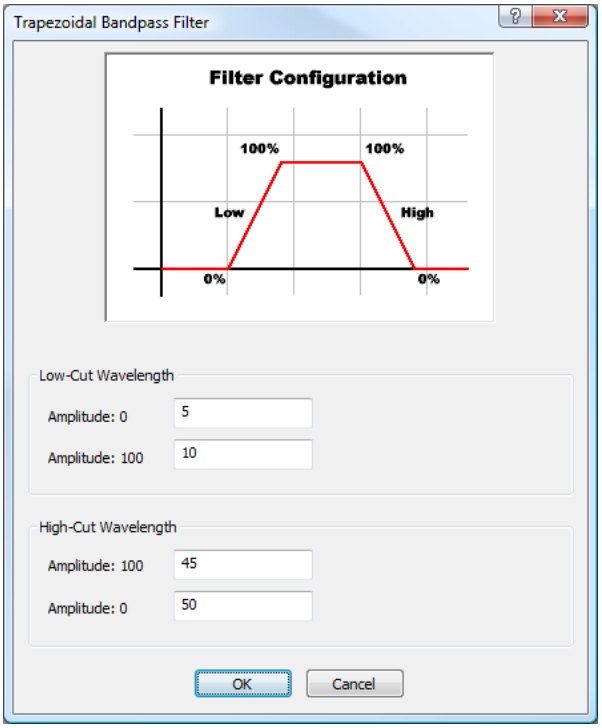
11.3.5. BANDPASS FILTER

A bandpass filter retains wavelengths in a user-defined range, and filters out all shorter and longer wavelengths. Selecting (right-click menu)
Processing → Log Filters → Bandpass Filter opens a dialog box in which to specify the cutoff wavelengths.



11.3.6. TRAPEZOIDAL BANDPASS FILTER

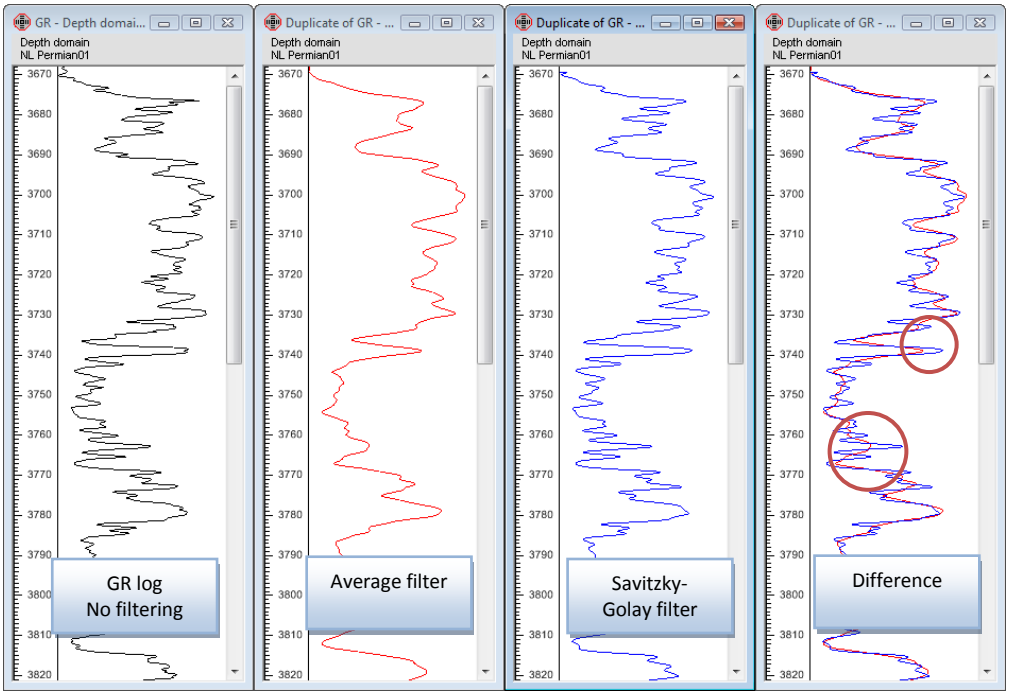
The sharp cutoff of the simple bandpass filter has the effect of introducing spurious wavelengths and masking the data. This effect is reduced by using a trapezoidal bandpass filter, in which the high and low ends of the filter are tapered. Selecting (right-click menu) Processing → Log Filters → Trapezoidal Bandpass Filter opens a dialog box in which to specify the cutoff wavelengths.



Specify both ends of the high and low tapers. In the illustrated example, wavelengths below 5m are cut out altogether. Wavelengths between 5 and 10m are passed with increasing amplitude. All wavelengths between 10 and 45m are passed unaltered in amplitude. Wavelengths from 45 to 50m are passed but with decreasing amplitude, and all information with wavelength longer than 50m is eliminated.

11.3.7. SAVITZKY-GOLAY FILTER

The Savitzky-Golay filter is a variation on the Average filter. If an average filter is applied on data with narrow peaks, the amplitude of the peaks decrease due to the filtering. With the Savitzky-Golay filter, more of the peak's amplitude is preserved after the filtering.



11.3.8. SAND FILTER

Sand Filter is a function designed to suppress the adverse effect of blocky sands on spectral analysis in some situations. It can be useful in analysing turbidites, for example. (A very “boxy” log can generate spurious wavelengths in a spectral analysis.) It requires a window of analysis to be defined, which should be slightly larger than the average thickness of the blocky sands present in the well. The effect of the Sand Filter function is to smooth off the edges of the sand bodies, so that they no longer resemble "box-cars".

Make a duplicate from the log on which you wish to perform Sand Filter. Display the log in a data pane, and right-click on that pane for the menu. Select

Processing → Log Filters → Sand Filter.

The Sand Filter dialog box opens. Input the window size, and click OK. The transformed GR log shows more or less regular peaks and the blocky character of the sand is filtered out.

11.3.9. V_SH

Calculates percent shale in shaly sandstones from the GR values by using a formula that requires you first to define the GR value of clean sand. Replaces the GR values with shale percent values.

Make a duplicate of the log for which you wish to perform V_sh. Display the log in a data pane; go to the right-click menu for that pane and select Processing → Log Filters. Click on the V_sh option. In the V-Shale Parameters dialog box, input the maximum and minimum values of the GR. Click OK.

Note that the effect of this procedure is to normalize the GR log to values between 0 and 1.

11.4. ADDITIONAL FUNCTIONS

11.4.1. MUTE WINDOW

The Mute Window function allows the user to replace a segment of a log with a specified null value. For example in an interval of bad data, or extreme values, it may be helpful to replace all values with zero or some other neutral value, to avoid unwanted effects when performing spectral analytical operations. To "mute" a window in the data, right-click over the log's Data Pane, and click on Processing → Log Filters → Mute Window. Specify the top and bottom depths of the interval to be muted, and the value to be used to replace the unwanted values. Click OK.

11.4.2. SHIFT LOG

The Shift Log function subtracts a user-defined number from the depth of every value in the log. Select Processing → Log Filters → Shift Log and type the depth shift into the Shift Log dialog box. Negative numbers move the log up, and positive numbers move it down. Data which is moved outside the domain interval is lost.

11.4.3. INTERPOLATE

The Interpolate function makes a linear interpolation between two specified depth points in the log. Select Processing → Log Filters → Interpolate, to open the Linear Interpolation dialog box. Type in the top and bottom depths of the interval to be interpolated, and click OK. The result is a diagonal line connecting the log values at the top and bottom of the interpolated interval.

11.4.4. ERODE WINDOW

The Erode function removes a specified depth interval from the log, and closes up the gap. It could be used, for example, to remove an igneous intrusion from within a sedimentary succession.

Select Erode Window from the (right-click) Processing menu. The Erode Window dialog box prompts you to enter the top and bottom depths of the section to be removed; press OK. Note that Erode Window affects only the current log; other logs from the same well (and domain) remain unaffected.

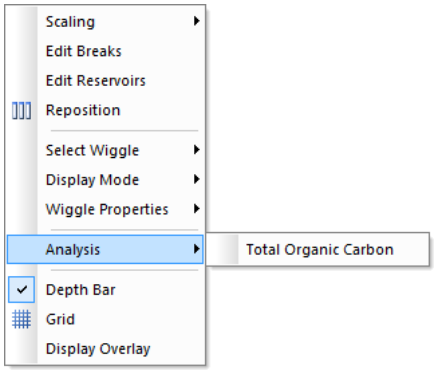
11.4.5. DEPOSIT SECTION

The Deposit function adds a depth interval to a log, and interpolates new values within the newly created interval.

Select Deposit from the (right-click) Processing menu. The Deposit dialog box prompts you to enter the depth at which section is to be added, and the thickness to be added; press OK. Note that Deposit affects only the current log; other logs from the same well (and domain) remain unaffected.

11.5. MULTI LOG ANALYSIS

New in CycloLog is the multi log analysis. These analyses are only available when logs are shown in the overlay mode.



11.5.1. ESTIMATING THE TOTAL ORGANIC CARBON

It is possible to estimate the Total Organic Content (TOC) in a well from a combination of multiple logs. The estimation is based on two logs. Combinations of logs which can be used for this analysis are:

- Resistivity – Sonic
- Resistivity – Neutron
- Resistivity – Density

For this analysis the logs must be in specific units.

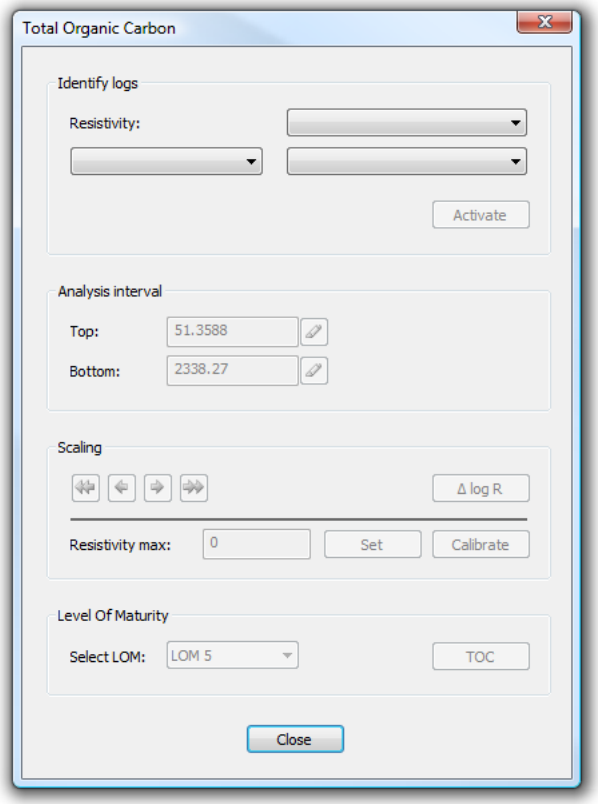
Log	Units
Resistivity	ohm.m
Sonic	µsec/ft
Neutron	V/V (0 – 100)
Density	g/cm3

Workflow

In the following workflow the resistivity and the sonic curves are used to calculate the TOC content in the well.

The well should be divided into several intervals. Each interval must have a single Level Of Maturity (LOM) value. If the LOM value is not known, it can be derived from measured vitrinite reflectance values (Hood et al., 1975).

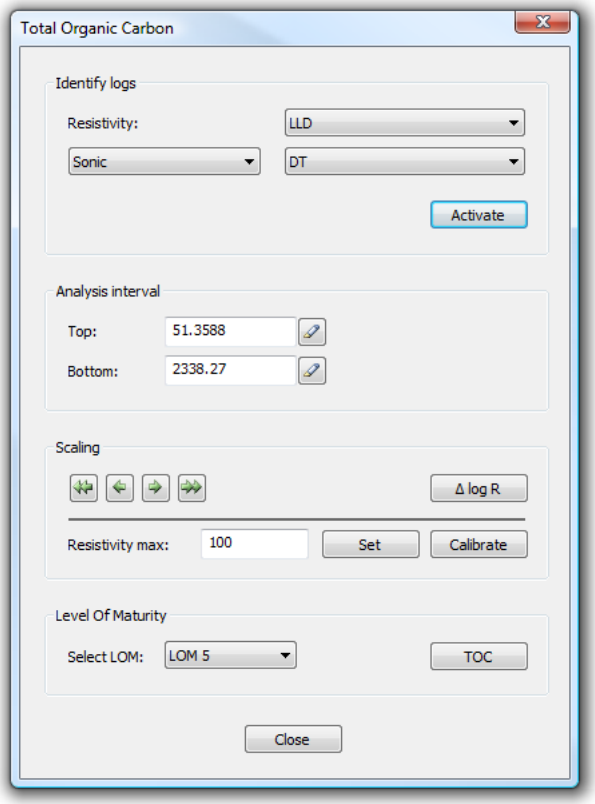
Start by displaying the resistivity curve and the sonic curve together in an overlay pane. Right click in the pane and select the Analysis submenu. Click on the Total Organic Carbon item and the Total Organic Carbon window appears.



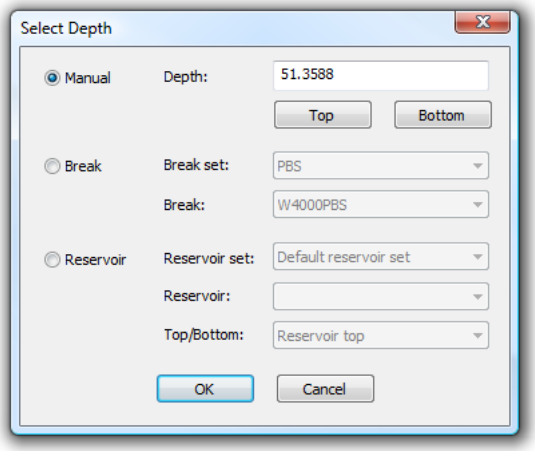
In the first step the user has to select the right curves in the Identify logs part.

- Select the resistivity curve.
- Select the type for the other curve, in this case the sonic.
- And select the sonic curve.
- When the logs are selected, click on the Activate button.

The other controls in the dialog are activated and the logs in the overlay pane are scaled using preset values.



Give the analysis interval for the analysis. The interval can be entered immediately or values from break or reservoir interpretation can be used. When the pen button behind the input fields are clicked, the following dialog appears.



When using the Manual option, the user can enter a depth or click on the Top or Bottom button. If the Top button is clicked, the well start depth is shown in the depth edit field. If the Bottom button is clicked, the well end depth is shown in the depth edit field.
The Break option allows the user to select the depth of a break. When a break set is selected, all breaks within the break set are shown.
The Reservoir option allows the user to select the top or bottom from an interval. When a reservoir is selected, all reservoirs within the reservoir set is shown. In the top/bottom selection box, the user can choose whether to use the interval top depth or the interval bottom depth.
Click on the OK button to use the depth in the calculation.

Fill in the level of maturity value in the Select LOM box.

Depending on the knowledge about the well there are two separate ways to calculate the TOC. If there is a non organic clay rich interval present in the well, this interval can be used to calibrate the calculation. If no non organic clay rich interval can be indentified and there are TOC measurements from cores, these TOC measurements can be used to calibrate the calculation.

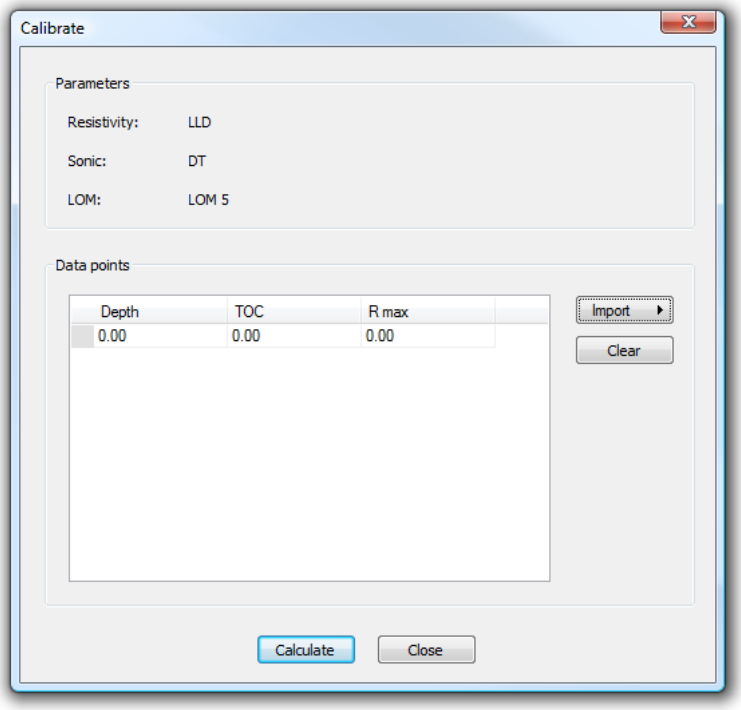
Using a calibration interval
Scroll to the calibration interval in the overlay pane. Use the left and right buttons on the dialog to shift the curves over each other.

If the two curves overlay in the calibration interval, it is assumed that there is no organic content present in this interval.

When the Δ log R button is clicked, the separation between the two curves is calculated. If the TOC button is clicked, the level of maturity is used to convert the separation between the two curves into a TOC curve.

Using TOC measurements
When it is not possible to identify a non organic clay rich interval and TOC core measurements are present, these measurements can be used to generate a TOC curve calibrated with the TOC measurements.

To calibrate using the TOC measurements, click on the Calibrate button.



The parameter section shows the selections made by the user in the Total Organic Content dialog. It shows which resistivity curve is used, what the type is of the other curve used, and which one is the other curve. It also shows the selected LOM value.

The user can input the Depth – TOC values in the grid manually, but it is also possible to import the Depth – TOC values from a file or the clipboard. The Clear button will clear all the values from the grid.

When the Calculate button is clicked, the scaling value for the resistivity curve is calculated. For each data point the calculated resistivity value gives the scaling for at which the separation gives the measured TOC value.

It is now up to the user to use his expert eye to select an average value to use as the resistivity scaling value. When the user has decided on the right value, the dialog can be closed using the Close button.

Fill in the resistivity scaling value in the Resistivity max edit field and click on the Set button. The scaling of the curves in the overlay pane is adjusted according to the user's settings.

When the Δ log R button is clicked, the separation between the two curves is calculated. If the TOC button is clicked, the level of maturity is used to convert the separation between the two curves into a TOC curve.

References

Hood et al, 1975, Organic metamorphism and the generation of petroleum: AAPG Bulletin, v. 59, p.986 – 996.

Passey et al, 1990, A practical model for organic richness from porosity and resistivity logs: AAPG Bulletin, v. 74, p.1777 – 1794.

12. LOG SPECTRAL ANALYSIS

12.1. INTRODUCTION

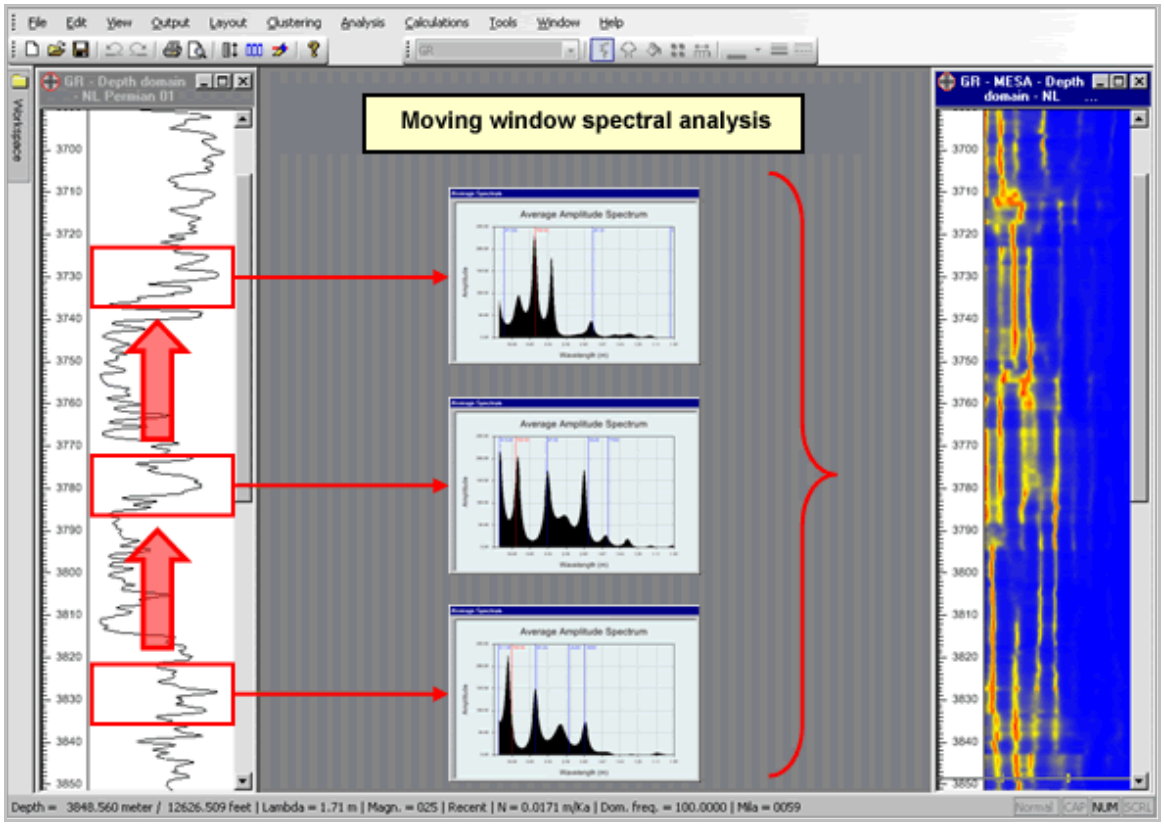
Spectral (frequency-domain) analysis of wireline log data is the most important and distinctive feature of CycloLog. The primary reason for using spectral methods is the understanding that cyclic climatic change is recorded in strata, which can therefore be expected to contain information in the frequency domain. If a wireline log is viewed, not just as a series of datapoints, but as a regularly-spaced sampling of a complex waveform, then spectral methods of analysis are required to fully understand it.

This section of the Manual introduces spectral analysis of log data, especially MESA (maximum entropy spectral analysis), and its application in identifying Milankovitch (orbitally-forced) cyclicity in the data.

12.2. MOVING-WINDOW SPECTRAL ANALYSIS

CycloLog is designed to perform spectral analysis of log data extremely quickly and efficiently, and to display the results against depth, allowing immediate stratigraphic interpretation of the results.

CycloLog uses a “moving window” approach to spectral analysis. Computing the frequency spectrum of an entire log would be meaningless, as the statistical properties of geological data are highly variable downhole (they are “non-stationary”, in statistical terms). Consistency of frequency properties is much more likely in a short section of the data. Therefore, CycloLog normally computes frequency spectra in a large number of short (and overlapping) windows of analysis. The window-length is defined by the user and is typically in the order of 10m; the step between successive windows is typically 1m.



The spectral analysis for each window generates a frequency spectrum, which is a graph of amplitude (signal strength) against wavelength; it shows the relative contribution of a range of wavelengths to the waveform of the data. The large number of graphs generated by the moving window approach can be stacked up and contoured in a way that shows graphically the persistent contribution of particular wavelengths to the data.

12.3. SPECTRAL ANALYSIS METHODS AVAILABLE

Several different methods of spectral analysis are now available in CycloLog, and some experimentation is recommended to find the most effective method for different applications.

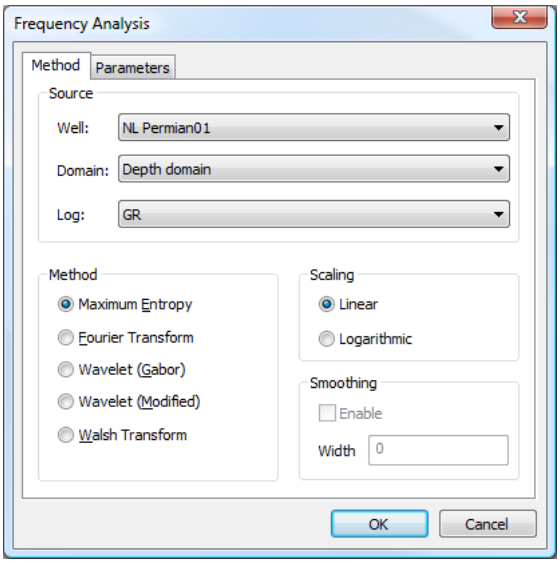
Method	Characteristics
Maximum Entropy Spectral Analysis (MESA)	Determination of spectral content of a "depth window" through the calculation of a "prediction error filter" for that window and subsequent analysis of the resultant filter coefficients. The resulting spectra are characteristic for the window, and not for the window centre. Smearing of information will occur.
Fast Fourier Transform (FFT)	Determination of spectral content of a "depth window" through matching of the data in that window to a discrete set of harmonic (sine and cosine) functions. The resulting spectra area characteristic for the window, not for the window centre. Smearing will occur.
Gabor Wavelet Transform (GWAV)	Determination of spectral content of a "depth window" through matching of the data in that window to a discrete set of wavelets. Resulting spectra are local by nature, because the wavelets are "focused" in the window.
Modified (CycloLog) Wavelet Transform (MWAV)	Determination of spectral content using MESA and GWAV. This method, specific to CycloLog, results in a high-resolution spectrum.
Walsh Transform (WALT)	Determination of spectral content of a "depth window" through matching of the data in that window to a discrete set of "step functions". The resulting spectra are characteristic for the window, not for the window centre. Smearing will occur.

Although FFT may be the most familiar method from other applications (e.g. communications), it is less applicable to geological data, because it attempts to decompose the data into exact sine waves, and geological data are very rarely precisely periodic. MESA is generally the most appropriate method, because it generates a model of the data (rather than an exact decomposition). It is thus much more tolerant of any imperfections in the expression of an underlying periodicity (such as Milankovitch cyclicity). Gabor and Continuous Wavelet Transforms (GWAV and CWAV) methods have advantages in certain situations, particularly where the original data are very spiky – large spikes in the data can dominate the frequency spectra to the point where more interesting frequencies are obscured.

Whereas FFT and MESA analyse the frequency spectrum within a window of finite length, GWAV and MWAV effectively define a spectrum at a point; this makes a difference to the way the results are interpreted.

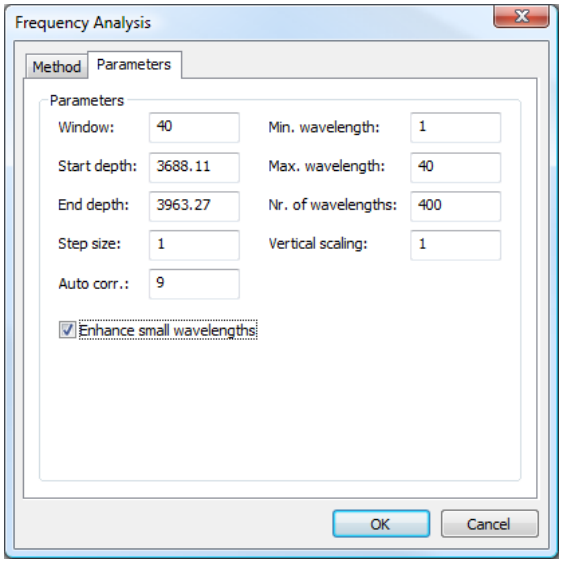
12.4. PERFORMING A SPECTRAL ANALYSIS

From the Menu Bar click on Analysis → Frequency Analysis. The Frequency Analysis dialog box opens.



From the Methods tab, select the log to be analysed, and the spectral analysis method. The vertical scale of the resulting spectra can be scaled either linearly (the default), or (if unusually high peaks are expected) logarithmically. The Smoothing option is only applicable for the Walsh Transform.

Now select the Parameters tab:



Note that the values that appear in the dialog box are not necessarily those recommended below, and it will be necessary to change at least some of them. The recommended values are those that have been found to work best with most data. However, in cases where sedimentation rates are either unusually slow or unusually fast, it may be necessary to experiment with different length windows, and this may in turn require some of the other parameters to be set to different values.

Set the **window length** – if in doubt, try the default length of 40m first, then experiment with shorter and longer windows. Set the start and end depths of the interval to be analysed (the default is the total depth interval of the current project). The spectral analysis necessarily starts and ends at 0.5 x window-length from the top and bottom of the selected data range.

The **step size** is the distance between successive overlapping windows; increasing the number gives a smoother result but will take a few seconds more to run.

The **autocorrelation number** is defined only for MESA. A value of approximately 0.25 of the window length is recommended.

The **Minimum and Maximum Wavelength** parameters control the horizontal scale of the frequency spectrum; as this scale is logarithmic, the minimum may not be zero. A scale of 1 to 100 will normally capture most of the information for the suggested window length of 40m, but experimentation is again recommended.

Number of wavelengths controls the number of steps along the horizontal axis of the spectral display. The default value of 400 generally gives good resolution.

Vertical scaling: it is suggested to keep the default value of 1.

Enhance small wavelengths: in many analyses, the information from the shorter wavelengths is swamped by the longer wavelengths; it is recommended to check this box if you want to see the information from the full range of wavelengths.

When all the parameters are set, click OK. The analysis runs, and creates a new log in the tree structure in the Workspace, called (e.g.) GR – MESA (if you are analyzing the GR log with the MESA method). Double-click on the log name to open it.

12.5. SPECTRAL IMAGE DISPLAY TOOLS

12.5.1. THE SPECTRAL ANALYSIS DATA PANE

The results of a spectral analysis open in another Data Pane; this has its own depth bar and it scrolls in parallel with other logs from the same well/domain. However, it also has some special properties, including a special cursor, and a special right-click menu.

12.5.2. THE SPECTRAL ANALYSIS DATA PANE CURSOR

When the cursor is held over a spectral analysis data pane, it changes to a horizontal bar with five tick marks. The second tick mark from the left is large than the other four, and is the one used to estimate wavelength. Position this large tick mark over the waveband you are interested in, and note the wavelength ("Lamba") displayed on the Status Bar, to the right of the Depth (in meters and feet). The other items on the Status Bar will be explained below; this information is also repeated in the Information Worksheet, if it is open.

The tick marks on the spectral analysis cursor represent the five main Milankovitch periodicities:

- 400 ka Long eccentricity
- 100 ka Short eccentricity (the large tick mark)
- 41 ka Obliquity
- 23 ka Precession
- 21 ka Precession

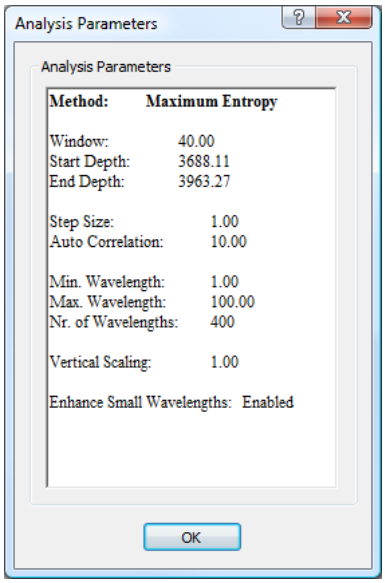
The wavelength ratio between the positions of the five tick marks is exactly the same as the cycle period ratios between the corresponding Milankovitch cyclicities. Assuming (which is rarely the case) that the Milankovitch periods are represented by rock thickness in perfect proportion to their time durations, then spectral analysis of a facies-sensitive wireline log should yield a set of cycle wavelengths that can be identified with the Milankovitch periods by comparing their ratios. This is the purpose of the special cursor. If you hypothesize that one particular wavelength is the 100ka cycle, place the large tick mark over that wavelength, and the other tick marks on the cursor will then predict the wavelengths of the other four Milankovitch periods.

12.5.3. THE SPECTRAL ANALYSIS RIGHT-CLICK MENU

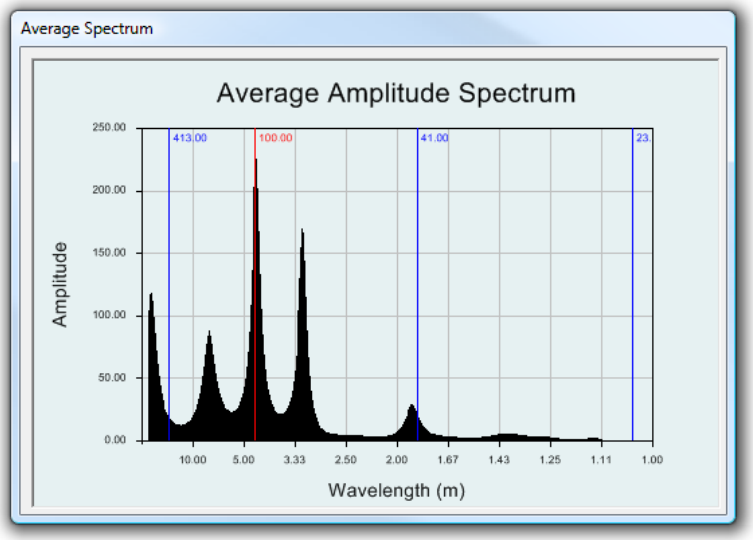
Spectral Analysis Data Panes have a different right-click menu from that of the normal log data pane.

The Scale Vertical, Edit Breaks and Reposition options on the right-click menu are equivalent to the same items on the right-click menu of a log Data Pane.

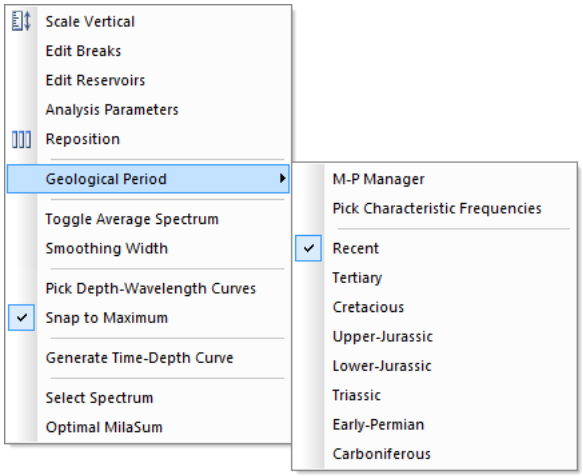
The Analysis Parameters option opens an information box showing the parameters that were set for the spectral analysis whose results are displayed in the current spectral data pane.



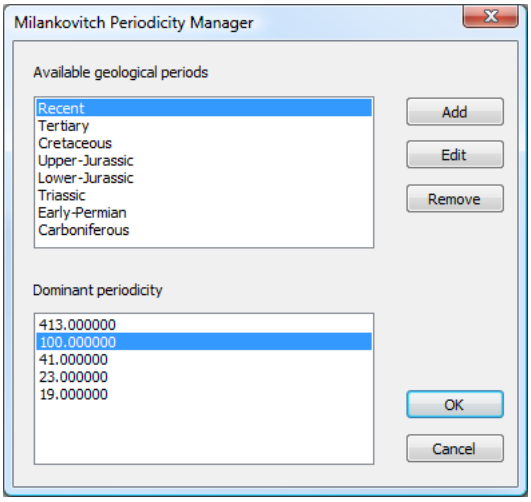
Toggle Average Spectrum switches on (and off) a box showing the average wavelength power spectrum at the depth of the cursor. Moving the cursor up and down will show how the spectrum changes through the log. (The colored vertical lines relate to the identification of Milankovitch frequencies) Note the logarithmic scale, with longer wavelengths to the left, shorter wavelengths to the right.



The Geological Period option allows selection between several sets of Milankovitch period ratios. It is believed that the ratios between the eccentricity, obliquity and precession cycles has changed through geological time, as a result of changes in the distance between the Earth and Moon. The ratios currently available in CycloLog are taken from the publication by Berger and Loutre (IAS Special Publication 19, 15-24, 1994).



The Milankovitch periods quoted above are correct only for the Recent. For earlier periods, select the nearest available time, or open the Milankovitch Periodicity Manager (M-P Manager option on the Geological Periods sub-menu) to define a new set of periods.



To create a new scheme, click Add. Give a name to the new scheme and click Add to specify each of the new cycle periods (in ka – thousands of years). Click OK to add your scheme to the list of Available Geological Periods. You can Edit or Remove user-defined schemes, but you cannot either edit or remove any of the pre-defined schemes.

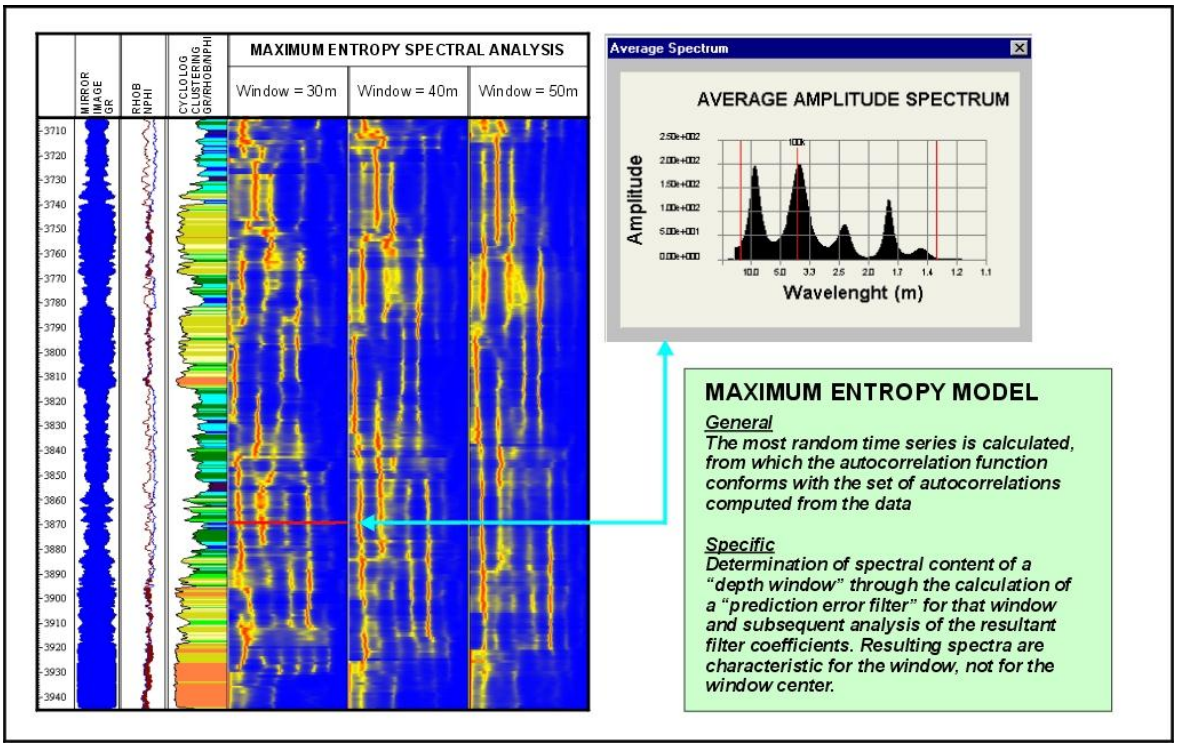
Also use the M-P Manager if you wish to change the periodicity that is represented by the large tick mark on the spectral analysis cursor (the "dominant periodicity"). Click over the period that you wish to make the new Dominant Periodicity. The identity of the dominant period appears on the Status Bar ("Dom.Freq."). In the Average Amplitude Spectrum window, the dominant frequency is represented by a red line, while the other four frequencies are blue lines.
Other right-click menu items are explained under Identification of Milankovitch Cycles.

12.6. COMPARISON OF SPECTRAL ANALYSIS RESULTS

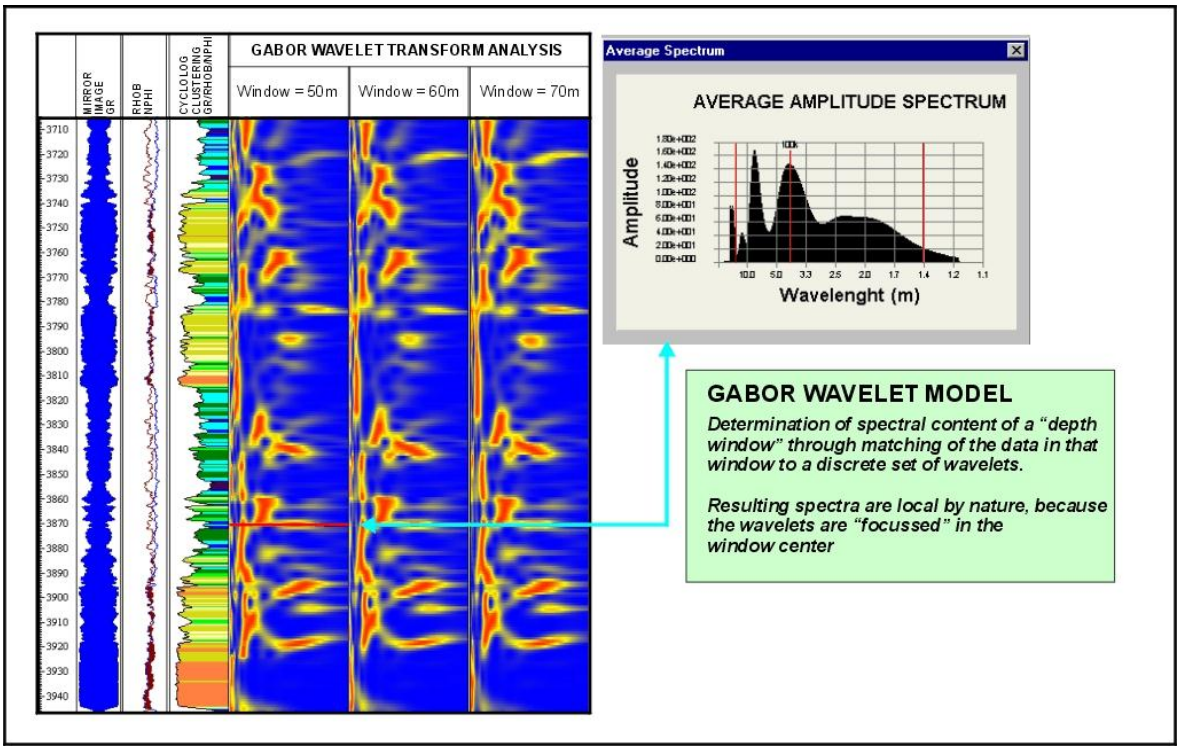
For an overview of the different appearance of the output from the different spectral analysis methods, we have generated analyses using four of the main methods. All were performed on the same GR log, and all the methods except for the Walsh Transform have been normalised so that all the spectral images can be compared with each other.

The cursor in the images was placed at the same depth position. The Average Amplitude Spectrum graph displays the spectrum peaks at the position of the cursor. The main cursor has been defined as the short eccentricity (100 Ka) (see description of the Milankovitch analysis cursor later in this section of the Manual).

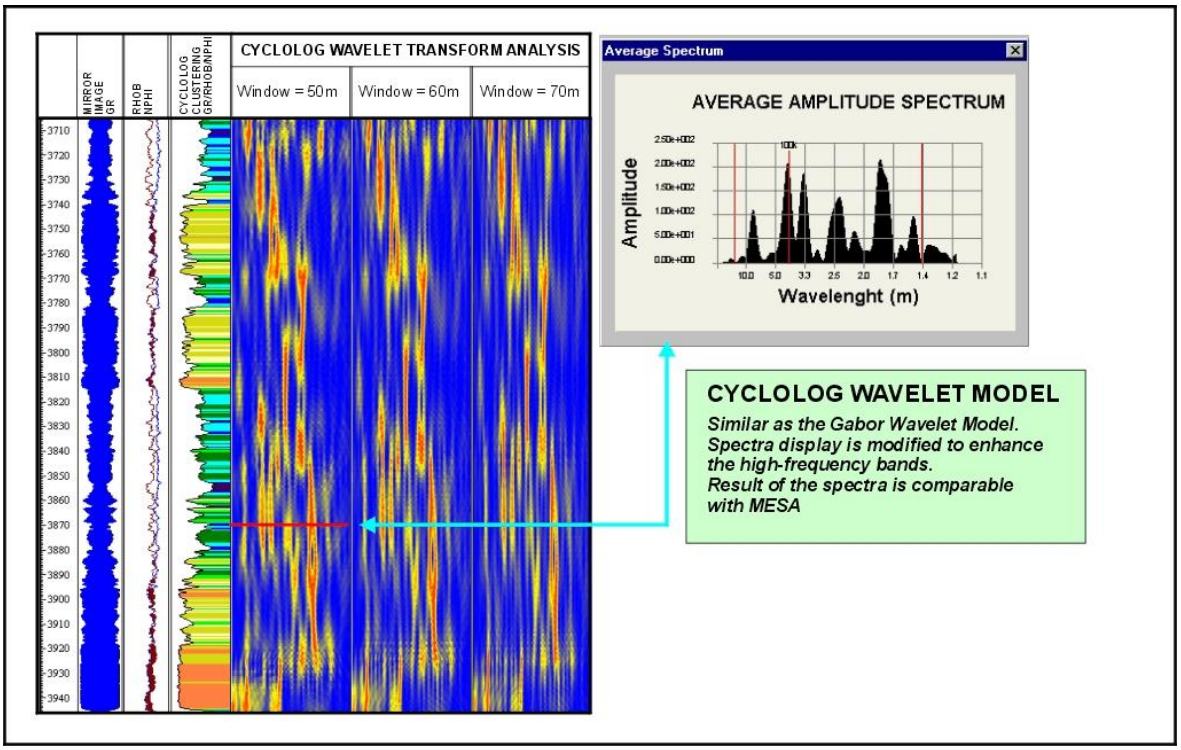
12.6.1. MAXIMUM ENTROPY SPECTRAL ANALYSIS (MESA)



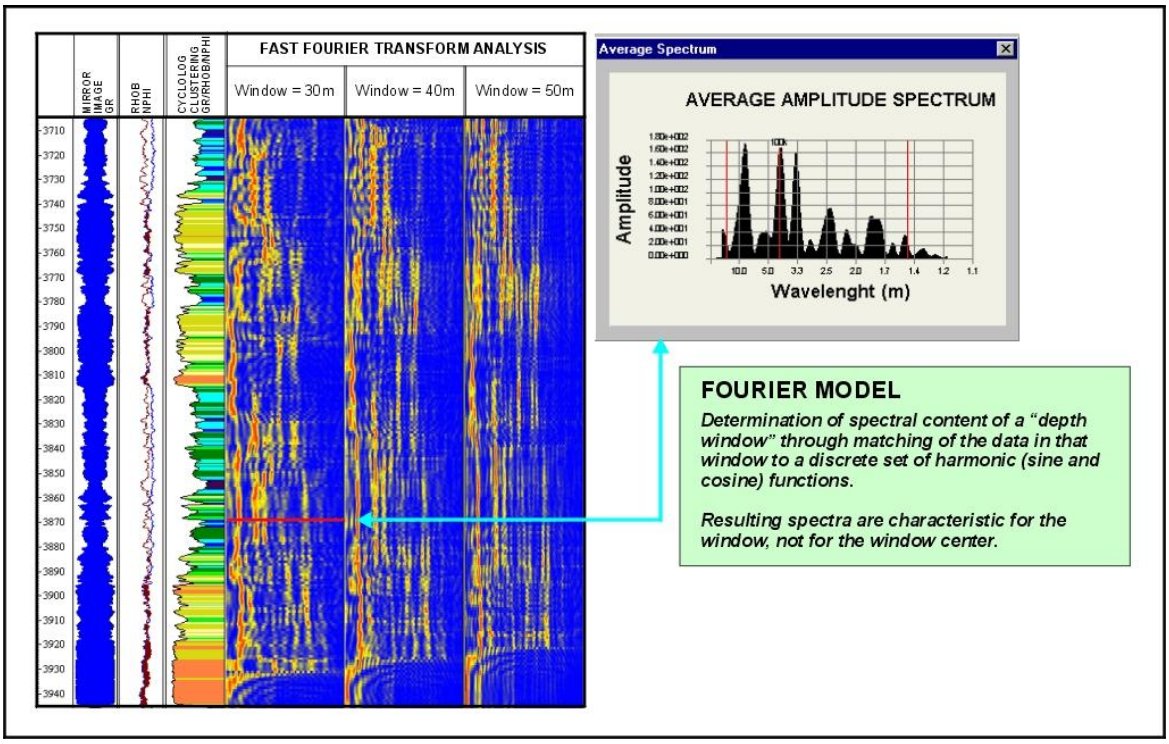
12.6.2. GABOR WAVELET TRANSFORM (GWAV)



12.6.3. MODIFIED (CYCLOLOG) WAVELET TRANSFORM (MWAV)



12.6.4. FAST FOURIER TRANSFORM (FFT)



12.7. IDENTIFICATION OF MILANKOVITCH CYCLES

12.7.1. VISUAL DETERMINATION

Generate at least three MESA spectral image transforms from a suitable, facies-sensitive log (typically the GR). See above for the procedures. Use window sizes of 30m, 40m and 50m.

Select the most appropriate geological period (right-click on the spectral image Data Pane, select Geological Period and click the relevant geological period). Check that the Dominant Periodicity (default = 100ka eccentricity cycle) is the one you want; go to (right-click menu) Geological Period → M-P Manager if you want to change it. (If you have more than one spectral analysis data pane open, you will need to make the same changes for each, as the settings are tied to an individual window.)

Display the Average Amplitude Spectrum graph by right-clicking on the spectral image Data Pane, and click Toggle Average Spectrum. Note that the power spectrum graph includes the positions of the tick marks on the spectral analysis cursor, each labeled with its Milankovitch period (in ka). By moving the cursor within the data pane, you can try to achieve the best visual match between the predicted cycle ratios and the actual spectral peaks.

A simple numerical score of the fit between actual and predicted ratios is provided by the Ratio Match Number ("Mila", at the right end of the Status Bar – also displayed in the Information Worksheet if open). This is an arbitrary score that is maximized when the best fit to the predicted ratios is found. It is also used in the semi-automated search for Milankovitch ratios described below.

The Status Bar and the Information Worksheet also show an estimate of the Net Sediment Accumulation rate (N, in the middle of the Status Bar). This estimate assumes that the 100ka Milankovitch cycle has been correctly identified, allowing a direct correlation between elapsed time and sediment thickness.

12.7.2. AUTOMATED DETERMINATION (MILASUM)

It is also possible to let CycloLog make a best-fit determination of the likely identification of log cyclicity with Milankovitch periods. Note that CycloLog will always find a solution, but the user must decide whether or not CycloLog's mathematically optimal solution is geologically

acceptable. For example, it is important to choose a horizontal (wavelength) scale for the spectra that is likely to include the target periods.

CycloLog's method – Milasum – is based on the Mila (Ratio Match Number) parameter that CycloLog calculates for the goodness of fit of an individual spectrum with the Milankovitch period ratios. Milasum generates an optimal fit for the entire log.

To use Milasum, generate one or more MESA spectral image transforms from a facies-sensitive log (typically the GR). See above for the procedures.

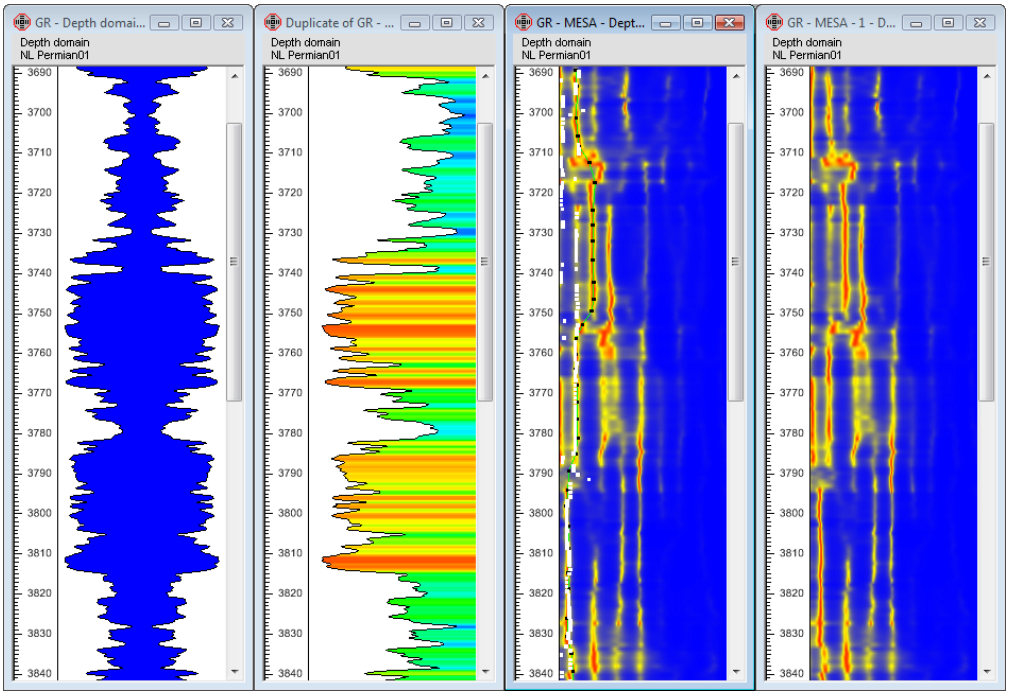
Select the most appropriate geological period from Geological Period → M-P Manager on the spectral display right-click menu. Also in the M-P Manager, choose the most suitable Dominant Periodicity (e.g. 100ka Eccentricity). This will be the periodicity for which CycloLog searches, so it must be a period that can reasonably be expected to be resolved by the log.

Select and click Optimal MilaSum from the right-click Data Pane menu. CycloLog performs the calculation and puts a series of white dots over the spectral peaks that correspond to the mathematical best fit for the 100ka Milankovitch cycle. You can now go back to the M-P Manager and select a different Dominant Periodicity (e.g. Obliquity); CycloLog will re-run the analysis and display its identification of the Obliquity peaks.

12.7.3. MAPPING MILANKOVITCH CYCLES TO GENERATE A TIME-DEPTH CURVE

Identifying spectral peaks with particular Milankovitch cycles is the key to defining the relationship between rock and geological time. If the Milankovitch period is known for a given depth interval, this gives an estimate of the amount of geological time represented by that part of the well. Therefore, we can define a time-depth curve linking points in the well with a linear geological time scale in thousands of years (ka). This leads to estimates of sediment accumulation rate, and to the possibility of converting the vertical scale for the log from Depth into Geological Time – from the Depth Domain to the Geological Time Domain in CycloLog's terminology.

CycloLog allows the user to define such a Depth-Time curve by picking points on the spectral display that are identified with a particular Milankovitch period (the 100ka Eccentricity cycle, for example).



Generate a MESA spectral image transform (e.g. use the GR). See above for the procedures. Use window size 30m and 50m. Select the most appropriate geological period and the Dominant Frequency (see above for procedures). At this point you can run Milasum (Optimal Milasum from the right-click menu) to guide you if you wish. Now choose Pick Depth-Wavelength Curves from the right-click spectral Data Pane menu. The shape of the cursor changes into a pencil and a black cross.

To define, put the pencil on the selected spectral band and click the left mouse button. A black square appears. Follow the band and left-click again at your next selected position. Keep going, being particularly careful to define any jumps in the spectral band, as these represent significant changes in sedimentation rate. If you come to the bottom of the screen, you can click in the scroll bar without affecting the definition of your line.

To finish the line (e.g. at a termination of a spectral band), double-click the left mouse button.

To delete a point (black square), put the black cross at the point you want to delete and push the DELETE button.

When you have finished defining the line on the screen, click (right-click menu) Generate Time-Depth curve. You will be prompted to define the "origin" of the curve, which is the point in the log from which geological time is to be measured. The default is to define the top of the log as time=zero, but you can change this if you wish. When you click OK, the curve will be generated and added to the tree structure in the Workspace worksheet.

12.8. GENERATING SYNTHETIC WAVEFORMS

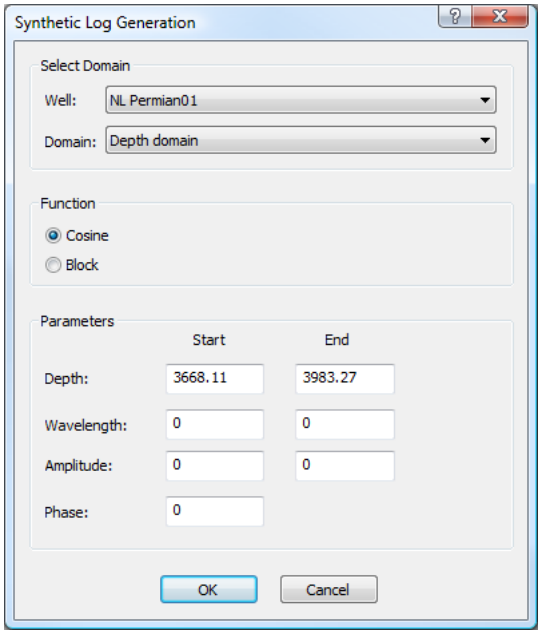
CycloLog can generate synthetic waveforms, with user-defined properties of wavelength, amplitude and phase. These curves can be useful for comparison with real data, or for investigating the relative merits of different spectral methods.

To generate a synthetic curve, go to the Tools menu and select Synthetic Log Creation. Select the appropriate well and domain if there is more than one in the current project.

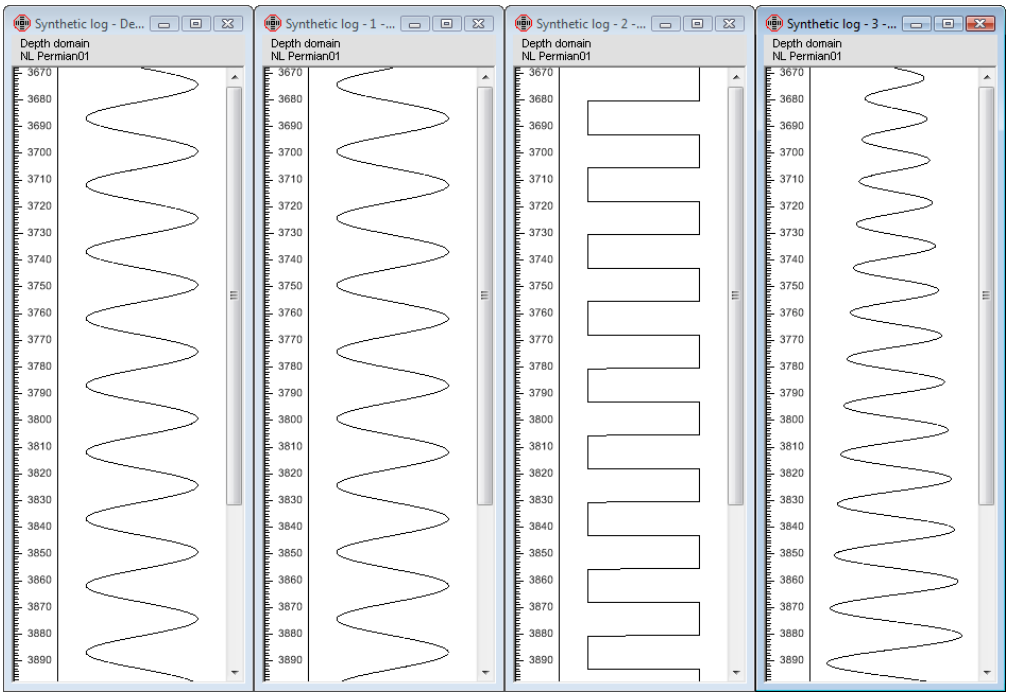
The waveform can either be a cosine wave or a square wave – select Cosine or Block from the Function buttons.

The depth interval defaults to the total interval for the current well/domain – change the top and bottom depth if you want the synthetic to extend over a more restricted interval.

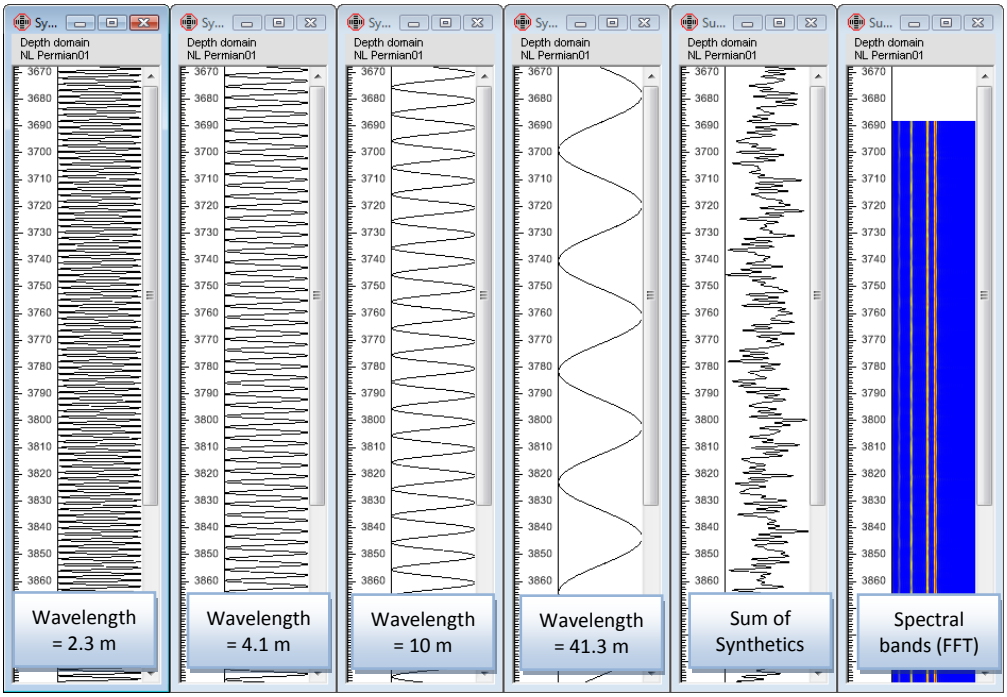
You can now specify the wavelength and amplitude of the desired curve. If you give the same wavelength and amplitude for the top and bottom, then the curve will have constant wavelength and amplitude throughout. If the wavelength and/or amplitude are different at the top and bottom, CycloLog will interpolate to give the curve a wavelength/amplitude that varies smoothly from top to bottom of the synthetic (see examples).



In the example illustrated you can see four panes with four different synthetic logs. The first pane shows a synthetic log created a wavelength of 25 meters and constant amplitude. The second pane shows a synthetic log with a wavelength of 25 meters, constant amplitude but with a phase of 180 degrees. The third pane shows a synthetic log using a block function with a wavelength of 25 meters and constant amplitude. The fourth and final pane shows a synthetic log with a wavelength of 25 meters and increasing amplitude from 1 to 2.



Several synthetics can be combined using CycloLog's Log Processing functions, to make complex waveforms with user-defined properties. The following example shows five synthetics with (constant) wavelengths in the ratio of the (present-day) principal Milankovitch periods. In the fifth pane, these have been added together to form a single composite waveform. The spectral bands in the sixth pane (which was generated using the Fourier spectral analysis option) confirm the absolute constancy of the wave structure of the synthetic despite its irregular appearance.



12.9. LOG SPECTRAL ATTRIBUTES

Most of the geological applications of spectral analysis can be performed without specialist knowledge of the mathematical details. For those interested in the detail, it is possible to calculate the following Log Spectral Attributes in CycloLog:

- Instant Amplitude
- Instant Frequency
- Instant Phase
- Instant Cosine

These functions are all accessed through the right-click menu for a normal log Data Pane (note, not the spectral transform Data Pane): click Processing → Log Attributes on the right-click menu.

Log attributes are calculated through application of a Hilbert transform. This transform yields the complex signal from which the various attributes are derived. The complex signal may be written:

$$L_c(z) = L_A(z) \cdot e^{i\phi(z)}$$

Where L_c indicates the complex signal, L_A indicates the instant amplitude and ϕ indicates the instantaneous phase. The original log data may be derived from the complex signal as:

$$L(z) = L_A(z) \cdot \cos(\phi(z)) = \mathrm{Re}(L_c(z))$$

The analytical signal is given by:

$$L'(z) = L_A(z) \cdot \sin(\phi(z)) = \mathrm{Im}(L_c(z))$$

From L(z) and L'(z) we derive the **instantaneous amplitude** as

$$L_A(z) = \sqrt{(L(z)^2 + L'(z)^2)}$$

The **instantaneous phase** is derived using

$$\phi(z) = \arctan\left(\frac{L'(z)}{L(z)}\right)$$

The **instantaneous cosine** is derive as

$$\cos(\phi(z)) = \frac{L_c(z)}{L_A(z)}$$

Finally the **instantaneous frequency** is derived as the derivative of instantaneous phase

$$\omega(z) = \frac{d\phi(z)}{dz}$$

13. SPECTRAL ATTRIBUTES (PEFA AND INPEFA) FOR HIGH-RESOLUTION LOG CORRELATION

13.1. INTRODUCTION

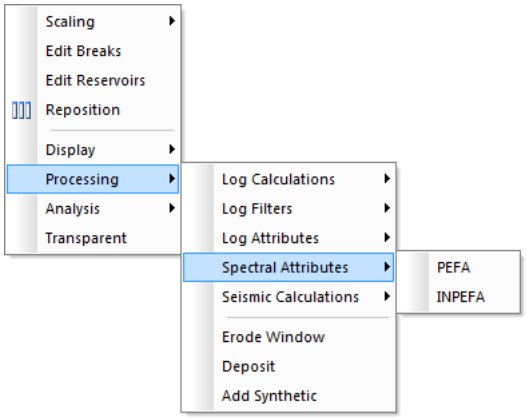
Maximum Entropy Spectral Analysis (MESA) and its role in identifying Milankovitch cycles was described in the previous section of this Manual. A more general application of MESA is in the frequency-domain transforms of log data that we use in high-resolution stratigraphic correlation.

MESA is used to generate two types of spectral attributes:

- The **Spectral Change Attribute** identifies changes in the spectral properties of the log, which are candidates for important stratigraphic breaks. The spectral change attribute is also known as **PEFA** (Prediction Error Filter Analysis).
- The **Spectral Trend Attribute** derives trends in the spectral properties of the log. It can be shown that changes in these trends are related to changes in the depositional environment induced by orbitally-forced climatic change. The link between periodic (e.g. Milankovitch) climatic change and depositional environment is the rationale for the use of spectral methods to analyse facies-sensitive wireline logs. The spectral trend attribute is also known as **INPEFA** (Integrated PEFA).

This section of the Manual describes the generation of spectral attribute log transforms in CycloLog, along with the CycloLog functions that assist in their use in stratigraphic correlation. The details of the underlying theory of climate stratigraphy are beyond the scope of the manual.

Spectral attribute transforms are accessed in CycloLog through the data pane right-click menu:



As with all log transforms, we recommend making copies of the log before running spectral attribute transforms.

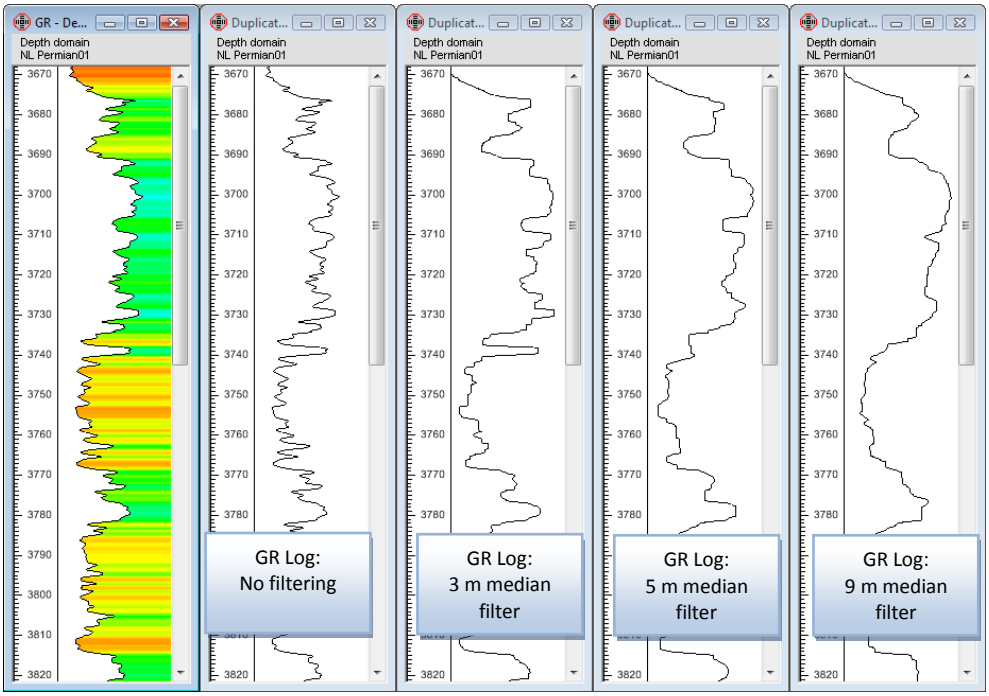
13.2. SPECTRAL CHANGE ATTRIBUTE (PEFA)

13.2.1. WHAT PEFA DOES TO THE DATA

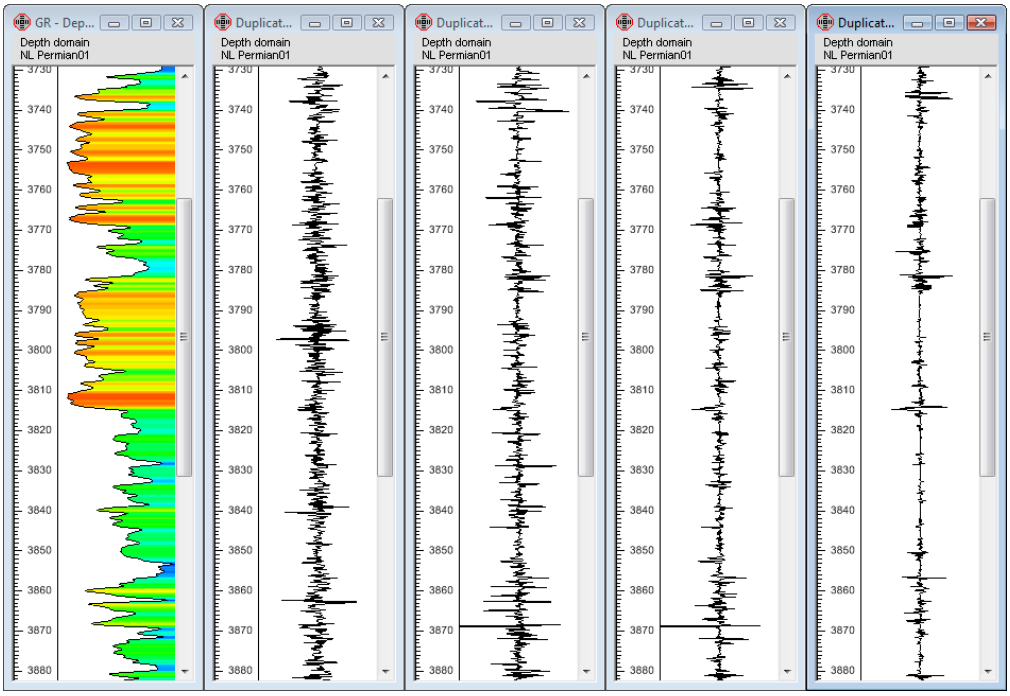
The PEFA routine replaces each point with the difference between the actual value and the value predicted by Maximum Entropy Spectral Analysis (MESA). MESA analyses the frequency content of the data within a window of user-specified length, producing a model of the analysed data expressed as a set of superimposed waveforms. This model is then used to predict the next data-point up the curve. A perfect prediction results in a prediction error of zero; otherwise the value is non-zero. Strongly positive and strongly negative values suggest discontinuities in the data, and hence possible stratigraphic breaks.

13.2.2. RUNNING PEFA (SPECTRAL CHANGE ATTRIBUTE)

Running PEFA on several copies of a log, each smoothed with a median filter of different window length, can yield useful information about the persistence of stratigraphic breaks at different wavelengths. Make several duplicates of the log (in our example the GR) and run a Median Filter analysis with a different window size (e.g. 3m, 5m and 9m) on each log.



Now run PEFA on each of these log transforms. Select PEFA from the (right-click menu) Processing → Spectral Attributes menu. In the Prediction Error Filter dialog box, select the interval of analysis (the default is the entire log) and accept the default filter size of 10m (changing the filter length does not greatly alter the result). Each resulting PEFA curve will be scaled to its own minimum and maximum values. In order to be able to compare them directly, you should make the horizontal scale the same for all of them. In the example, the scale is -10 to +10. (The units are those of the original log, API units in the case of a GR log).



The interpretation of the PEFA curve is as follows.

- Most of the values are close to the zero line, meaning that the prediction errors are small, and the prediction is therefore good; the spectral properties of the data remain relatively unchanged from one window to the next.
- Longer spikes on the PEFA curve represent depths where the prediction breaks down, due to a sharp change in the spectral properties of the log. These depths are candidates for a stratigraphic break.
- Filtering removes short wavelength “noise” from the data. PEFA spikes that persist when such noise has been filtered out are likely to have greater (e.g. regional) significance than PEFA spikes that do not persist through all the differently filtered versions of the log.

13.3. SPECTRAL TREND ANALYSIS (INPEFA)

13.3.1. WHAT INPEFA DOES TO THE DATA

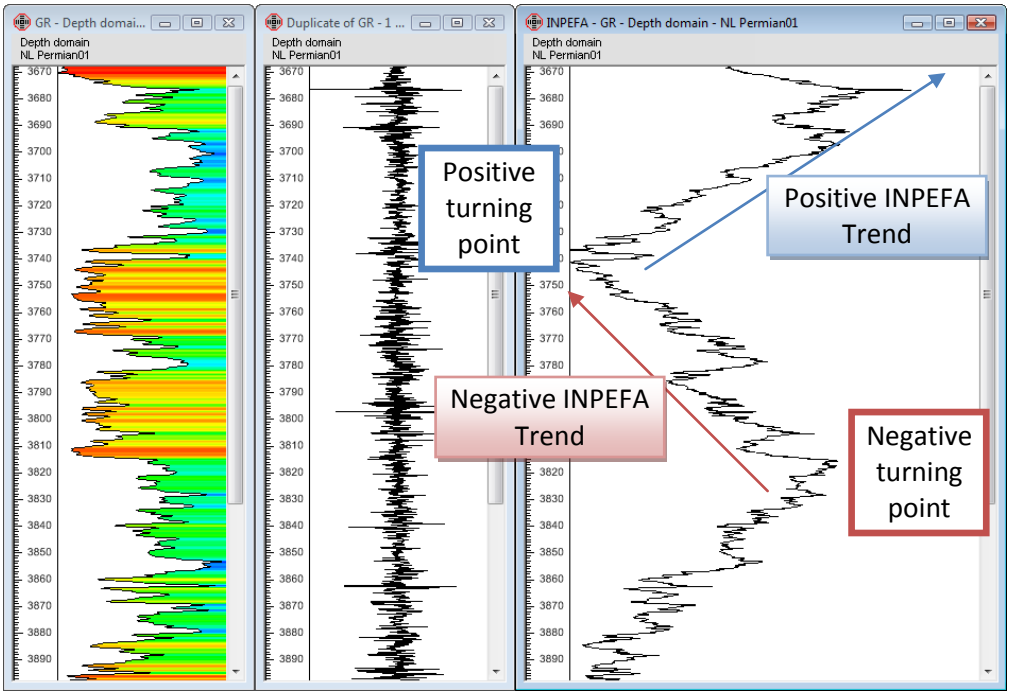
INPEFA calculates the integral of the PEFA curve (i.e. the area under the PEFA curve). INPEFA is thus a curve that shows the trends in the PEFA values. INPEFA can be used to correlate logs

from different wells, if there is sufficient evidence that changes in INPEFA trend are controlled by regionally synchronous events such as a climatic change or a widespread influx of sandy sediment.

13.3.2. RUNNING INPEFA (SPECTRAL TREND ATTRIBUTE)

INPEFA is generated by using the INPEFA function in the Spectral Attributes function menu. First make duplicates of the log to which you wish to apply INPEFA. It is again essential to select a log that is responding to depositional facies; in our example we use the GR.

Right-click on the Data Pane and select Processing → Spectral Attributes → INPEFA. In the Prediction Error Filter box select the interval of analysis (the default is the entire log) and accept the default value of 10m for the Filter Size. Click OK. The log will be transformed to an INPEFA curve. Give the curve a meaningful name if you want to keep it. Note that it can be helpful to display the INPEFA curve in a wide track; drag the side of the Data Pane to increase its width.



13.3.3. INTERPRETING THE INPEFA CURVE

The INPEFA curve reveals trends in the spectral properties of the log data. An interval characterised by one trend is separated from intervals of the opposite trend (above and below) by more or less sharp turning (or inflection) points. We call an upward trend of increasing INPEFA values a **positive trend**; an upward trend towards decreasing INPEFA values is a **negative trend**. A change from a negative to a positive trend marks a **positive turning point**; a change from positive to negative is a **negative turning point**.

We can interpret the INPEFA curve in mathematical terms by considering its derivation.

- A **positive trend** marks an interval through which the prediction error filter has persistently under-estimated the log value above the moving window.
- A **negative trend** marks an interval through which the prediction error filter has persistently over-estimated the log value above the moving window.

In geological terms, and assuming that the log in question is the GR log:

- a **positive trend** represents an interval in which the log values are more shaley than predicted; this is a candidate for a transgressive, or flooding, interval;
- a **negative trend** represents an interval in which the log values are more sandy than predicted; this is a candidate for a regressive, or shallowing, interval.

Note that, while the mathematical interpretation is objective, the geological interpretation depends on the context. INPEFA curves from a deepwater marine environment may be interpreted quite differently from INPEFA curves from fluvial sediments.

Further discussion of the geological application of INPEFA curves is beyond the scope of this Manual, but users are invited to discuss ideas with ENRES at any time.

13.4. THE DYNAMIC INPEFA FUNCTION

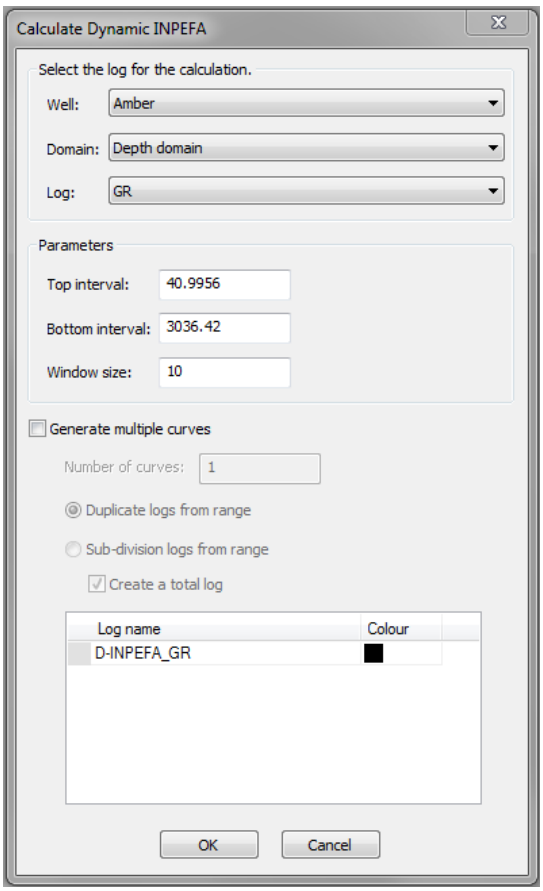
Because of the way INPEFA is calculated, the amount of detail revealed in an INPEFA curve tends to diminish as the interval of analysis gets longer. Therefore, it is often advantageous to analyze only a short section of the data. For example, a correlation study may start by looking for the large-scale longer term features of the INPEFA curve – the longer trends and the major turning points. Having established a preliminary framework from these, the next stage is to look in more detail at the section between the major turning points, to achieve the next higher order

level of detailed correlation. Restricting the INPEFA curve to a narrower interval often yields progressively more detail, allowing increased resolution of correlation.

CycloLog therefore includes a powerful Dynamic-INPEFA function, which allows the depth interval of the INPEFA curve to be modified interactively.

13.4.1. CREATING THE DYNAMIC INPEFA CURVE

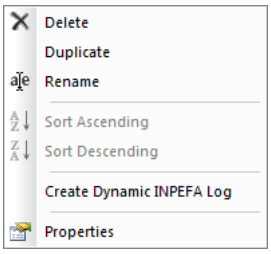
To make a Dynamic-INPEFA curve, go to the Calculations menu and select Dynamic INPEFA (or use the keyboard shortcut CTRL + D). Select the log from the drop-down list. The default values for the Top and Bottom Depths will be the top and bottom of the entire log; you can restrict this if you wish. The Window Size is the length of the moving window for the INPEFA analysis, and can usually be left at the default value of 10m. Click OK, and the Dynamic INPEFA curve will be generated and added to the tree structure in the Workspace worksheet, with the default name of D-INPEFA. It can be renamed if you wish. Using the Generate multiple curve option the user can create multiple dynamic INPEFA curves at the same time.



When generating multiple curves, the user also has the option to split the generated INPEFA curve into a specified number of smaller subsections, using the “Sub-division logs from range” radio button. It is also possible to generate an additional INPEFA log with these sub-divided logs that contains the entire INPEFA data. Note: the number of curves you enter applies to the number of divisions in this case; the optional “Create a total log” function adds another log to this list.

13.4.2. QUICK CREATE THE DYNAMIC INPEFA CURVE

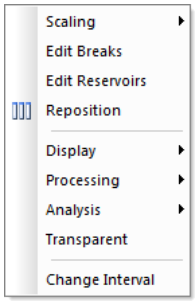
Dynamic INPEFA curves can also be created from the Workspace. For logs which can be used as the basis for a dynamic INPEFA curve, an extra option is added to the right click menu.



When the Create Dynamic INPEFA log menu item is clicked the Calculate Dynamic INPEFA window appears. The well, domain and log settings are automatically set for the active log. When the OK button is clicked the newly generated INPEFA curve will be added to the Workspace.

13.4.3. CHANGING THE DYNAMIC INPEFA ANALYSIS INTERVAL

Open the Dynamic INPEFA log by double-clicking on its name in the Workspace tree structure. It opens in a normal Data Pane. The only difference is that the right-click menu has an additional item: Change Interval. To restrict the interval of analysis for the INPEFA curve, click Change Interval on the data pane right-click menu. Colored lines appear at the top and bottom of the INPEFA curve and the cursor changes to a hand symbol. Move the lines by dragging with the left mouse button; the INPEFA curve is instantly recalculated for the new interval.



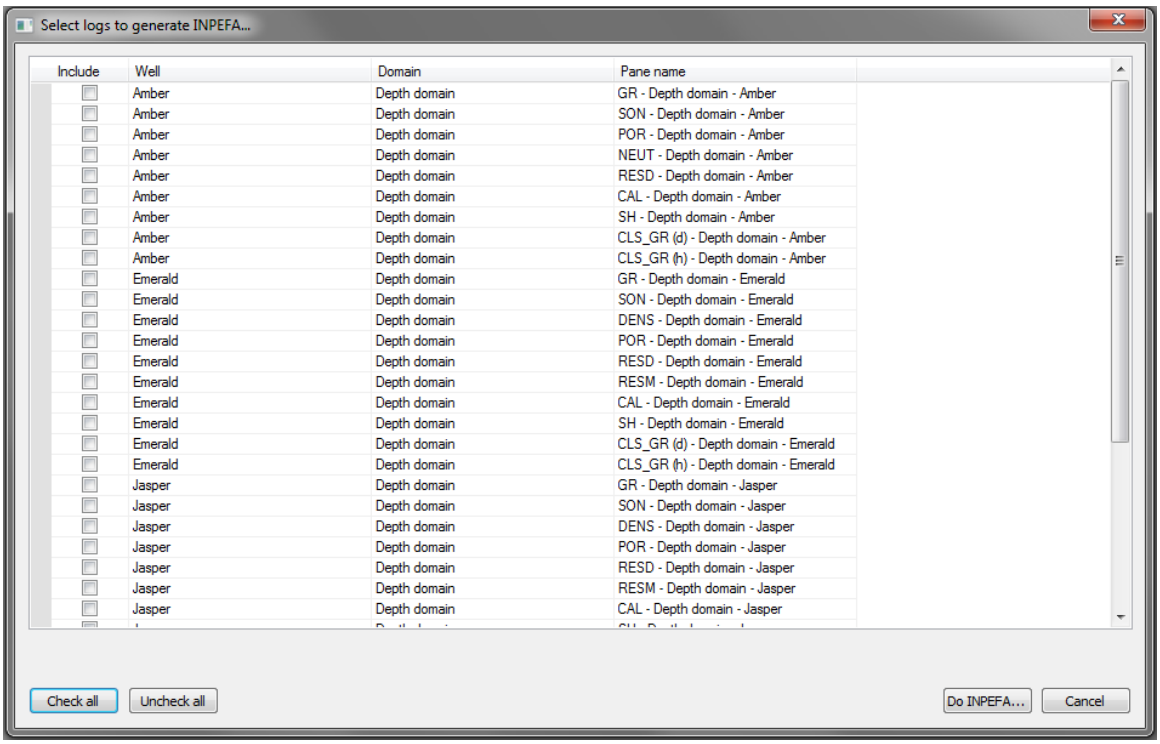
To stop adjusting the analysis interval and change the cursor back to the pointer, click Change Interval again.

14. BATCH PROCESSING

14.1. BATCH INPEFA OPERATIONS

Select the menu item Batch Operations -> INPEFA…

The user will be presented with the Batch INPEFA log selection dialog:

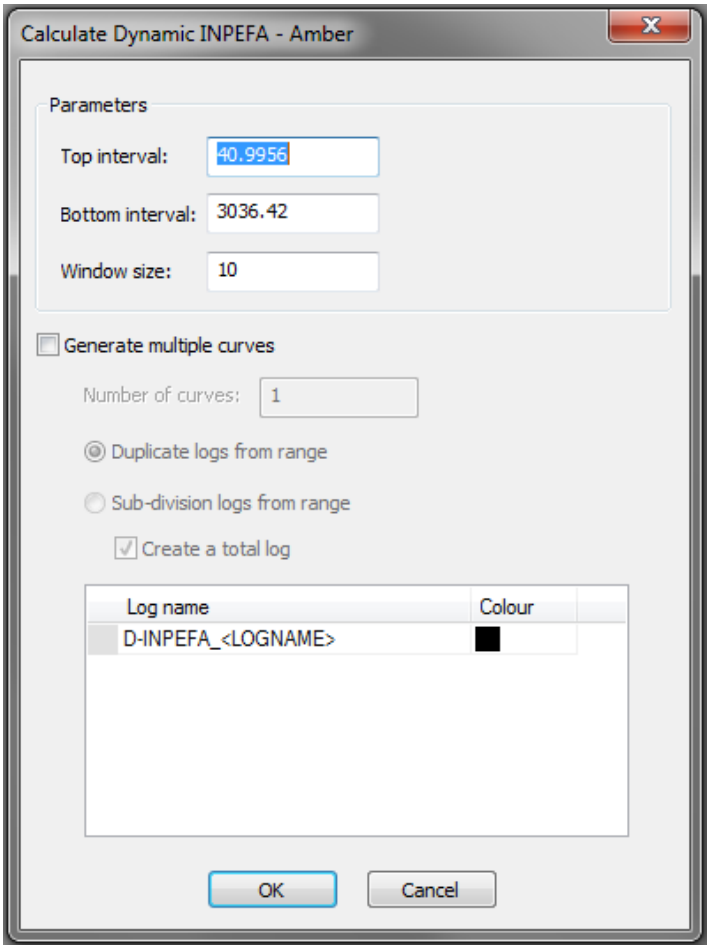


Include	Well	Domain	Pane name
	Amber	Depth domain	GR - Depth domain - Amber
	Amber	Depth domain	SON - Depth domain - Amber
	Amber	Depth domain	POR - Depth domain - Amber
	Amber	Depth domain	NEUT - Depth domain - Amber
	Amber	Depth domain	RESD - Depth domain - Amber
	Amber	Depth domain	CAL - Depth domain - Amber
	Amber	Depth domain	SH - Depth domain - Amber
	Amber	Depth domain	CLS_GR (d) - Depth domain - Amber
	Amber	Depth domain	CLS_GR (h) - Depth domain - Amber
	Emerald	Depth domain	GR - Depth domain - Emerald
	Emerald	Depth domain	SON - Depth domain - Emerald
	Emerald	Depth domain	DENS - Depth domain - Emerald
	Emerald	Depth domain	POR - Depth domain - Emerald
	Emerald	Depth domain	RESD - Depth domain - Emerald
	Emerald	Depth domain	RESM - Depth domain - Emerald
	Emerald	Depth domain	CAL - Depth domain - Emerald
	Emerald	Depth domain	SH - Depth domain - Emerald
	Emerald	Depth domain	CLS_GR (d) - Depth domain - Emerald
	Emerald	Depth domain	CLS_GR (h) - Depth domain - Emerald
	Jasper	Depth domain	GR - Depth domain - Jasper
	Jasper	Depth domain	SON - Depth domain - Jasper
	Jasper	Depth domain	DENS - Depth domain - Jasper
	Jasper	Depth domain	POR - Depth domain - Jasper
	Jasper	Depth domain	RESD - Depth domain - Jasper
	Jasper	Depth domain	RESM - Depth domain - Jasper
	Jasper	Depth domain	CAL - Depth domain - Jasper

From here, the user can select individual logs to which INPEFA should be applied.

There are also additional options for Check All and Uncheck All, should this be more appropriate than individual selections.

Once all choices have been made, the user clicks the Do INPEFA… button. For each individual Well referred to by the selected logs, the INPEFA calculation dialog will appear:



The settings here will apply to all logs for the named Well. These settings are the same as for the usual single log INPEFA operation (minus the log and well selection drop down lists) – see section 13.

15. SEISMIC CALCULATIONS

15.1. INTRODUCTION

CycloLog can perform a number of operations for relating logs to seismic data. Most of these depend on availability of a sonic and/or a density log.

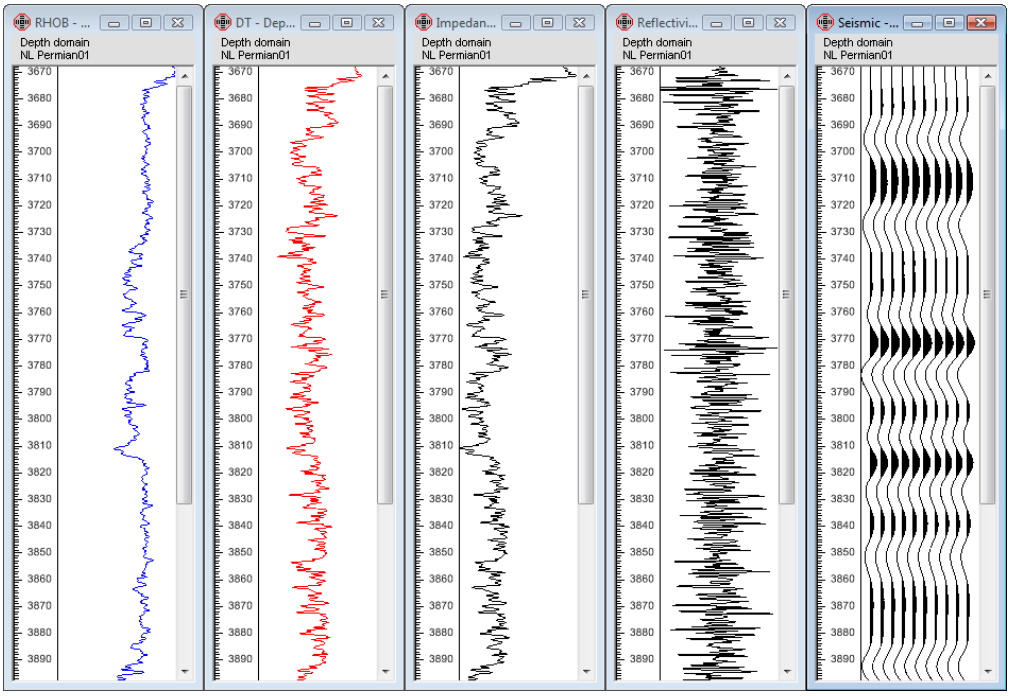
15.2. GENERATING SEISMIC SYNTHETICS MANUALLY

CycloLog can be used to generate a pseudo-seismic section from sonic and density curves.

The first step is to generate an Acoustic Impedance curve; this is done by dividing the density (RHOB) by the sonic (DT). Make a duplicate of RHOB and double-click on the duplicate to display it in a Data Pane.

In the duplicate RHOB data pane, select Processing → Log Calculations → Divide Logs. The Log Math Operations dialog box opens. Select DT as the log by which to divide the density log, and click OK. CycloLog transforms the duplicate RHOB log by dividing it by the DT log. The resulting curve is now the Acoustic Impedance.

Now calculate the reflectivity. Right-click in the Acoustic Impedance pane, select Processing → Seismic Calculations. Click on Reflectivity. The Acoustic Impedance curve is now transformed into a reflectivity curve.



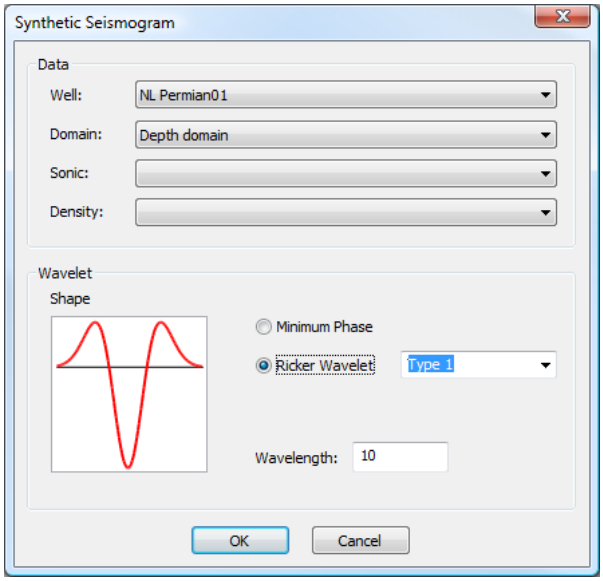
The pseudo-seismic trace is generated from the reflectivity curve and a user-defined seismic wavelength. Two types of wavelets are available to calculate a synthetic seismogram, a minimum phase wavelet or the Ricker wavelet. Right-click in the Reflectivity pane, select Processing → Seismic Calculations → Synthetic Seismogram and choose the wavelet you want to use. In the Calculate Seismics dialog box, input an appropriate seismic wavelength (25m in the illustrated example). Click OK. The reflectivity curve transforms into a single synthetic seismic trace. To distinguish the positive and negative parts, right-click the mouse button in this pane, select Display → Toning. Check the Draw toning box and select positive or negative according to the polarity.

Finally, to create a pseudo-section from the single trace, right-click the mouse button again and select Display → Pseudo Section. The display changes to ten parallel copies of the trace, to give the appearance of a seismic section.

15.3. GENERATE SEISMIC SYNTHETICS

Besides the manual way of calculating seismic synthetics there is an automated way to calculate the seismic synthetics in one step.

To open the Synthetic Seismogram dialog go to the menu bar and click Calculations → Synthetic Seismogram.



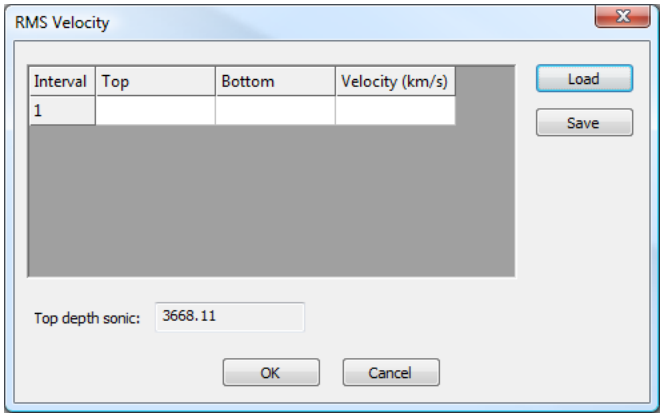
Select the well and the domain for which you want to calculate the seismic synthetic. Then select the Sonic and the Density log you want to use. There are two wavelets you can choose for the calculation, the Minimum Phase wavelet and the Ricker wavelet. When using the Ricker wavelet, you can choose from four types. Type 1 is the standard Ricker wavelet; the other three types are the Ricker wavelets which include more "ringing". After you have specified the wavelength of the wavelet you can click OK. The synthetic seismogram will be added to the tree structure in the Workspace.

15.4. TWO-WAY TRAVEL TIME: TIME-DEPTH CURVES

A graph of two-way time against depth can be calculated from the sonic log. (This calculation creates a new log, so you do not need to make a duplicate of the sonic log.) Go to the right-click menu in the sonic log data pane, and select Processing → Seismic Calculations → Two-way Travel Time. You will be prompted for a reference depth, the default value being the minimum depth of the current dataset. Enter a depth (within the depth range of the current dataset) at which the two-way time is known, and enter the two-way travel time in milliseconds. CycloLog calculates the time-depth relationship for the whole depth interval of the current dataset, creating a new log in the Workspace tree structure. The new log is named Time-Depth Curve; it can be re-named.

15.5. RMS VELOCITY

A RMS Velocity log can be calculated from the sonic log. Make a duplicate of the sonic log, and display it in a data pane. Go to the right-click menu in that data pane, and select Processing → Seismic Calculations → RMS Velocity.



If the sonic log is not available from the top of the well, you may define the velocity model for the top part of the well yourself. (If no intervals are specified, the velocity for the missing interval is assumed to be zero.) In the above dialog box, you are told that sonic data are available from 3668.11m, so you need to define the velocity for the interval from 0 to 3668.11m. You can define this as a single interval of constant velocity, or as several successive intervals. Enter the top depth interval and the average velocity for that interval. Press return to add another interval. You can save this data as an ASCII file by pressing the Save button. If you already have a saved velocity model, you can retrieve it by pressing the Load button.

Now press OK to transform the DT log to RMS velocity.

15.6. CONNECTING RMS VELOCITY AND TWO-WAY TIME

Using the two-way travel time calculated from the sonic, the RMS velocity can be connected to the seismic time.

Make a duplicate of the sonic log, and display the log in a data pane. Go to the right-click menu in that data pane, and select Processing → Seismic Calculations → Two-Way Traveltime option. A dialog box opens in which you can specify a reference TWT for a reference depth

(default depth is the top of the sonic data). Click OK to transform the sonic log into a two-way time log.

15.7. SONIC FROM DENSITY AND VICE VERSA

CycloLog uses standard functions to estimate a sonic log if you only have a density log, or a density log if you only have a sonic log.

To calculate a sonic log from a density log, go to the Calculations menu on the main Menu Bar, and select Sonic from Density. In the dialog box, check that you are in the right well and domain, and select the density log from the drop-down list. Click OK, and CycloLog will create a new log and add it to the tree structure in the Workspace worksheet, giving it the name Calculated Sonic.

The formula to calculate the sonic log from the density log is:

$$DT = \frac{10^6}{\left(\frac{RHOB}{0.23}\right)^4}$$

To calculate a density log from a sonic log, go to the Calculations menu and select Density from Sonic. In the dialog box, check that you are in the right well and domain, and select the sonic log from the drop-down list. Click OK, and CycloLog will create a new log and add it to the tree structure in the Workspace worksheet, giving it the name Calculated Density.

The formula to calculate the sonic log from the density log is:

$$RHOB = 0.23 * \left(\frac{1}{DT} * 10^6\right)^{0.25}$$

16. PETROPHYSICS

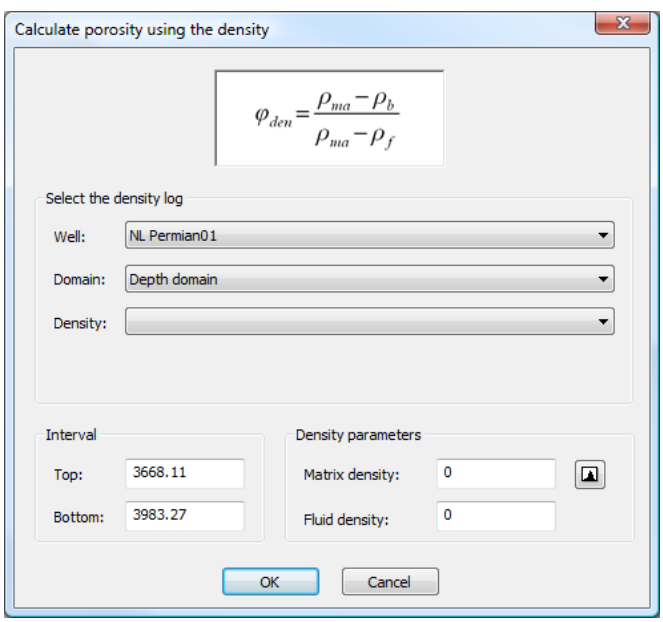
CycloLog offers some routines for basic petrophysical analysis. It is possible to calculate porosities, permeabilities and the water saturation. It is also possible to apply a correction to the calculated porosity and permeability using core measurements.

16.1. CALCULATE POROSITY

CycloLog offers three ways of calculating the porosity depending on the logs available. The porosity can be calculated using the density curve, the sonic curve or a combination of the density and the neutron density curves.

16.1.1. USING DENSITY

To calculate the porosity from the density curve go to the Petrophysics menu, choose Porosity and click on Use Density log.



Select the density log you want to use for the porosity calculation in the Select the density log section. In the Interval section you can define the interval for which you want to calculate the

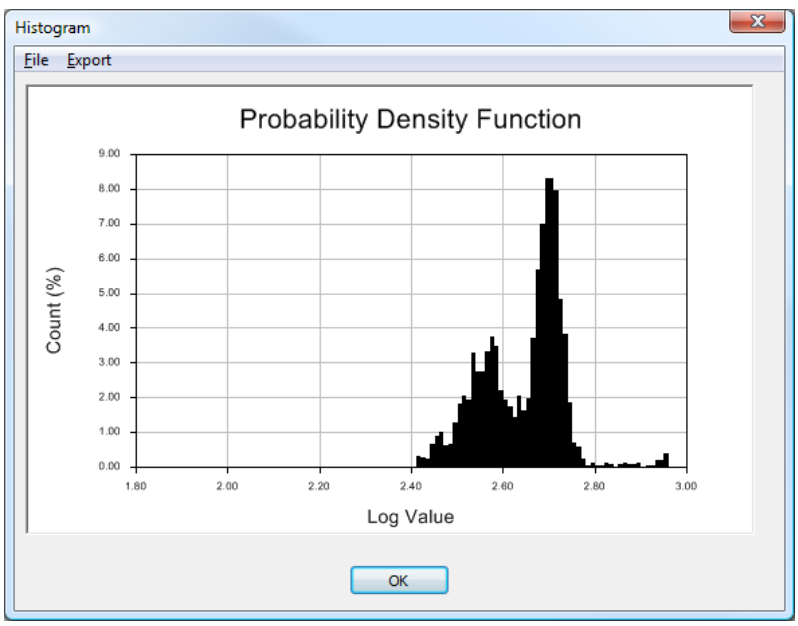
porosity. In the Density parameters section you will have to define the Matrix density and the Fluid density for the calculation.

Commonly used values for the matrix density are:

Lithologies	Matrix density (g/cc)
Quartz / sandstone	2.648
Calcite / limestone	2.710
Dolomite	2.850
Anhydrite	2.977
Halite	2.032

Commonly used values for the fluid density are 1.0 g/cc for fresh mud systems or 1.1 g/cc for salt mud systems.

If you like to infer the matrix density from the data, you can use the Histogram button next to the Matrix density box.

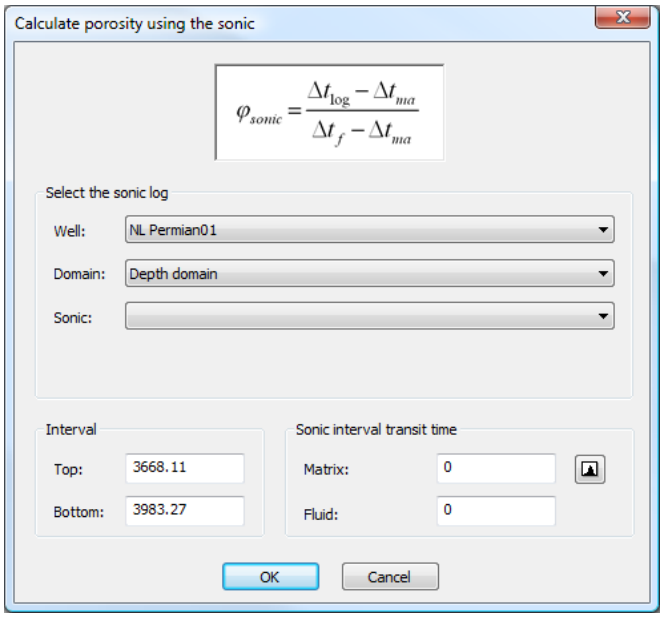


The density values for the defined interval are shown in a histogram. Using the left mouse button you can select the density you want to use. A single red line is drawn on the left mouse click position. If you close the histogram by clicking on the OK button, the selected density is automatically placed in the Matrix density box.

When you click on the OK button in the Calculate porosity using the density dialog, a new log is created and added to the tree structure in the Workspace.

16.1.2. USING SONIC

To calculate the porosity from the sonic curve go to the Petrophysics menu, choose Porosity and click on Use Sonic log.



Select the sonic log you want to use for the porosity calculation in the Select the sonic log section. In the Interval section you can define the interval for which you want to calculate the porosity. In the Sonic interval transit time section you will have to define the Matrix transit time and the Fluid transit time for the calculation.

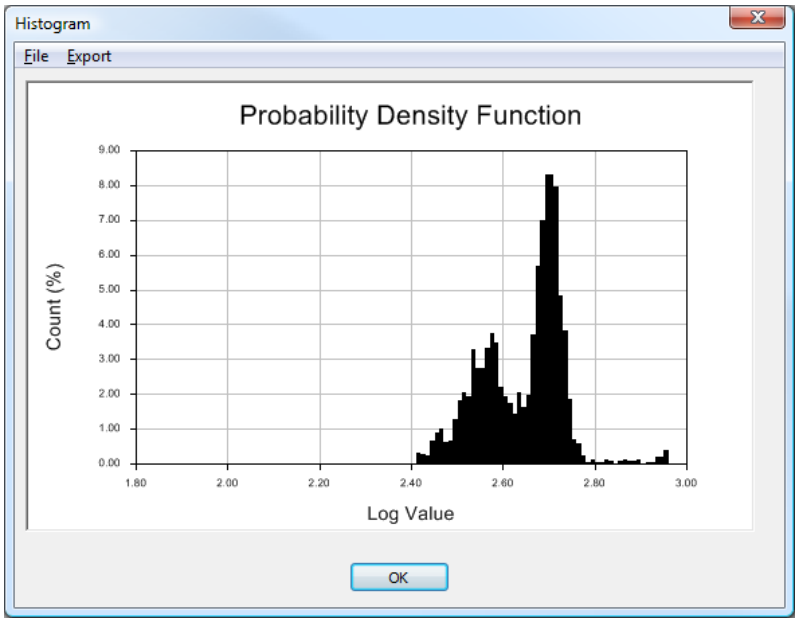
Commonly used values for the matrix transit time are:

Lithologies	Δt_{ma}(µs/ft)
Sandstones	55.5 or 51.0
Limestones	47.5
Dolomites	43.5
Anhydrite	50.0
Salt	67.0

Casing (iron)	57.0

Commonly used values for the fluid transit time are 189 µs/ft for fresh mud systems or 185 µs/ft for salt mud systems.

If you like to infer the matrix transit time from the data, you can use the Histogram button next to the Matrix box.

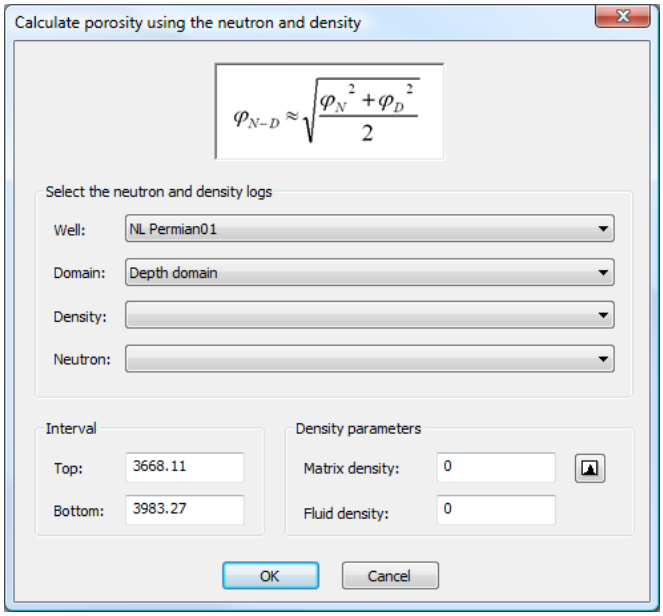


The sonic values for the defined interval are shown in a histogram. Using the left mouse button you can select the matrix transit time you want to use. A single red line is drawn on the left mouse click position. If you close the histogram by clicking on the OK button, the selected matrix transit time is automatically placed in the Matrix box.

When you click on the OK button in the Calculate porosity using the sonic dialog, a new log is created and added to the tree structure in the Workspace.

16.1.3. USING DENSITY AND NEUTRON DENSITY

To calculate the porosity from the density and the neutron curve go to the Petrophysics menu, choose Porosity and click on Use Density and Neutron log.



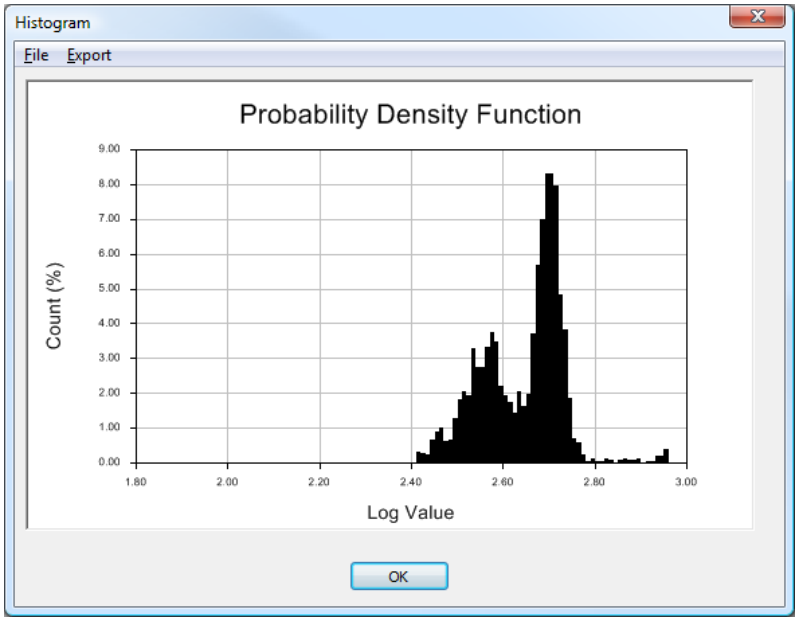
Select the density log and the neutron log you want to use for the porosity calculation in the Select the neutron and density logs section. In the Interval section you can define the interval for which you want to calculate the porosity. In the Density parameters section you will have to define the Matrix density and the Fluid density for the calculation.

Commonly used values for the matrix density are:

Lithologies	Matrix density (g/cc)
Quartz / sandstone	2.648
Calcite / limestone	2.710
Dolomite	2.850
Anhydrite	2.977
Halite	2.032

Commonly used values for the fluid density are 1.0 g/cc for fresh mud systems or 1.1 g/cc for salt mud systems.

If you like to infer the matrix density from the data, you can use the Histogram button next to the Matrix density box.



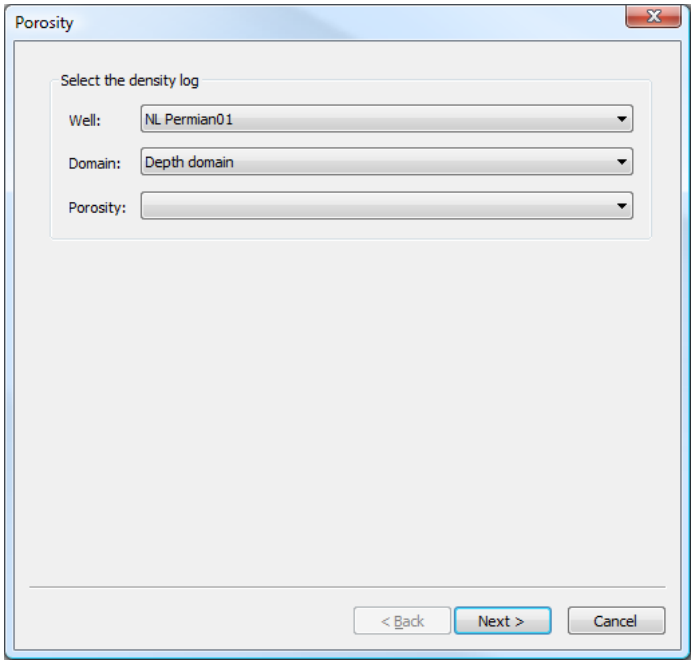
The density values for the defined interval are shown in a histogram. Using the left mouse button you can select the density you want to use. A single red line is drawn on the left mouse click position. If you close the histogram by clicking on the OK button, the selected density is automatically placed in the Matrix density box.

When you click on the OK button in the Calculate porosity using the neutron and density dialog, a new log is created and added to the tree structure in the Workspace.

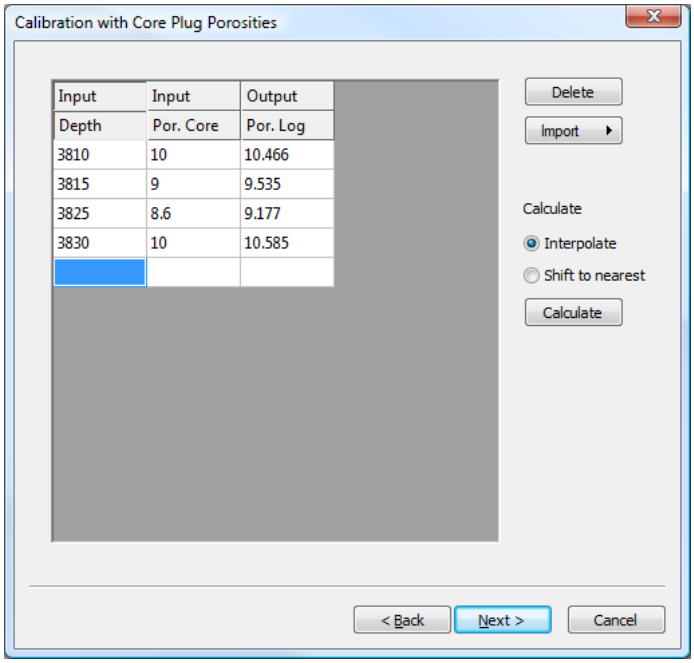
16.2. CALIBRATE POROSITY

The calculated porosity can be calibrated using true porosity measurements. For the calibration a relationship is calculated between the calculated and true porosities. This relationship is used to calibrate every sample in the calculated porosity curve.

To calibrate the porosity, go to the Petrophysics menu and select Calibrate Porosity.



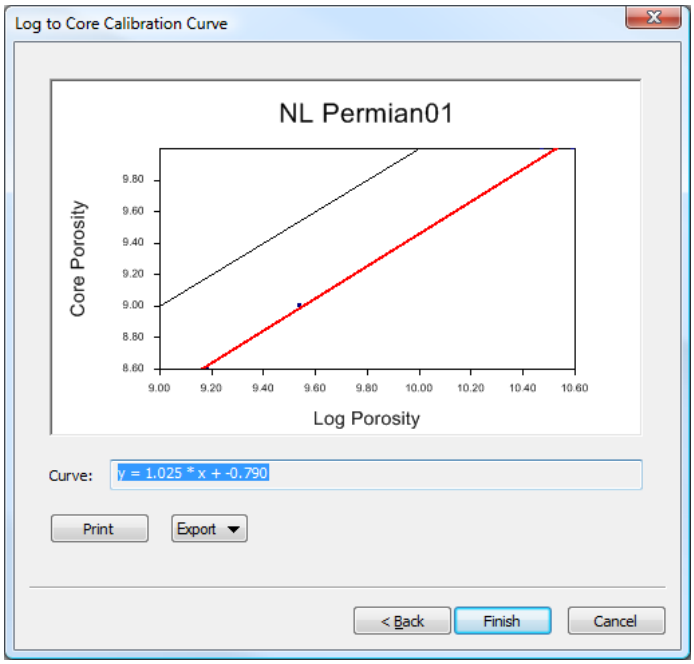
In this dialog you can select the porosity log you would like to calibrate. Click Next to go to the next step in the calibration.



You will see a grid in which you can type in the depths and the core porosities at those depths. The Calculate button can be used to obtain the porosities from the porosity curve. The curve porosities at a specific depth can be calculated using an interpolation between the two

porosities closest to the given depth or you can use the nearest porosity in the porosity curve. The Delete button will clear the grid, the Import button can be used to insert the depths and core porosities from a file or the clipboard.

Click Next to go to the next step in the calibration.

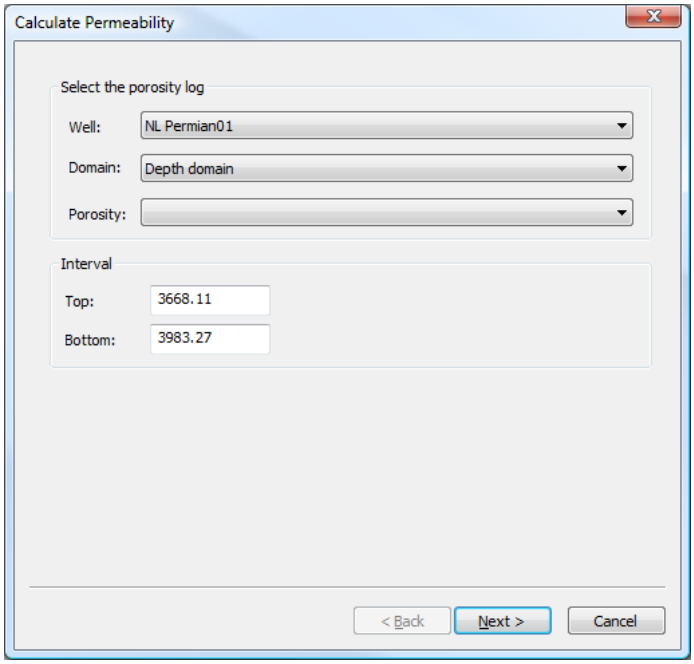


You will see the relationship between the porosities from the porosity curve and the true porosities. The black line is the reference line when no calibration is needed. The red line is the calculated relationship used in the calibration. The black dots in the chart are the given data points. In the Curve box you will see the mathematical formula for the relationship. The chart can be printed or exported to a graphics file for later use.

Click on Finish to complete the calibration on the porosity curve. A new curve is added to the tree structure in the Workspace.

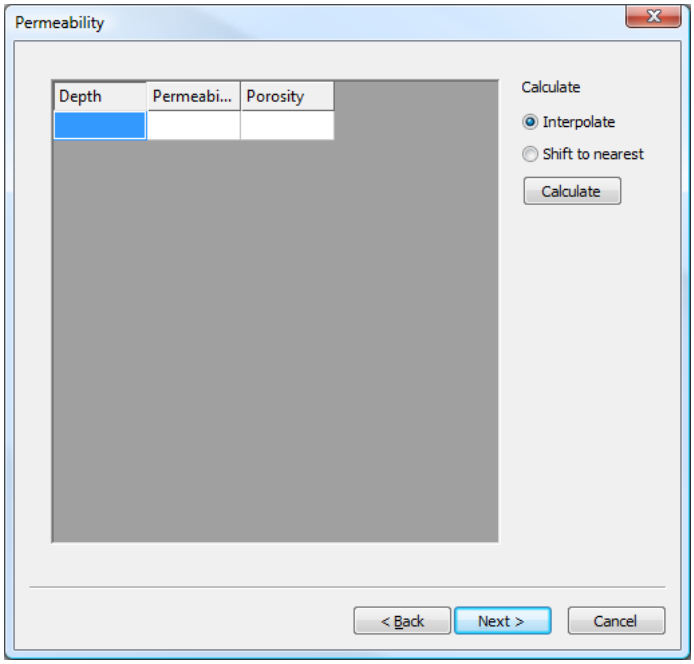
16.3. CALCULATE PERMEABILITY

If you have calculated a porosity curve or a porosity curve is already available and you have core permeability measurements, the permeability curve can be calculated. Go to the Petrophysics menu and select Permeability.



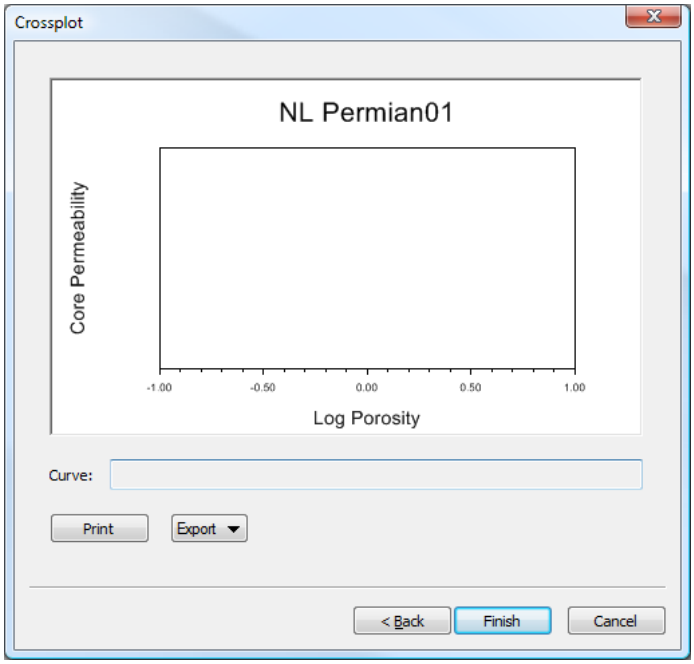
Select the porosity curve used in the calculation in the Select the porosity log section. In the Interval section you can define the interval for which you want to calculate the permeability.

Click Next to go to the next step in the calculation.



You will see a table in which you have to fill in the depths and the core permeabilities. The porosities are automatically inserted if you click on the Calculate button. If the Calculate button is clicked, the porosity is calculated from the porosity curve using the interpolated porosity of the two nearest porosities or the nearest porosity is used.

Click on Next to go to the next step in the calculation.

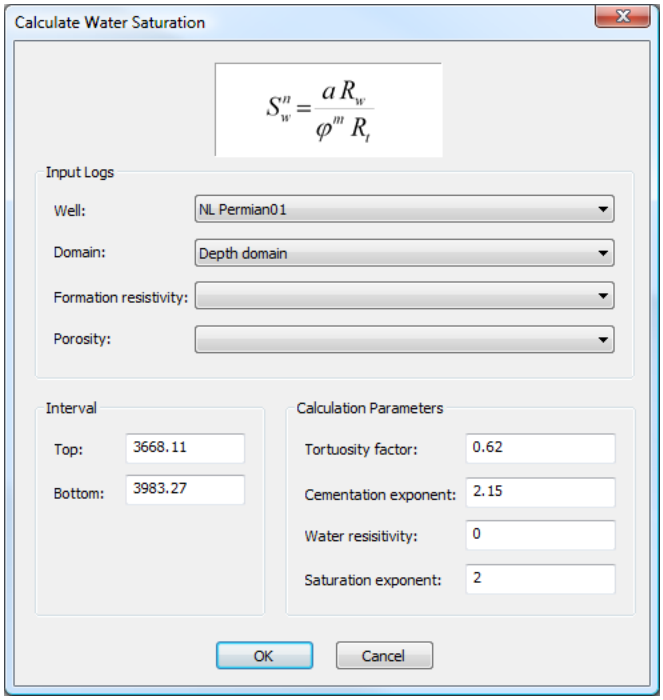


The calculated relationship between the porosity and the measured permeabilities is shown in the chart. The chart can be printed or exported to a graphics file for later use.

If you click in Finish a new log will be added to the tree structure in the workspace.

16.4. CALCULATE WATER SATURATION

You can calculate the water saturation if a porosity curve and the formation resistivity are available. To calculate the water saturation, go to Petrophysics, Water Saturation and select the Water Saturation item.



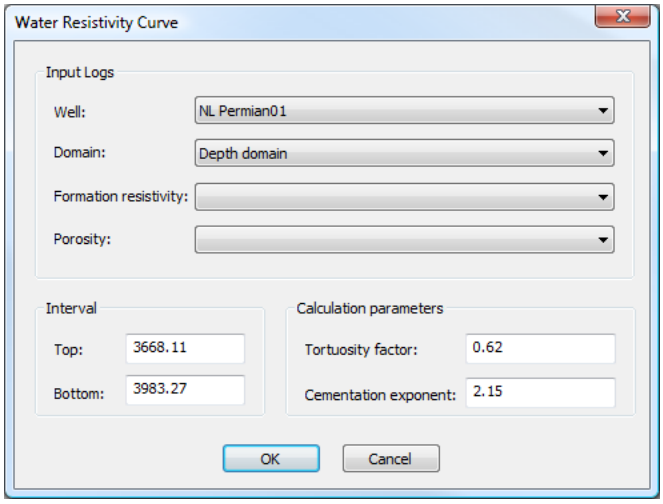
In the input logs you will have to specify the Formation resistivity curve and the Porosity curve. If there is no formation resistivity curve available, sometimes the deep resistivity curve can be used instead. In the interval section you can enter the interval for which you want to calculate the water saturation. In the Calculation parameters you will have to enter the parameters used for the calculation. Most commonly used values for the parameters are:

	Limestones	Sandstones
a (tortuosity factor)	0.62	1
m (cementation exponent)	2.15	2
n (saturation exponent)	2	2

If you click OK the water saturation curve is calculated and added to the tree structure in the Workspace.

16.5. CALCULATE WATER RESISTIVITY

Sometimes if the water resistivity is not known, it is possible to estimate the water resistivity using the Archie equation. To calculate the water resistivity go to the Petrophysics menu, go to the Water Saturation item and select the Water Resistence Curve menu item.

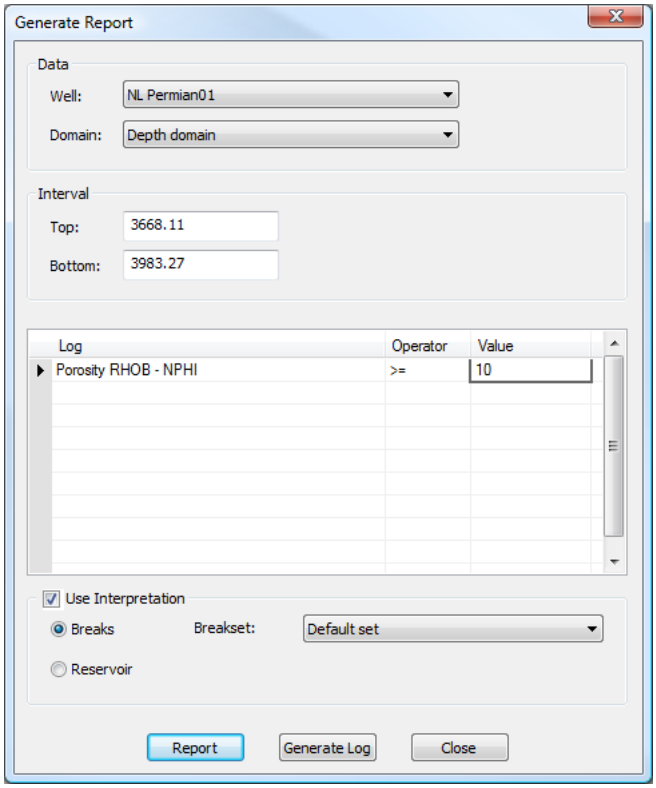


In the Input Logs section you will have to select the Formation resistivity curve and the porosity curve. In some cases if the formation resistivity curve is not available, the deep resistivity curve can be used. In the interval section you can specify for which interval you want to calculate the water resistivity curve. In the Calculation parameters you must enter the tortuosity factor and the cementation exponent. Most commonly used values for these parameters and mentioned in the previous section.

If you click OK the water resistivity curve is calculated and added to the tree structure in the Workspace. If you open the water resistivity curve in a pane and you are able to identify a 100% water bearing layer, you can determine an estimate of the water resistivity in that layer. This value can be used to calculate the water saturation.

16.6. CREATING A PETROPHYSICAL REPORT

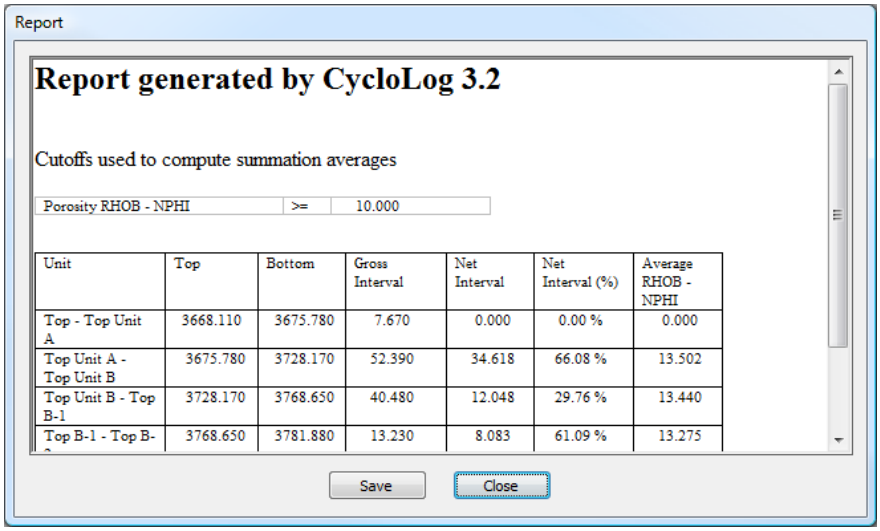
CycloLog provides a way of creating simple reports of petrophysical calculations, e.g. what percentage of the porosity log contains a porosity greater than 10%. For creating reports go to the Analysis menu and choose the Report option.



You can select in the Data section for which Well and Domain you want to make a report. The Interval section defines the interval for which the report is made. In the grid you can define several conditions for the report. A condition consists of a log name, the conditional operator and a value. In the illustration above the condition is defined as the samples of the Porosity RHOB – NPHI log which are greater or equal 10.

The calculations can be made for a total interval, or a break or reservoir interpretation can be used to define sub intervals. To use a break or reservoir interpretation, check the Use Interpretation. Select if you want to use Breaks or Reservoirs to define sub intervals and select the set you want to use.

Click on the Report button to generate the report.



The report shows the conditions you have defined in the grid control. In a table you will find the results of the calculations base on the conditions. The first column shows the top and bottom name of the interval. The second column shows the top of the intervals while the third column shows the bottom of the intervals. The fourth column shows the gross interval which is equal to the bottom minus the top of the interval. The fifth column shows how much of the gross interval satisfy the conditions. The sixth column shows the net interval as a percentage of the gross interval. The following columns show the average of all the samples within the interval which fulfill the condition.

Using the Save button you can save the report into a file for inclusion in a report. Click on the Close button to close the report.

The Generate Report window also contains a button to generate a log from the condition defined. If the Generate Log button is clicked a new log is created and added to the tree structure in the Workspace. The newly created log contains samples which have the value of 1 if they fulfill the conditions otherwise the samples are 0. This log can for example be used to color a GR log on those intervals where the porosity is greater than 10%.

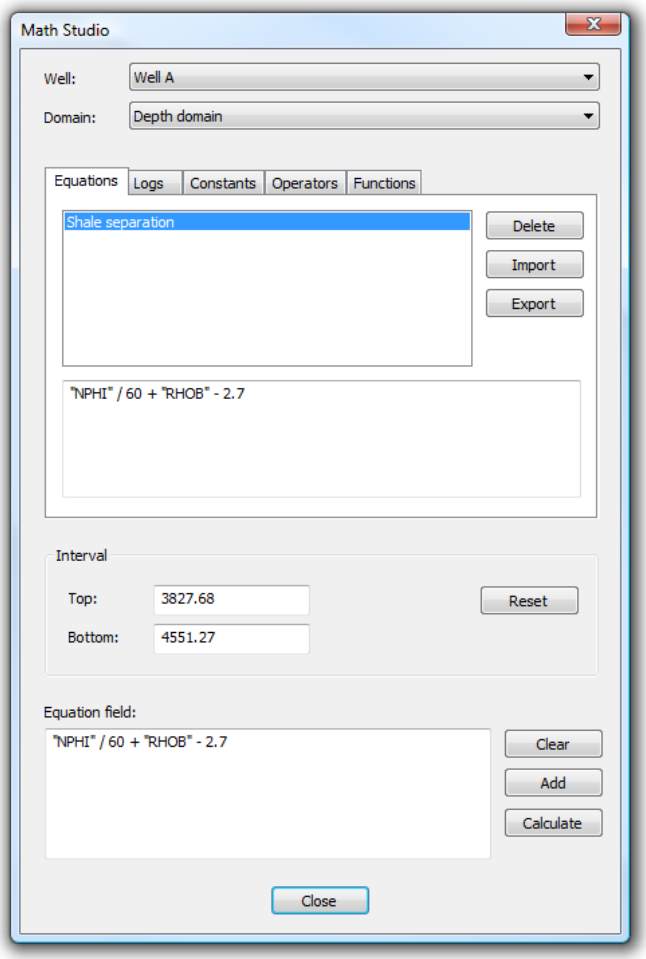
The Close button will close the Generate Report window.

17. MATH STUDIO

17.1. INTRODUCTION

The Math Studio enables many types of mathematical calculations with logs. It uses a conventional mathematical dialog box.

Open the Math Studio by selecting Tools → Math Studio on the main Menu Bar. Click on Tools in the Menu Bar and click on Math Studio. The Math Studio dialog box opens.



The Math Studio can be used to set up, run, and store equations. Defined equations are stored in the project file for future use of the same equation. The elements required to define equations are found in the four tab pages: Logs, Constants, Operators, and Functions.

17.2. SETTING UP AN EQUATION

These elements are added to the Equation Field by double clicking on them. Thus, the equation shown in Known Equations was set up as follows:

1. double-click NPHI from the Logs tab page;
2. double-click the Divide operator (/) from the Operators tab page;
3. type “60”;
4. double-click the Add operator (+) from the Operators tab page;
5. double-click RHOB from the Logs tab page;
6. double-click the Subtract operator (-) from the Operators tab page;
7. type “2.7”.

The equation is then given a name: click the Add button and type a name in the Save Equation dialog box. The equation and its name are added to the Equations tab page. (The example is a measure of the separation of the neutron and density curves on a standard overlay plot, in the case where neutron density is expressed as a percentage. If neutron density is on a scale of 0 to 1, then shale separation is ϕ / 0.6 + ρ – 2.7). The Clear button will clear the equation field area. The Delete button will delete the equation from the Equations tab page and from the project.

17.3. TO RUN AN EQUATION

To run an equation such as the example shown, double-click on its name in the Equations tab page to copy it to the Equation Field. Now click the Calculate button. The equation runs and creates a new log transform, which is added to the tree structure in the Workspace worksheet. The new log transform is given the name of the equation (Shale separation in the example shown), but it can be renamed.

The standard setting for the calculation interval is the complete depth interval. In the Interval area the user can define a different calculation interval. The Reset button will reset the calculation interval back to the whole depth interval.

17.4. SAVING AND RETRIEVING EQUATIONS

To save an equation, click on its name in the Known Equations area, and click the Export button. You will prompted to navigate to a folder, and to give a name for the file, which will be given the file extension *.equ. The file is a text (ASCII) file and can be opened in any text editor.

To retrieve an equation, click the Import button and navigate to the folder where the equation is stored. Double-clicking on the *.equ file will add it to the Equations tab page of the Math Studio dialog box.

18. CLUSTER ANALYSIS OF LOGS

18.1. INTRODUCTION

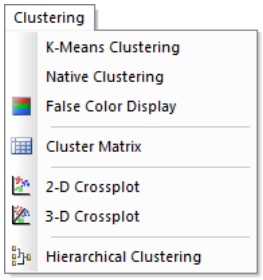
Cluster analysis is the search for groups or clusters in the data in such a way that objects of the same cluster resemble each other, while objects in different clusters are dissimilar. Cluster analysis of log data is used to identify and display distinct electrofacies within the logged section, where each electrofacies is a rock unit having log values that fall within a particular range. Cluster analysis has a variety of uses; for example, it can distinguish different lithofacies (e.g. sandstones, limestones, coals etc) or distinguish different rock properties (e.g. gas-charged versus water-wet sands), provided appropriate logs are used in the analysis. There are two main groups of clustering methods: non-hierarchical and hierarchical.

Non-hierarchical cluster analysis groups objects into a pre-determined number of groups, using an iterative algorithm that optimizes a chosen criterion. Starting from an initial classification, units are transferred from one group to another or swapped with units from other groups, until no further improvement can be made to the criterion value. CycloLog has two methods of non-hierarchical clustering: CycloLog Native Clustering, and K-means clustering.

Hierarchical cluster analysis starts by assigning the n data objects or samples to n separate clusters each containing one member. At each stage of the clustering, the two closest clusters are merged into one larger cluster, until finally all the units have been formed into a single cluster. The results of a hierarchical clustering can be represented by a dendrogram, which indicates the relative distances between samples and groups of samples. CycloLog includes one hierarchical clustering method, with optional stratigraphic constraining.

Beside the automated cluster analyses, CycloLog also provides a way to perform a manual clustering. The user selects the cluster centers or cluster area and lets CycloLog assign data to the clusters.

In addition, CycloLog offers a False Color display function. These functions are accessed from the Clustering menu on the main Menu Bar; some are also available from the Clustering Toolbar.

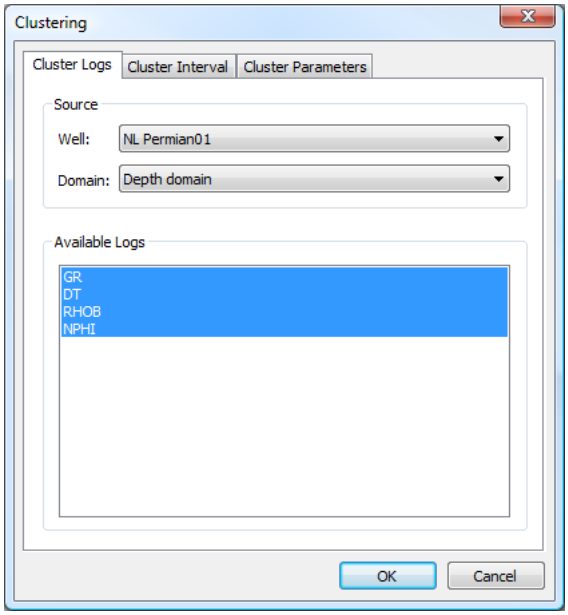


18.2. CYCLOLOG NATIVE CLUSTERING

This method classifies well log data through the selection of a set of representative cluster centers out of a (huge) set of randomly distributed cluster centers. The algorithm used to select or reject cluster centers is based upon minimization of the average distance to cluster centers while the average distance between cluster centers is maximized.

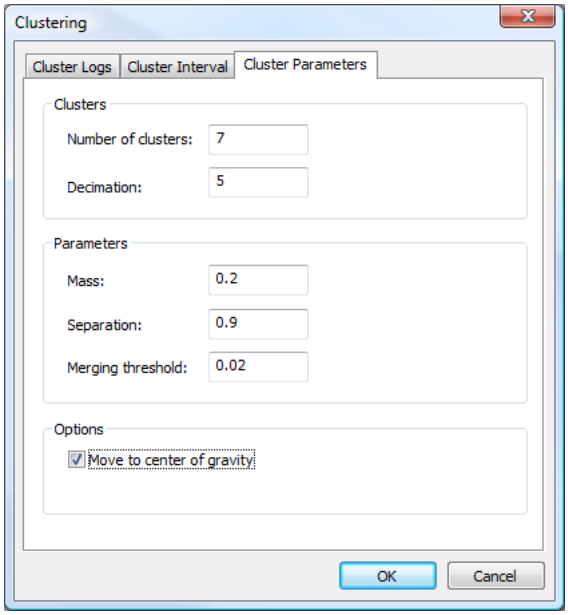
18.2.1. PERFORMING CYCLOLOG NATIVE CLUSTER ANALYSIS

From the Clustering menu, select Native Clustering, to open the Clustering dialog box.



On the Cluster Logs tab, select the logs that you wish to include in the cluster analysis. (If the current project includes more than one well, or more than one domain, select the correct well and domain from the drop-down lists.) On the Cluster Interval tab, enter the top and bottom depths of the interval to be analyzed.

Now select the Cluster Parameters tab, where you can set various parameters that control the details of the clustering process. Users who are not familiar with the details of cluster analysis may prefer to accept all the default values; others may wish to experiment with different values.



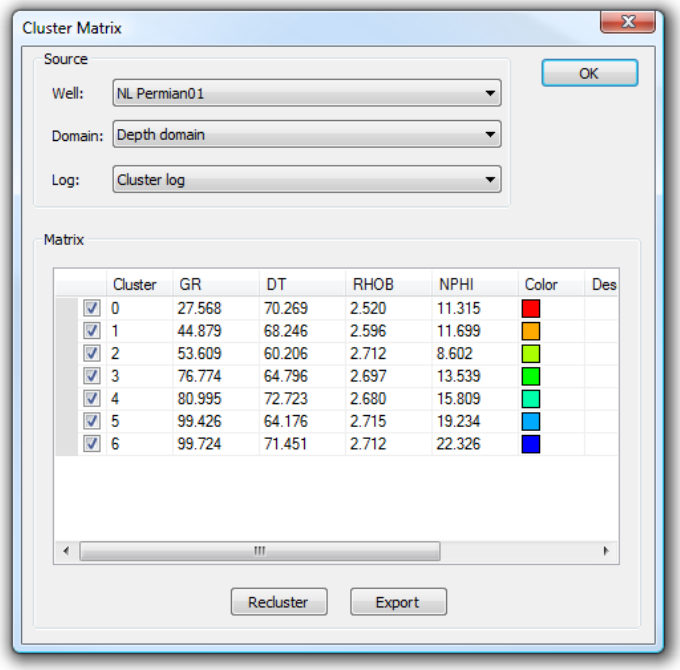
Click OK. A status bar will show the progress of the analysis.

The cluster analysis creates a new log and adds it to the tree structure in the Workspace worksheet; the cluster log will be named Cluster by default, but it can be renamed. Each depth in the analyzed interval is assigned to a numbered cluster according to the values of the logs included in the cluster analysis. The new log therefore comprises an integer value for each depth in the log. Displaying the log in a new data pane will reveal its box-like structure. If you hold down the left mouse button and move the cursor over the data pane, the Status Bar (and the Information Workspace, if open) will show the cluster value at that depth. A good way to see the relationship with the original logs is to use the Display → Color With function to color one of the original logs with the results of the cluster analysis.

18.2.2. USING THE CLUSTER MATRIX

Select Clustering from the Menu Bar and click on Cluster Matrix. The Cluster Matrix dialog box appears. You can also open the Cluster Matrix from the Clustering Toolbar.

The Cluster Matrix displays a summary of the results of a cluster analysis, in the form of a table. Use the drop-down lists at the top of the dialog box if you have run more than one cluster analysis in the current project.



The table shows the mean log values in each cluster, allowing the user to investigate possible relationships between individual clusters and their petrophysical properties. The table has space for comments, in free format, in case you want to record your observations. Note that the order of the clusters is in increasing order of the mean values of the first log in the list. The cluster matrix can be sorted by the value of any of the logs – click on the header of the column by which you want to sort the clusters.

Default colors are assigned to the clusters, but you may change these. Click on the cluster color cell whose color you want to change. Activate the drop down button to select a new color.

You also may give a description to each cluster. Click to select the cluster description cell. The cursor is placed inside the text box and a new description can be typed in the box.

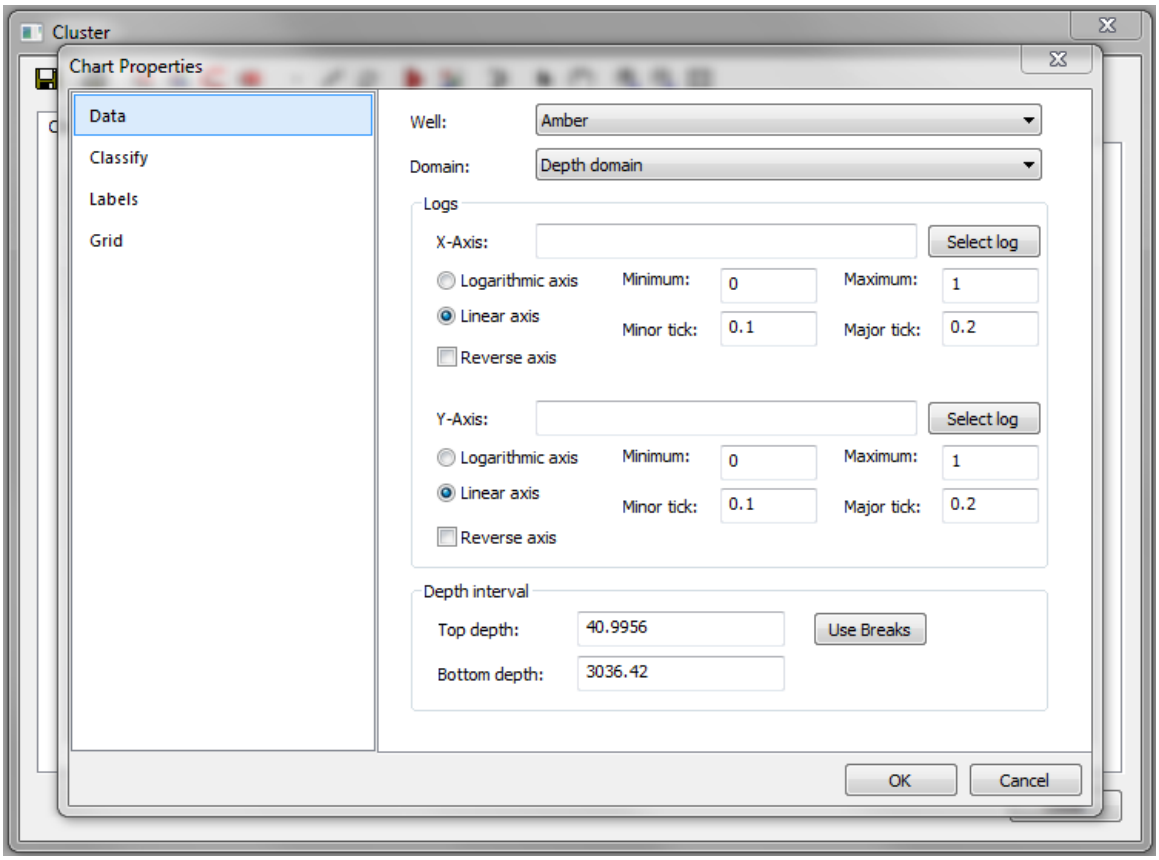
You can delete a cluster, and reassign all the depths to the remaining clusters. To delete a cluster, take away the tick on that cluster and click the Recluster button in the dialog box.

You may also export the cluster scheme. Click the Export button, enter a name for the file, and click OK. The scheme will be exported as an ASCII file with the file extension *.cls. In the current version of CycloLog, this cannot be used to cluster the logs from another well.

18.3. MANUAL CLUSTERING

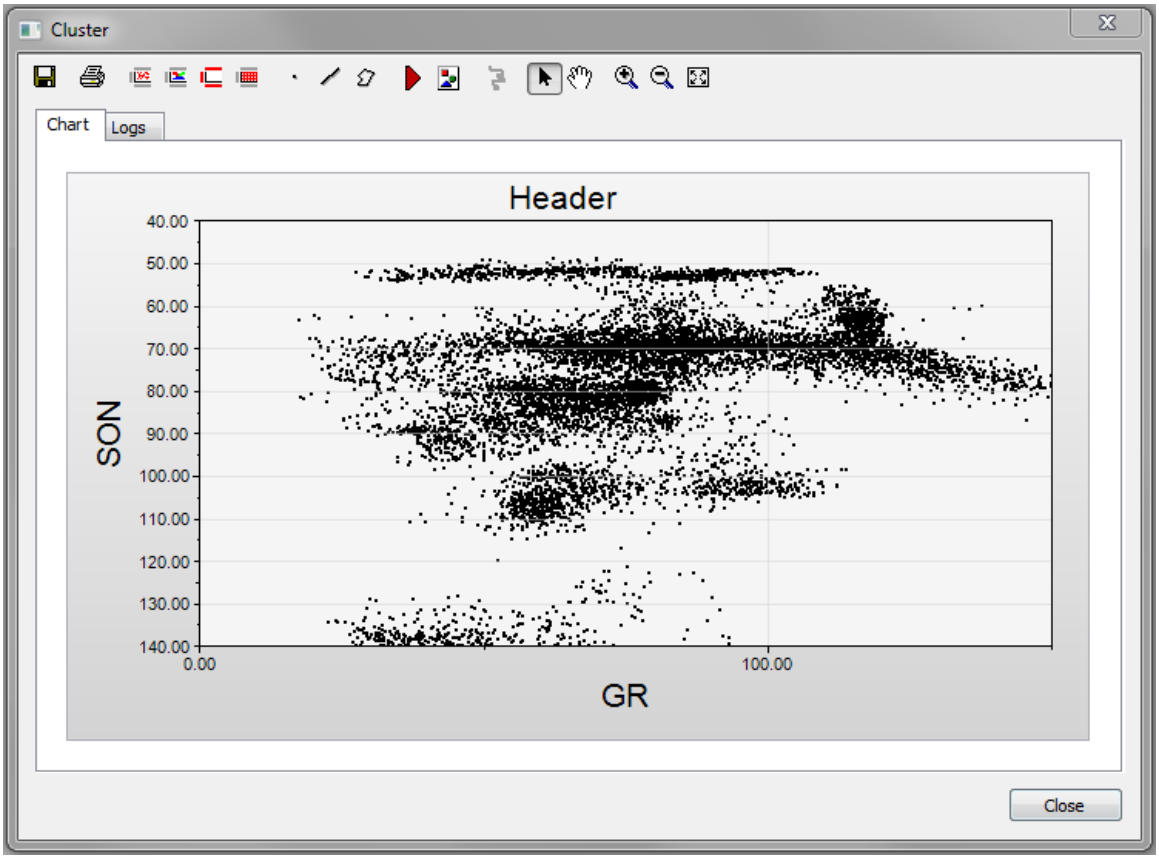
Graphic displays of clusters in two dimensions can be generated manually. The 2-D display can be accessed either from the Clustering menu on the main Menu Bar (select Clustering → 2-D Crossplot), or from the Clustering Toolbar. Either action opens the 2D Crossplot graph box.

On opening the 2D crossplot, the user will be presented with the Chart Properties dialog:



The minimum information the user needs to specify at this point is the X-Axis Log and the Y-Axis Log, using the Select Log buttons in each relevant section of the Data properties page.

Once this is completed, clicking on OK bring up the Cluster chart window.



Cyclolog will, in the absence of user-specific information, attempt to intelligently deduce the correct names for the X and Y axis labels. The user can configure these manually as required (see properties sections below).

On the top side on the dialog you will find the cluster chart toolbar.

: Save as

: Print

: Chart data

: Classify data

: Labels

: Grid

: Cluster center

: Cluster line

: Cluster polygon

: Perform clustering

: Show cluster shapes

: Generate log from cluster results

: Select cluster

: Move cluster

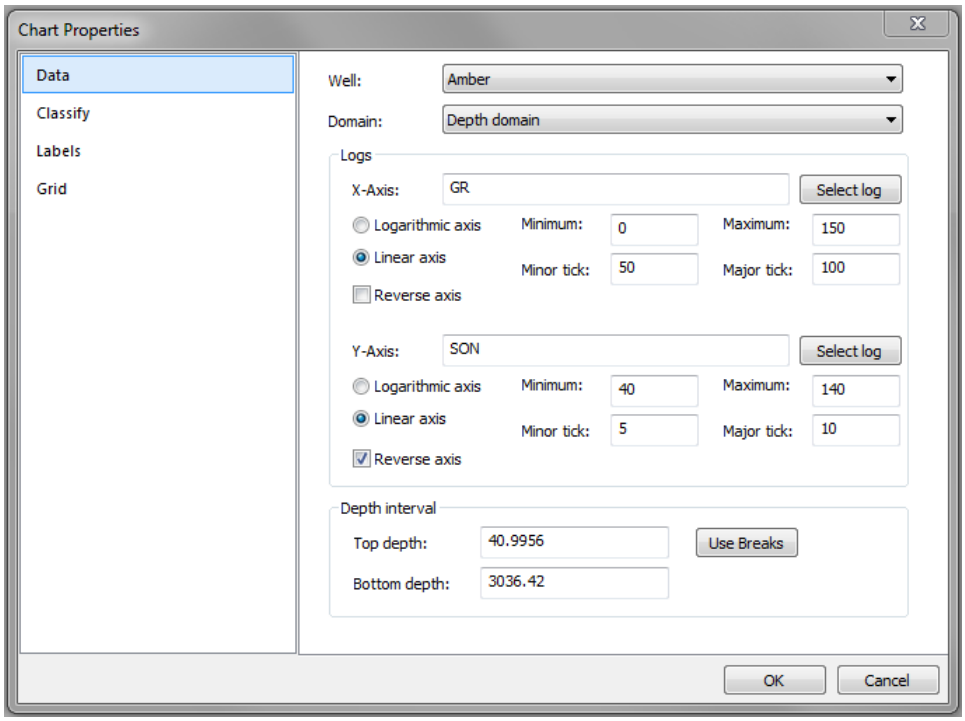
: Zoom in

: Zoom out

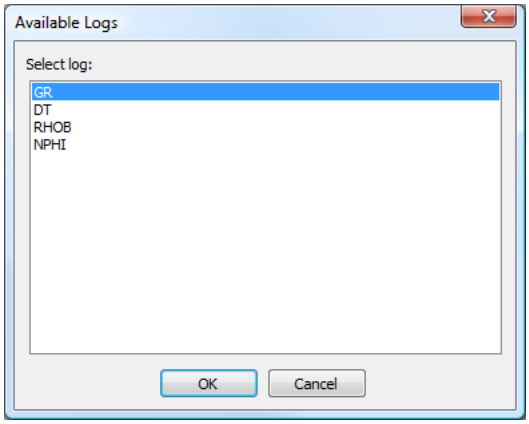
: Reset zoom

18.3.1. CHART DATA

The chart data properties page is displayed when the Cluster window first appears, and also when the user clicks on the Chart data button on the toolbar.



Using the Well and Domain drop-down lists you can select the well and domain of which you want to display data in the chart. The Select log buttons allow you to select the logs you want to display. When one of these buttons is clicked a list appears with available logs.

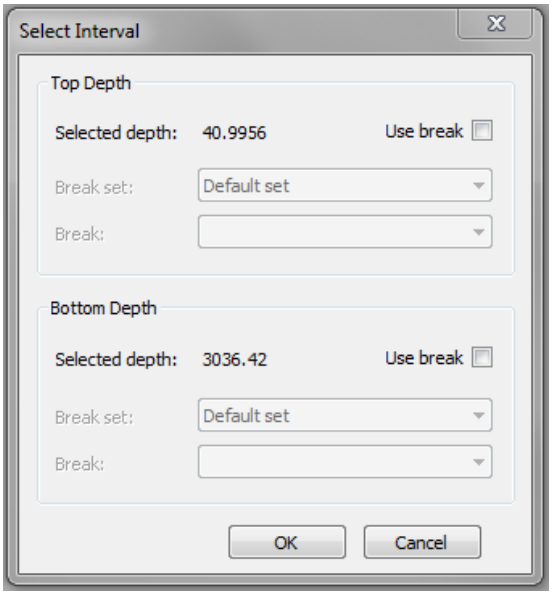


If you have selected the log you want to display and clicked on the OK button, the log name will be displayed on the Chart data window. The axis information will be automatically deduced by Cyclolog for the chosen logs, however these values can be manually configured as required.

The Chart Properties settings for each axis allow for selection of a linear or a logarithmic axis. The Minimum and Maximum boxes let you define the minimum and the maximum of the axis. The Minor tick value draws small markers along the axis using the minor tick value as the distance between the markers. The Major tick value draws larger markers and annotations along the axis with the major tick value as the distance between the markers.

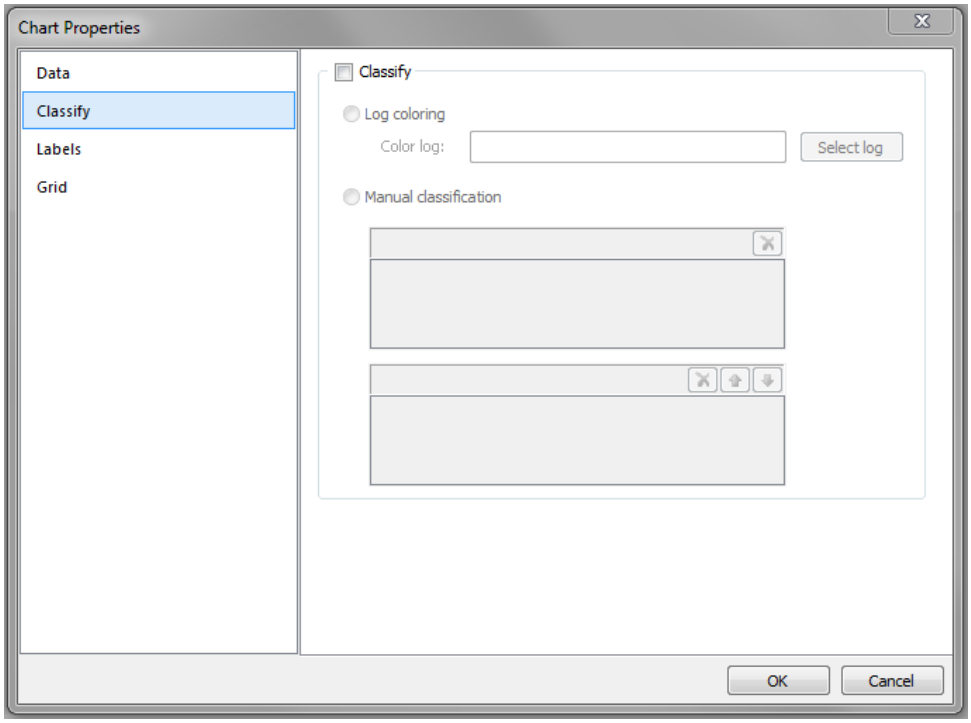
If the Reverse axis option is checked, the axis is reversed with the maximum value on the left side and the minimum value on the right side.

The top and bottom depth can be set manually, or predefined breaks can be used via the Use Breaks button.



18.3.2. CLASSIFY DATA

The Classify Data window can be opened by clicking on the Classify data button on the toolbar.

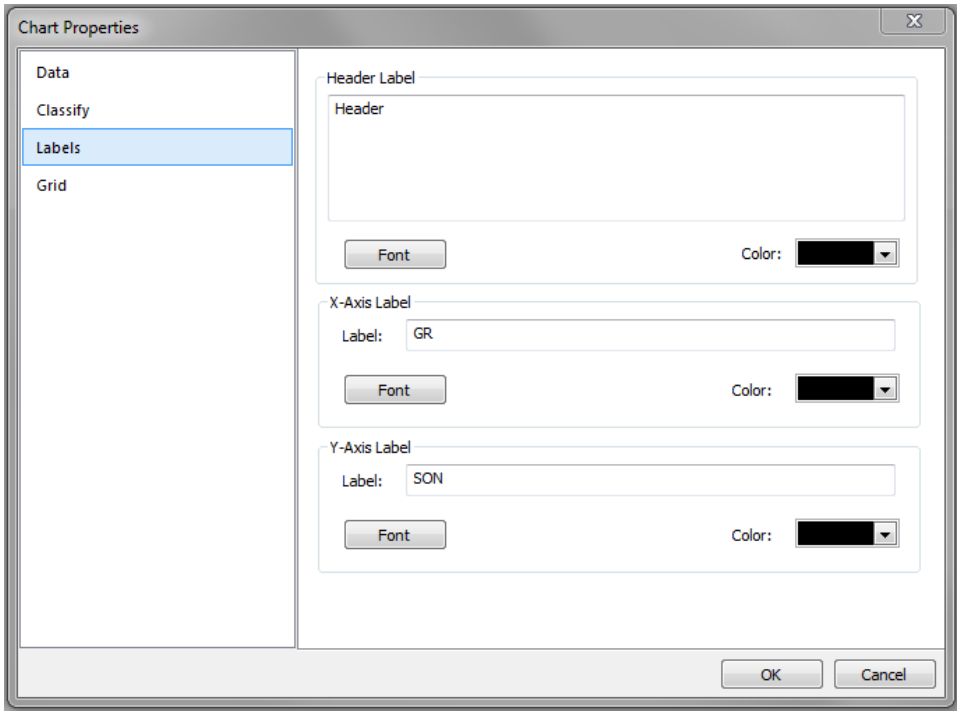


If classification is turned on by checking the Classify option, CycloLog supports two types of classifying. The first classifying type is the Log coloring. If this type is selected, a log can be chosen from a list by clicking on the Select log. The values and color palette from the chosen log are then used to color the samples of the selected data in the chart.

The second classifying type is using the cluster shapes. Cluster shapes, such as cluster centers, cluster lines and cluster polygons, can be drawn manually on the chart. These cluster shapes are used during the clustering operation to assign samples to defined clusters. Cluster centers and cluster lines are listed in the top list box. Cluster polygons are shown in the bottom list box. Cluster shapes can be deleted by selecting a cluster shape form the list box and clicking on the X button in the list box header. The arrows in the cluster polygon list box can be used to change the order in which samples are assigned to a cluster polygon. Since polygons can be overlapping their relative order influences the cluster assignment of samples.

18.3.3. CHART LABELS

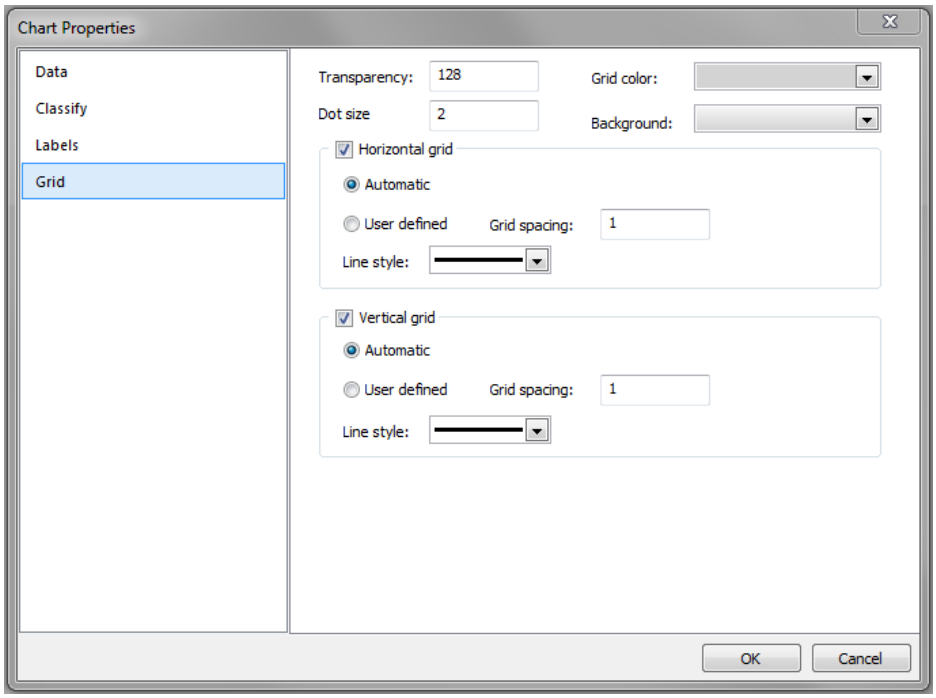
The Chart labels window can be displayed by clicking on the Chart labels button in the toolbar.



In this window you can change the text and style of the chart header, and the labels and style of the axis labels. In the Header Label text box, you can enter the text which appears as a header above the chart. The Font button allows you to change the font type of the header. The Color button lets you change the color of the header. The same applies to the axis fields.

18.3.4. CHART GRID

The Chart grid window can be displayed by clicking on the Chart grid button on the toolbar.



The Transparency box lets you define the transparency of the grid. The value for the transparency must be between 0, full transparency, and 255, full transparency. The transparency allows you to see any data points obscured by the grid lines. The Grid color button can be used to change the color of the grid lines.

The Dot size edit box allows you to specify the size of each point displayed in the Chart. The default is 2, and the maximum value is 32.

The standard chart background is a gradient from light grey to darker grey. The Background button lets you choose a solid color or a gradient as the chart's background.

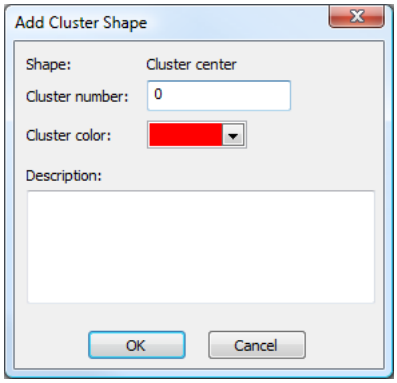
Horizontal and vertical grid lines can be turned on by checking the Horizontal grid or the Vertical grid options. The settings for the grid lines can be automatic or user defined. If the Automatic grid lines are selected, CycloLog decides at which spacing the grid lines are drawn. When the User defined option is selected, you can decide the grid spacing by entering a spacing value in the Grid spacing text box. In the Line style list box, you can select if you want solid grid lines or e.g. dashed grid lines.

18.3.5. CREATING CLUSTERS

Clusters are created by drawing cluster shapes directly on the chart. There are three types of cluster shapes:

- Cluster centers
- Cluster lines
- Cluster polygons, irregularly closed shapes on the chart

Cluster centers can be defined by clicking on the chart. Select the Cluster center option on the toolbar, the mouse cursor is now a cross if you it over the chart. Click on a location on the chart to define a cluster center. A window appears where you can enter additional information about the cluster.



Cluster number shows the identification number of the cluster. This number is automatically generated and need not be changed. The Cluster color button lets you change the cluster color. In the Description area you can enter some additional information.

To define cluster lines, you must select the Cluster line option on the toolbar. Move the mouse to the start of the cluster line and click the left mouse button. Hold down the left mouse button

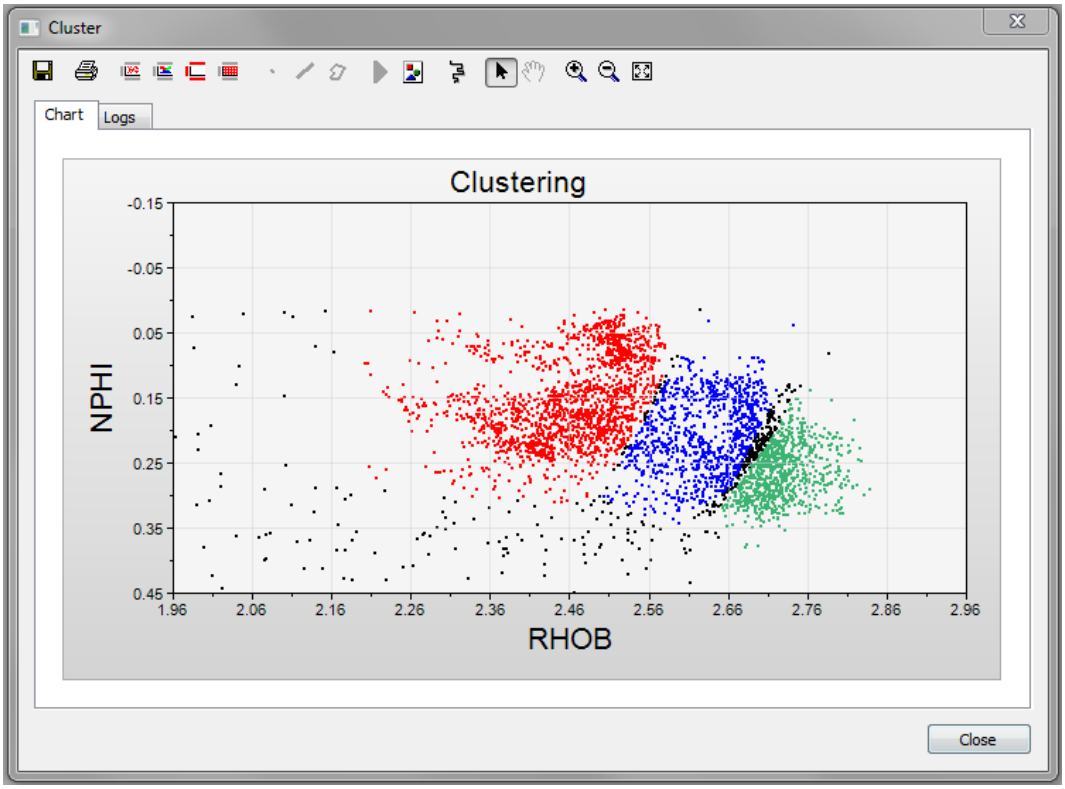
and move to the end of the cluster line. Release the mouse button and the cluster line has been defined. A window appears in which you can define additional cluster properties.

To define cluster polygons, click on the Cluster polygon option on the toolbar. Every left mouse click on the chart is one point of the polygon. For the last point of the polygon, you must double-click on the end location. A closed polygon is drawn on the chart and a window appears in which you can define additional cluster properties.

18.3.6. CLUSTERING

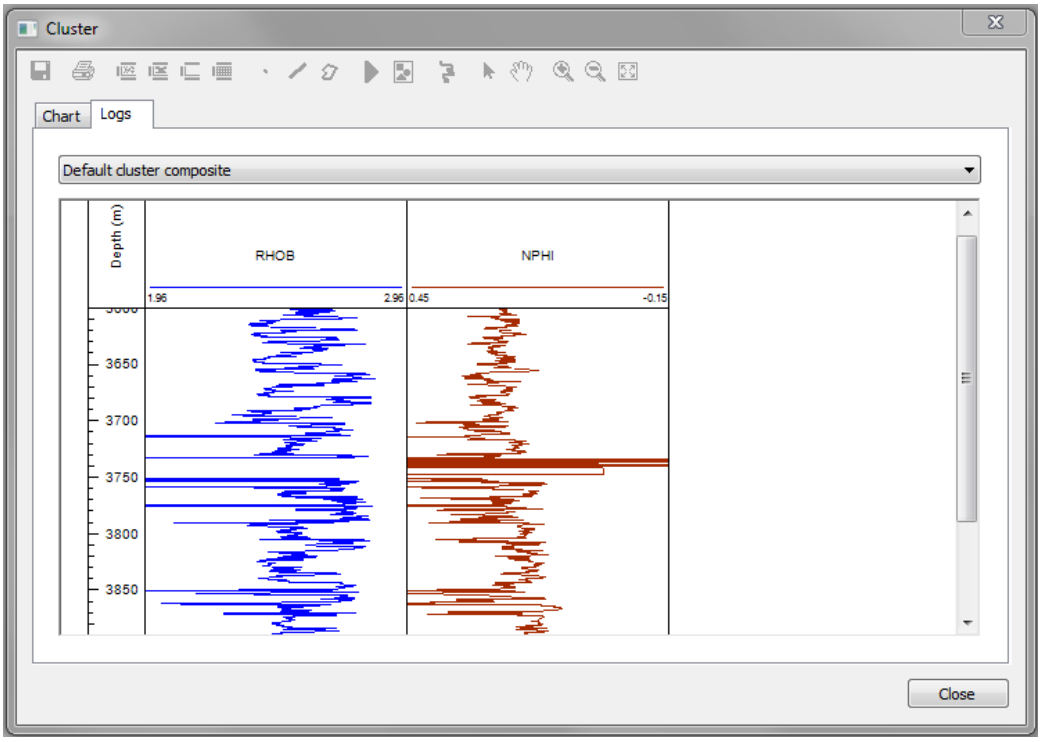
The clustering is performed when the Cluster button on the toolbar is clicked. Clustering of the data occurs in two stages. During the first stage every sample is checked if it lies within a cluster polygon. If a sample lies within a cluster polygon, the sample is assigned to that cluster. During the second stage all unassigned samples are used. Every unassigned sample is assigned to its closest cluster center or cluster line.

If you turn off the cluster shape drawing by clicking on the Show cluster shape button on the toolbar you will see the result of the clustering without the cluster shapes.



Note that if you have turned off the showing of the cluster shape it is not possible to define new clusters. To define new clusters, you must turn on showing of the cluster shapes.

The result of the clustering can also be shown with respect to the logs used. Select the Logs tab to show the clustered logs.



You will see a standard composite chart with a cluster column on the left side. It is also possible to display the cluster column besides other composite charts. You can select an existing composite chart from the available composite charts in the list above the chart.

The result of the clustering can be transformed into a log. If the Generate log button is clicked on the toolbar a new log is generated containing the cluster result. The log is added to the tree structure in the Workspace and can be shown in a separate pane or included in composite charts.

18.3.7. EDITING CLUSTERS

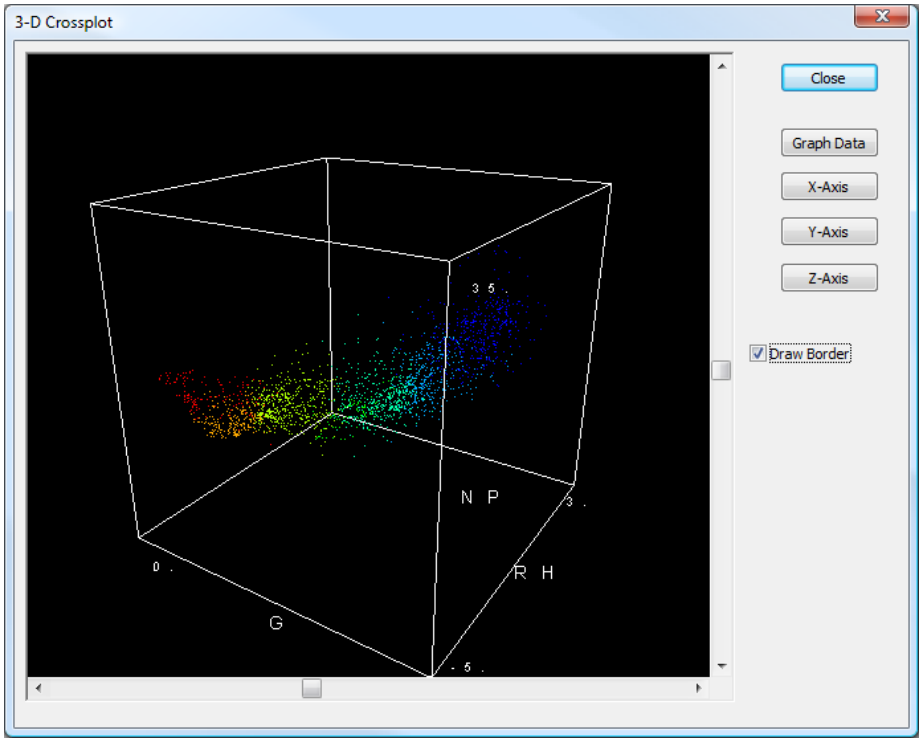
The cluster shapes can be changed by turning on the Move cluster option on the toolbar. The mouse cursor changes into a hand of you move it over the chart. Grab a cluster point by clicking the left mouse button and holding the button down. Move the selected cluster point to its new position and release the left mouse button. Double-clicking on a cluster will show the window in which you can change the cluster properties, such as the color.

18.3.8. ZOOMING

Using the Zoom in and Zoom out buttons on the toolbar, you can take a better look at some parts of the chart. Pressing on the Reset zoom button on the toolbar will reset the zoom and display the chart in its original settings.

18.4. 3-D GRAPHICAL DISPLAY OF THE CLUSTERS

Graphic displays of the clusters in three dimensions can also be generated. The 3-D display can be accessed either from the Clustering menu on the main Menu Bar (select Clustering → 3-D Crossplot), or from the Clustering Toolbar. Either action opens the 3D Crossplot dialog box.



To select the data to be displayed on the 3-D crossplot, click the Graph Data button.

Note that there is an option to display the original log data, without the clusters. Assuming that you want to display the clustering results, select the Cluster option. If you have run more than one cluster analysis, select the appropriate one from the drop-down list. Use the X, Y and Z drop-down lists to select the logs that you want to define the X, Y, and Z axes of the graph.

Return to the 3D Crossplot box by clicking OK. The graph is displayed, with the axes represented by a three-dimensional frame. The axes will be labeled by default with the names of the logs that you have selected, but you can change these labels, and also the numerical details of the axes, by clicking on the X-Axis, Y-Axis and Z-Axis buttons. You can turn the frame on and off with the Draw Border check box.

The graph can be rotated using the scroll bars at the side and bottom of the display.

The 3-D graph cannot be printed or exported.

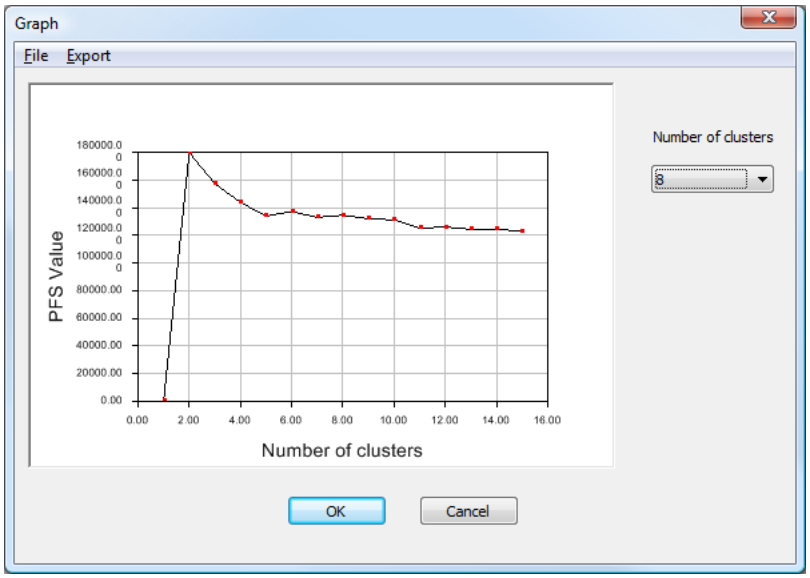
18.5. K-MEANS CLUSTER ANALYSIS

K-means clustering attempts to assign objects to a user-defined number (K) of clusters. A problem with the K-means method is that k cannot be known in advance; there are therefore two stages to the analysis, the first of which is to determine a good value for k. Having selected a value for k, the analysis divides the objects between k random clusters, and then move objects between those clusters with the goals of minimizing variability within clusters and simultaneously maximizing variability between clusters.

From the Clustering menu, select K-Means Clustering, to open the Clustering dialog box.

On the Cluster Logs tab, select the logs that you wish to include in the cluster analysis. (If the current project includes more than one well, or more than one domain, select the correct well and domain from the drop-down lists.) On the Cluster Interval tab, enter the top and bottom depths of the interval to be analyzed. On the Cluster Parameters tab, set the number of clusters; this should be larger than the number of clusters you expect to use – say, 15.

Click OK. A status bar will show the progress of the analysis.



A graph is now displayed, from which the final number of clusters is to be decided. The graph shows how the PFS value (a clustering statistic) falls off with increasing numbers of clusters. Choose a value that represents the point where the graph flattens out; 12 would probably be

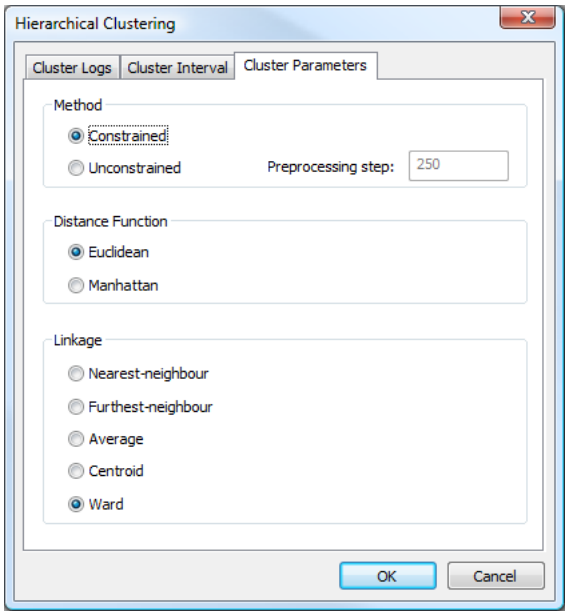
selected from the above graph. From the drop-down list (Number of clusters) select the value 12, and click OK to perform the final cluster analysis.

The cluster analysis creates a new log and adds it to the tree structure in the Workspace worksheet; the cluster log will be named K-means by default, but it can be renamed. Each depth in the analysed interval is assigned to a numbered cluster according to the values of the logs included in the cluster analysis. The new log therefore comprises an integer value for each depth in the log. Displaying the log in a new data pane will reveal its box-like structure. If you hold down the CTRL key and move the cursor over the data pane, the status bar (and the Information Workspace, if open) will show the cluster value at that depth. A good way to see the relationship with the original logs is to use the Display→Color With function to color one of the original logs with the results of the cluster analysis.

18.6. HIERARCHICAL CLUSTERING

To run a hierarchical cluster analysis, select Hierarchical Clustering from the Clustering menu in the main Menu Bar. The Hierarchical Clustering dialog box opens, which has three tabs, for Cluster Logs, Cluster Interval, and Cluster Parameters. On the Cluster Logs tab, select the logs to be included in the cluster analysis. On the Cluster Interval tab, either accept the default interval (which is the total depth interval for the current project) or specify a more restricted interval. The Cluster Parameters tab has options for Constrained or Unconstrained Clustering, the Distance Function to be used, and the type of Linkage to be used.

Unconstrained Clustering places no stratigraphic restriction on the membership of the final clusters; samples from the top of the well could form part of the same cluster as samples from the bottom of the well. In the Constrained version, the analysis is forced to maintain the original order of the samples, so that the resulting dendrogram reflects the similarity between adjacent samples. Instead of scanning the whole distance matrix for the most similar objects, constrained clustering scans just the distances of adjacent cases.



The **Distance Function** is the method of calculating the distance between objects during the clustering:

The **Euclidean distance** is the geometric distance in multidimensional space:

$$d(x,y)=\sqrt{\sum_i (x_i - y_i)^2}$$

The **Manhattan (or city-block) distance** is the average difference across dimensions. In most cases, this distance measure yields results similar to the simple Euclidean distance. However, the effect of single large differences (outliers) is dampened (since they are not squared). The Manhattan distance is computed as:

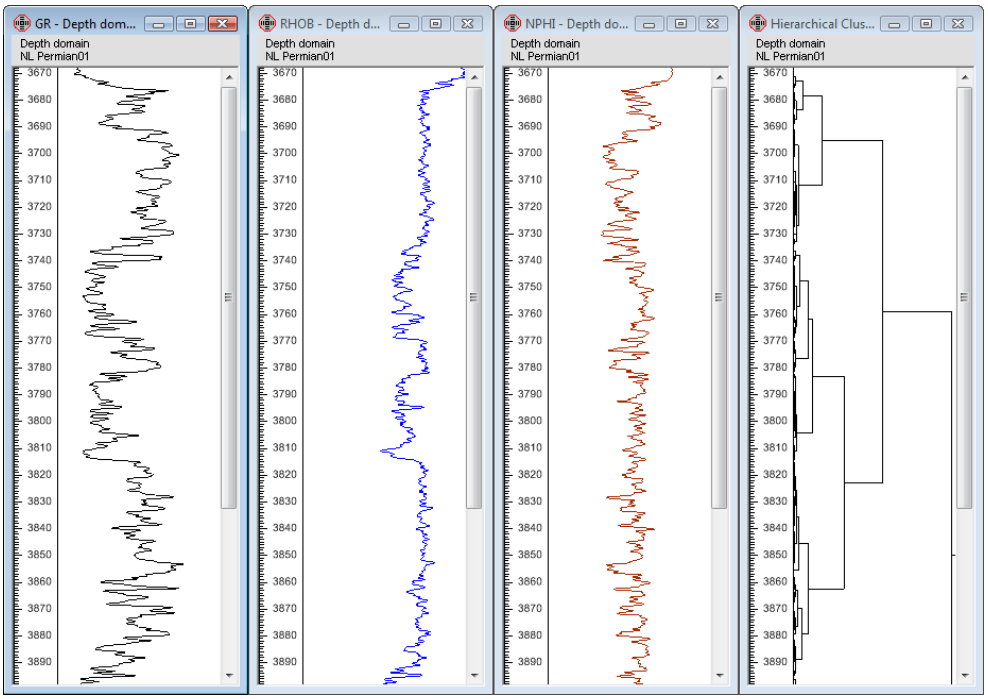
$$d(x,y)=\sum_i |x_i - y_i|$$

The choice of **Linkage** method determines the objects/groups between which the distance is measured. In **Nearest Neighbor** clustering, the distance between one group and another is taken as the distance between their two closest points. **Furthest Neighbor** clustering takes the distance between the two furthest points as being the distance between the two groups. **Average linking** represents the distances between groups as the mean of all the pairwise distances between members of the two groups. The **Centroid method** takes the distance between the centroids of the two groups. **Ward's method** is also called minimum variance clustering: instead of measuring the distances between clusters, the method determines how much variation exists within each cluster. The clusters to be joined in each round of clustering are the two that will give the smallest increase in within-cluster variation.

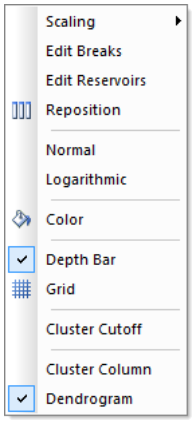
The methods suggested by the default values in the dialog box are Constrained Clustering using Euclidean distances and Ward's distance measure.

18.6.1. CONSTRAINED HIERARCHICAL CLUSTERING

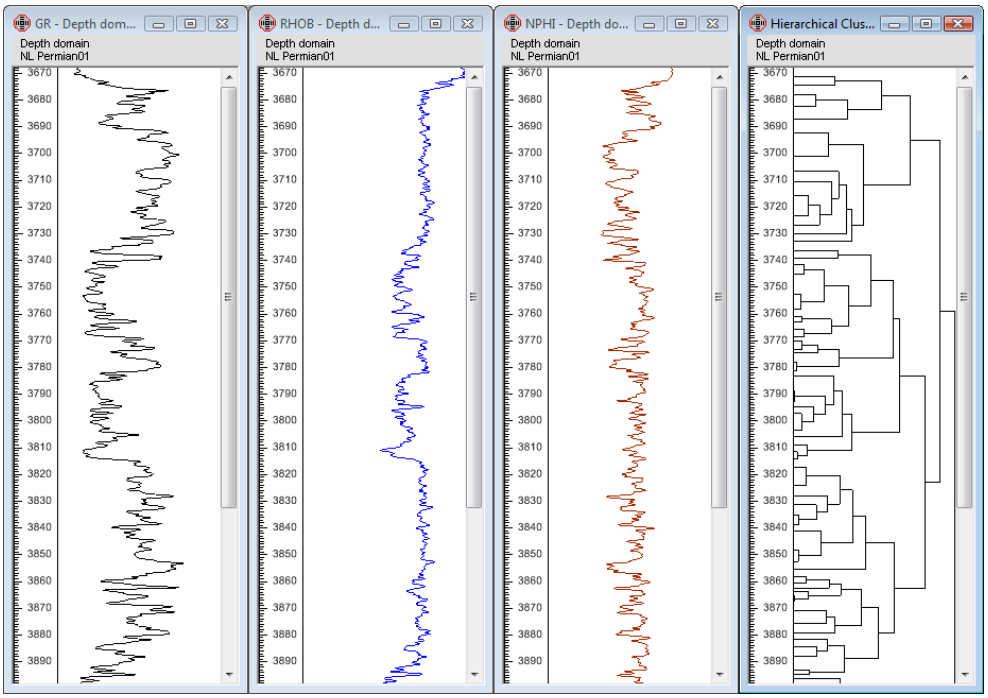
In the next illustration a depth constrained hierarchical clustering has been performed on the GR, RHOB and NPHI log.



The fourth pane shows the tree like structure, called a dendrogram, belonging to a hierarchical clustering. The standard scaling can make it difficult to see the clusters in which the data has been organized. The scaling and the display mode can be changed with the right-click mouse button in the hierarchical data pane.

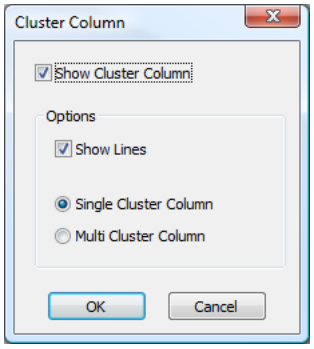


If the horizontal scaling has been adjusted from 0.2 to the maximum of the hierarchical log, and the display mode is changed from Normal to Logarithmic the cluster result becomes clearer.

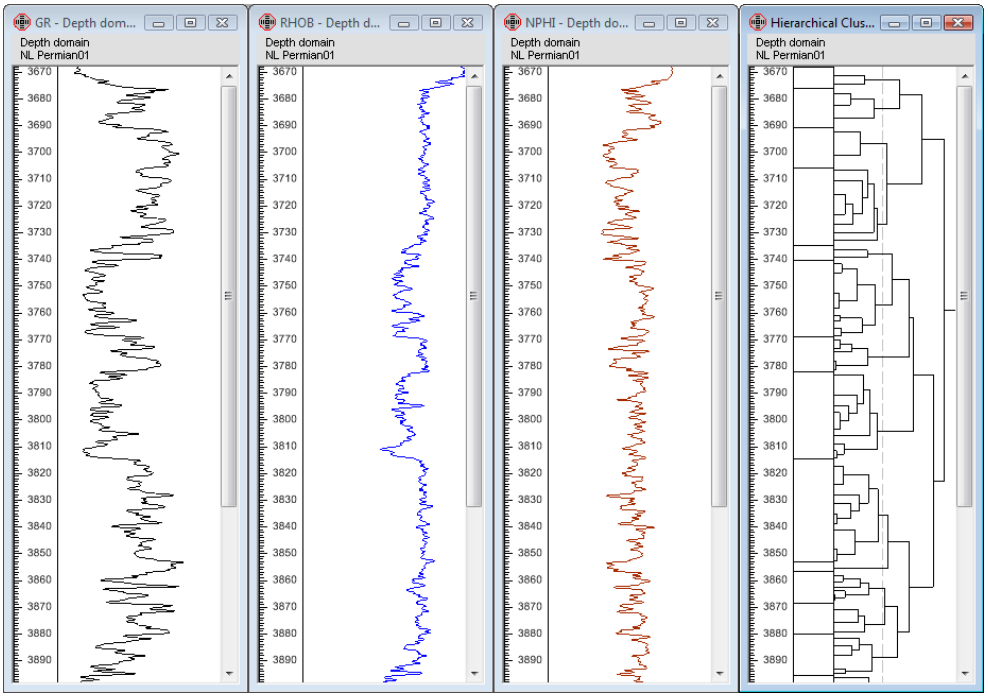


Up to now the data has not yet been divided into clusters. This can be done manually and can be changed any time you like. To create the cluster, go the right click menu and select the Cluster Cutoff option. The mouse cursor is now changed into a cross. If you press the left mouse button the cluster cutoff is set and the clusters are created. Selecting a new cluster cutoff results in a new cluster assignment of the data. A vertical dashed line is drawn at the cluster cutoff value you have chosen.

The clusters can be made visible by activating the cluster column. Activating the cluster column is done by clicking on the Cluster Column option in the right click menu.

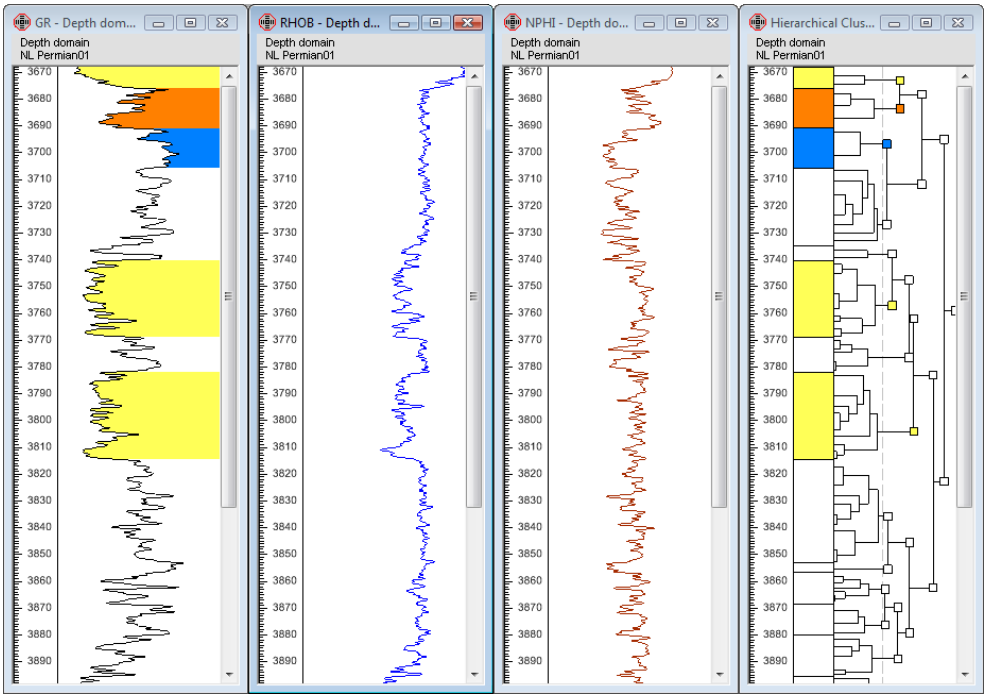


If the Show Cluster Column option is activated, a column is drawn besides the dendrogram. The Show Lines option can be used to draw lines between the clusters in the cluster column. Single Cluster Column can be used to draw one column besides the dendrogram, Multi Cluster Column can be used to draw multiple columns besides the dendrogram showing how the clusters are divided.



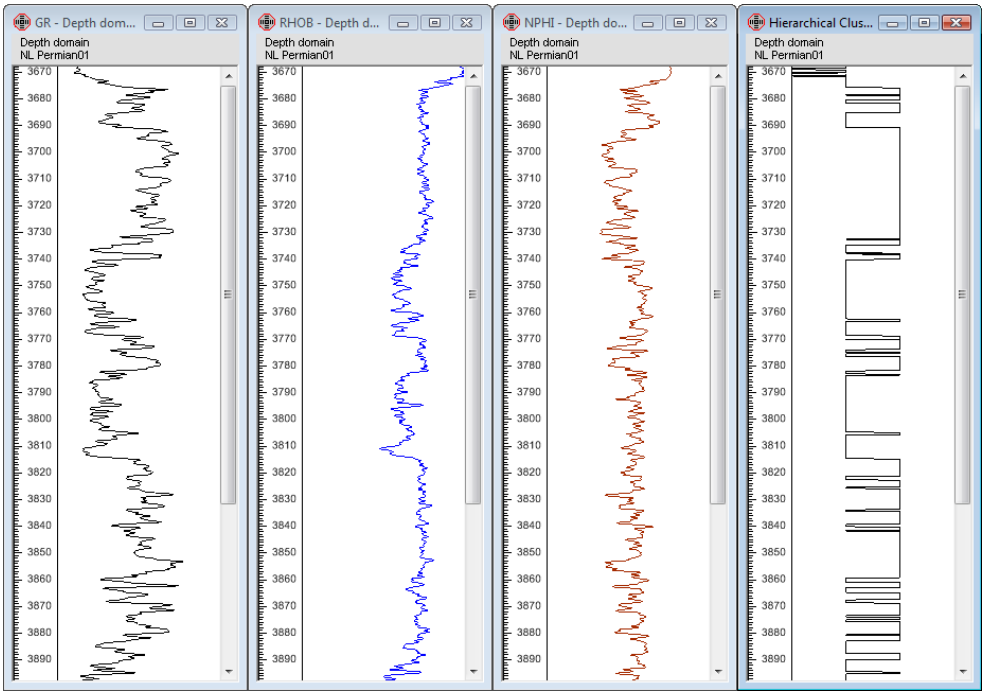
A color can be assigned to all clusters created. To enable the coloring mode, select the Color option in the right click menu. Before the "joining points", where two clusters are joined into a new cluster, a small rectangle is drawn which can be used to color the cluster. Double-click on a

color rectangle to display the color dialog and assign a color to the cluster. The color rectangles are only shown on the right side of the cluster cutoff. The cluster coloring can be used to color fill other logs, as shown in Section 5.4.8.

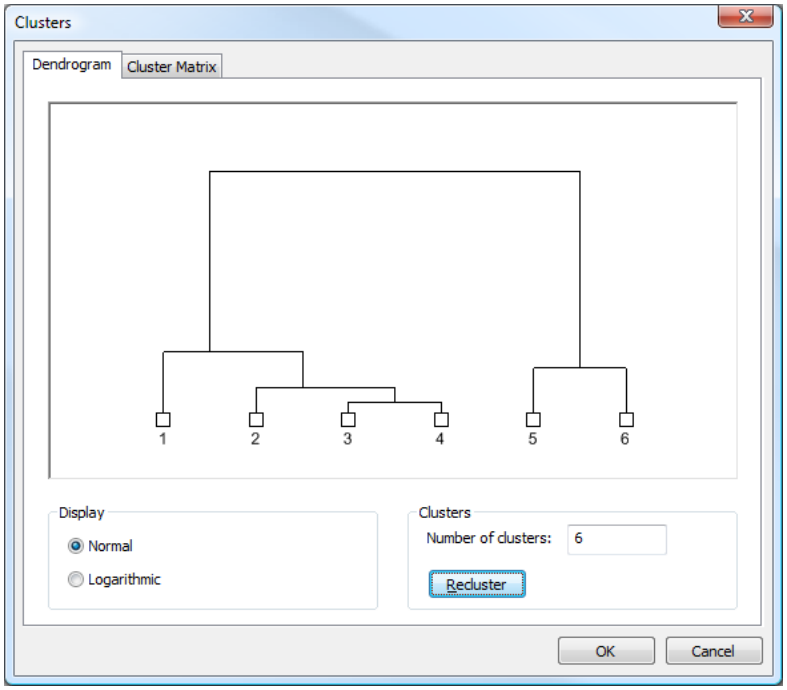


18.6.2. UNCONSTRAINED HIERARCHICAL CLUSTERING

The unconstrained hierarchical clustering does not use any constraints on the clustering. The unconstrained clustering occurs in two steps, a pre-clustering step and the actual hierarchical clustering. A pre-clustering step is necessary because otherwise the calculations would take too long on larger intervals. During the pre-cluster step the data is clustered into a selected number of clusters using the K-Means clustering. These K-Means clusters are then clustered using the hierarchical cluster method.



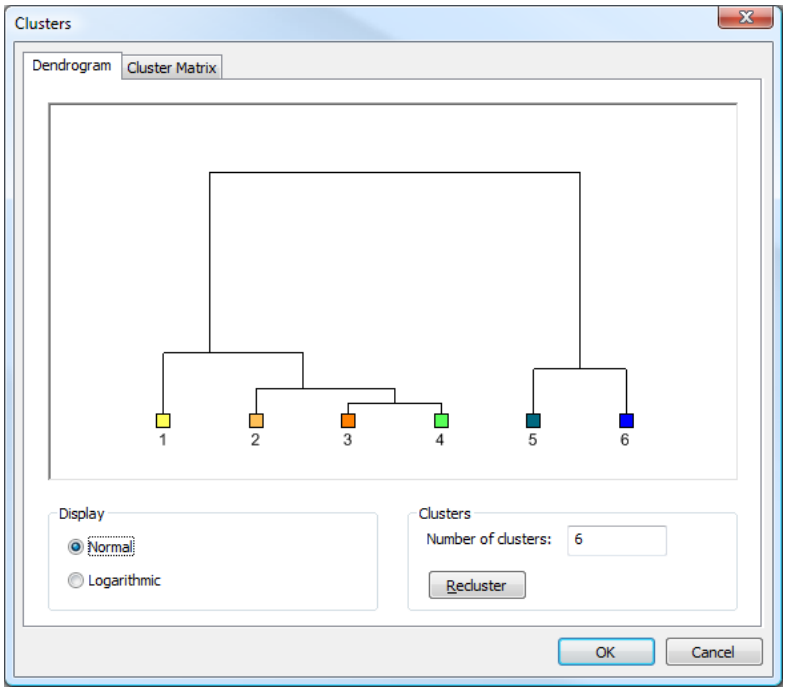
Initially the data in the cluster interval is assigned to two clusters. The number of clusters can be changed at any time using the Set Cluster option in the right click menu in the pane.



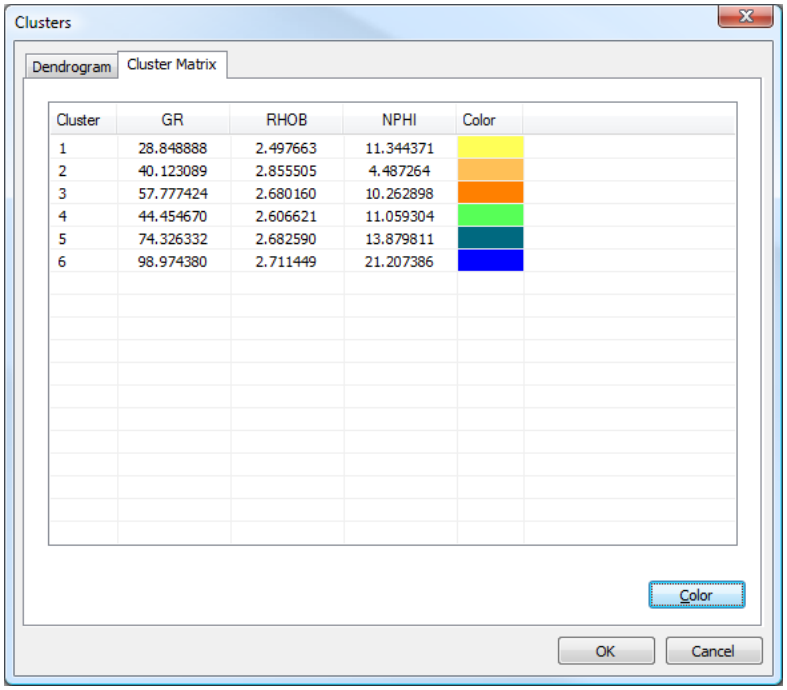
The dendrogram can be shown in Normal mode and in a Logarithmic mode. The logarithmic display of the dendrogram helps to make the dendrogram better visible if there are a lot of

clusters. The number of clusters can be changed by entering the new number of clusters in the Number of clusters text box and clicking the Recluster button.

Cluster colors can be assigned by double clicking on the color rectangle above the cluster number. A color window appears and after selecting a color, the color is assigned to the cluster.

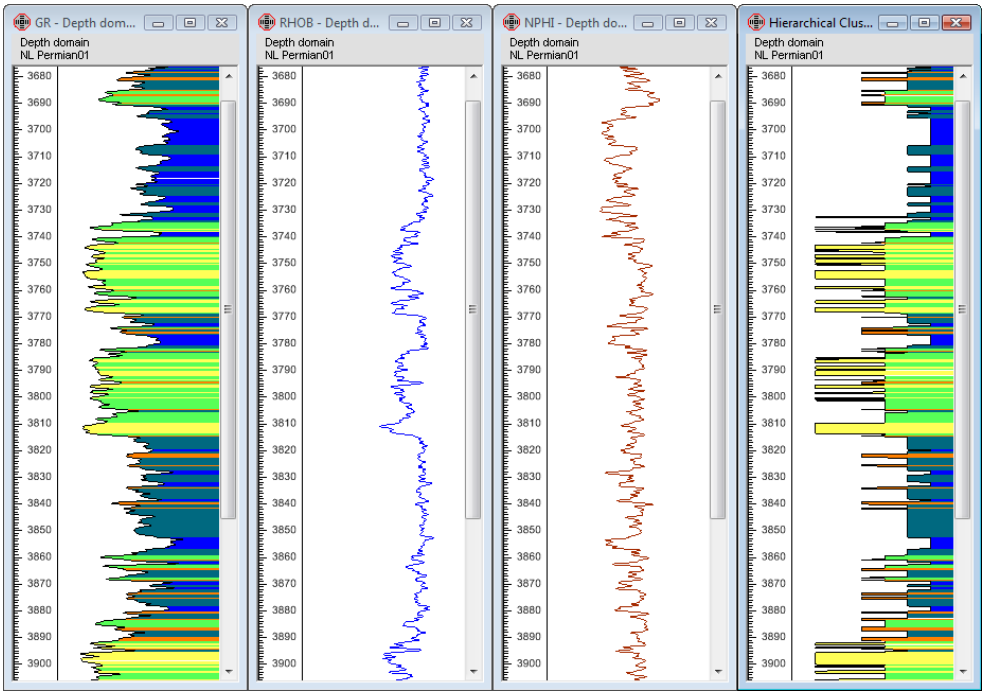


The cluster colors can also be changed on the Cluster Matrix tab.



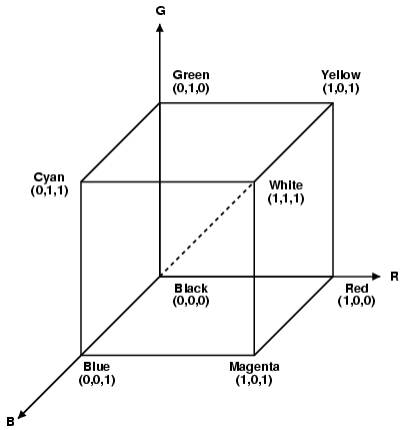
The Cluster Matrix tab also shows the cluster centers calculated using the hierarchical clustering. The columns can be sorted by clicking on the header of the column. If a cluster is selected by clicking on it, the color can be changed by clicking on the Color button.

If the coloring is turned on in the hierarchical clustering pane, the clusters are colored with the assigned color. This coloring can also be use to color other logs, see Section 5.4.8.

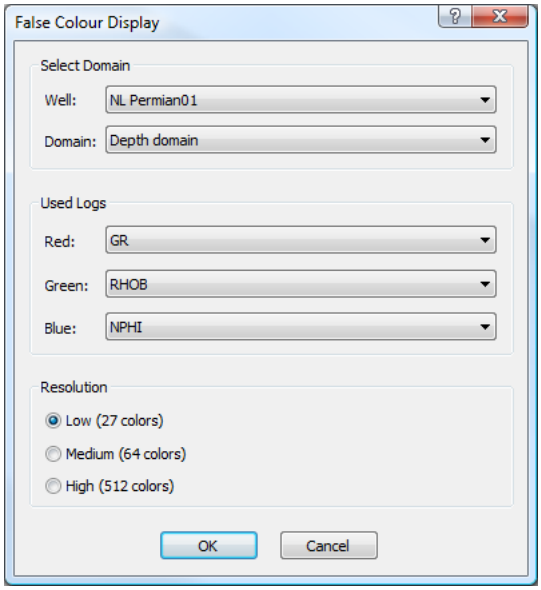


18.7. FALSE COLOR DISPLAY

Although not strictly a form of clustering, the False Color Display option is included in the Clustering menu, accessed from the main Menu Bar. A false color display uses different colors to represent quantities, such as log values.

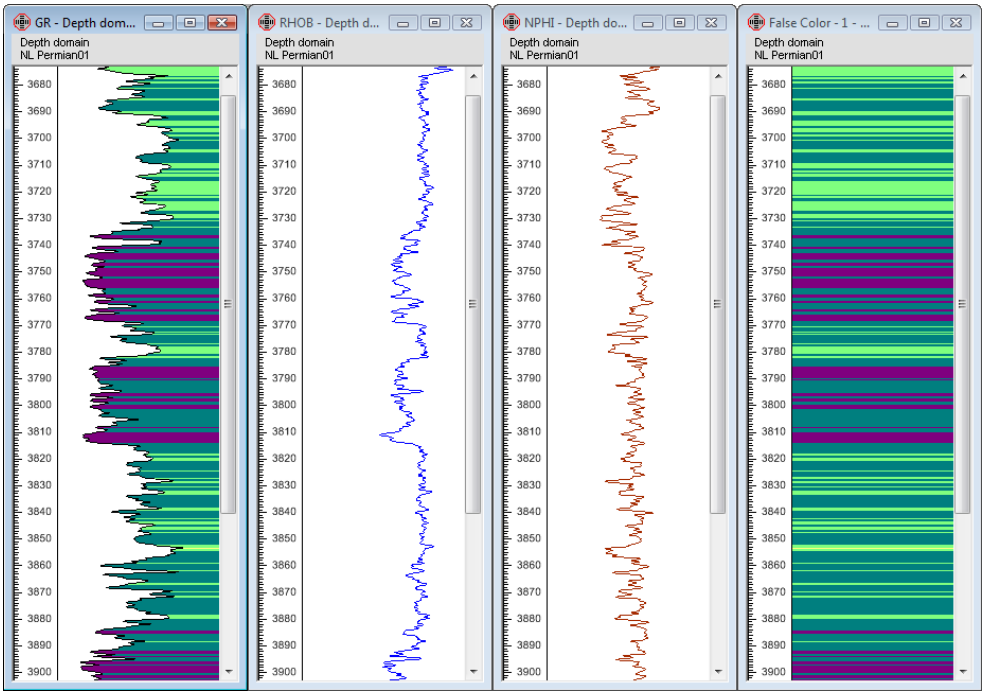


False coloring uses the color cube to transform log data into a color. Select Clustering → False Color Display to open the False Color Display dialog box. Use the drop-down lists to assign different logs to the colors Red, Green and Blue. Choose from the three available levels of resolution, and press OK.



The selected logs in the Used Logs section are projected along the red, green and blue axes. The Resolution determines in how many block the color cube is divided. Each block is assigned a color depending on the amount of red, green and blue. Each log sample is then projected into the color cube and assigned the color of the block in which the sample lies.

CycloLog creates a new log called False Color and adds it to the tree structure in the Workspace worksheet. This can be displayed on its own in a Data Pane, but it is more meaningful if used to color one or more of the logs; use the Display → Color With option on the right-click data pane for the log that you want to color with the False Color scheme.


GR - Depth dom...
Depth domain
NL Permian01
RHOB - Depth d...
Depth domain
NL Permian01
NPHI - Depth do...
Depth domain
NL Permian01
False Color - 1 - ...
Depth domain
NL Permian01
3680
3690
3700
3710
3720
3730
3740
3750
3760
3770
3780
3790
3800
3810
3820
3830
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3850
3860
3870
3880
3890
3900

19. MARKOV CHAIN ANALYSIS

19.1. INTRODUCTION

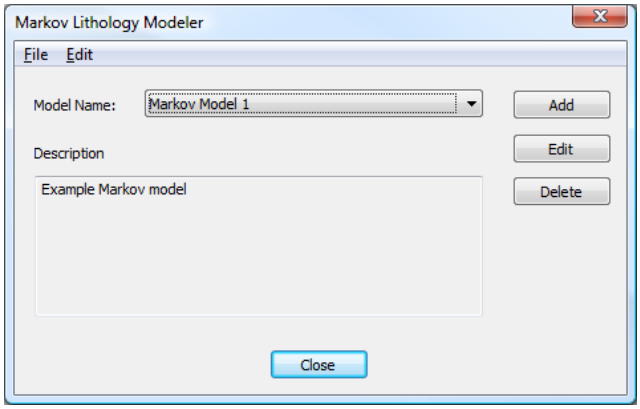
Markov chain analysis investigates the (upward) transitions from one lithology to another. In a randomly organized succession of sediments, upward transitions between all pairs of lithologies (sandstone to shale; sandstone to siltstone, siltstone to shale, and so on) would all have equal probability. We know that this is not the case and that certain upward transitions are more likely than others; Markov analysis is a way of quantifying these differences, and using them to characterize facies associations.

19.2. DEFINING A LITHOLOGY MODEL

A Markov analysis requires strict definition of a set of lithological states. With log data, this is easily done in terms of log values. For example, we can define a set of lithologies from the GR log alone, by dividing the range of GR values in a given log into, say 10 equal parts. If we wish to include data from more than one log, then it is a very simple procedure in CycloLog to use cluster analysis to define a set of numerical lithologies that correspond with natural groupings in the data (see the section on Cluster Analysis in this Manual).

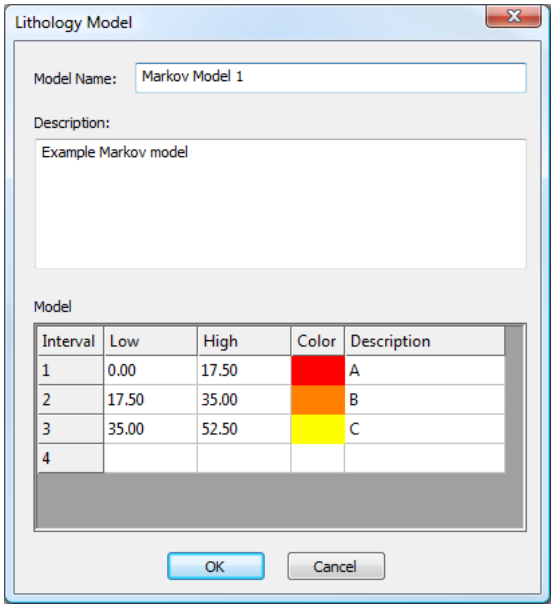
The lithology model for an individual Markov analysis can be defined as the first stage of the analysis (see below). If a model is likely to be used for several Markov analyses, it is better to define the model as a separate step, before starting the analysis.

To define a lithology model for use in Markov Analysis, go to the Tools menu on the main menu bar, and select Markov Lithology Modeller. The following dialog box opens.



Under Model Name, the drop-down menu shows a list of previously defined models. If you have provided descriptions of these, the description for the selected model will appear in the Description area of the dialog box.

To add a new model, click the Add button. The Lithology Model dialog box opens:



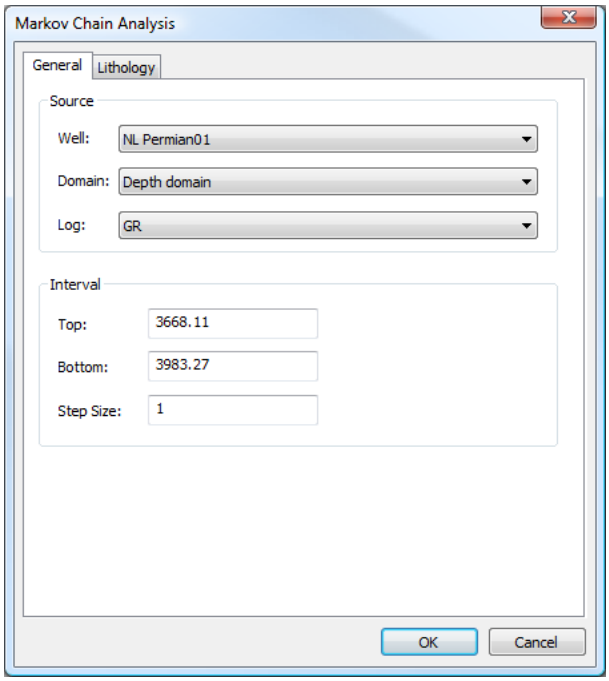
Enter a unique name in the Model Name area, and provide a short description if you wish. Now go to the Model area to specify the bottom and top values for each interval that you wish to define as a “lithology”. Double-click on the first cell in the table (row 1, Low column) and enter the bottom value of the first lithology interval (e.g. 0). Tab to the next cell and enter the high value of the first interval (e.g. 17.5). Tabbing to the next cell (or double-clicking on it) brings up a standard color wheel, from which you can select a color to represent this “lithology” on the

display. You can also add a brief text description if you wish. Now enter the values, color and description for the next lithology (e.g. 17.5-35) and so on.

When you have defined all of the intervals in your model, click OK and the name of the new model will be added to the list in the Model Name drop-down menu. All models are automatically saved in the My Documents\Models folder. To save the model to another location, select it in the drop-down menu, and click File → Export. Provide a unique filename, and the model will be saved as an ASCII file.
You can edit a pre-existing Markov lithology model; select it in the drop-down menu, and click Edit. Make the changes you want in the Lithology Model dialog box and click OK to save it again.

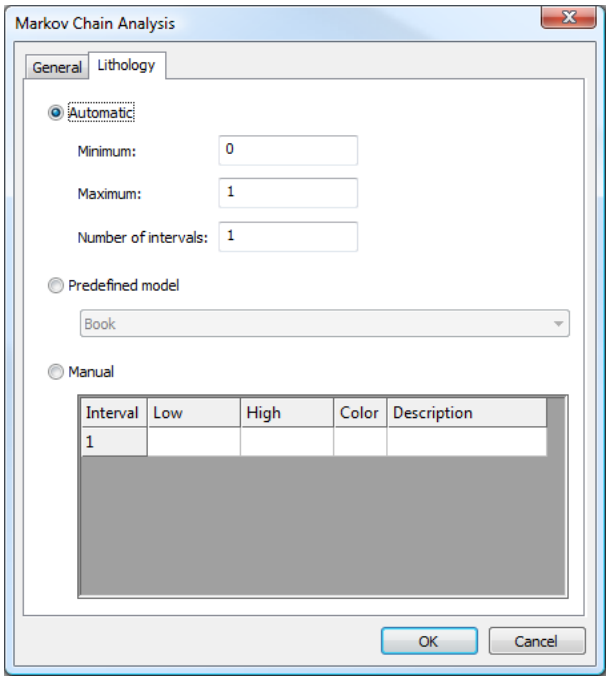
19.3. RUNNING A MARKOV ANALYSIS

To run a Markov analysis, go to the Analysis menu and select Markov Chain Analysis. The Markov Chain Analysis dialog box opens:



On the General tab, select the log on which you wish to run the analysis (e.g. a GR log, or a Cluster log). (Check that the Well and Domain are correct if there is more than one well/domain in the project.) The default interval is the depth interval of the project; change the top and

bottom depths if you want to analyze a more restricted interval. The Step Size is the vertical distance between the samples that are used in the analysis; this does not have to be the same as the vertical sampling interval of the original log data. Note that the Markov Analysis uses a regular sampling interval; there will therefore be a number of "self-transitions" in the result, where there has been no change in "lithology" between one sample and the next one above it.



There are three alternatives for selecting a model.

The **Automatic** option divides the scale of the selected log into equal parts. The user defines the minimum value, the maximum value, and the number of intervals into which the scale is to be divided. You can either fix arbitrary limits to the scale (e.g. 0 and 175 for the GR log), or you could use either the Log Statistics or Histogram functions (go to the Analysis sub-menu on the Data Pane right-click menu for the log in question) to view the actual minimum and maximum values for that particular log. Note that it may be better to use an arbitrary scale if you want your results to be comparable from one well to another.

The **Predefined Model** option allows you to re-use a lithology model that you defined for an earlier Markov analysis. (See above for how to define and save a lithology model.) When you select Predefined Model, the drop-down list will show the available models – click on the one you want to use.

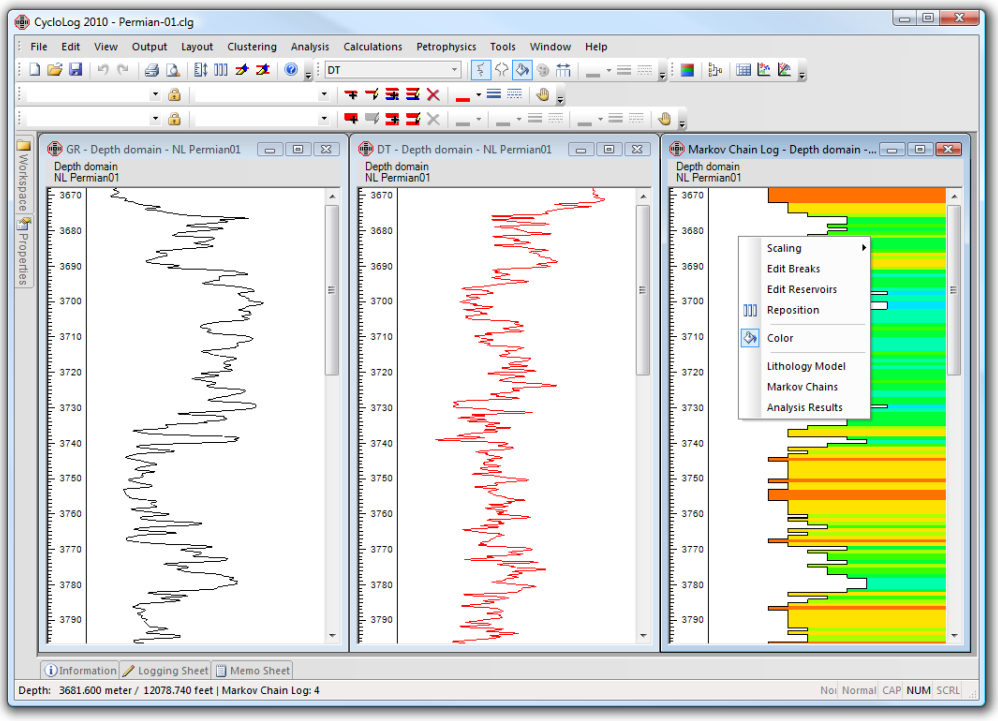
The **Manual** option allows you to define a model, but not to save it. (See above for how to define and save a lithology model.) Double-click on the first cell in the table (row 1, Low column) and enter the bottom value of the first lithology interval (e.g. 0). Tab to the next cell and enter the high value of the first interval (e.g. 20). Tabbing to the next cell (or double-clicking on it) brings up a standard color wheel, from which you can select a color to represent this "lithology" on the display. You can also add a brief text description if you wish. Now enter the values, color and description for the next lithology (e.g. 20-40) and so on.

When you have selected or defined the lithology model, click OK. The analysis runs, and a log showing the division into the "lithologies" that you have defined will be added to the tree structure in the Workspace worksheet. You can display this "log" like any other, including coloring it (Display → Color from the right-click menu over the data pane for the Markov Chain "log", or use the Fill shortcut on the Log toolbar). You can rename the log if you wish, in the Workspace worksheet.

Note that you cannot overlay the Markov Chain log on any other log (for example, to compare it directly with the original log). This is because of the option to run the Markov Chain analysis at a different sampling interval from that of the original logs.

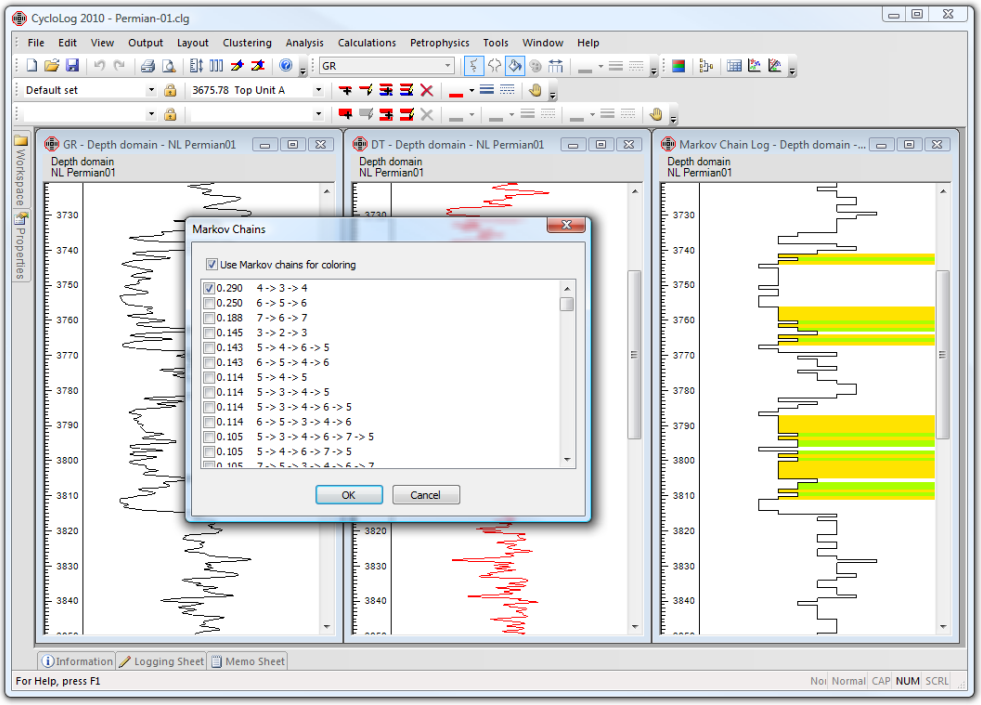
19.4. INTERPRETING THE MARKOV ANALYSIS RESULTS

Display the Markov log by clicking on its name in the Workspace worksheet. When you right-click in the Markov data pane, a new menu appears:



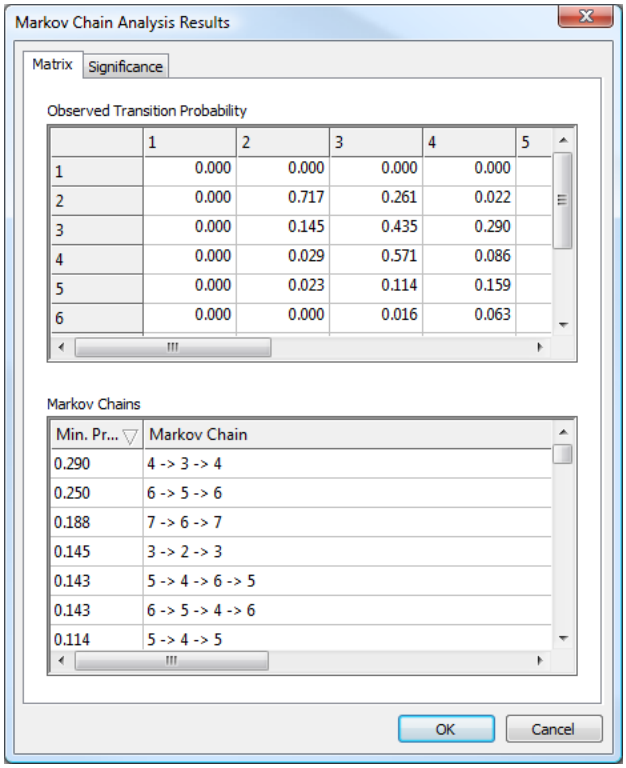
The Scaling (horizontal and vertical scales), Edit Breaks, Edit Reservoirs and Reposition options are as in other similar menus. The Color option fills the log with the colors assigned to the "lithologies" defined in the Markov Lithology Model. The Lithology Model option displays the lithology model used for the analysis, showing a table of the bottom and top values for each "lithology", the color assigned to it, and its text description if there is one. (If there is no user-defined text description, CycloLog adds the number of the lithology to the description.)

The Markov Chains option opens a box that shows the transition chains that have been identified, in decreasing order of their probability of occurrence:



The left-hand column in the dialog box shows the minimum probability associated with each chain, and the Markov Chain column shows the chains of transitions that have been identified by the analysis. In the illustrated example, the most probable chain is from lithology 3 to lithology 2 before returning to lithology 3. This chain can be selected for coloring on the data pane by clicking in the Use Markov Chain for coloring check-box and checking the chain. The selective color fill then shows only those lithologies that occur in this particular transition chain. This can help to identify the occurrence of a particular facies association.

The Analysis Results option opens another table of results, with two tabs: Matrix and Significance.

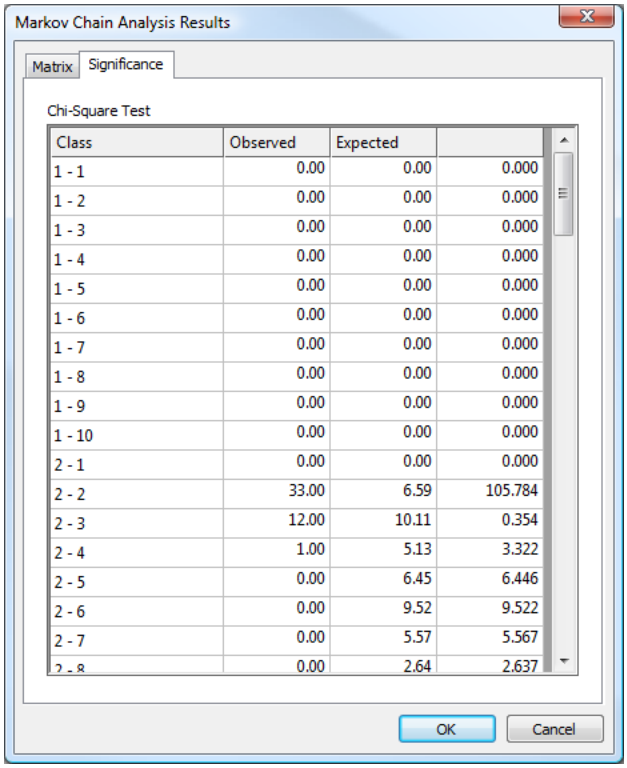


	1	2	3	4	5
1	0.000	0.000	0.000	0.000	
2	0.000	0.717	0.261	0.022	
3	0.000	0.145	0.435	0.290	
4	0.000	0.029	0.571	0.086	
5	0.000	0.023	0.114	0.159	
6	0.000	0.000	0.016	0.063	

Min. Pr...	Markov Chain
0.290	4 -> 3 -> 4
0.250	6 -> 5 -> 6
0.188	7 -> 6 -> 7
0.145	3 -> 2 -> 3
0.143	5 -> 4 -> 6 -> 5
0.143	6 -> 5 -> 4 -> 6
0.114	5 -> 4 -> 5

On the Matrix tab, the Observed Transition Probability Matrix shows the probability of transitions between all possible pairs of lithologies. The Markov Chains table is repeated from the Markov Chains box described above. The significance of the Minimum Probability value can now be seen; in the example shown, the minimum probability associated with the transition chain 4→3→4 is 0.29. This is the probability of the pairwise transition 3→4, while the probability of the transition 4→3 is higher, at 0.571. The minimum probability is simply the lowest of the pairwise transition probabilities in the whole of each chain.

On the Significance tab are displayed the results of a set of chi-square significance tests on the pairwise transition probabilities. The three columns display the Observed and Expected values, and the chi-square statistic, for each pairwise transition.

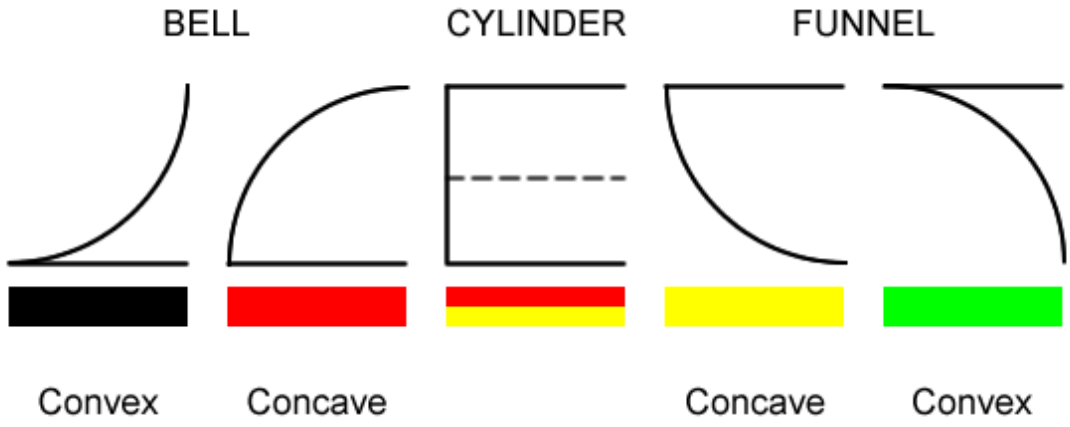


Class	Observed	Expected	
1 - 1	0.00	0.00	0.000
1 - 2	0.00	0.00	0.000
1 - 3	0.00	0.00	0.000
1 - 4	0.00	0.00	0.000
1 - 5	0.00	0.00	0.000
1 - 6	0.00	0.00	0.000
1 - 7	0.00	0.00	0.000
1 - 8	0.00	0.00	0.000
1 - 9	0.00	0.00	0.000
1 - 10	0.00	0.00	0.000
2 - 1	0.00	0.00	0.000
2 - 2	33.00	6.59	105.784
2 - 3	12.00	10.11	0.354
2 - 4	1.00	5.13	3.322
2 - 5	0.00	6.45	6.446
2 - 6	0.00	9.52	9.522
2 - 7	0.00	5.57	5.567
2 - 8	0.00	2.64	2.637

20. LOG PROFILE ANALYSIS

Log profiles contain useful diagnostic information at all scales. Profile shapes of individual units are caused primarily by depositional and erosional processes in individual environments. Profile trends at larger scales reflect long term changes in factors such as grain size and sediment supply. More detailed information can be found in Geologic log analysis using computational methods by J.H. Doveton (Geologic Log Analysis Using Computer Methods, AAPG Computer Applications in Geology, No.2).

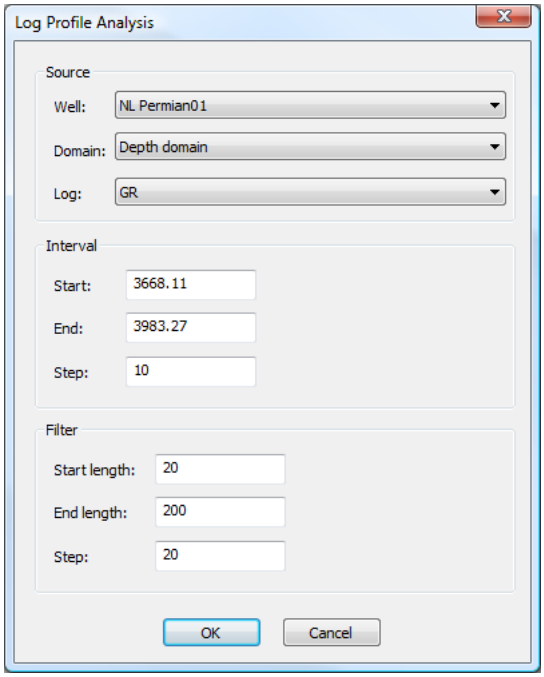
A polynomial best-fit curve is calculated over an interval during a sliding window analysis. The profile shapes are inferred from the polynomial curve. The profile shapes used in the analysis are illustrated in the following image.



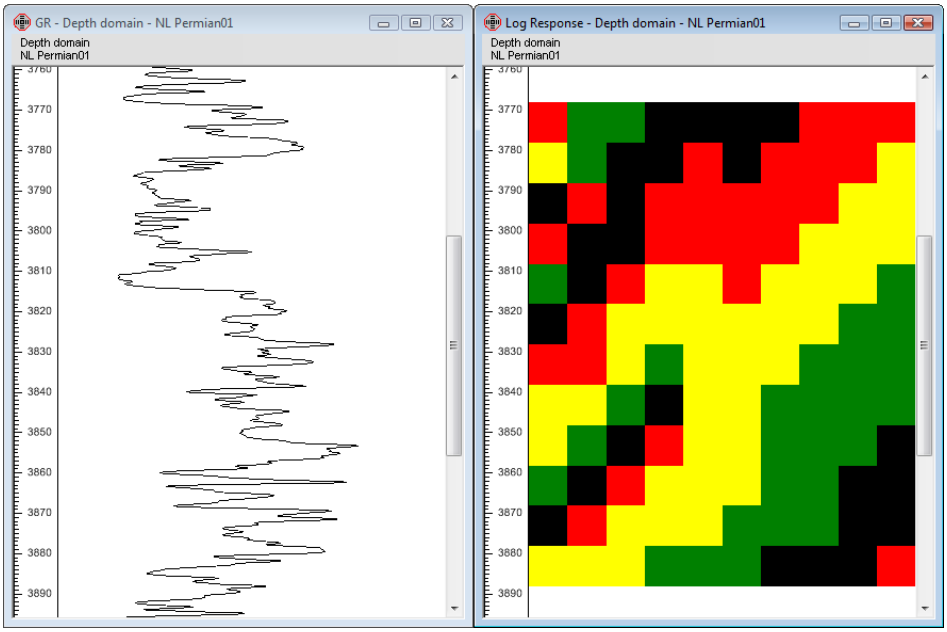
Profile shapes are displayed in the profile log pane using the colors below the shapes.

20.1. RUNNING THE LOG PROFILE ANALYSIS

The log profile analysis can be found in the Analysis menu. Click on the Log Profile Analysis to display the analysis window.



In the Source section you can select the log on which you want to perform the analysis. The Start and Stop define the analysis interval; the Step is the step size of the analysis. An analysis is performed for each step window. The Filter section defines the size of the sliding analysis windows. A series of analyses is done, starting with an analysis using a sliding window where the window size is the Start length up to an analysis using a sliding window where the window size is the End length and all windows in between where the step size is Size. After the analysis has been done, a new log is added to the tree structure in the Workspace.


GR - Depth domain - NL Permian01
Depth domain
NL Permian01
3760
3770
3780
3790
3800
3810
3820
3830
3840
3850
3860
3870
3880
3890
Log Response - Depth domain - NL Permian01
Depth domain
NL Permian01
3760
3770
3780
3790
3800
3810
3820
3830
3840
3850
3860
3870
3880
3890

21. DOMAIN CONVERSION

21.1. INTRODUCTION

Most analyses in CycloLog will be carried out in the Depth Domain, i.e. with depth (in feet or meters) as the vertical axis. If CycloLog output is to be directly compared with seismic data, it may sometimes be convenient to convert log data to a vertical scale representing two-way travel time (TWT). CycloLog handles this through the ability to convert between different domains whose vertical scales are related in non-linear ways. Thus, for example, vertical depth and two-way time are linked through a time-depth curve, which represents the changing velocity structure of the section with depth. Knowing the time-depth curve, there is a one-to-one relationship between vertical depth and two-way time. To make a conversion from the depth to the seismic domain (or vice versa), CycloLog therefore only needs to be provided with a time-depth curve.

The construction of seismic time-depth curves has been described in Section 15.4 above.

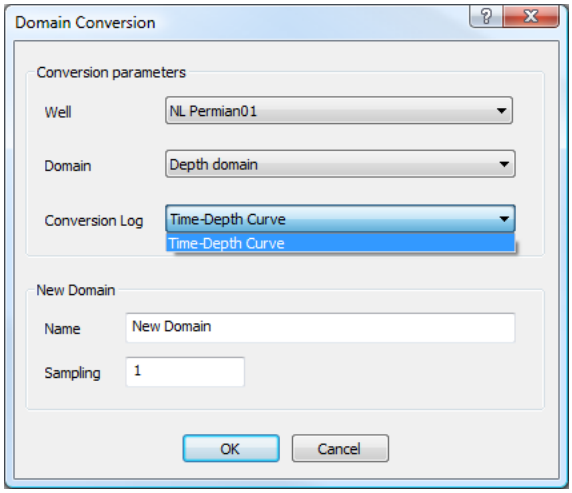
The same principle applies to conversion between depth and geological time. If Milankovitch cycles can be identified in a well, this leads to a relationship between depth and geological time, because the periods of the Milankovitch cycles are known. Analysis of Milankovitch cyclicity can therefore be expressed in the form of another kind of time-depth curve, which can be used to convert depths in a well to relative geological time (i.e. time in millions of years relative to some arbitrary point in the well). If there is one or more points in a well where the age is known precisely (in millions of years) then the depth can be related directly to absolute geological time (in millions of years before present).

The construction of geologic time-depth curves by mapping Milankovitch periodicities has been described in Section 12.7.3 above.

CycloLog holds the time-depth information in the form of another “log”, which appears in the Workspace tree structure, and can be displayed like any other log. The log used for the conversion must be fully defined over the domain depth interval and every next depth samples must have a greater data value. This is necessary because otherwise a converted depth sample must be defined by only one depth sample.

21.2. TO PERFORM A DOMAIN CONVERSION

Select Domain Conversion from the Tools menu on the main Menu Bar. The Domain Conversion dialog box opens:



Check that the current well and domain are correct. The drop-down list of Conversion Logs will list all available Time-Depth curves in the current Domain; select the one that you want to use for the conversion. Give the new domain a name (e.g. “Seismic Domain”) and specify the sampling interval, in either thousands of years (ky) for a geologic time domain conversion or milliseconds for a seismic (TWT) domain conversion. Click OK. The new domain will be added to the tree structure in the Workspace worksheet, including domain-converted copies of all the logs existing in the original (depth) domain.

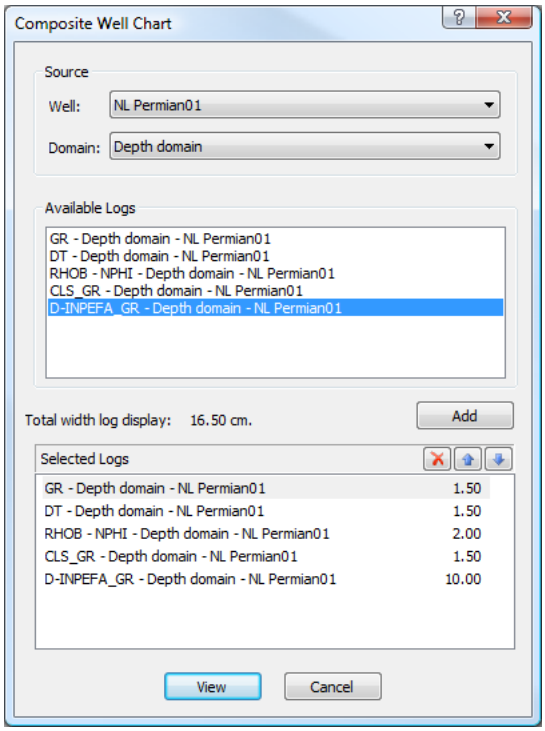
You can now work on the logs in the new domain in exactly the same way as for the logs in the original Depth Domain.

22. COMPOSITE WELL CHARTS

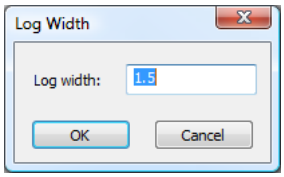
CycloLog now has advanced functionality for setting up, modifying, and editing report-quality composite well charts. Charts are now saved within a project. They can also be printed, and exported to a variety of graphics formats for inclusion in other documents.

22.1. TO SET UP A COMPOSITE WELL CHART

In the Menu Bar select Output → Composite Well Chart.



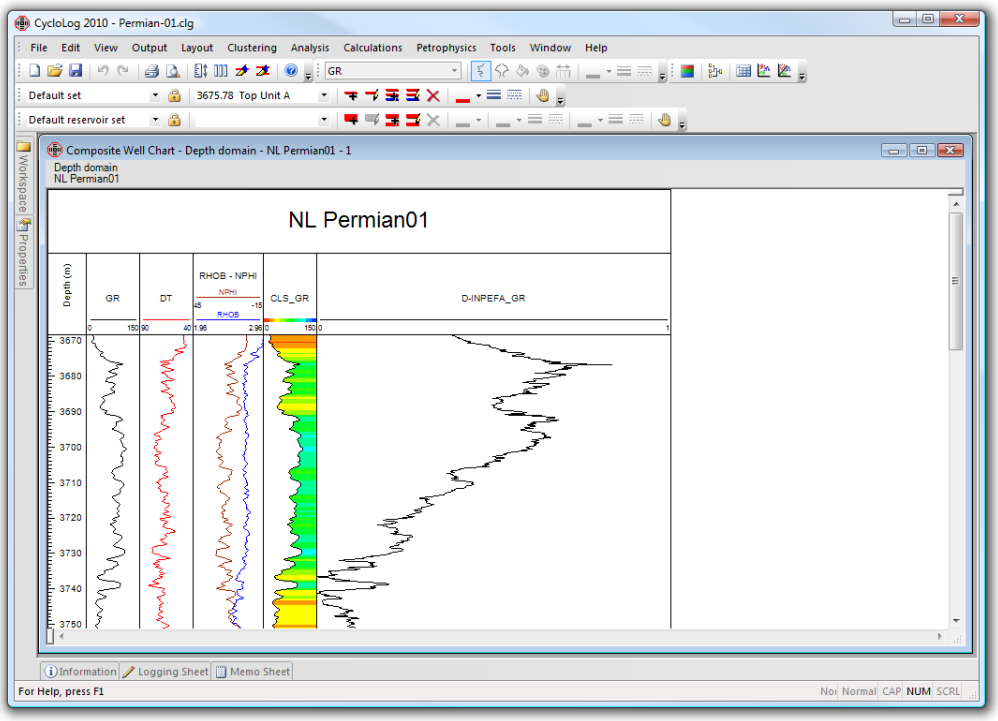
Under Available Logs, all of the logs currently displayed are listed. **Note that a log must first be displayed in a Data Pane before it can be included in a Composite Chart.**



To include a log in the Composite Chart, double-click on its name in the Available Logs list. The Log Width dialog box opens; enter the required width (in cm) of the log track in the chart (this can be changed later). Click OK, and the log is added to the Selected Logs list, with its track width in centimeters. Click on the next log to be added, and so on.

The order of the logs in the Selected Logs list (top to bottom) is now the order in which they will appear on the Composite Chart (from left to right). The order can be changed by clicking on a log in the list and using the up and down arrows to move it up or down the list. (You can change the order again later.) You can also delete a log from this list by selecting it and then clicking the red cross.

To display the Composite Chart in a Data Pane, click the View button at the bottom of the Composite Well Chart dialog box. The chart is displayed in a new data pane, and the chart is added to the tree structure in the Workspace worksheet, with the default name “Composite Well Chart - Depth Domain - <Well name>”. Maximize the data pane if you want to see the whole chart without having to use the horizontal scroll bar.

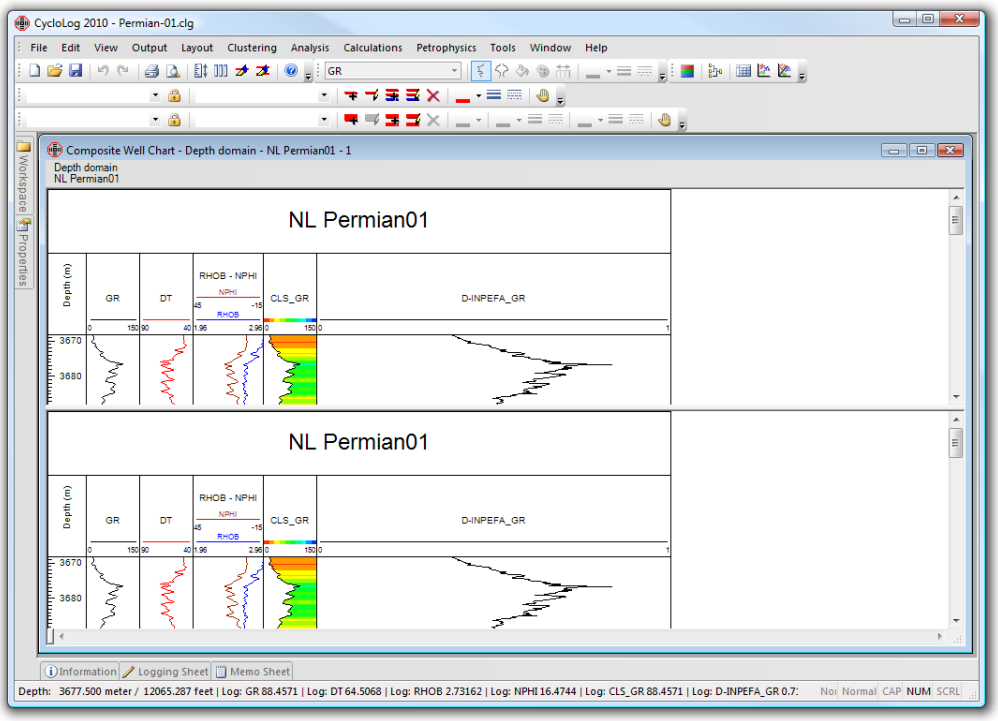


Note that CycloLog adds a depth bar, a title bar (using the well name as default), and headers for each log track; all of these features can be modified by the user.

Notice also that the Status Bar shows the value of all the logs in the chart at the position of the cursor. Breaks can also be added, edited and deleted, as in a normal (single-log) data pane. This makes a composite chart useful as a working display, as well as a finished product for output.

22.2. SPLITTING THE COMPOSITE CHART

To compare different parts of the same composite chart to each other, CycloLog offers the possibility to split the composite pane. Above the vertical scroll bar and left of the horizontal scroll bar are small buttons that can be dragged, holding the left mouse button down, onto the composite chart. The composite chart is then automatically divided into two parts. If the splitter between the two charts is moved to its original position the composite chart is alone in the pane.



22.3. PRINTING AND EXPORTING COMPOSITE CHARTS

Composite charts can be sent straight to a printer, or exported from CycloLog as graphics files in a variety of formats.

To print a composite chart, make sure that it is the active data pane. Go to the File menu, where you can use Print Preview to see how the chart will fit on to the paper. If you need to make adjustments, use the File → Page Setup and File → Print Setup options as needed. Then click on File → Print and OK to print the chart.

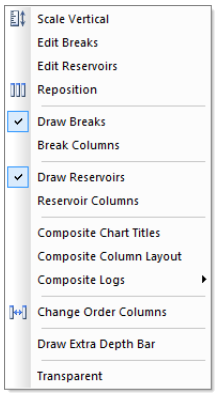
To export a composite chart as a graphics file, go to the Output menu and select the required file format (Bitmap, GIF, JPG, PNG, TIFF are the available options). Give the new file a name and navigate to the folder in which you want it to be created. Click OK.

Note that you can check the size of the chart by clicking on Output → Chart Size. The size (in cm) is shown, but cannot be modified.

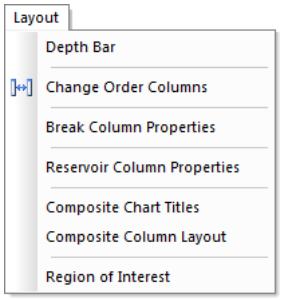
22.4. MODIFYING THE COMPOSITE WELL CHART

22.4.1. THE COMPOSITE CHART RIGHT-CLICK MENU

A comprehensive set of functions for modifying the composite well chart can be accessed by right-clicking over the composite chart data pane. Some other aspects of the composite chart, including its total depth interval, are accessed through the Properties item at the bottom of the right-click menu – see Section 22.4.11 below. (The Edit Breaks and Reposition items in this menu are included for convenience – descriptions can be found elsewhere.)

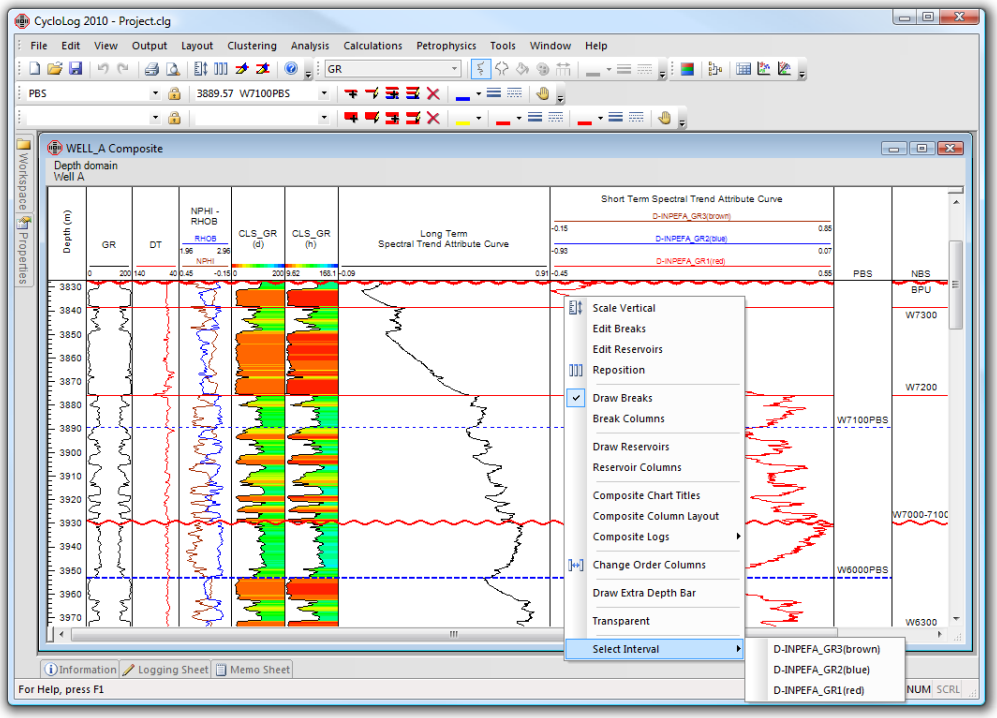


Functions for modifying a composite chart are also available through the Layout menu on the main Menu Bar; there is a specific Layout menu for composite charts.



22.4.2. CHANGING THE DYNAMIC INPEFA ANALYSIS INTERVAL

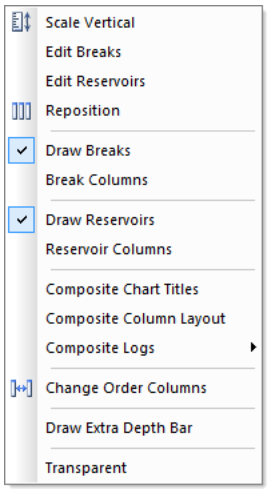
The analysis interval of a dynamic INPEFA curve can also be adjusted interactively in the composite chart. When the right click context menu is accessed when the mouse in on top of a column containing INPEFA curves, an additional menu item is available. This extra menu item contains a list of the INPEFA curves in the column.



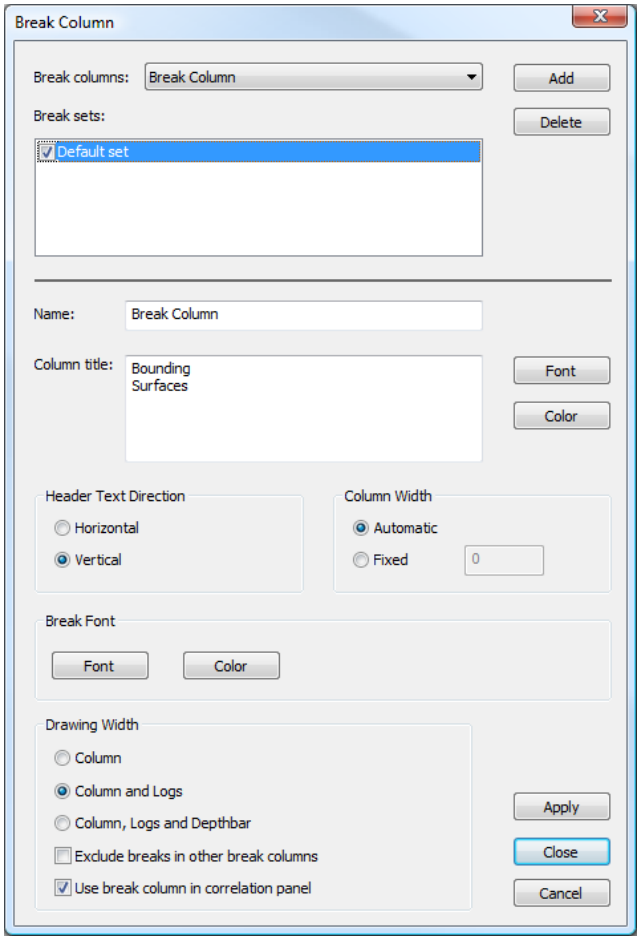
When the user selects one of the curves, the horizontal interval bars appear on the composite chart. Using the mouse the user can change the analysis interval by dragging the horizontal bar to its new position just like in the single pane situation.

22.4.3. ADDING BREAK COLUMNS TO A COMPOSITE CHART

If you have defined any breaks for a well, these will appear as lines across all the log columns in the composite chart, with labels in the last (right-hand) column only. Drawing of the breaks in the composite chart can be turned off in the right click menu by turning off the Draw Breaks menu item.



It may be more convenient to have all the break labels in a separate column. To do this, select Break Columns from the Composite Chart right-click menu; the Break Column dialog box opens:



To add a break column, click Add. The break sets that have been defined appear in the Break Sets box. Any or all of these can be selected by clicking in its check-box. All breaks from all the selected break sets will be displayed in the new break column unless they have been de-selected in the Break Manager (see Section 7 of this Manual).

The new break column is called Break Column by default, but can be re-named in the Name box (important if you have more than one break column on a chart). By default, the column will be labeled "Bounding Surfaces" on the composite chart itself, but you can change this also, by typing the new name in the Column Title box. You can also modify the font and color in which the column title is displayed on the chart; click on the Font and Color buttons.

The column title can be further modified with the Header Text Direction buttons, to make it read either horizontally or vertically.

The column width can be specified exactly (in centimeters), or can be set to Automatic (the default) in which case the column width is adjusted to accommodate the longest break label in the set.

Using the Break Font button you can change the font and color of the break names in the break column. Each column can have its own font settings.

The extent of the horizontal lines representing the breaks can also be modified, using the various options under Drawing Width in the dialog box:

- Column Only draws the line only in the break column;
- Column and Logs also draws the line across the log tracks
- Column, Logs and Depthbar draws the line across the break column, all logs, and the depthbar.
- Exclude breaks in other columns prevents breaks belonging to other break columns from appearing in the current column.

Use break column in correlation panel allows the breaks in this column to function as correlation lines in a correlation panel (see Section 23 of this Manual).

If you are adding break columns, or making modifications to more than one break column, it is important to click the Apply button before using the Break Columns drop-down list to switch between break columns.

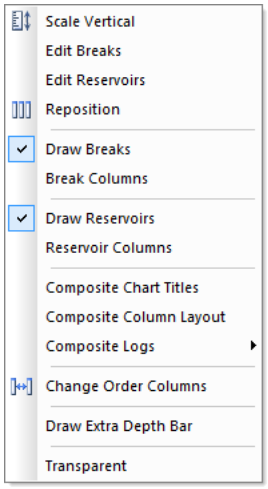
You can delete a break column by selecting it from the Break Columns drop-down list, and clicking the Delete button.

New columns, and modifications to existing columns, will not appear on the chart until you have clicked the Close button.

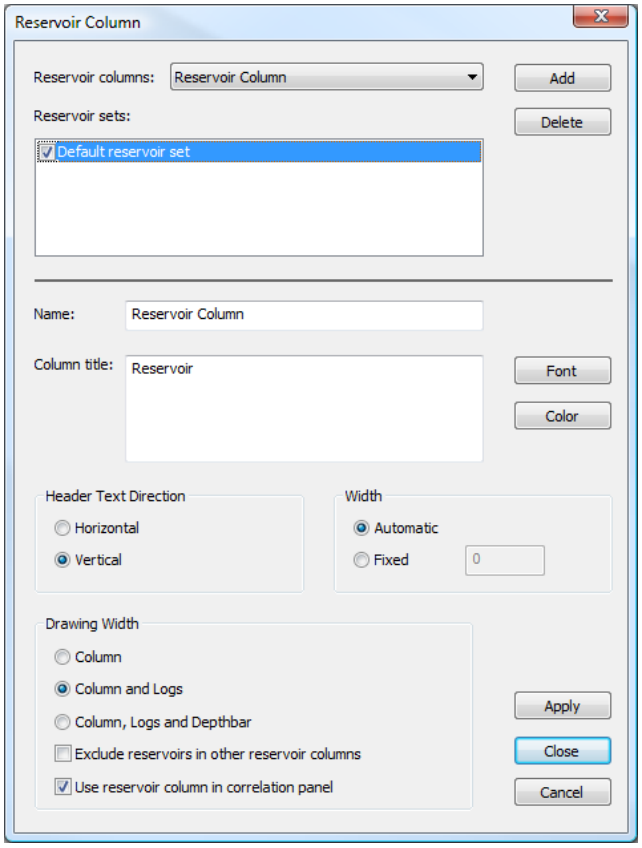
Changing the visible break sets for the column can also be done using the right click context menu. Position the mouse cursor over a break column and click on the right mouse button. The composite logs submenu shows a list with all break sets. The visibility of the break set can be changed by clicking on the break set name.

22.4.4. ADDING RESERVOIR COLUMNS TO A COMPOSITE CHART

If you have defined any reservoirs for a well, these will appear as intervals across all the log columns in the composite chart, with labels over the columns. Drawing of the reservoirs in the composite chart can be turned off in the right click menu by turning off the Draw Reservoirs menu item.



If reservoirs are drawn on the composite chart, it may be more convenient to have all the reservoir labels in a separate column. To do this, select Reservoir Columns from the Composite Chart right-click menu; the Reservoir Column dialog box opens:



To add a reservoir column, click Add. The reservoir sets that have been defined appear in the Reservoir Sets box. Any or all of these can be selected by clicking in its check-box. All reservoirs from all the selected reservoir sets will be displayed in the new reservoir column unless they have been de-selected in the Reservoir Manager (see Section 8 of this Manual).

The new reservoir column is called Reservoir Column by default, but can be re-named in the Name box (important if you have more than one reservoir column on a chart). By default, the column will be labeled "Reservoir" on the composite chart itself, but you can change this also, by typing the new name in the Column Title box. You can also modify the font and color in which the column title is displayed on the chart; click on the Font and Color buttons.

The column title can be further modified with the Header Text Direction buttons, to make it read either horizontally or vertically.

The column width can be specified exactly (in centimeters), or can be set to Automatic (the default) in which case the column width is adjusted to accommodate the longest reservoir label in the set.

The extent of the intervals representing the reservoirs can also be modified, using the various options under Drawing Width in the dialog box:

- Column draws the reservoir only in the reservoir column;
- Column and Logs also draws the reservoir across the log tracks
- Column, Logs and Depthbar draws the reservoir across the reservoir column, all logs, and the depthbar.
- Exclude reservoirs in other columns prevents reservoirs belonging to other reservoir columns from appearing in the current column.

Use reservoir column in correlation panel allows the reservoirs in this column to function as reservoir intervals in a correlation panel (see Section 23 of this Manual).

If you are adding reservoir columns, or making modifications to more than one reservoir column, it is important to click the Apply button before using the Reservoir Columns drop-down list to switch between reservoir columns.

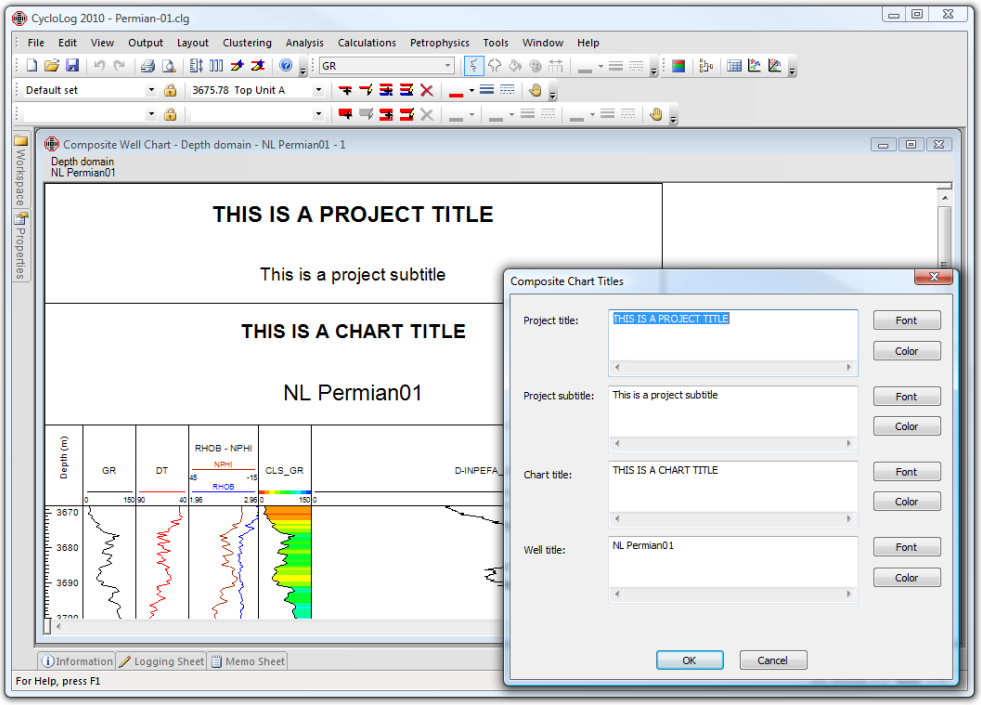
You can delete a reservoir column by selecting it from the Reservoir Columns drop-down list, and clicking the Delete button.

New columns, and modifications to existing columns, will not appear on the chart until you have clicked the Close button.

Changing the visible reservoir sets for the column can also be done using the right click context menu. Position the mouse cursor over a reservoir column and click on the right mouse button. The composite logs submenu shows a list with all reservoir sets. The visibility of the reservoir set can be changed by clicking on the reservoir set name.

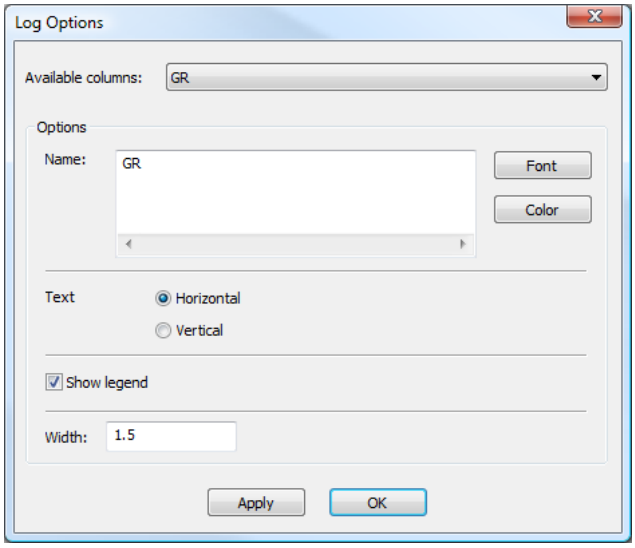
22.4.5. ADDING CHART TITLES

To add titles to a chart, select Chart Titles from the composite chart right-click menu. Four different levels of title are available, each with the option of selecting different fonts and colors. Although the levels are known as Project Title, Project Sub-title, Chart Title and Well Title, you can use them in any way you wish, including omitting them altogether. By default, the well name appears in the Well Title box, but this can be changed.



22.4.6. CHANGING THE COLUMN LAYOUT

The headers of the log column widths, and the column widths, can be changed. Select Composite Column Layout from the composite chart right-click menu. The Log Options dialog opens.

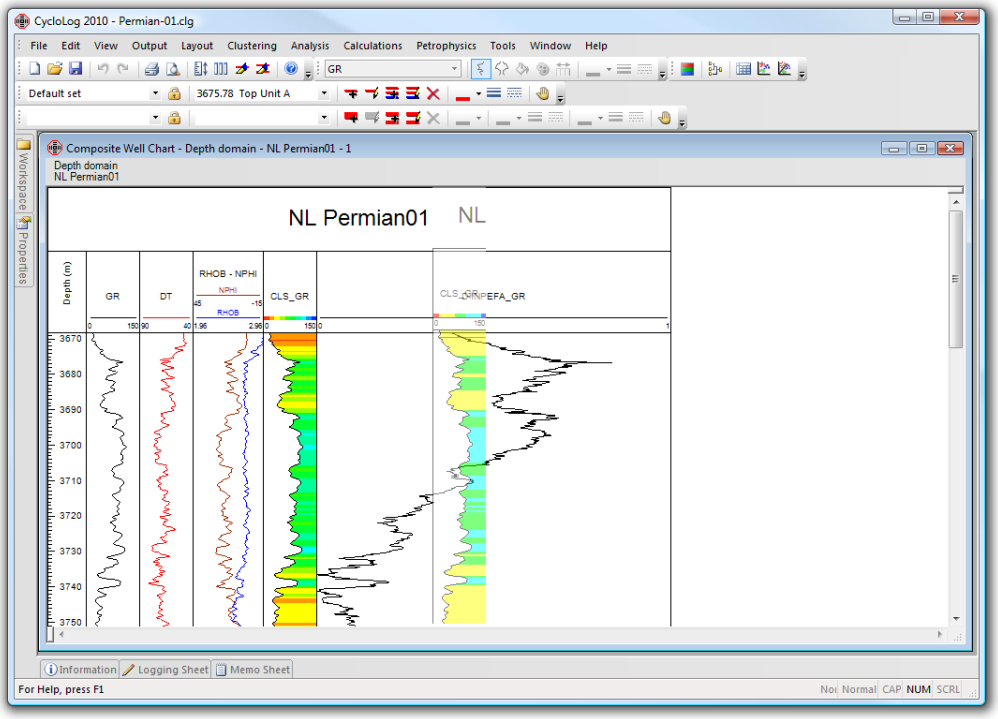


To modify the details of a log column, select that log from the Available Columns drop-down list. You can now change the name of the column, the font and color, and the text direction (horizontal or vertical). You can also change the width of the column. Each log column normally has a legend showing the color of the wiggle for each log in the column, and the horizontal scale for each log. You can switch this legend off by clicking in the Show Legend check-box to remove the tick-mark.

Click the Apply button before selecting another log, or your changes will not take effect.

22.4.7. CHANGING THE COLUMN ORDER

The order of the columns in a composite chart can be changed. Select the Change Order Columns option from the composite chart right-click menu. The cursor changes to a hand symbol. Place the cursor over the column you want to move, and hold down the left mouse button. Drag the column to its new position (a faint copy of the column will move with the cursor) and release the mouse button.



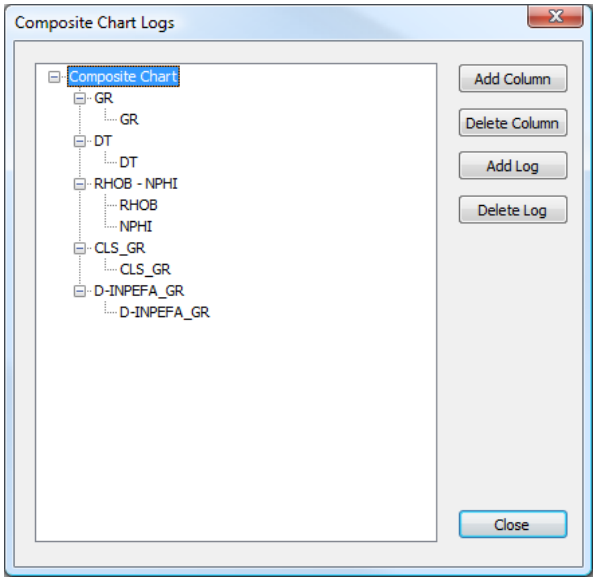
When you have finished making changes to the column order, go to the right-click menu and click Change Order Columns again, to change the cursor back to a pointer.

22.4.8. ADD AN EXTRA DEPTHBAR

You can add a second depth bar to the right-hand side of the composite chart, which can be useful if the chart is very wide. Click Draw Extra Depthbar on the composite chart right-click menu once to add the second depthbar, and again if you want to remove it.

22.4.9. CHANGE THE CONTENT OF LOG COLUMNS

Changes can be made to the logs that appear in a column, and columns can be deleted. Go to the Composite Logs option in the composite chart right-click menu and select the Composite Logs Dialog. The Composite Chart Logs dialog box appears, with a tree structure representing the columns and the logs included in each column. Note that two logs appear for a column with overlaid logs such as neutron and density.



Note that none of your changes will be effective until you have closed the Log Options dialog box.

To delete a column, select it in the tree structure and click Delete Column.

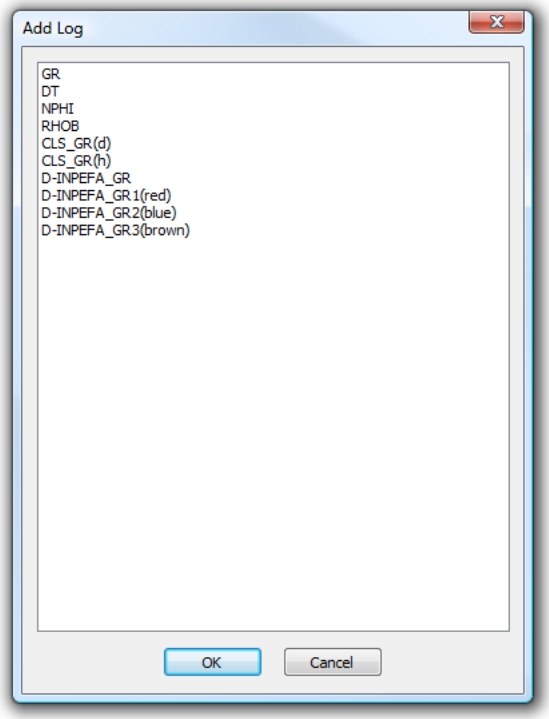
To add a column, the log (or log overlays) that you want must already be displayed in a data pane. When you click the Add Column button in the Log Options dialog box, you will see a list of Available Panes, from which you can select the one that you want.

To add a log to an existing column (i.e. to overlay another log on one that is already displayed), select the name of the column in the tree structure, and click Add Log. You will be offered a list of all available logs (not only those currently displayed). Select the log that you want to add, and click OK. The log is added to the selected column in the tree structure. When you close the dialog box, the log is added to the display.

To delete a log from a column, select the name of that log in the tree structure, and click Delete Log. You are asked to confirm the deletion, and then the log will be removed from the tree structure. It will be removed from the display when you close the dialog box.

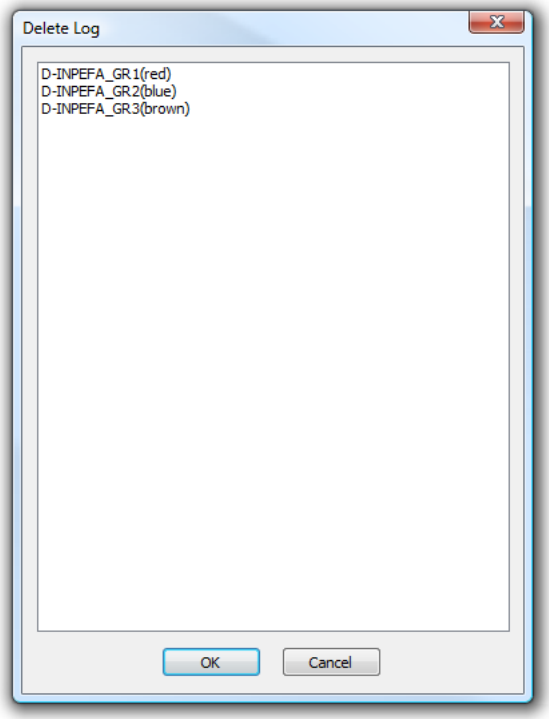
The content of a column can also be changed using the right mouse button context menu. To add an empty log column to the composite chart, click on the right mouse button, go to the Composite Logs sub menu and select the Add Column menu item. An empty column is added to the end of the composite chart. To remove a column, move the mouse cursor to the column which has tom be removed, click on the right mouse button, go to the Composite Logs sub menu and select the Delete Column menu item. The column is removed from the composite chart.

To add logs to a column, position the mouse cursor above the column. Click on the right mouse button and select the Composite Logs submenu. Select the Add Log option. A window is shown containing logs which can be added to the column.



It is possible to select more than one log at the same time. Click OK to show the logs in the column.

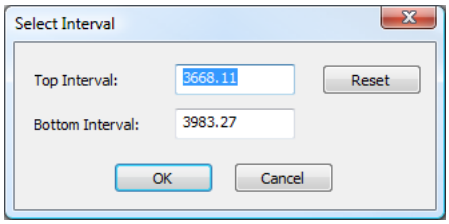
To remove a log from the column, move the mouse cursor above the column. Click on the right mouse button, got to the Composite Logs submenu and select the Delete Log option. A window appears with all the logs inside the column.



Select the log or logs you want to remove and click on the OK button. The logs will now be removed from the column.

22.4.10. TO CHANGE THE DEPTH INTERVAL OF A COMPOSITE CHART

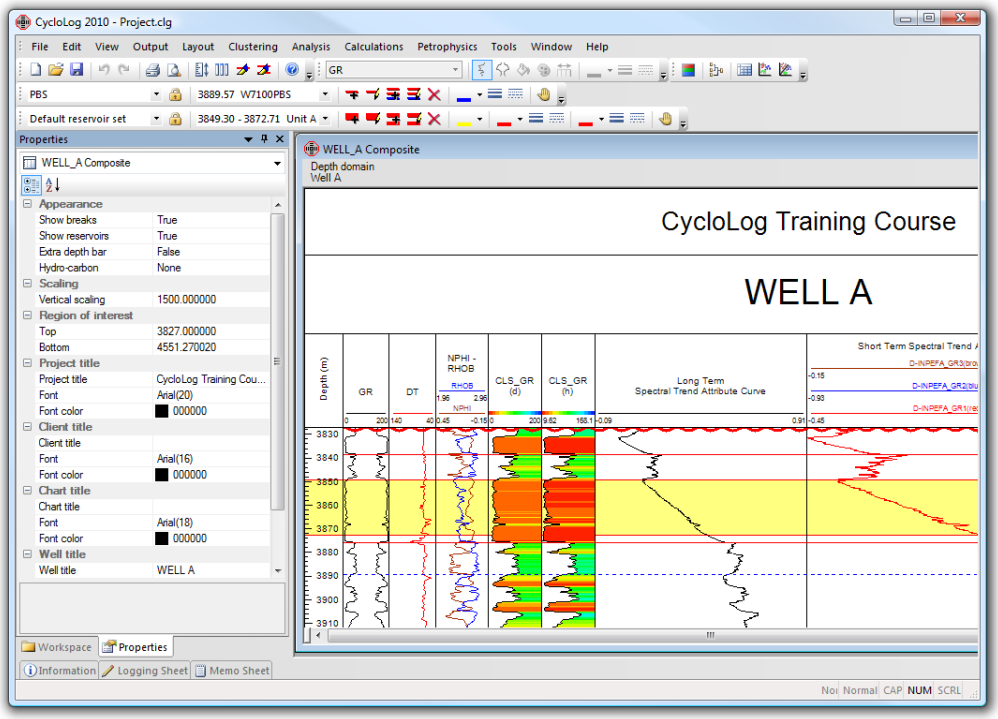
The depth interval covered by a composite chart can be changed. By default, the depth interval is the total interval covered by the data in the project. If you want to reduce this, to show only part of the available data, go to the Layout menu on the main Menu Bar, and click on Region of Interest.



In the Select Interval dialog box, change the top and bottom intervals to the required values and click OK. You can restore the depth interval to the original values by clicking the Reset button.

22.4.11. COMPOSITE CHART PROPERTIES

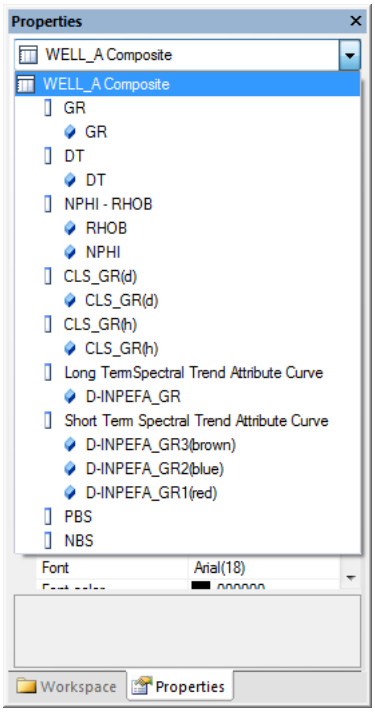
Many properties of the composite chart are summarized, and can be modified from the Properties Bar.



All properties which can be changed in the composite chart are shown in the Property Bar. The properties are assigned to three levels:

- the composite chart,
- the log column,
- the logs inside the column

The levels can be changed using the drop down box in the property bar.



When a property is changed, the result is immediately shown in the composite chart.

23. WELL CORRELATION PANELS

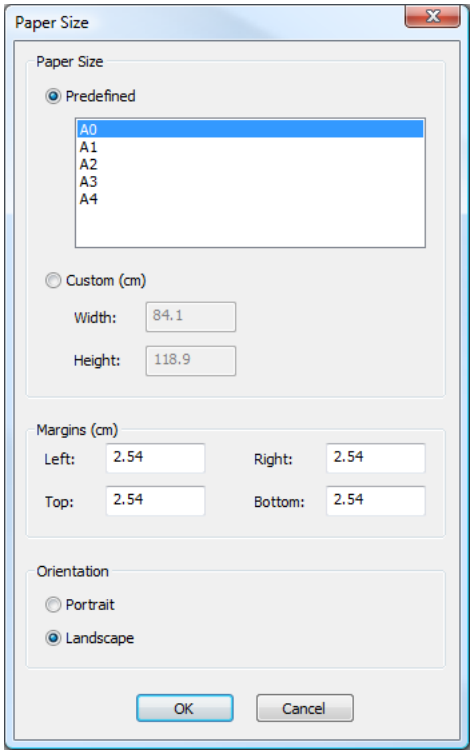
23.1. INTRODUCTION

An important feature in CycloLog is the functionality to construct, display, export and print correlation panels. Correlation panels in CycloLog consist of two or more Well Composite Charts in which the same names are used for the same Breaks, such that CycloLog can associate the same breaks in adjacent wells and draw lines between the wells to link the breaks. In addition to the automated construction of correlation lines, the Correlation Panel functions included a suite of drawing tools, for drawing correlation lines that cannot (for various reasons) be drawn automatically, and for adding further graphical material such as text boxes so as to generate a finished product of high quality, suitable for a report or presentation.

For a correlation panel to be constructed in CycloLog, all the wells belonging to it must be in the same CycloLog Project.

23.2. STARTING A CORRELATION PANEL

To open a new correlation panel, go to the Output menu on the main Menu Bar, and click Correlation Panel. The first dialog box to open is for specifying the paper size and orientation:

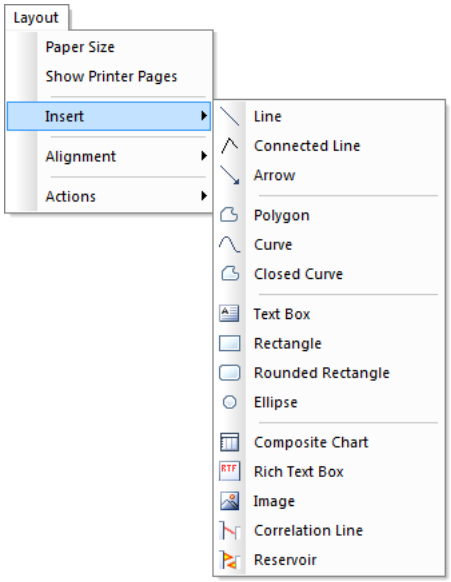


Paper Size can be one of a number of predefined sizes (A5 to A0), or you can select the Custom option and define the paper size yourself. The default width for the Margins is 2.54 cm (1 inch) all round, but you can change these if you wish. You should also select the paper orientation – Portrait or Landscape – though this can be changed later. Click OK and the Correlation Panel graphics window opens, with an outline to show the position of the margins; note the horizontal and vertical rules, calibrated in centimeters. You can maximize this window, to within the limits of the main Data Window.

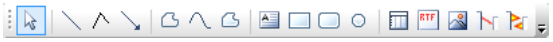
The new correlation panel will appear in the tree structure in the Workspace worksheet. Note that it appears in the tree structure at the same level as the wells. A correlation panel can be deleted or renamed in the Workspace worksheet, by selecting and then right-clicking on its name in the tree structure.

23.3. CORRELATION PANEL MENUS

Most of the commands needed for constructing a correlation panel are to be found on a special Layout menu, accessed from the main Menu Bar. (There is no right-click menu associated with correlation panel graphics windows.)



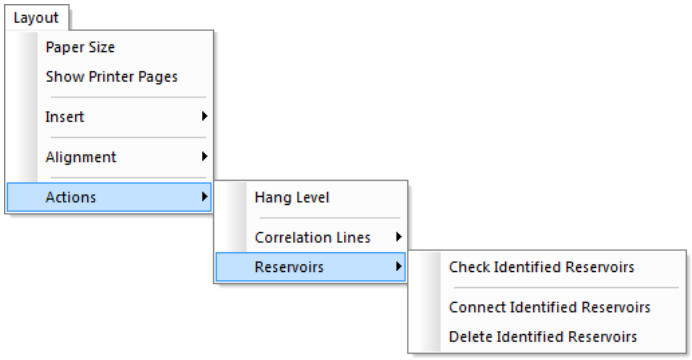
The functions on the Layout → Insert menu can also be found on the Drawing toolbar:



On the main Layout menu, the Paper Size option leads to the dialog box already described above. Show Printer Pages superimposes a grid of faint, dashed lines on the Correlation Panel graphics window, dividing it into rectangles that represent the page layout for the current printer.

The Insert sub-menu offers a variety of objects that can be inserted into the correlation panel. Most of these are standard Windows drawing objects, such as lines, arrows, polygons, text boxes and images. The two that are specific to CycloLog are the Composite Chart, the Correlation Line, and the Reservoir.

The Actions sub-menu contains further items that are specific to the construction of a correlation panel; these will be discussed in more detail below.



Tools for formatting objects included in a correlation panel are included on the Format toolbar:

23.4. INSERTING A WELL COMPOSITE CHART

Assuming that you have already constructed the composite charts to be included in your correlation panel, you can now insert them in the chart.

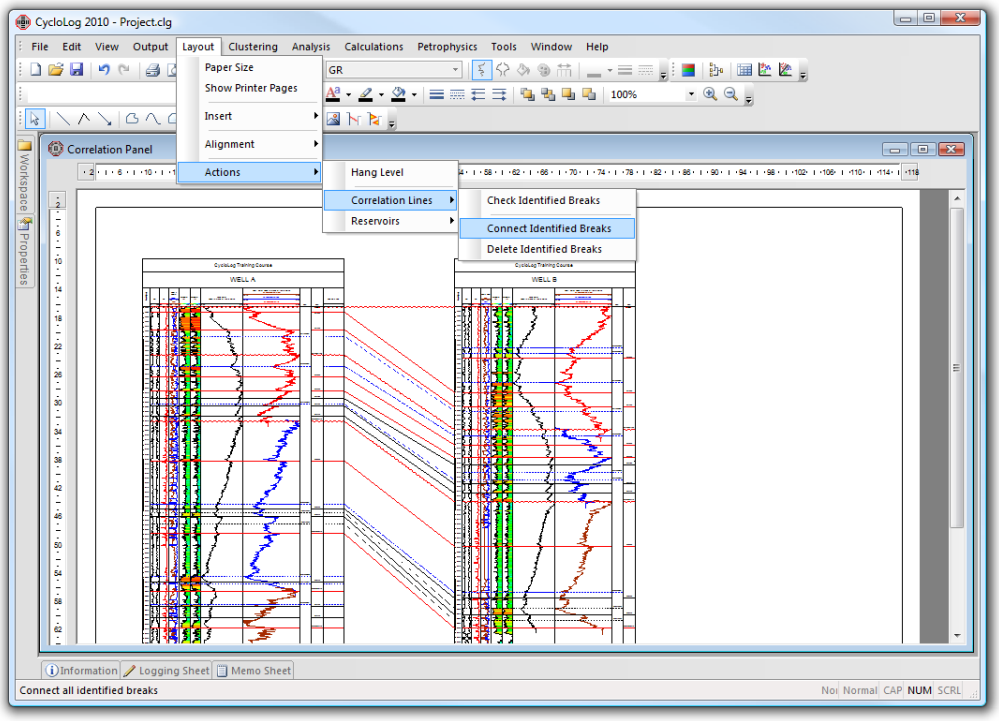
Go to the Layout menu on the main Menu Bar and select Insert → Composite Chart. The cursor changes to a cross. Place the cursor where you want the top left corner of the composite chart to appear, and click once. A dialog box opens with part of the project tree structure, showing the composite charts available in the project; click on the one you want to insert, and it will appear in the composite chart. Continue to add composite charts to the panel in the same way.

Note that you can zoom out if the chart is too large to fit in the screen; open the Format toolbar if it is not already open, and use the drop-down menu or the Zoom In and Zoom Out buttons on the toolbar. Once you have selected one of these zoom tools, you can also use the scroll-wheel on the mouse for further zooming in or out.

The relative position of the composite charts can be adjusted; click and drag anywhere over the composite chart that you want to move.

23.5. DRAWING CORRELATION LINES

CycloLog will draw all correlation lines between breaks that it can identify from their names; it is therefore important that you use exactly the same names for the same breaks in different wells. To draw all the correlation lines that can be drawn automatically, got to the Layout menu and select Actions → Correlation Lines.



There are two options:

- Check Identified Breaks
- Connect Identified Breaks

Both of these options draw the same initial set of correlation lines. The major difference between the two is that Check Identified Breaks draws gray lines in the background, while Connect Identified Breaks creates lines that are objects that can take part in further user-controlled drawing activity. The check options is therefore suitable for a quick check (for example, that all breaks are correctly labeled), whereas Connect Identified Breaks is more appropriate for generating the final panel for printing.

Note that the resulting correlation lines follow the style of the breaks that they connect; they take the same color, line width, and line style.

You can also delete all automatically drawn correlation lines; select Delete Identified Breaks from the same menu.

23.6. MANUALLY ADDING CORRELATION LINES

Automated correlation line drawing can only create correlation lines between adjacent wells that have the same breaks. Where a break has been identified in one well but not in the adjacent well, you may still wish to show a correlation line, for example in cases of unconformity.

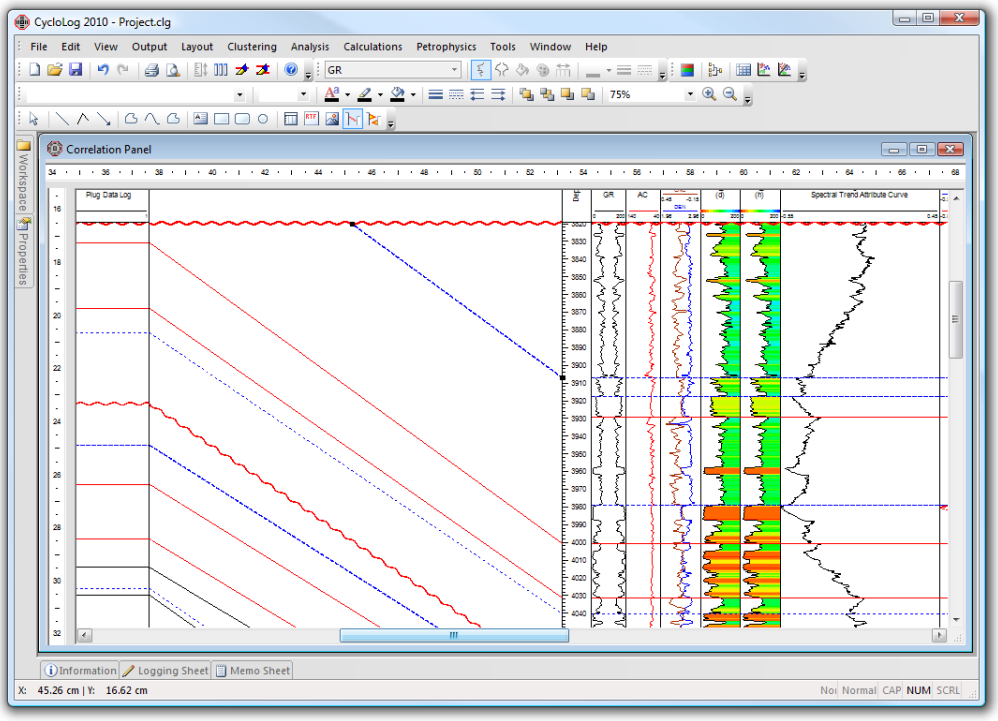
Using the correlation line button you can draw correlation lines yourself. These correlation lines can end on another correlation lines to indicate unconformity between wells. A user-drawn correlation line cannot be connected to a quick-connected break. All the "dumb" lines must be converted into correlation lines.

To draw a manual correlation line, go to the Layout menu and select Insert → Correlation Line. Or, select the Correlation Line button on the Drawing toolbar. The cursor changes to a cross (+). When the cursor is moved to a position close to the left or right end of a break on one of the composite charts, the cursor changes again, to a cross with a flash symbol (⚡) by it. Note that a correlation line can only begin at the left or right end of a break line.

To define the starting point of the correlation line, press the left mouse button and hold it down while you drag the cursor to the end point of the required line. You can let the correlation line end in any of the following three places:

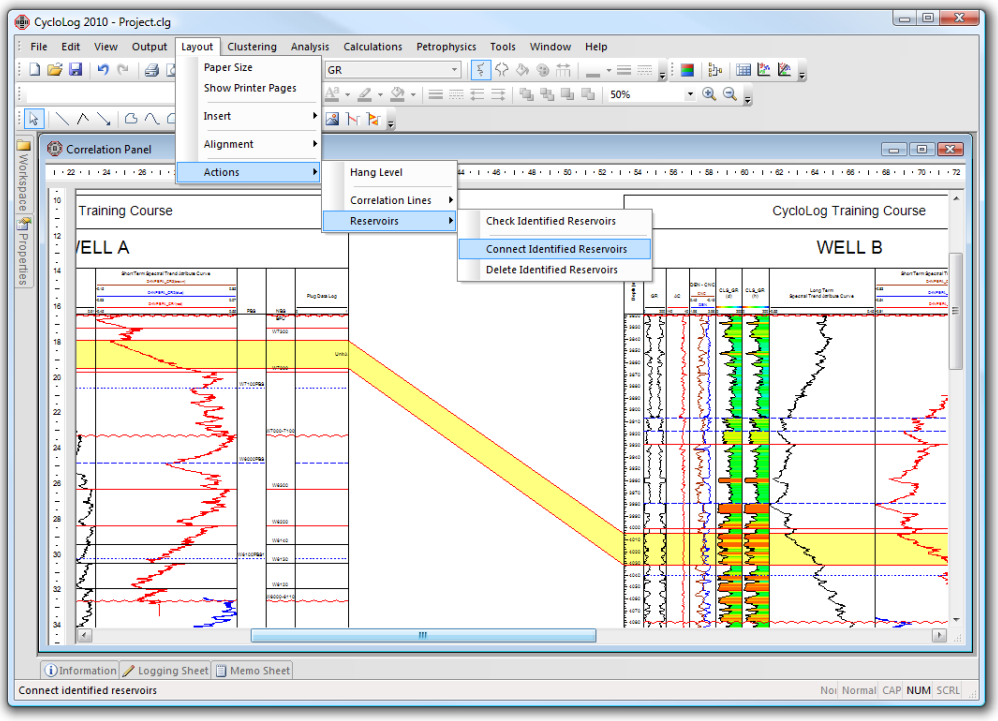
1. Anywhere on the panel. In this case, the endpoint is now fixed and will not change even if you move the composite charts.
2. On the left or right side of a composite chart at any defined break depth. In this case the correlation line will be redrawn if the position of the composite chart is changed.
3. Anywhere along another correlation line. In this case the correlation line adjusts itself if the composite charts are moved.

Note that the style of the correlation line is automatically adjusted to the style of the break from which the correlation starts.



23.7. DRAWING RESERVOIRS

CycloLog will draw all reservoir intervals between reservoirs that it can identify from their names; it is therefore important that you use exactly the same names for the same reservoirs in different wells. To draw all the correlation lines that can be drawn automatically, got to the Layout menu and select Actions → Correlation Lines.



There are two options:

- Draw Identified Reservoirs
- Connect Identified Reservoirs

Both of these options draw the same initial set of connected reservoirs. The major difference between the two is that Draw Identified Reservoirs draws gray reservoir intervals in the background, while Connect Identified Reservoirs creates connected intervals that are objects that can take part in further user-controlled drawing activity. The draw option is therefore suitable for a quick check (for example, that all breaks are correctly labeled), whereas Connect Identified Reservoirs is more appropriate for generating the final panel for printing.

Note that the resulting reservoir intervals follow the style of the reservoirs that they connect; they take the same color, line width, and line style.

You can also delete all automatically drawn reservoir intervals; select Delete Identified Reservoirs from the same menu.

23.8. MANUALLY ADDING RESERVOIRS

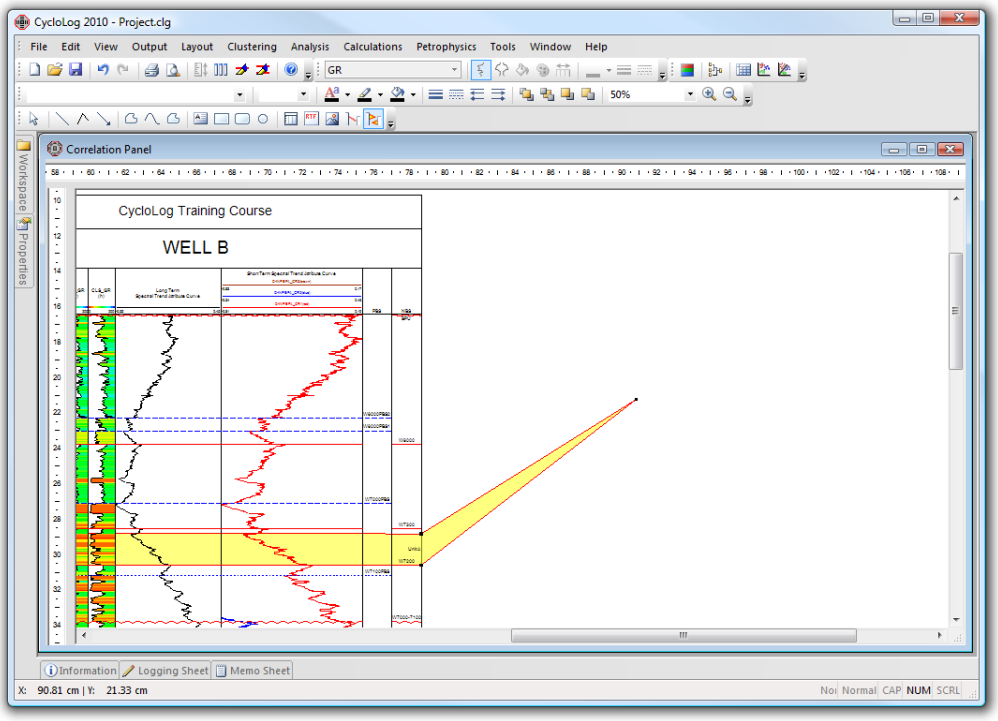
Automated reservoir drawing can only create reservoir intervals between adjacent wells that have the same reservoirs. Where a reservoir has been identified in one well but not in the adjacent well, you may still wish to show a pinching out of the reservoir.

To draw a manual correlation line, go to the Layout menu and select Insert → Reservoir. Or, select the Reservoir button on the Drawing toolbar. The cursor changes to a cross (+). When the cursor is moved to a position close to the left or right end of a reservoir on one of the composite charts, the cursor changes again, to a cross with a reservoir symbol by it. Note that a reservoir interval can only begin at the left or right end of a reservoir.

To define the starting point of the reservoir interval, press the left mouse button and hold it down while you drag the cursor to the end point of the required interval. You can let the reservoir interval end in any of the following two places:

1. Anywhere on the panel. In this case, the endpoint is now fixed and will not change even if you move the composite charts.
2. On the left or right side of a composite chart at any defined reservoir interval depth. In this case the reservoir interval will be redrawn if the position of the composite chart is changed.

Note that the style of the reservoir interval is automatically adjusted to the style of the break from which the correlation starts.

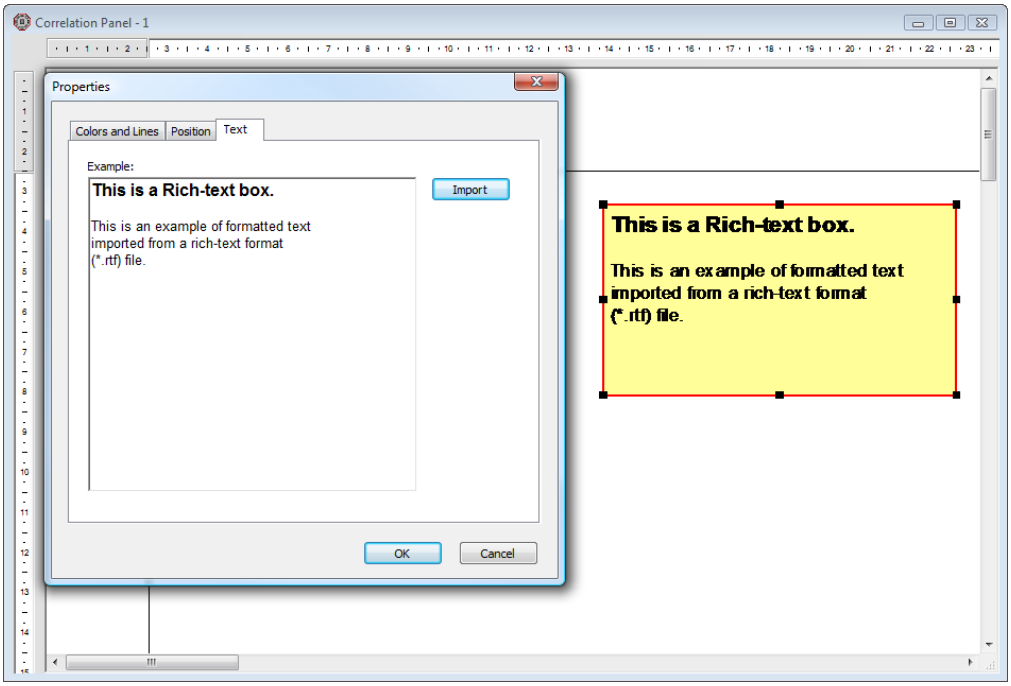


23.9. ADDING A TEXT BOX

You can add one or more text boxes to the correlation panel. These can be either a regular Text Box, or a Rich-Text box.

- The text in a regular Text Box can only be of a single font, size and style, which is selected within CycloLog. The text wraps automatically to fill the box.
- The text in a Rich Text Box can have a variety of fonts, sizes and styles, but it will not wrap within the box. The text is set up in a word-processing applications such as Word, saved as a Rich-Text Format file, and imported into the text box, where the text can be edited but the font/size/style cannot be changed.

To insert a text box of either kind, go to the Layout → Insert menu, or to the Drawing toolbar, and select Text Box, or Rich Text Box. Click and drag the cursor from the top-left corner to the bottom-right corner of the required box (it can be resized and/or moved later). A Properties dialog box opens, which has three tabs: Colors and Lines, Position, and Text.



To enter the text, select the Text tab.

- For a regular Text Box, type the text in and click OK. The text box appears in the selected position. To modify the text, or to change the formatting, double-click on the text box to re-open the Properties box. You can also use the tools on the Format toolbar.
- For a Rich Text Box, click the Import button and navigate to the *.rtf file in which you have saved the text to be included in the text box. You may have to adjust the size of the box, or edit the text in the *.rtf file and re-import it, in order to achieve the best results.

To adjust the size of a text box, click on it once, to show the resizing handles. Use the cursor to drag the resizing handles to make the box the required size.

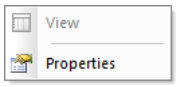
To reposition a text box, double-click to open the Properties box. Select the Position tab, change the coordinates, and click OK. You can also move a box by repeatedly using the resizing handles. If a text box (or other drawing object) is concealing another object, you can change their relative overlap using the Move to Front, Move to Back etc tools on the Format toolbar.

To add background color or to change the color of the outline of a text box, double-click on the box to open the Properties box, select the Colors and Lines tab, and make the changes that you want.

23.10. INSERTING OTHER DRAWING OBJECTS

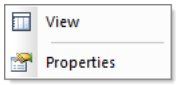
You can also insert other drawing objects, including lines, arrows, polygons and images (in bitmap format only) into the correlation panel. The procedure is similar for all of them: click the item you want to insert on the Layout → Insert menu, or on the Drawing toolbar, and then click the cursor to indicate the position on the panel. Connected lines, polygons, curves and closed curves are finished by double-clicking over the last point.

The properties of the inserted objects can be accessed through the context menu. To show the context menu, click the right mouse button on an object.



Objects already inserted can also be edited by double-clicking on them.

When the object is a composite well chart, then the context menu also shows a View option.



When this option is clicked a separate window opens containing the composite well chart. Any changes made in the composite chart will immediately reflected in the correlation panel.

23.11. ALIGNING OBJECTS

In the Align toolbar you can find several functions which help you placing objects on the correlation panel.

: Align left; aligns the left side of all selected objects to the left side of the first selected object.

: Align right; aligns the right side of all selected objects to the right side of the first selected object.

: Align top; aligns the top side of all selected objects to the top side of the first selected object.

: Align bottom; aligns the bottom side of all selected objects to the top side of the first selected object.

: Center horizontally; all selected objects are centered horizontally.

: Center vertically; all selected objects are centered vertically.

: Distribute horizontally; all the horizontal space between the outermost selected objects is distributed evenly between all selected objects.

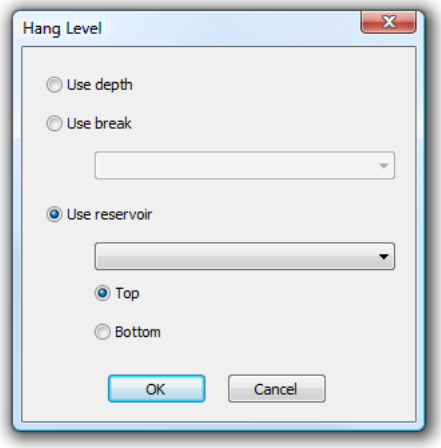
: Distribute vertically; all the vertical space between the outermost selected objects is distributed evenly between all selected objects.

: Make same width; all selected objects are assigned the same width as the first selected object. This command is not available for composite charts.

: Make same height; all selected objects are assigned the same height as the first selected object. This command is not available for composite charts.

23.12. CHANGING THE HANG LEVEL

The stratigraphic level on which the well composites are “hung” (aligned) can be changed. Go to the Layout menu and select Actions → Hang Level.



Several levels can be used for a hang level. The depth can be used as a hang level, a break can be used for a hang level and a reservoir can be used for a hang level. When a reservoir is used for a hang level, the user can specify if the top or the bottom of the reservoir must be used for the hang level. After the hang level has been chosen, click OK. The correlation panel is redrawn with the new hang level.

23.13. PRINTING AND EXPORTING CORRELATION PANELS

Correlation panels can be printed directly from CycloLog. Use the Layout → Show Printer Pages option to see how the plot will fit on the paper size available to the current printer. File → Print Preview will also show the layout, page by page.

Alternatively, finished correlation panels can be exported from CycloLog as graphics files, for importing to other applications. Available graphics formats are Bitmap, GIF, JPG, PNG, and TIFF. Select the required format from the Output menu on the main Menu Bar, navigate to the required folder, and give the output file a name.

24. EXPORTING WELL DATA

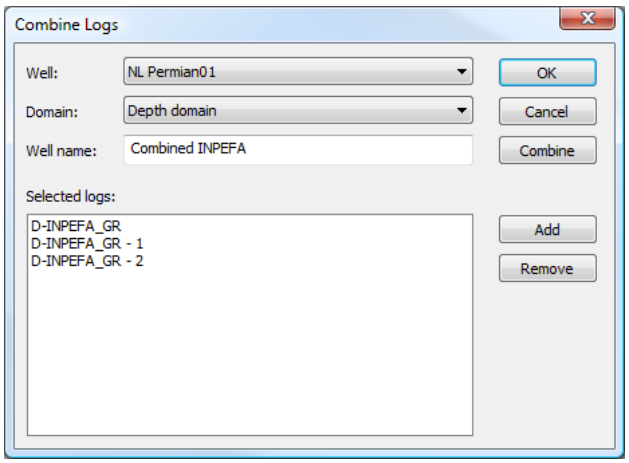
24.1. INTRODUCTION

CycloLog can export three different kinds of information, for use in other applications.

- Log data, including log transforms such as INPEFA curves.
- Breaks data
- Reservoir data
- Graphics

24.2. COMBINING LOGS FOR EXPORT

If logs are exported for using in other programs you sometimes have the problem of limited log import. Not all generated logs can be imported into the program due to a limited number of user defined logs (e.g. INPEFA logs). The data from several INPEFA logs can easily be combined into one log using the Combine Logs option in the Tools menu.



You will have to select the correct Well and Domain to work on. In the Well name you can enter the name for the new combined log. In the Selected logs list you will find the selected logs which will be combined. If you click Add you will see a list from which you can select logs to combine. The Remove button will remove the currently selected log in the Selected logs list

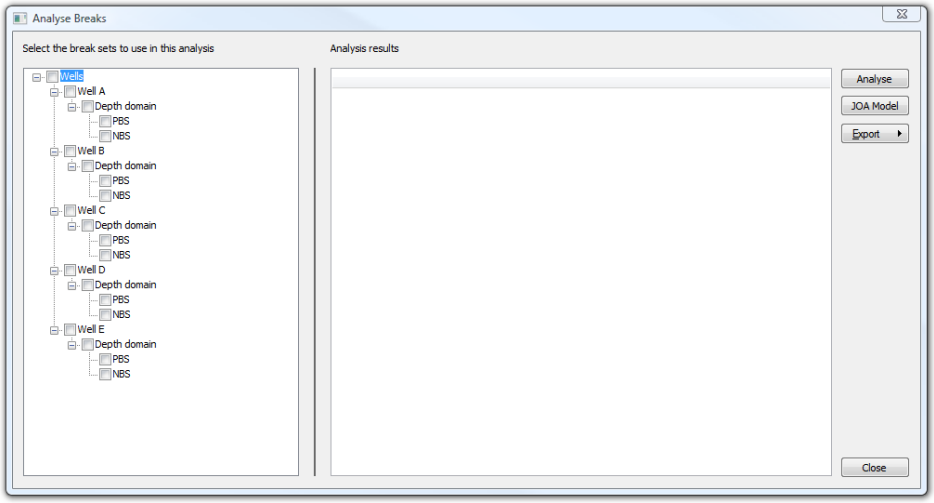
from the list. The Combine button will create the new combined log from the selected logs. Please note that the combined logs must not be overlapping otherwise the log data will be changed.

24.3. EXPORTING BREAKS TO OTHER PROGRAMS

Besides the simple exporting of a break set to an ASCII file, CycloLog contains options for a more sophisticated export of the breaks. You can use the Break Analysis to generate a table of picks using multiple break interpretations for more wells. It is also possible to export generated breaks to Jewel Suite from JOA as a model definition or a marker set.

24.3.1. EXPORT A TABLE OF PICKS

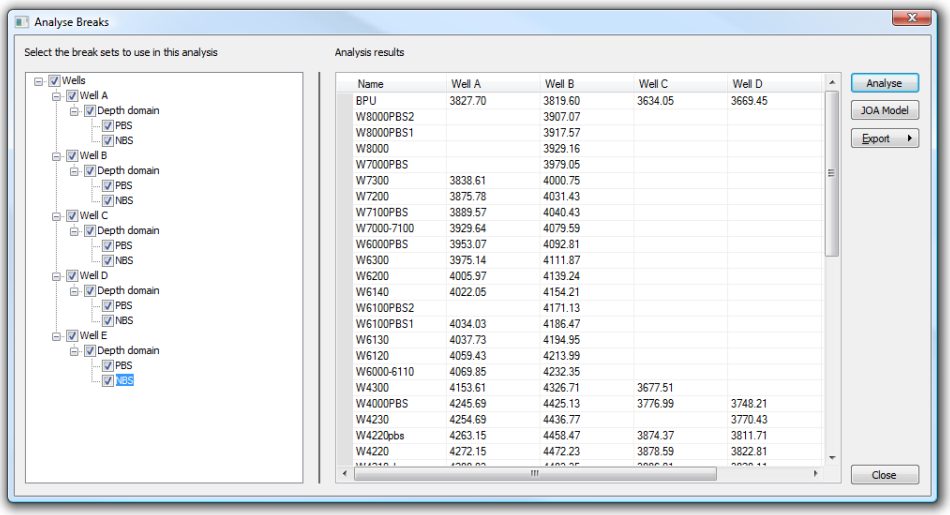
Go to the Analysis menu and select the Analyse Breaks option to show the Analyse Breaks window.



In this window you can select the break sets you want to use during the analysis. It is not possible to select domains or wells. Break sets which hold multiple breaks with the same name cannot be chosen. Breaks within a break set who do not have a name assigned to them are not used in the analysis.

If the Analyse button is clicked, CycloLog starts to analyse the breaksets. During the analysis CycloLog tries to identify the underlying relationships between all the breaks in the selected

breaksets. The relative order of all the breaks are inferred and shown in the Break Level window.



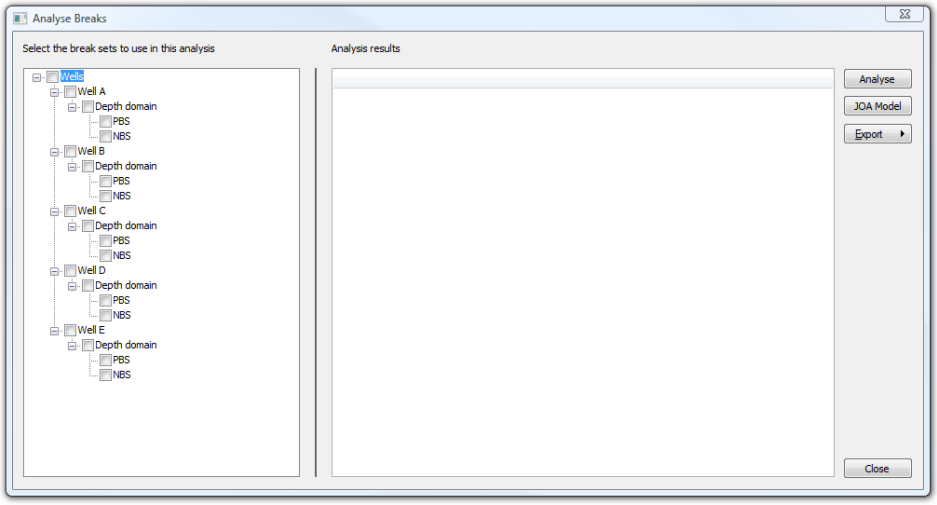
Name	Well A	Well B	Well C	Well D
BPU	3827.70	3819.60	3634.05	3669.45
W8000PBS2		3907.07		
W8000PBS1		3917.57		
W8000		3929.16		
W7000PBS		3979.05		
W7300	3838.61	4000.75		
W7200	3875.78	4031.43		
W7100PBS	3889.57	4040.43		
W7000-7100	3929.64	4079.59		
W6000PBS	3953.07	4092.81		
W6300	3975.14	4111.87		
W6200	4005.97	4139.24		
W6140	4022.05	4154.21		
W6100PBS2		4171.13		
W6100PBS1	4034.03	4186.47		
W6130	4037.73	4194.95		
W6120	4059.43	4213.99		
W6000-6110	4069.85	4232.35		
W4300	4153.61	4326.71	3677.51	
W4000PBS	4245.69	4425.13	3776.99	3748.21
W4230	4254.69	4436.77		3770.43
W4220pbs	4263.15	4458.47	3874.37	3811.71
W4220	4272.15	4472.23	3878.59	3822.81

Sometimes there is not enough data available to find the correct interpretation scheme. For example, if Break A is defined in one well to be below Break B and in another well Break B is defined to be below Break A the interpretation is not consistent and cannot be inferred.

A table of picks can be exported by clicking on the Export button and selecting the Table of picks option. You can save the table of picks in an ASCII file which can be opened in any program such as Excel.

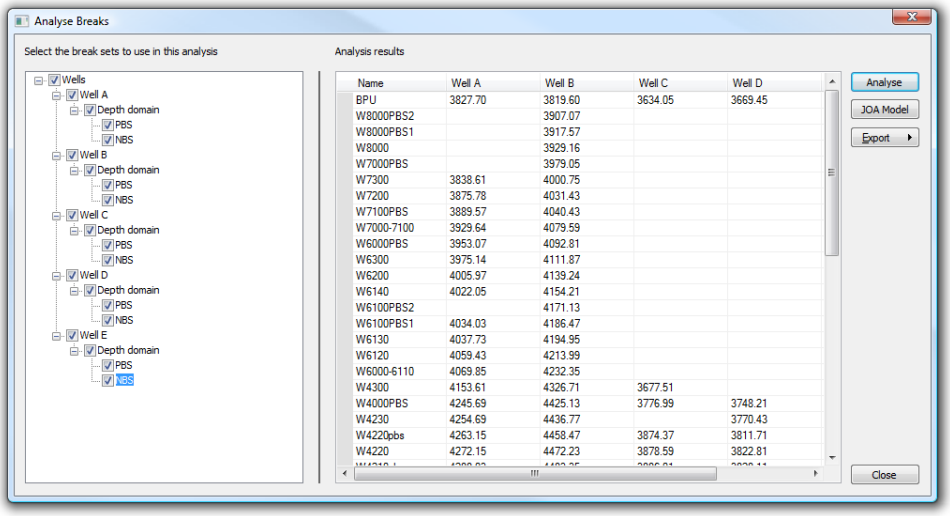
24.3.2. EXPORT TO A JOA MARKERSET

Breaks can be exported to JOA's Jewel Suite by saving the break analysis as a JOA Markerset. To generate a markerset go to the Analysis menu and select the Analyse Breaks option.



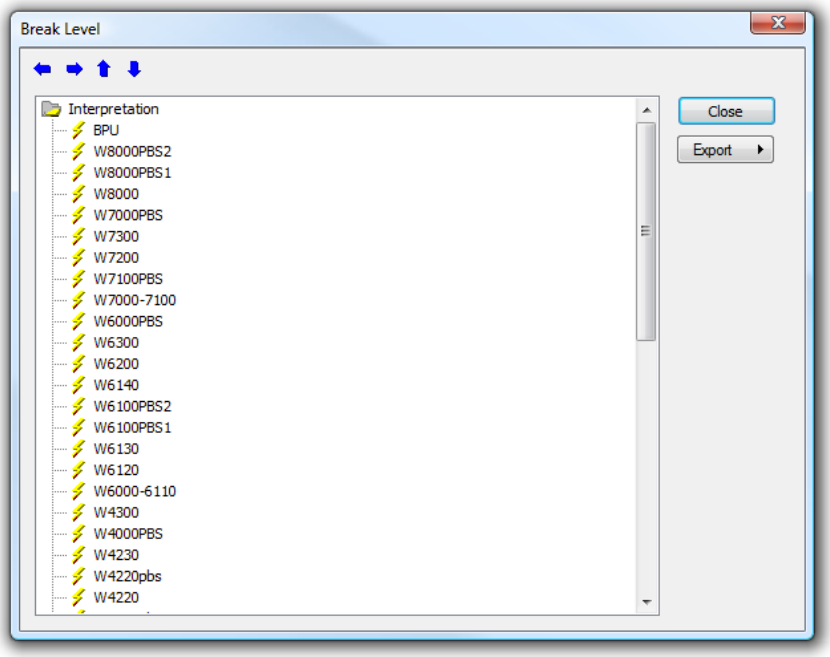
In this window you can select the break sets you want to use during the analysis. It is not possible to select domains or wells. Break sets which hold multiple breaks with the same name cannot be chosen. Breaks within a break set who do not have a name assigned to them are not used in the analysis.

If the Analyse button is clicked, CycloLog starts to analyse the break sets. During the analysis CycloLog tries to identify the underlying relationships between all the breaks in the selected break sets. The relative order of all the breaks are inferred and shown in the Break Level window.



Sometimes there is not enough data available to find the correct interpretation scheme. For example, if Break A is defined in one well to be below Break B and in another well Break B is defined to be below Break A the interpretation is not consistent and cannot be inferred.

To export the analysis to a JOA Markerset click on the JOA Model button.

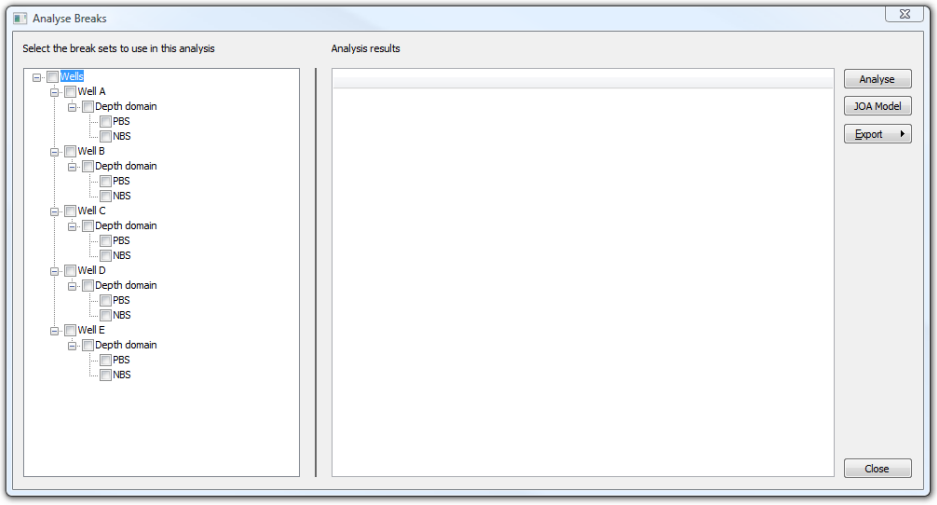


The up and down arrows can be used to shift selected breaks up and down the list for manual adjustment.

A JOA Markerset can be saved by clicking on the Export button and selecting the JOA Markerset option. The saved file can be opened within JOA's Jewel Suite.

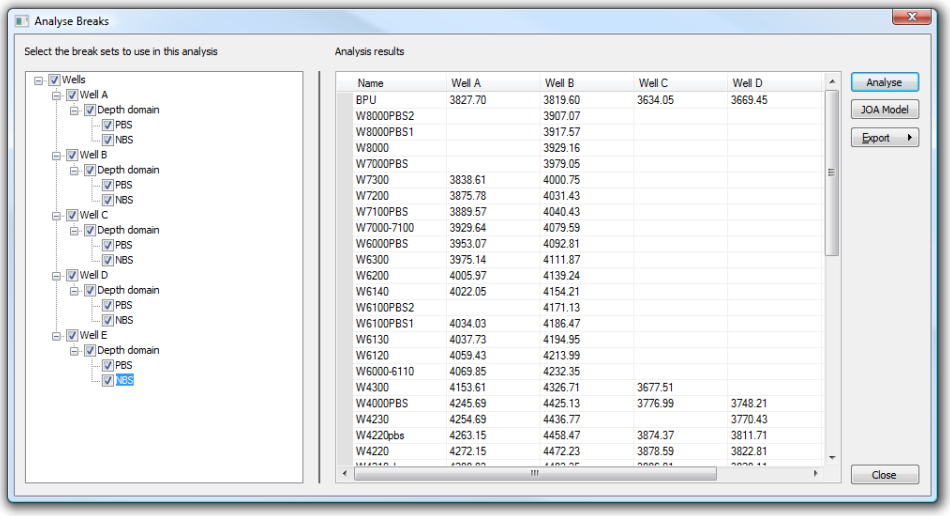
24.3.3. EXPORT TO A JOA MODEL DEFINITION

A model definition is the hierarchical presentation of the markerset used in Jewel Suite. A break interpretation within CycloLog can be converted into a JOA model definition using the Analyse Breaks option on the Analyse menu.



In this window you can select the break sets you want to use during the analysis. It is not possible to select domains or wells. Break sets which hold multiple breaks with the same name cannot be chosen. Breaks within a break set who do not have a name assigned to them are not used in the analysis.

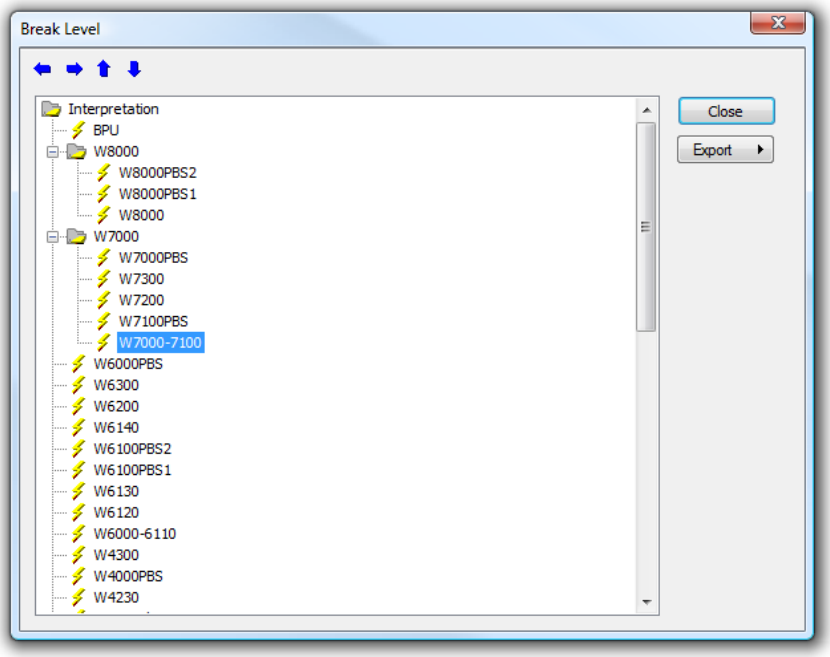
If the Analyse button is clicked, CycloLog starts to analyse the break sets. During the analysis CycloLog tries to identify the underlying relationships between all the breaks in the selected break sets. The relative order of all the breaks are inferred and shown in the Break Level window.



Name	Well A	Well B	Well C	Well D
BPU	3827.70	3819.60	3634.05	3669.45
W8000PBS2		3907.07		
W8000PBS1		3917.57		
W8000		3929.16		
W7000PBS		3979.05		
W7300	3838.61	4000.75		
W7200	3875.78	4031.43		
W7100PBS	3889.57	4040.43		
W7000-7100	3929.64	4079.59		
W6000PBS	3953.07	4092.81		
W6300	3975.14	4111.87		
W6200	4005.97	4139.24		
W6140	4022.05	4154.21		
W6100PBS2		4171.13		
W6100PBS1	4034.03	4186.47		
W6130	4037.73	4194.95		
W6120	4059.43	4213.99		
W6000-6110	4069.85	4232.35		
W4300	4153.61	4326.71	3677.51	
W4000PBS	4245.69	4425.13	3776.99	3748.21
W4230	4254.69	4436.77		3770.43
W4220pbs	4263.15	4458.47	3874.37	3811.71
W4220	4272.15	4472.23	3878.59	3822.81

Sometimes there is not enough data available to find the correct interpretation scheme. For example, if Break A is defined in one well to be below Break B and in another well Break B is defined to be below Break A the interpretation is not consistent and cannot be inferred.

To export the analysis to a JOA Model definition click on the JOA Model button.



The up and down arrows can be used to shift selected breaks up and down the list for manual adjustment. The left and right arrows can be used to define a hierarchy level. To place the W8000 breaks in a separate level, you must select the W8000PBS2 break and click on the right arrow. A folder is created which contains the W8000PBS2 break. The name of the folder can be changed by double clicking on the folder name, similar to the Windows Explorer, or by selecting the item and pressing the F2 button on the keyboard. The W8000PBS1 break can be added by dragging the break to the folder.

If a hierarchical model has been created, the model can be exported to a JOA Model definition file by clicking on the Export button and selecting JOA Model Definition.

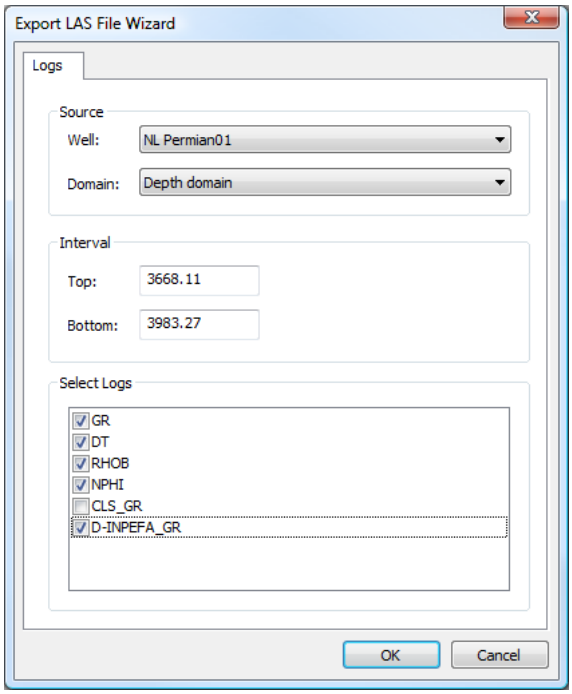
24.4. EXPORTING LOG DATA

Log data that you have worked on in CycloLog can be exported, for use in other applications. This includes log transforms such as INPEFA curves.

The main export options are LAS, General ASCII, and CycloLog format. They are all accessed from the File → Export menu.

24.4.1. EXPORTING LOG DATA IN LAS FORMAT

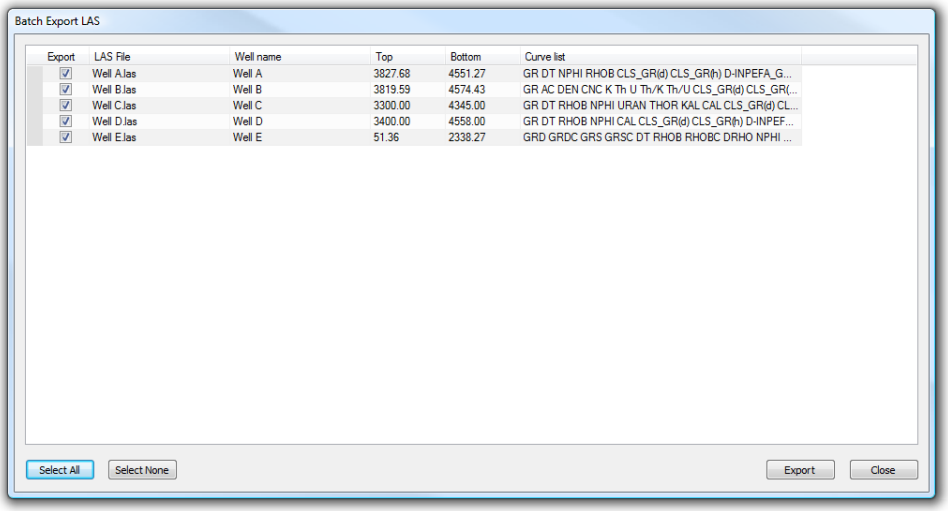
To export log data in LAS format, select LAS File from the File → Export sub-menu.



Check that the well and domain are correct if there is more than one well/domain in the project. Then select the logs for inclusion in the export file and click OK. A Save As dialog box opens; navigate to the folder in which you want to save the file, and give it a name – CycloLog will add the .las extension.

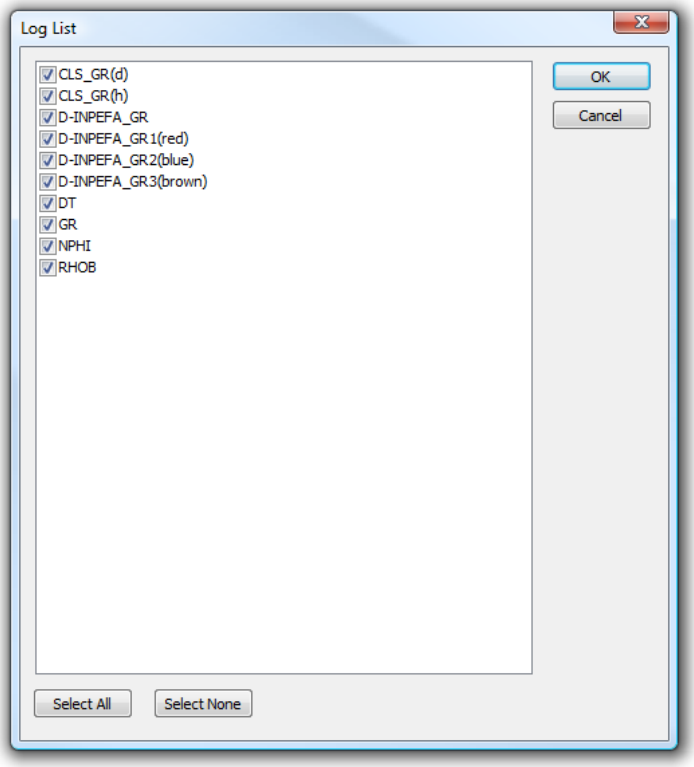
24.4.2. BATCH EXPORT LOG DATA IN LAS FORMAT

To export log data from multiple wells the batch export function can be used. This function can be found in the File menu, under the Export sub menu. Click on the Batch Export LAS option.



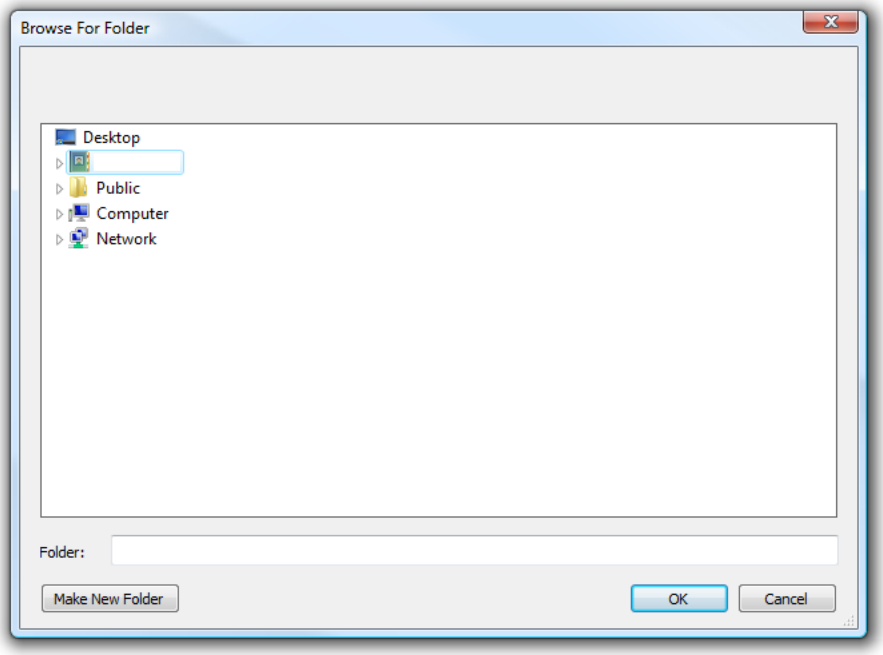
All wells in the project are shown in a list. Selecting a well for export can be done by checking the checkbox in front of the well row. The button Select All will select all wells for export; the Select None button will remove all checks so that no wells are exported.

The LAS file name can be changed by typing in a new file name. The top and bottom can be adjusted to define a new interval for export. When the button in the Curve list column is clicked a list appears showing all the logs in the well.



The user can select which logs must be exported by checking the checkbox in front of the log names. The Select All button will select all the logs; the Select None button will select none of the logs for export. By default, all logs are selected for export.

To export all the log data, click on the Export button. A window appears where a folder must be selected where all the LAS files will be created.



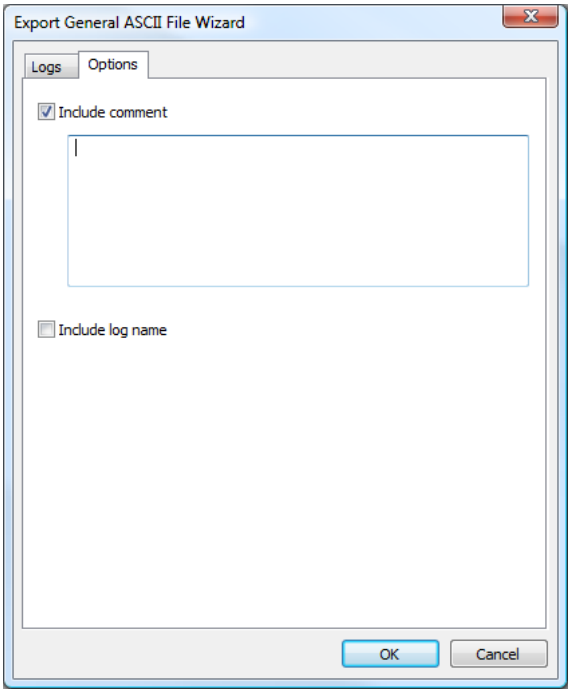
Clicking on OK will start the export process.

24.4.3. EXPORTING LOG DATA IN ASCII FORMAT

To export log data in ASCII format, select General ASCII from the File → Export sub-menu.

The Export General ASCII dialog box has two tabs; the Logs tab is identical to the Export LAS box illustrated above.

The Options tab has two check boxes, for selecting the following options:



Include comments: If you wish to add a comment, check the box and type your comment in the box; it will be included as header information in the output file.

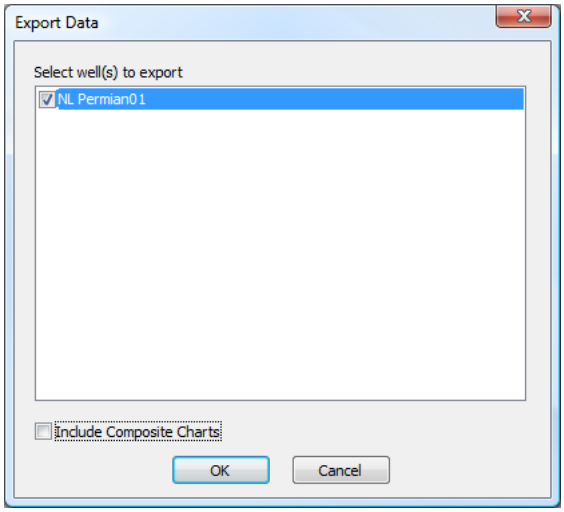
Include log name: If you check this box, CycloLog adds a list of the names of the logs included in the file. If you do not check this box, it is important to remember which logs you have included, as there will be nothing to remind you in the ASCII file.

On the Logs tab, check that the well and domain are correct if there is more than one well/domain in the project. Then select the logs for inclusion in the export file and click OK. A Save As dialog box opens; navigate to the folder in which you want to save the file, and give it a name – CycloLog will add the .asc extension.

24.4.4. EXPORTING LOG DATA IN CLG FORMAT

Exporting a well in CycloLog format is more or less equivalent to using File → Save As, except that you can choose to omit any composite charts. Also, if you are working in a multi-well project, you can select just one well, or a sub-set of the wells, for export.

To export log data in CycloLog format, select CycloLog File from the File → Export sub-menu.

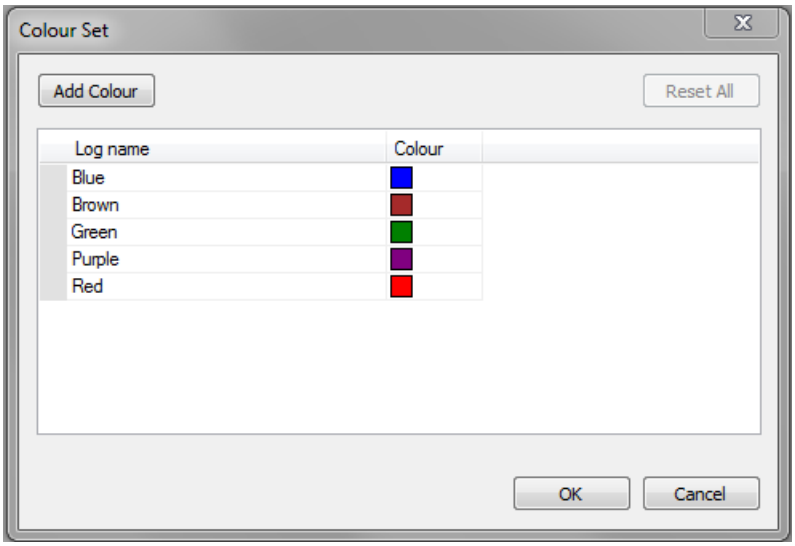


The only option is whether or not to include composite charts. When you click OK, a Save As dialog box opens; navigate to the folder in which you want to save the file, and give it a name – CycloLog will add the .clg extension. Note that there is no option to export any correlation panels.

25. COLOUR SET

The Cyclolog colour set feature is used by the INPEFA generation function, to automatically generate colours for the logs generated.

The user can configure what colours get used for this process by clicking on the menu item Tools->Colour Set:



Auto generation of logs will use the colours in order for each Nth log, until it reaches the end of the colour list – it will then cycle back round, and continue.

The user can add additional colours (and name them according to taste), or modify the existing colours and names.

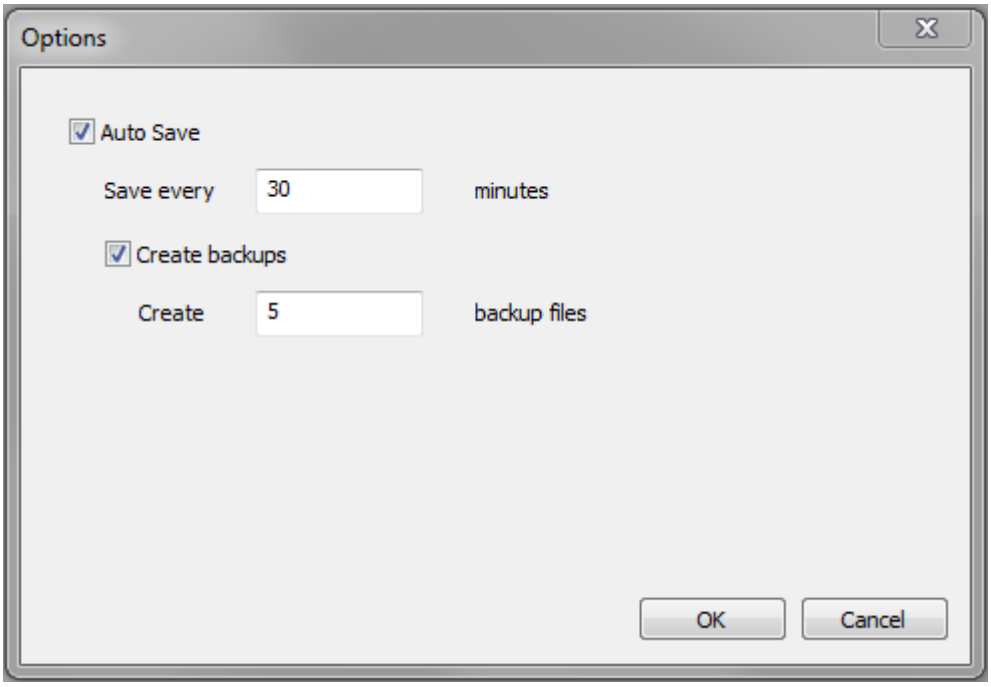
It is also possible to Reset All to factory settings.

Note: these colour settings are per-user, and per-machine. They do not get saved with .clg files, or shared with other users. Logs generated with these colours, however, will retain whatever colour was used when they were created.

26. AUTO SAVE & FILE BACKUP

Cyclolog has features to auto save your work after a specified amount of time, and also a facility to create multiple backups of your file as you work.

The options for both features can be found on the menu “Tools->Options…” This brings up the configuration options for Cyclolog:



26.1. AUTO SAVE

Auto save is enabled by default. You can disable it here, by unchecking the Auto Save checkbox. The number of minutes between auto saving (and backups, if enable) can be specified here. The default is 30 minutes.

26.2. CREATE BACKUPS

This feature is considered an optional sub-function of auto save, and so is enabled and disabled along with the master Auto Save feature.

However, you can enable and disable backups separately when auto saves are enabled, by clicking on the second check box. You can also enter the number of files that Cyclolog will maintain as backups, before deleting the oldest. The default is 5.

Backups are placed in a folder created at the same location as the .clg file, and named the same with an additional .BACKUP extension. Backup files are also named from the original file, but with additional time and date information added.