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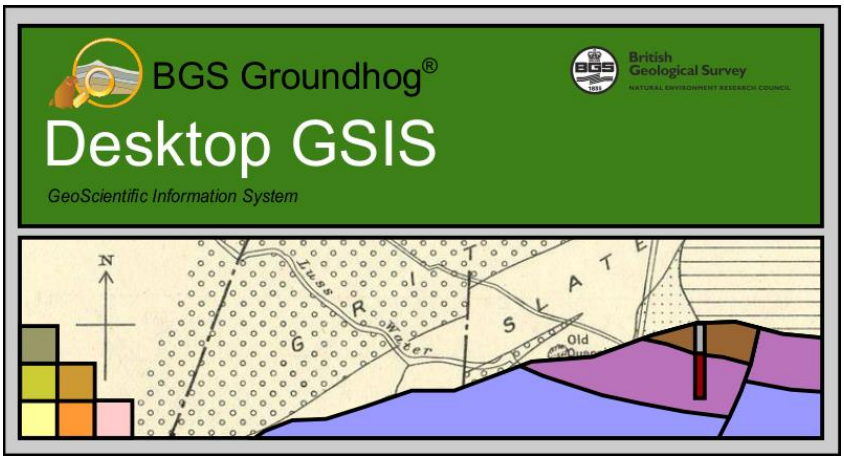
BGS Groundhog® Desktop Geoscientific Information System External User Manual

Modelling Systems

Internal Report OR/15/046



BRITISH GEOLOGICAL SURVEY

MODELLING Systems

INTERNAL REPORT OR/15/046

BGS Groundhog® Desktop Geoscientific Information System External User Manual

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BRITISH GEOLOGICAL SURVEY

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The London Information Office also maintains a reference collection of BGS publications, including maps, for consultation.

We publish an annual catalogue of our maps and other publications; this catalogue is available online or from any of the BGS shops.

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The British Geological Survey is a component body of the Natural Environment Research Council.

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Foreword

BGS Groundhog is a software platform developed by the British Geological Survey (BGS) for the management and display of subsurface geological information. There are two main components;

1. BGS Groundhog ***Web***
2. BGS Groundhog ***Desktop GSIS***

This user manual relates specifically to the ***Desktop GSIS*** component of the platform.

The software is available under the UK's Open Government Licence, which means the software is free to use, exploit and re-distribute for academic, personal, research or commercial purposes, subject to the terms of the UK's Open Government Licence.

Groundhog Desktop is intended as a basic GeoScientific Information System (GSIS*) – a software tool which facilitates the collation, display, filtering and editing of a range of data relevant to subsurface interpretation and modelling. It has been developed by the Modelling Systems software development team, with help and advice being provided by Holger Kessler, Steve Mathers and Ricky Terrington.

This manual provides information on the use of the software for external clients.

Contents

1 Overview

BGS Groundhog is a software platform developed by the British Geological Survey (BGS) for the management and display of subsurface geological information. There are two main components;

3. BGS Groundhog ***Web***
4. BGS Groundhog ***Desktop GSIS***

A brief description of the ***Web*** component is given below, but the remainder of this user manual relates specifically to the ***Desktop GSIS*** component of the platform.

1.1 BGS GROUNDHOG WEB

BGS Groundhog Web is a web-based virtual borehole and section viewer which allows the user to drill virtual boreholes and slice through a geological model both vertically and horizontally using interactive tools on the fly.

This tool offers a glimpse into how geological models will be increasingly made accessible via the Web.

To demonstrate the type of information available, the BGS have released free models for several areas of the UK that reflect a range of geological settings. You can try it here;

http://mapapps.bgs.ac.uk/geologyofbritain/home.html?mode=groundhog

A commercial version provides access to a selection of our commercial geological models;

https://shop.bgs.ac.uk/Groundhog/

For further information regarding BGS Groundhog **Web**, please contact our Enquiries service;

enquiries@bgs.ac.uk

+44 (0) 115 936 3143

1.2 BGS GROUNDHOG DESKTOP GSIS

BGS Groundhog Desktop GSIS (***Desktop GeoScientific Information System*** - hereafter "**Groundhog**") is a graphical software tool developed by the Environmental Modelling Directorate of the British Geological Survey for the display of geological and geo-spatial information such as interpreted (correlated) geological cross-sections, maps and boreholes.

The software is available under the UK's Open Government Licence;

http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

This means the software is free to use, exploit and re-distribute for academic, personal, research or commercial purposes, subject to the terms of the UK's Open Government Licence. We also require that you acknowledge the software in the following way wherever you use it to create or deliver any product, data, information or report;

- BGS Groundhog® Desktop Copyright © BGS/NERC (year).

For full details of the licensing and terms and conditions please refer to the license files in the installation directory.

For any enquiries regarding Groundhog **Desktop GSIS**, please contact;

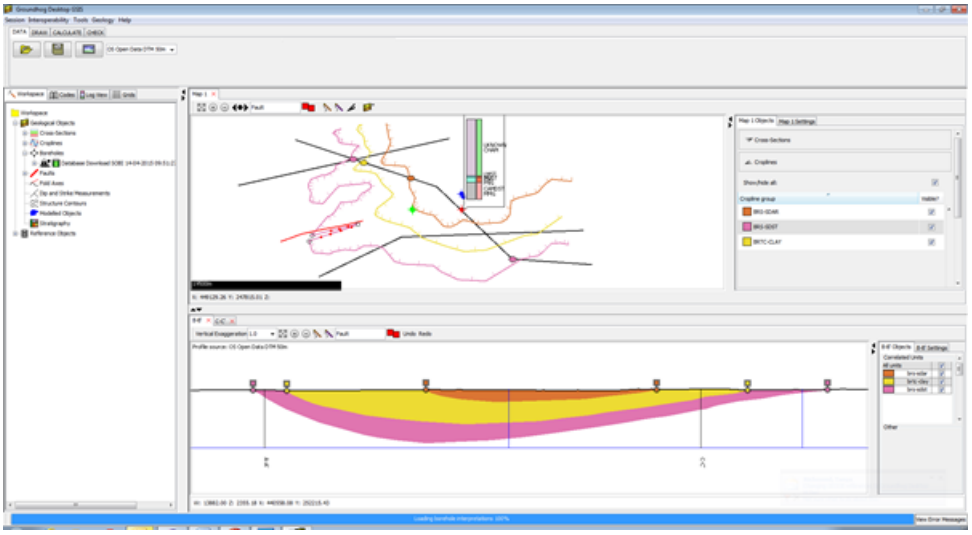
groundhog@bgs.ac.uk

For further information on the work of the BGS Environmental Modelling Directorate, please refer to;

http://www.bgs.ac.uk/research/environmentalModelling/

1.2.1 Capabilities

Groundhog Desktop is intended as a basic GeoScientific Information System (GSIS*) – a software tool which facilitates the collation, display, filtering and editing of a range of data relevant to subsurface interpretation and modelling. You can use Groundhog to load and display certain types of borehole data, geological map linework, interpreted (correlated) cross-section and faults. It also supports reference data such as elevation models and images and has basic editing capabilities.

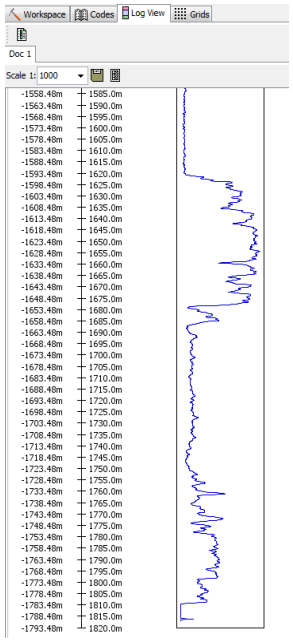


Typical view of Groundhog Desktop in use with map linework, cross-sections and boreholes loaded.

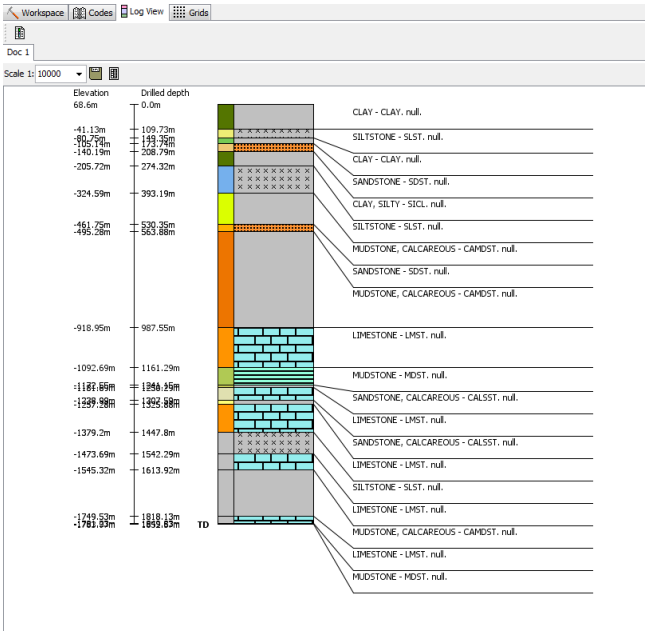
* Turner, A.K. (1992) Three-dimensional modelling with geoscientific information systems. Kluwer Academic Press, Dordrecht, 443 pp. (ISBN 0-7923-i550-2).

1.2.1.1 Borehole Log Capabilities

Groundhog can load and display basic borehole log information using interval-based and pick-based markers. Interval-based markers have a top and base range (“from” and “to” depth values). Pick-based markers have a single depth value and a measurement value (e.g. Gamma, Resistivity). Each marker can then have a set of additional values or categorized attributes attached such as lithology, lithostratigraphy, description etc. In the case of pick-based markers, attributes for typical codes such as lithology can be applied as ABOVE and/or BELOW the marker. Groundhog can load boreholes from a spreadsheet-type DAT file and also has basic support for LAS files. For further details refer to the **Log View** section of this manual. Depths are always **drilled depth** from the borehole collar height.



Gamma log loaded as pick-based data and drawn as a curve



Interpreted drillers log loaded as interval-based data and drawn as a log

1.2.1.2 MAP CAPABILITIES

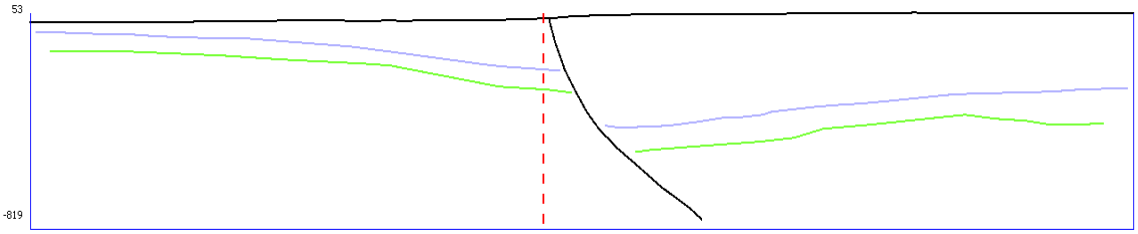
Groundhog can load and display geological map linework in terms of horizon BASE contacts ("croplines"). It can also present cross-section plan lines, fault trace linework, geo-registered map images and borehole positions.

To open a blank map window use **Session > Windows > New Map Window** then click on the zoom to full extent button.

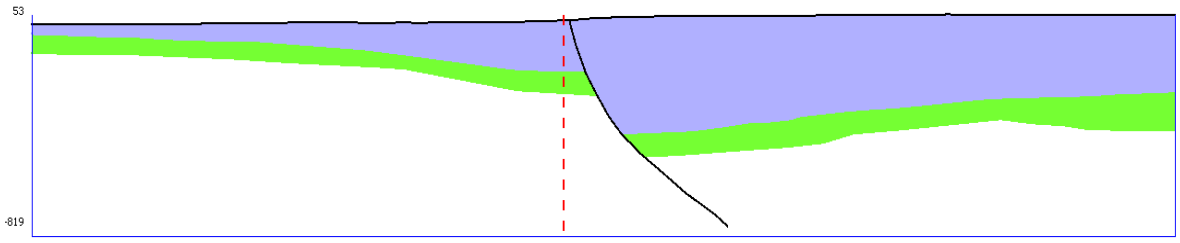
1.2.1.3 CROSS-SECTION CAPABILITIES

Groundhog can load and display interpreted (correlated) cross-section linework (horizon bases and fault sticks) and also display raster (image) backdrops which can be scaled interactively for digitizing. Basic borehole logs can also be displayed for correlation.

Groundhog displays lines in cross-section by default. However, if correlation lines are correctly constructed by using line-to-line snapping (refer to cross-section reference later in this manual) then a coloured-up section can be constructed.



Section with lines



Section with lines snapped together forming coloured-up polygons.

1.2.2 System Requirements

- PC or laptop running Microsoft Windows OS,
- 2-button mouse with scrolling wheel.

1.2.3 Download and Installation

Groundhog can be downloaded from

http://www.bgs.ac.uk/research/environmentalModelling/

To install, double click the **setup.exe** and follow the instructions in the installation wizard. NOTE: you may need administrator privileges to install the software, in which case please consult your system administrator or helpdesk.

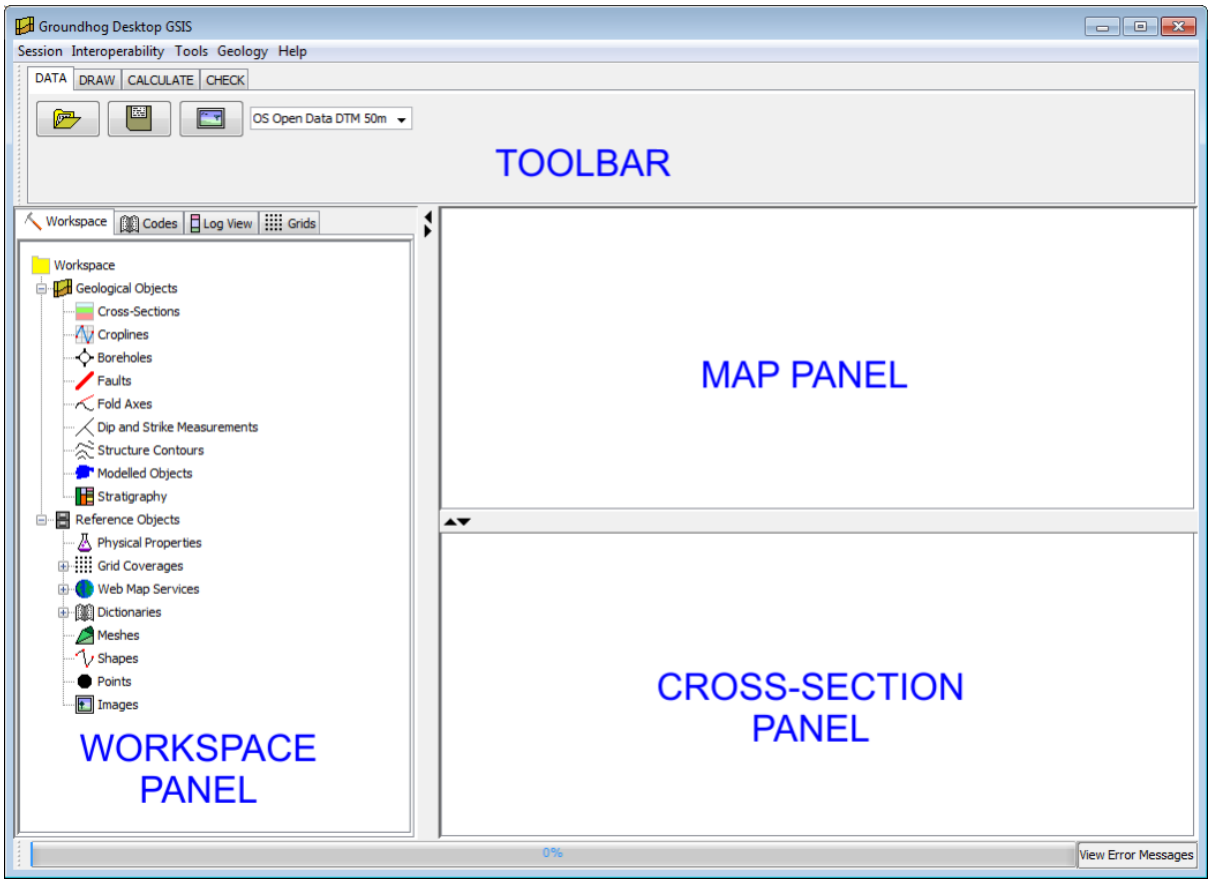
1.2.4 Support and Warranty

Groundhog Desktop is free software and comes with no support or warranty. Please refer to the licensing information within the installation folder for further details. We are happy to receive general enquiries regarding the software, but this does not constitute the offer of a helpdesk service.

groundhog@bgs.ac.uk

2 The User Interface

The user interface is divided into a series of panels. These panels can be undocked (split) if desired via ***Session*** > ***Windows*** > ***Dock/Undock All Windows***.



2.1 TOOLBAR

The toolbar includes a conventional menu bar and a tabbed panel of buttons for loading, saving and manipulating data.

2.2 MENUS

1. ***Session*** – various load/save options for assembling a workspace session,
2. ***Interoperability*** – various options for import/export of non-GDE-format proprietary and standardized data formats,
3. ***Tools*** – various useful data tools,
4. ***Geology*** – tools to predict and deduce geological information from workspace data objects,
5. ***Help*** – about Groundhog Desktop.

2.3 TOOLBAR TABS

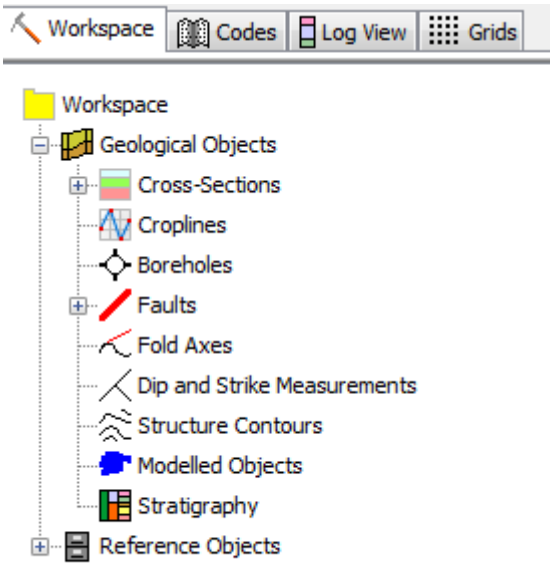
1. ***Data*** – workspace and data load/save buttons,
2. ***Draw*** – editing and digitizing functions and settings,
3. ***Calculate*** – prediction and deduction tools,
4. ***Check*** – data checking tools.

2.4 WORKSPACE PANEL

The workspace panel is a tabbed panel providing access to the data objects loaded into the workspace. It has the following tabs;

2.4.1 Workspace

This tab provides a categorized list of loaded data objects displayed in a hierarchical **workspace object tree** control. Depending on the category and the level of object in the object tree, various context-specific menus are available via right-click.

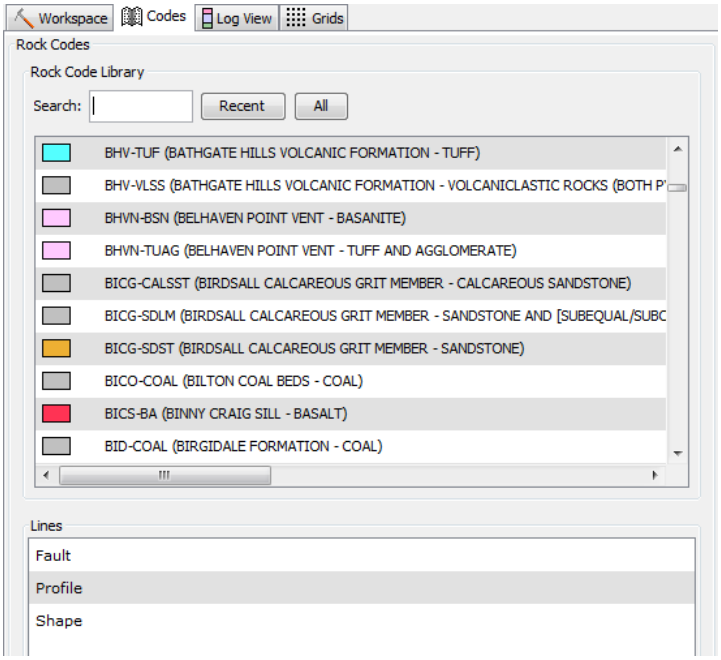


Note that not all object types displayed in the tree are currently supported, and may vary across versions of the software.

When you load a project its data objects will be added to this workspace object tree. To navigate the workspace object tree simply click on the + icons to expand each level of detail. Depending on the type of the object and the level of detail, various context-sensitive popup menus are available via ***right-click***.

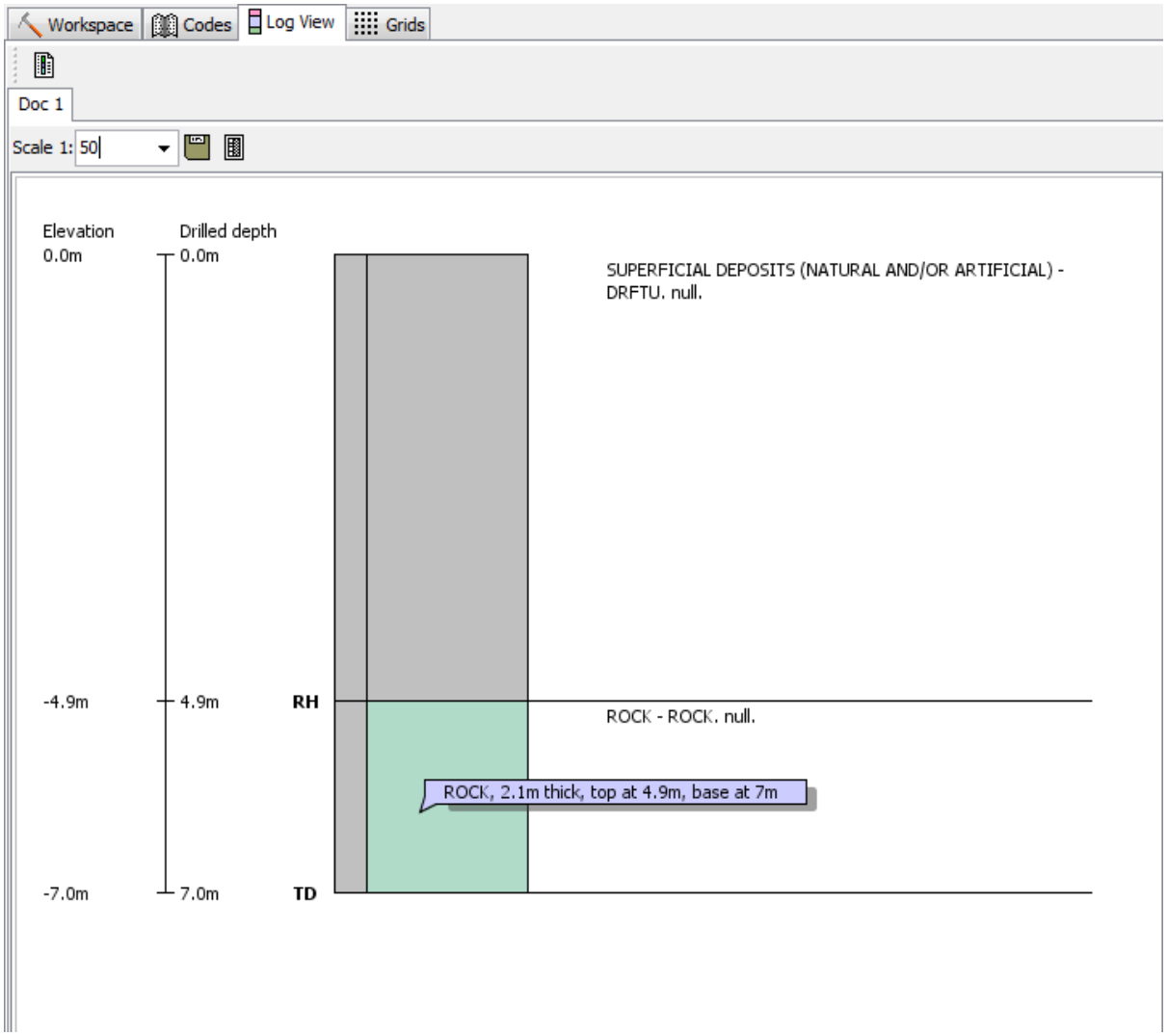
2.4.2 Codes

This tab provides a reference list of geological rock layer codes referred to as the **Coding Scheme**, including some special codes such as “FAULT”. Picking a code from this list makes that code the active code for editing/digitizing. For details of how this list is created refer to the **Dictionaries** and **Coding Scheme** sections of this manual.



2.4.3 Log View

This tab provides a downhole log viewing window for borehole data. Refer to the Log View section of this manual for further details.



2.4.4 Grids

This tab is currently not used.

2.5 MAP PANEL

The map panel is a container for any map windows you create. The map windows behave a little like tabbed windows in a web-browser. You can create as many map windows as you wish. For further details on map windows refer to the Map Window section of the manual.

To open a blank map window use **Session > Windows > New Map Window** then click on the zoom to full extent button.

2.6 CROSS-SECTION PANEL

The cross-section panel is a container for any cross-section windows you create. The cross-section windows behave a little like tabbed windows in a web-browser. You can create as many cross-section windows as you wish. For further details on cross-section windows refer to the Cross-Section Window section of this manual.

2.7 WORKSPACES AND PROJECTS

All data in Groundhog Desktop are held either in a **Workspace** or a **Project**. A **Workspace** is a high-level set of static reference data that may be common to many projects (e.g. DEM, national rock coding scheme). A **Project** is a set of individual data files that are actively being worked on (e.g. cross-sections, maps, boreholes).

2.7.1 Supported Data Types

Groundhog currently supports (to varying degrees);

- Dictionaries
- Colour legends
- Elevation grids (rasters)
- Unstructured meshes (TINs)
- Boreholes
- Interpreted cross-sections (correlation linework and fault sticks)
- Map linework ("croplines")
- Fault traces
- Geological sequence tables
- Images (including geo-registered images in map and section)
- Web Map Services (WMS)
- Shapes

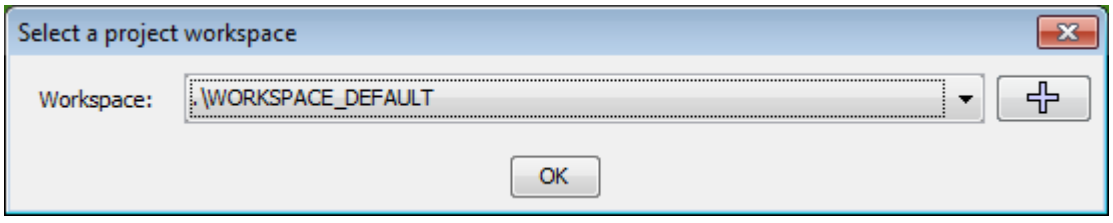
For more details on each, refer to the relevant sections below.

For most of the above, Groundhog has its own XML-based data file format referred to as Geological Object Markup Language (*.goml). Generally it is not advisable to edit these data files manually – they are designed for data transfer and local project storage. **XML schemas** for some of the key objects are available on request via groundhog@bgs.ac.uk

2.7.2 Workspaces

Groundhog workspaces are folders containing related collections of commonly used reference data. A single workspace may support several Grounghog projects by containing all of the common reference data for those projects, such as a national or regional rock coding scheme and a digital terrain model.

The default workspace is held in a folder called **WORKSPACE_DEFAULT** within the installation directory. Any reference data files included in this folder will be added to the default workspace. You can create your own workspaces by compiling the desired files in a folder of your choice and selecting this folder when Groundhog starts up by using the "+" button in the workspace selection dialog. The pull-down list contains a list of all previously loaded workspaces to choose from.



Typical data resources include;

- Dictionaries – usually at least a rock coding scheme,

- A colour legend file,
- Grids – e.g. a digital terrain model.

Workspace data resources can be included in two ways;

1. By physically placing the data file within the workspace folder,
2. By adding a file path to the data file into the **RESOURCES.txt** file.

The **RESOURCES.txt** file is a tab-separated file held within the workspace folder and comprising one data resource linkage per-line;

DATA TYPE	***NAME***	***PATH/URL***	***EXTRA INFO***
GRID	Terrain Model	C:\Data\terrain.asc	MODEL_CAP
DICTIONARY	London Formation Codes	C:\Data\LondonCodes.godic	
WMS	UK Geology Web Map Service	http://...etc	

Note: RESOURCES.txt contains no headers. They are included above for clarity.

For GRID type objects, the extra info of "MODEL_CAP" sets that grid as the reference terrain model for the workspace. This can be changed interactively within the user interface if necessary.

2.7.2.1 DICTIONARIES

A dictionary is simply a list of names with corresponding definitions (values). They are commonly used by Groundhog to look up descriptions of abbreviated or coded values, for example;

SSG	Sherwood Sandstone Group

Cu	Copper

Dictionaries are held in XML format with a file extension of *.godic (Geological Object DICtionary). The format is as follows;

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<GeologicalObjects>
  <dictionary name="Rock Codes" description="A list of rock codes">
    <dictionary_entry name="SST" value="Sandstone" />
    <dictionary_entry name="MDST" value="Mudstone" />
    <dictionary_entry name="LMST" value="Limestone" />
  </dictionary>
```

```
</GeologicalObjects>
```

Groundhog needs at least one dictionary which is referred to as the rock layer **coding scheme** (see next section).

Dictionaries can also be imported from a tab-separated text file where the first two columns of the file are the NAME and the VALUE. Further columns will simply be ignored.

2.7.2.2 CODING SCHEME

The coding scheme is a list of rock layer codes from which you can select for editing and digitizing. They are held as a **Dictionary** object. Groundhog ships with a pre-defined coding scheme based on the BGS Lexicon of Named Rock Units (http://www.bgs.ac.uk/lexicon/), but you can import your own codes from a tab-delimited text file (see ***Dictionaries***), or create your own coding scheme dictionary file in the workspace (WORKSPACE_DEFAULT\CODING_SCHEME.godic).

2.7.2.3 COLOUR LEGEND FILE

Colours are held in a tab-separated text file called LEGEND.txt in the workspace folder (WORKSPACE_DEFAULT\LEGEND.txt). You can add colours to the Groundhog workspace by adding to this file, or create your own file. The format is;

CODE	***RED***	***GREEN***	***BLUE***	***ORNAMENT IMAGE***
AAFS-AFSY	255	147	51	texture_library/a.jpg
ABBR-BREC	255	117	84	texture_library/b.png
ABBR-BRSS	255	117	84	C:\image.jpeg

Colours are defined in the RGB colour model http://en.wikipedia.org/wiki/RGB_color_model where values for each colour are between 0 and 255.

2.7.2.4 ELEVATION GRIDS

Groundhog supports regular grids for elevation models, for example a Digital Terrain Model. At least one grid to define the "model cap" (normally a terrain model) is required as this will be used to auto-generate profiles for the cross-section windows.

Groundhog has its own binary format for grid data which enables it to maintain a permanent reference to a master terrain model and query the necessary elevations and profile as required – for example when a new cross-section is created or loaded. This format is a binary version of an ESRI-style ASCII grid file (http://en.wikipedia.org/wiki/Esri_grid) and is very efficient because you can have a regional or national DTM coverage registered with Groundhog without any computer memory issues. Groundhog will automatically query this data layer as necessary.

Loading Grid Data

ASCII grids (*.asc) can be imported via ***Interoperability*** > ***Import*** menu and will be automatically converted to the Groundhog binary format in the background. The object will

be added to ***Reference Objects*** > ***Grid Coverages*** in the object tree. ASCII grids must have a header laid out in the following format;

```
ncols 2000
nrows 2500
xllcorner 100000
yllcorner 120000
cellsize 25
NO_DATA_VALUE -9999
154.6 157.2 159.8 161.4 162.7 164.3 165.4……[DATA…etc]
```

Groundhog will attempt to save a binary copy of the imported grid in the same folder as the ASCII file. If this is not possible (e.g. because the ASCII is in a read-only folder), Groundhog will instead save the binary file into the current workspace folder. If the grid is large the conversion process may take a few moments.

To add a new binary grid to your workspace so that they are always available make sure to add a reference to it into the RESOURCES.txt file, otherwise you will need to re-load the grid each session. Use one line pre-grid entry. If you wish to set the grid as the default capping grid, append the term "MODEL_CAP" to the end of the row. Note that the values in the row are tab-separated. E.g.;

```
GRID    A Grid    C:\Data\Grid_1.obgrid    MODEL_CAP
GRID    Another Grid    C:\Data\Grid_2.asc
```

If you add an ASCII grid to the RESOURCE.txt file it will be automatically converted to binary. The next time the workspace is loaded Groundhog will automatically find the corresponding binary grid file for the ASCII listing, so there is no need to update the RESOURCE.txt file after the conversion process.

2.7.2.5 IMAGES

Groundhog supports JPEG and PNG format image files which can be loaded via ***Session*** > ***Load Reference Objects*** > ***Image***. If the image has a world file it will be automatically detected and the image can then be displayed in a map window in the correct geographic location (geo-registered). Note that Groundhog does not support rotated images.

Loaded images can also be registered into a cross-section window interactively. This is particularly useful when digitizing. Refer to the **Cross-Section Window** section of this manual for further details.

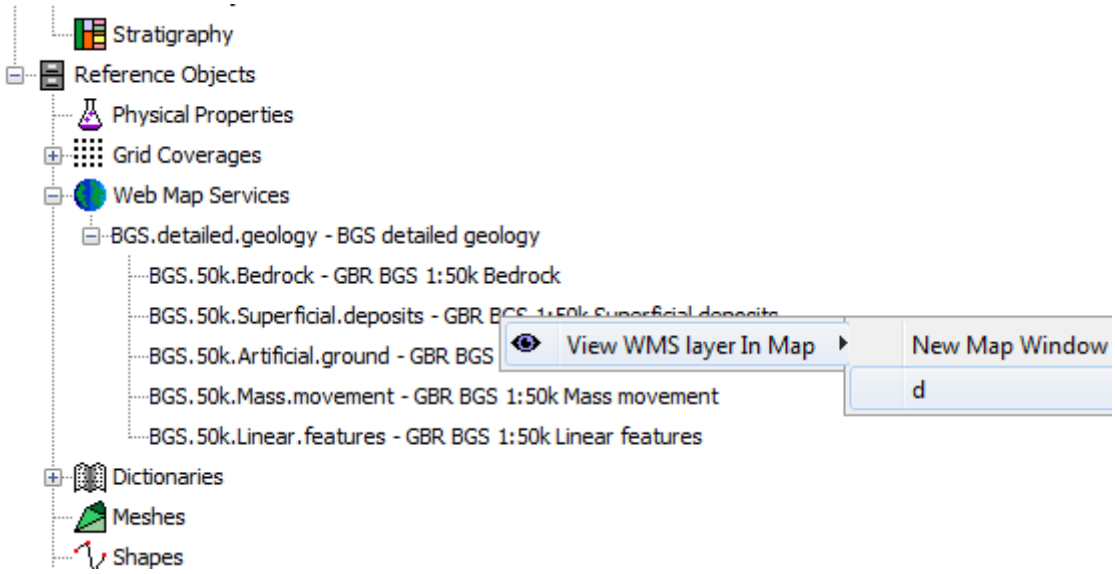
2.7.2.6 WEB MAP SERVICES

Groundhog is a rudimentary WMS client, allowing certain BGS-published WMS services to be displayed in the map window(s). The URL to the WMS should be included in the workspace RESOURCES.txt file, e.g.;

```
WMS    BGS_Detailed_Geology    https://map.bgs.ac.uk/arcgis/services/BGS_Detailed_Geology/MapServer/WMSServer
```

Loaded WMS services will be added to the Reference Objects > Web Map Services folder in the workspace object tree. The default workspace of Groundhog comes with a link to the BGS digital geological map as a WMS so this should automatically appear in the tree.

To display the WMS in the map window, ***right-click (on the WMS layer of interest)*** > ***View WMS Layer In Map***.



Note that Groundhog has no capability for Latitude/Longitude, so can only support WMS services which can respond to requests in a cartesian grid coordinate system (e.g. British National Grid).

2.7.3 Projects

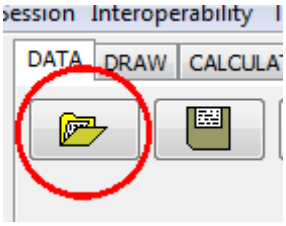
Projects are what you normally work with day-to-day to load and save the data you are working on. Project data is held in XML data files. For this, Groundhog has its own XML-based data file format referred to as Geological Object Markup Language (*.goml). Generally it is not advisable to edit these data files manually – they are designed for data transfer and local project storage.

Each GOML file contains objects of a single type, for example boreholes or cross-sections. When data is saved out as a Groundhog project a **Geological Object Project file (*.GOP)** and a series of **GOML** files is created, one per object type;

- Project1.gop
- Project1.**cross-sections**.goml
- Project1.**boreholes**.goml
- Project1.**faults**.goml
- Project1.**croplines**.goml

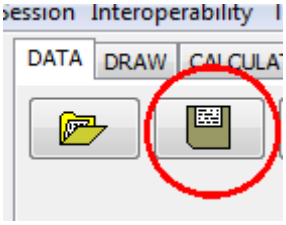
Note the naming convention. The first part of the file name is the name of the project, and the second part (shown in bold above) is the data type. Never re-name files manually because Groundhog relies on this naming convention to find all linked data files.

To load a project, simply pick the .gop file via ***Session*** > ***Load Project*** or click on the load button in the toolbar data tab.



All GOML files associated with the project will be automatically loaded. To load GOML data files individually use ***Session > Load Geological Objects > From GO File menu***. Data in other formats can often be imported and exported via the ***Interoperability*** menu (see the **Interoperability** section of this manual for further detail). Certain reference data can be loaded via ***Session > Load Reference Objects***.

To save a project use ***Session > Save Project*** or click on the save button in the toolbar data tab.



When saving a project, if you retain the existing project file name when you press save the previous versions of the data files will be over-written.

You are strongly advised to save your work regularly. Do not wait until the end of the day to save all of your work. You are also strongly advised to increment the project name from time-to-time to ensure you have a series of project backups should the saved-out data become corrupted, e.g.

- Project1_v**1**.gop
- Project1_v**2**.gop
- …
- Project1_v***n***.gop

Project data files are generally quite small, so keeping a series of backups should not present any data volume issues and superfluous backups can be deleted manually if desired.

3 Map Window

Map windows can be created either by sending existing loaded objects to them or by creating a new blank window.

To open a blank map window use **Session > Windows > New Map Window** then click on the zoom to full extent button.

At the current time there is no undo/redo capability on map objects – this function is still in development.

3.1 VIEWING OBJECTS

Many objects in the object tree can be viewed in map windows via **right click > View [object(s)] in Map Window**. This opens a sub-menu where you can either create a new map window or select an existing map window.

3.2 ZOOMING AND PANNING

Panning in the map window is achieved by holding down the left mouse button and dragging in the relevant direction.

Zooming in and out can be done by either:

(1) Using the mouse wheel, or

(2) Using the  and  buttons on the toolbar to incrementally zoom in or out.

To zoom to the full extent of the window use the button 

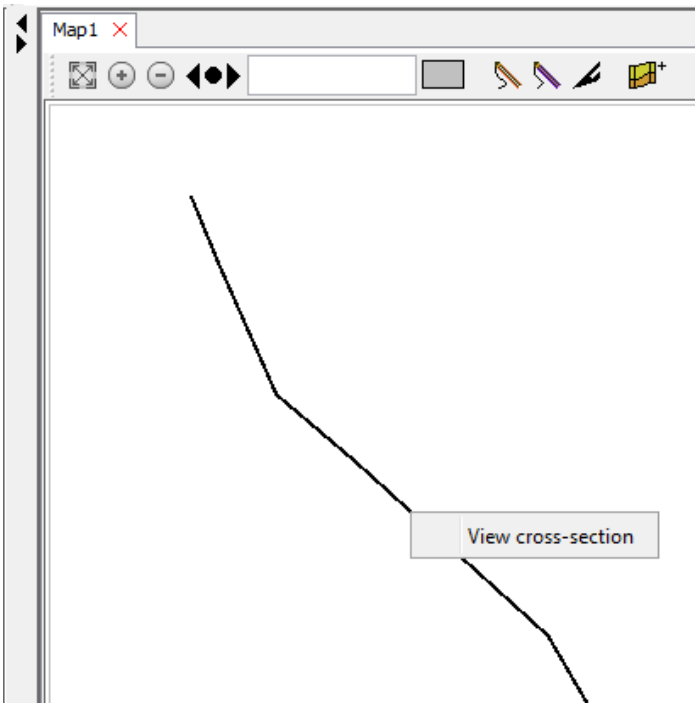
When you zoom in and out using the mouse wheel the reference point for the zoom will re-focus on the mouse cursor position, making it very easy to zoom in to an exact point of interest very quickly.

3.3 CROSS-SECTIONS

Cross-sections can be viewed as a line-of-section in the map window. Hold down the SHIFT key and hover over the line to peek into the geology of the cross-section at that position – the data will be presented as a log image.

3.3.1 Opening In Cross-Section WIndow

To view a cross-section in the section window from the map window, right-click on the displayed cross-section in the map window and select **View Cross-section**:

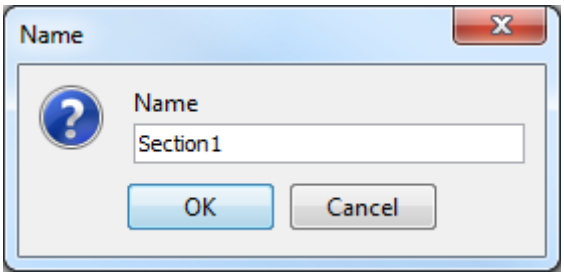


The selected cross-section will then be displayed within a new cross-section window.

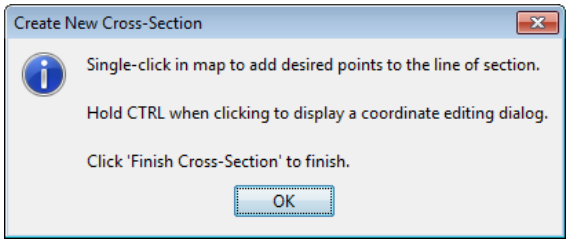
3.3.2 Drawing A New Cross-Section

To draw a new cross-section:

(1) Select the **Create New Cross-Section** button  from the map window toolbar.
(2) Specify a name for the new cross-section.

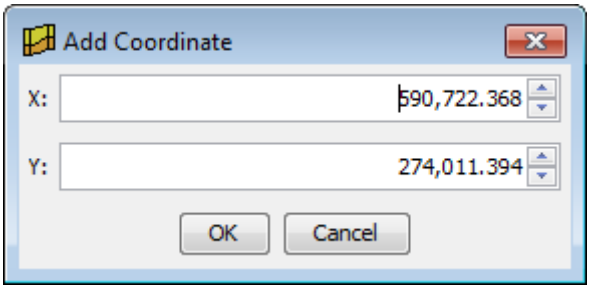


A message will appear explaining how to being construction.



(3) Start to draw the new cross-section using single mouse clicks within the map window to create the nodes of the line-of-section. If you have boreholes displayed in the map window these will be previewed if you hover over them – if you then click directly on the borehole position it will be added to the cross-section as a borehole object. If you click a position that is not a borehole position it will be added as a plain

coordinate. If you wish to edit the coordinate, hold down the CTRL key before clicking – this will display an edit dialog.



(4) To finish drawing the cross-section, once the final desired point of the line-of-section has been placed, select the **Finish Cross-Section** button 

from the map window toolbar.

3.4 CROPLINES

Croplines are effectively the geological map. Lines should always represent the **BASE** contact of the geological layer. Croplines can be at surface (outcrop) and/or sub-surface (subcrop), therefore the complete set of croplines for a given geological area will be a full sub-surface map of the BASE contacts of all of the geological horizons.

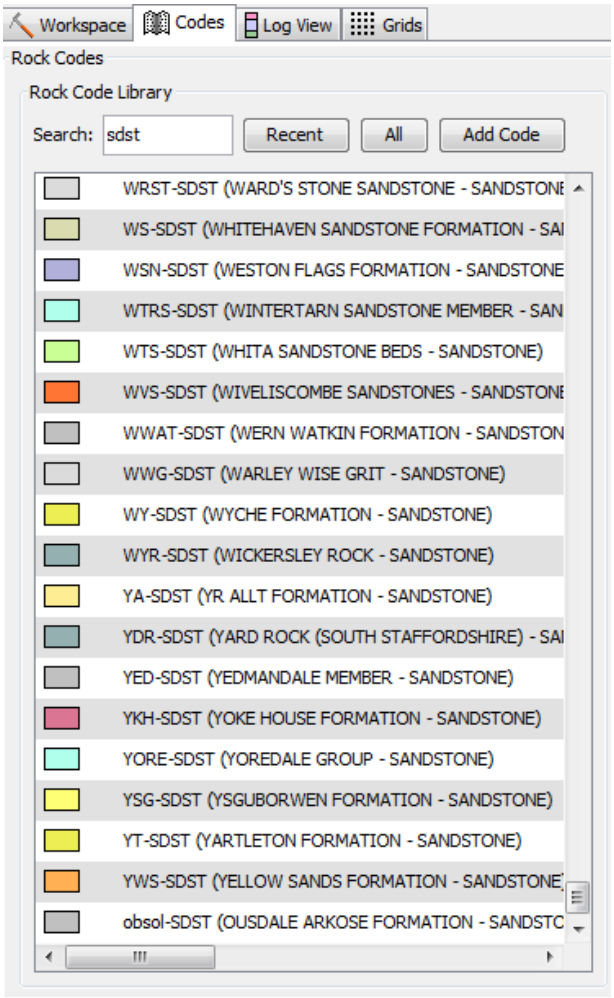
Croplines only represent true contacts – they should not be used to draw project boundaries to constrain horizon coverages.

Croplines are, by default, the representation of the BASE contact of the unit against the ground surface in the case of outcrop linework or against the base of an overlying horizon in the case of subcrop. However, in faulted geology a cropline may represent a contact of the BASE of the horizon with the fault plane. For further detail refer to the **Workflows > Fault Construction** section of the manual.

3.4.1 Drawing A New Cropline

To draw a new cropline:

(1) First select the desired rock layer code from the Rock Code Library. This will set the code as the currently active drawing code in the session. To do this, select the **Codes** tab from the left hand object reference window taskbar and scroll or search for the geological code:

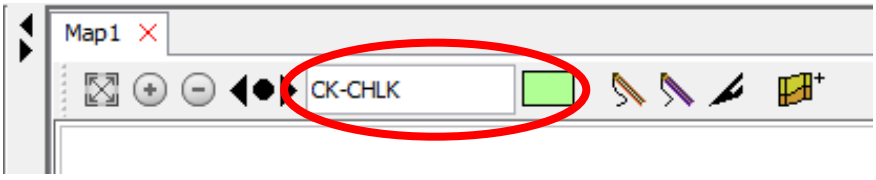


Or, select the **Recent** button to display a list of recently used codes to select from.

If your desired code does not exist, click on **Add Code** and enter the rock code name manually.

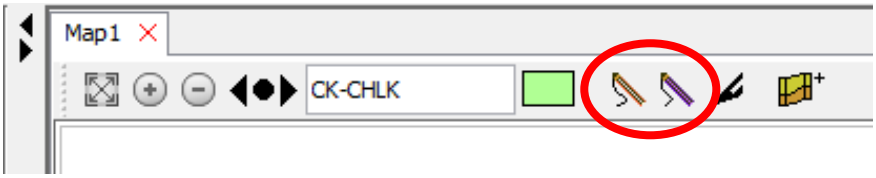
Alternatively, select the **DRAW** tab from the main taskbar to display the drawing 'ribbon' and select a rock code from the **Recent Codes** area:

Once selected the active rock code will be displayed in the map window toolbar as a label and a coloured box:



Another way to set the active rock code is to pick the code up from an existing piece of linework. To do this, hold down CTRL and move the mouse across the line – the rock code will be picked up and set as the active code.

(2) To start drawing a new cropline, select one of the two drawing tools in the map window toolbar:



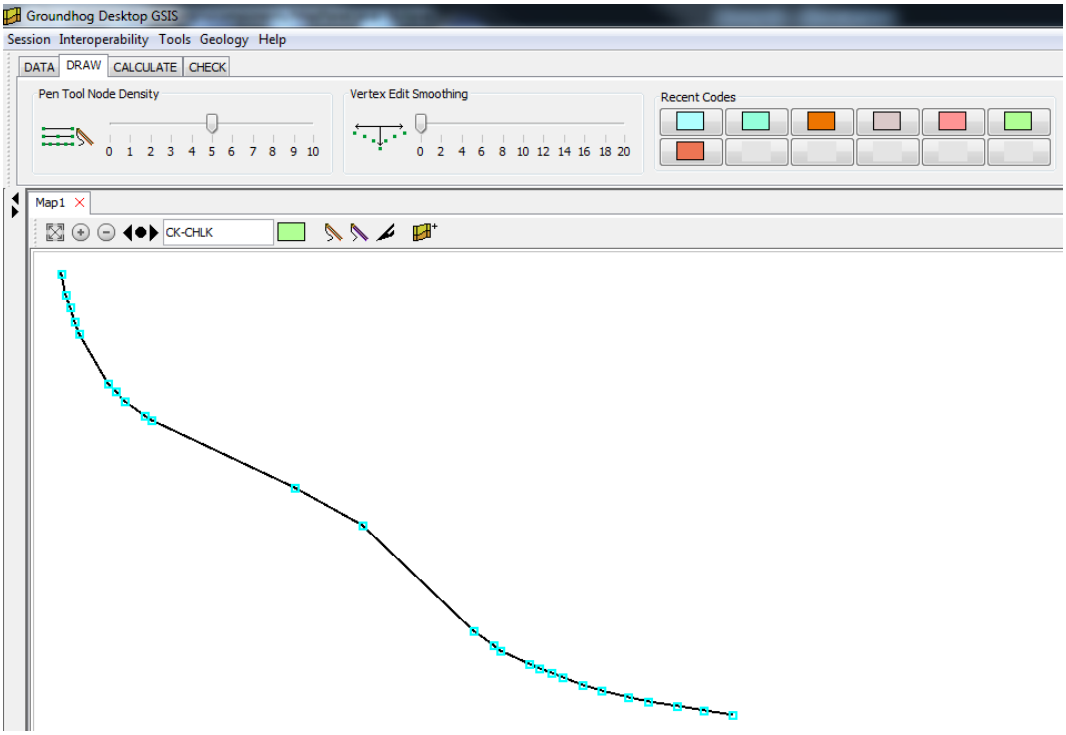
The left hand **pen tool** allows you to draw a new line by holding down the left mouse button and dragging the pen across the map window to trace the new cropline until the mouse button is released. Nodes are added automatically, the density of which can be adjusted in the DRAW ribbon by using the slider marked '**Pen tool node density'**. The line can subsequently be smoothed once drawn using the '**Vertex Edit Smoothing'** slider in the DRAW ribbon and moving the nodes around.

The right hand **digitizing tool** allows you to draw the line one node at a time, giving greater control over node positioning along the line. Use where positioning of nodes is more critical. Single-click to add nodes to the line and double-click to finish the line. Again, smoothing is possible by later editing.

(3) Once finished drawing, click the selected pen tool again to turn drawing mode off, or leave the pen active to continue to draw another cropline.

3.4.2 Editing A Cropline

To edit a cropline you must first make the line active by clicking on it with the left mouse button. The nodes are then displayed as shown below (cyan colour). Nodes can then be moved individual as appropriate or with the option to smooth the line to different levels using the slider 'Vertex Edit Smoothing' in the DRAW ribbon. The smoothing has the effect of causing nodes adjacent to the one being dragged to also follow the direction of the mouse cursor.



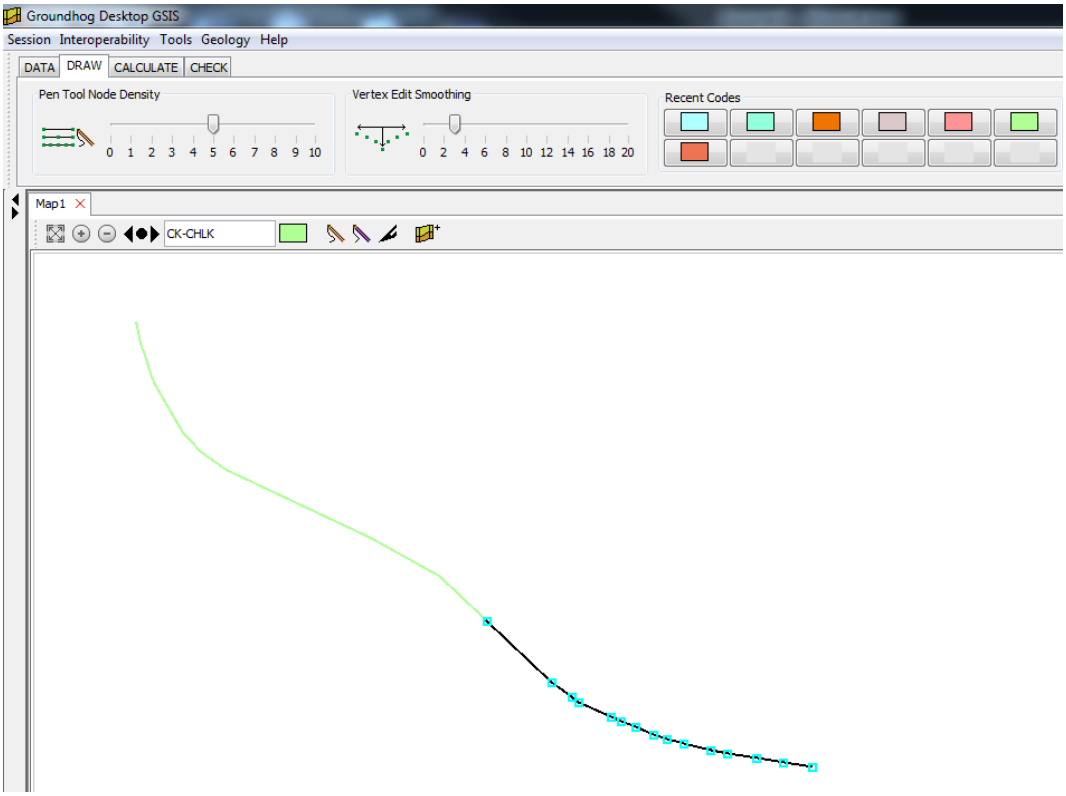
New nodes can be added by double clicking at the appropriate position along the active line.

Double clicking on an individual node in an active line will remove the node from the line.

To delete a whole line, right mouse click on the line and select **Delete Line**. A dialogue will appear asking for confirmation. Select yes to delete the line.

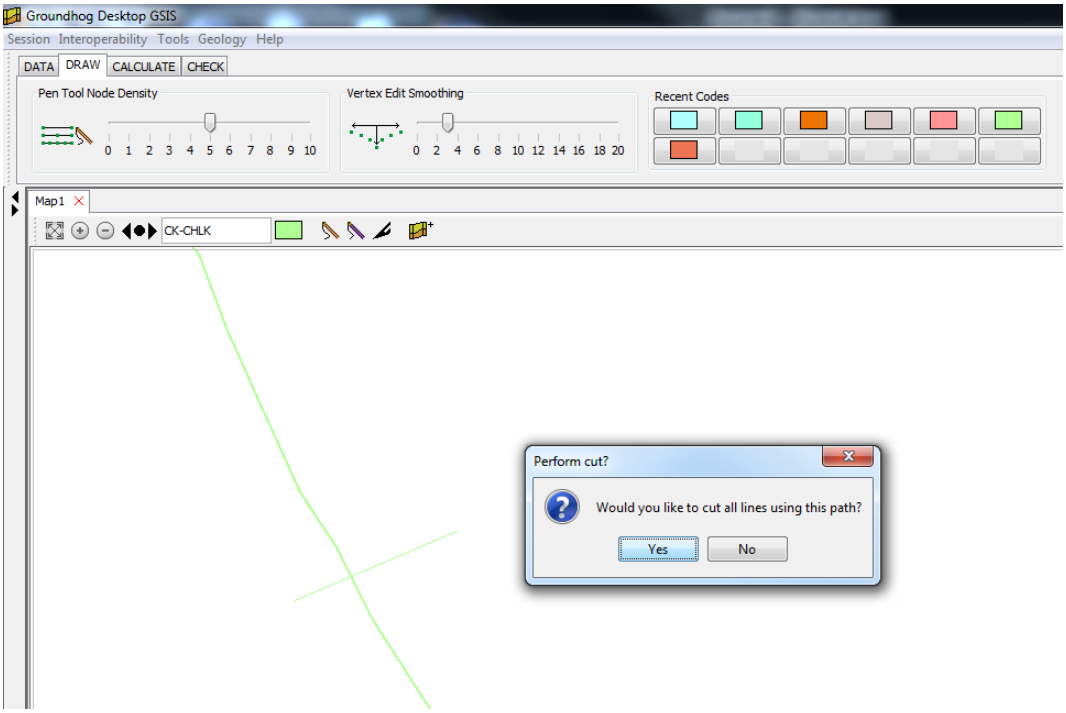
3.4.2.1 SPLITTING A CROPLINE

To split a cropline at a particular position, right mouse click on the line at the appropriate point where you wish to split the line and select **Split Line**. This will break the original cropline at the point of the right mouse click creating two separate lines.

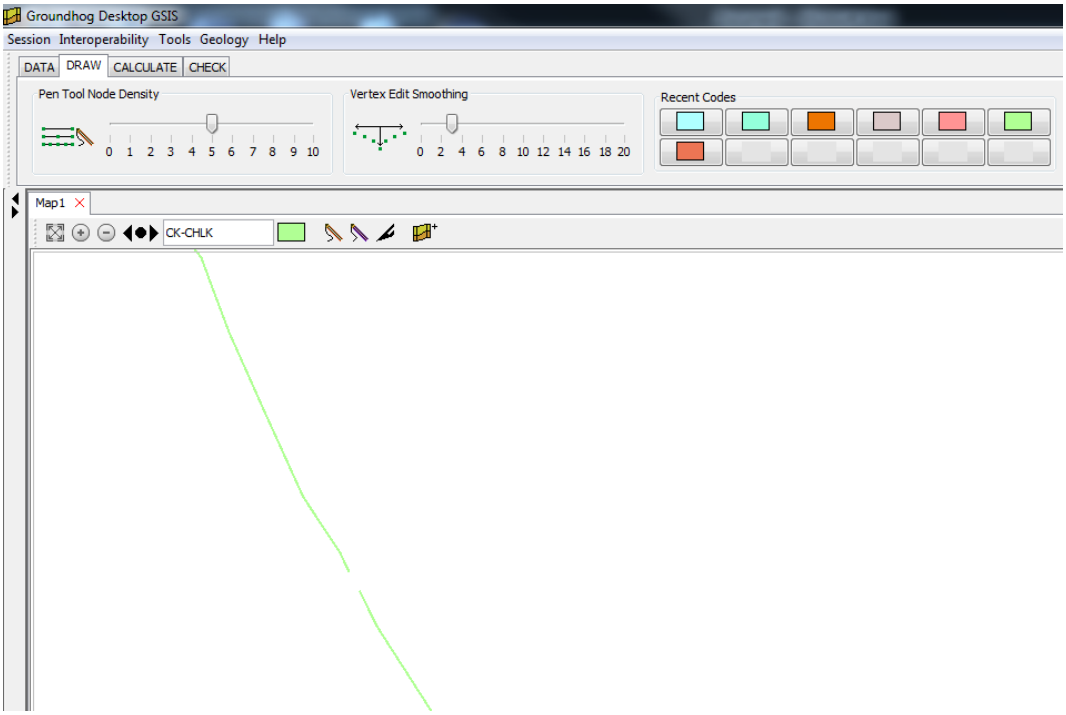


3.4.2.2 CUTTING CROPLINES

To cut a cropline or a set of croplines, select the **Cut lines** button  from the map window toolbar. Using this tool, draw a line from one side of the cropline to the other by clicking on one side of the line and double clicking on the other to finish the line. A dialogue will appear asking if you wish to cut all lines using this path:



Select **yes** to cut the cropline:

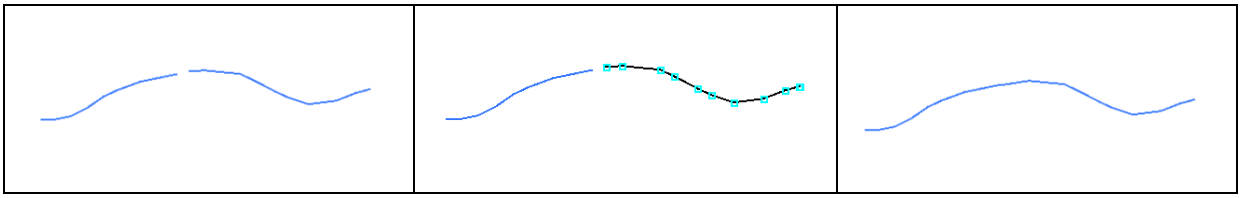


This is most useful when you need to cut several croplines along the same cut path, for example to introduce a fault trace.

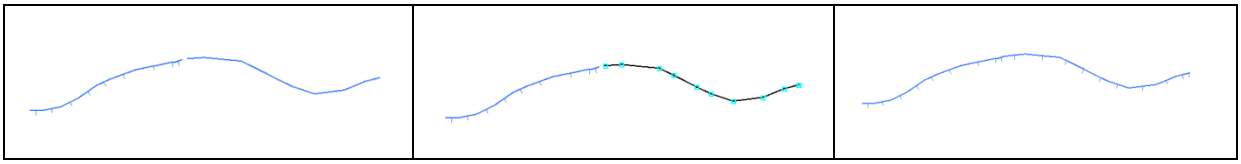
3.4.3 Joining Croplines

Two Croplines can be joined by dragging the end of one of the lines towards the end of the other line. When the two ends are brought close together the two lines will be joined. It is important to understand the way in which Cropline joins behave, depending on the properties of the line objects.

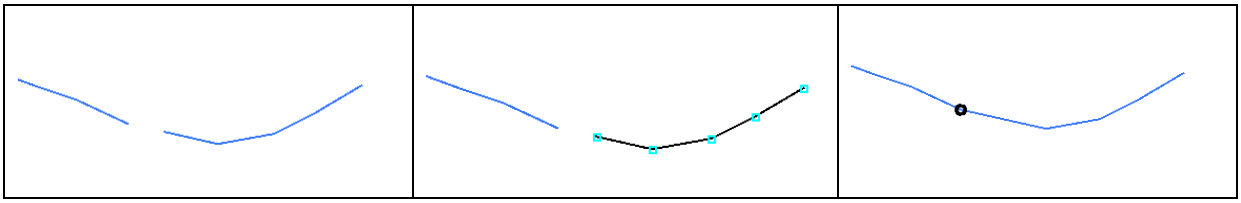
In general, the line you are editing (active line) will be merged into the line you connect it to. The merge process will attempt to preserve as much attribution as possible, but the attribution on the line you connect to will sometimes be given priority, for example if you join two lines with conflicting presence side attribution, the merged version of the line will adopt the side attribution from the line you connect the active line to.



Joining Simple Lines – lines are merged



Joining Lines With Side Attribution – lines are merged, attribution is retained



Joining lines with differing fault crop attribution – lines are snapped

If only one of the lines has side attribution, then the merged line will adopt that side value, regardless of whether the attribute is on the active line, or the line being connected to.

If both of the lines have a fault crop attribute, the merged line will also be flagged as a fault crop.

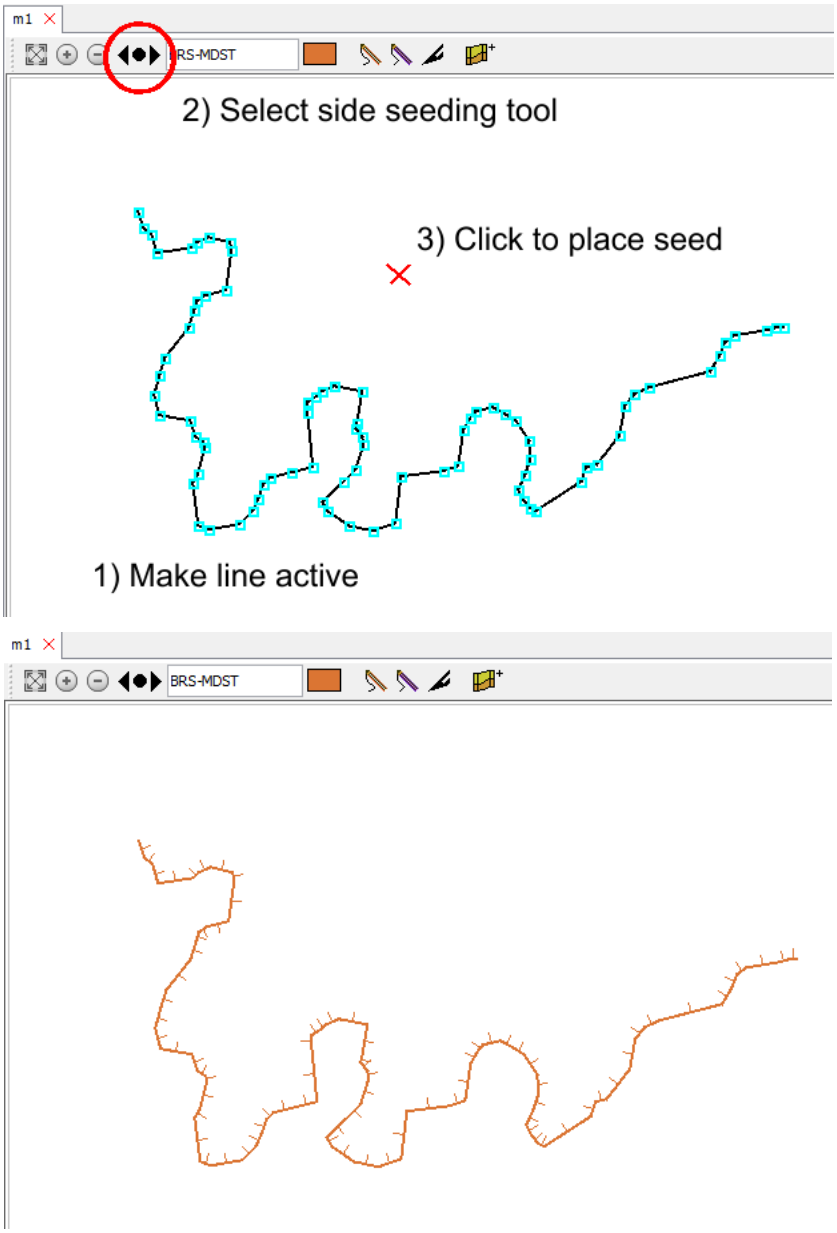
If only one of the lines has a fault crop attribute the lines will only be JOINED – they will not be merged into a single line, and will remain as two separate line objects snapped together. This is to allow the distinction between the two types of crop.

3.4.4 Seeding Layer Presence Side On Croplines

A basic cropline defines the base contact of a geological layer on the map, but it does not specify on which side of the line is the "presence" of that layer (i.e. to the left or right of the line). Because Groundhog deals with true contact lines rather than coverage polygons (a.k.a envelopes), the presence is attached via a SIDE attribute. The value of this SIDE attribute is either LEFT or RIGHT (or null if the side is not known). There are two ways to attach the SIDE attribute to the linework, interactively or automatically. The SIDE attribution is preserved in the project data files when the project is saved.

3.4.4.1 Attaching A Side Attribute Interactively

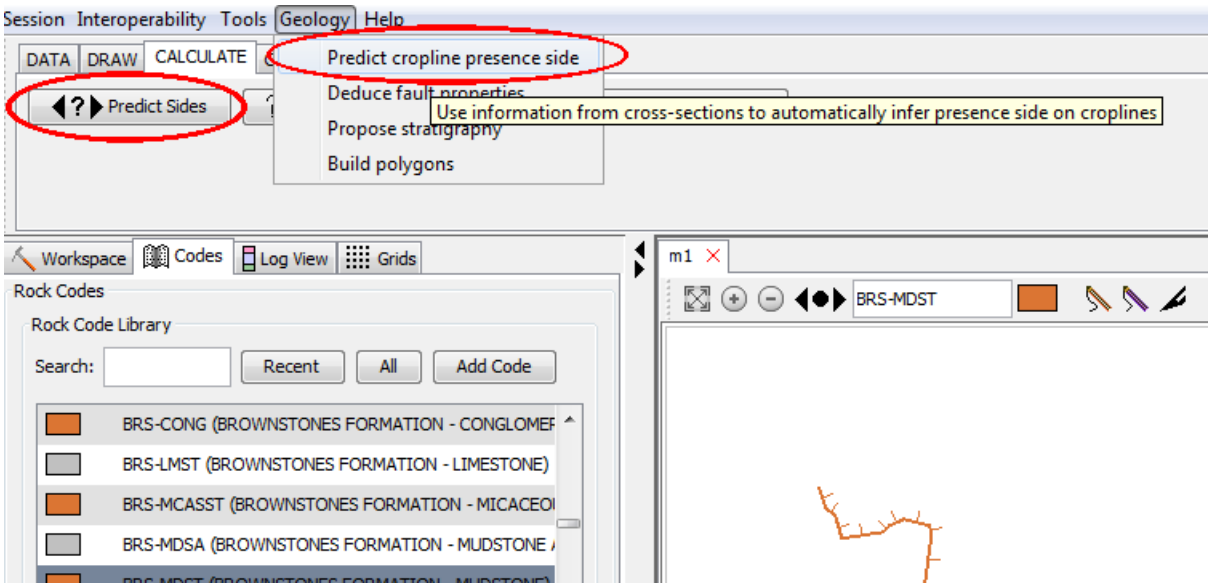
The SIDE attribute can be placed interactively in the map window by first making the line active, then picking the side tool and clicking on the map to the desired side of the line. Note that the side attribution tool is only active when a Cropline object is selected. Small side ticks appears graphically to show which side the attribute has been placed.



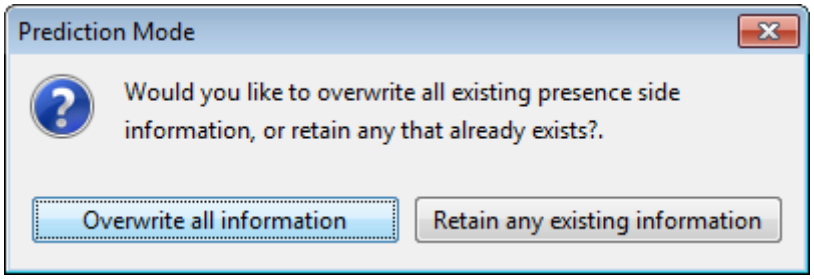
3.4.4.2 Attaching A Side Attribute Automatically

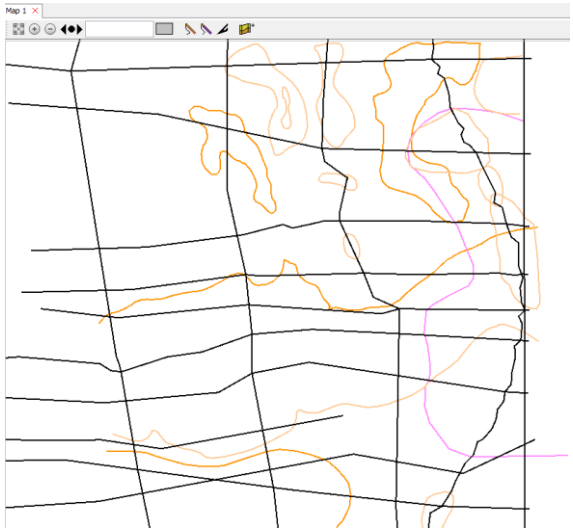
If you have correlated cross-sections in the workspace you can automate the side seeding process – Groundhog will attempt to use the correlation lines from the cross-sections to detect which side of the croplines are the presence of each layer. If the correlation linework agrees with the croplines (i.e. is snapped to or very close to the cropline positions) then the side attribute will be attached to the linework.

Either choose ***Geology > Predict Cropline Presence Side*** from the main menu, or click on the ***Predict Sides*** button in the calculate tab in the main toolbar ribbon.

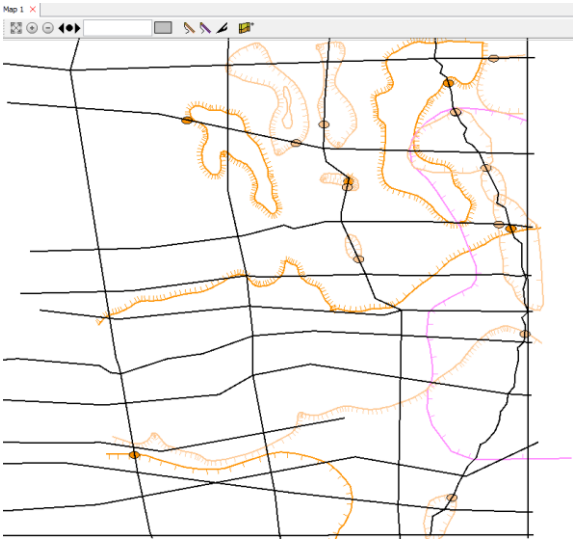


A dialog appears. If you choose "Overwrite all information" the automated process will overwrite any pre-existing SIDE attribution on the croplines, if you choose "Retain any existing information" the automated process will only attempt to attach SIDE attribution to cropline that do not currently have a value for that attribute.





Raw Linework Before Automated Prediction



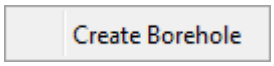
Linework Displaying Ticks Following Automated Prediction. The small ellipses show the seed positions that were used from the cross-sections.

Any linework that is not attributed as part of this process suggests either a lack of correlation of that horizon in any cross-section passing through that line, or rough correlation that is not close enough to the cropline position in the sections to be detected – snapping of linework within cross-section would resolve this. Otherwise, simply place the SIDE attribute manually as described earlier.

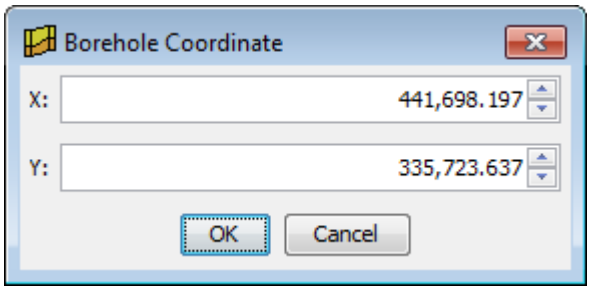
3.5 BOREHOLES

3.5.1 Entering Borehole Data Interactively

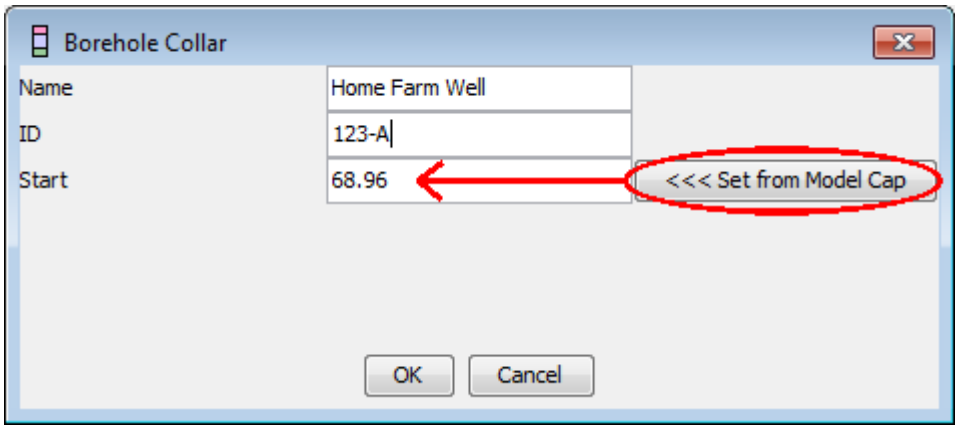
You can create individual boreholes and borehole logs interactively. First arrange a map window to show the area where you wish to place the borehole, then right-click either exactly where you want to place the borehole, or in a suitable blank area of the map if you wish to type the coordinates in. Select ***Create Borehole*** from the popup menu.



A coordinate position entry dialog will appear pre-populated with the map coordinates of the mouse click. Edit the coordinates as desired and click OK.

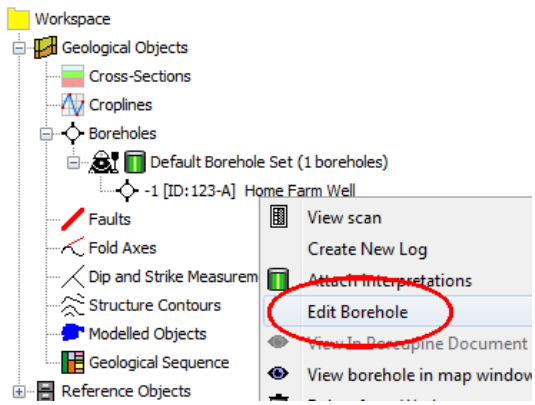


A borehole data entry dialog will appear. Here you can type a name for the borehole and set an identifier if you have one. You can also enter a collar height, or click on ***Set from Model Cap*** to extract a value from the current terrain elevation grid. Click ***OK***.

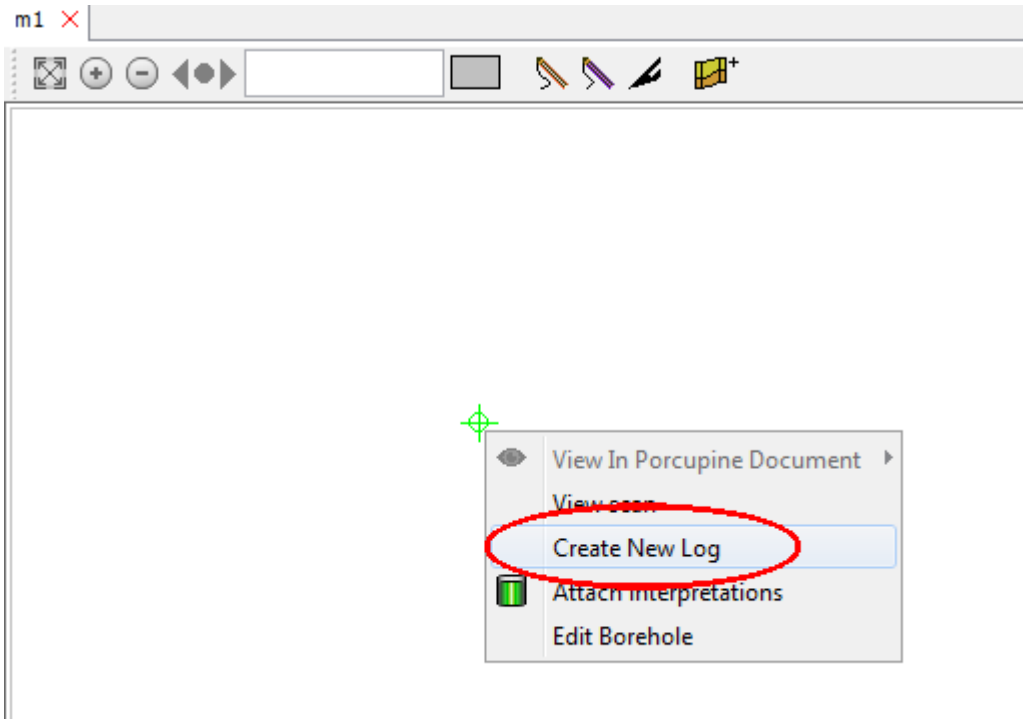


The borehole will be added to the map window, and will also be added to the default borehole dataset folder in the object tree. If the borehole is the only object in the map window, you may need to zoom to full extent to see it.

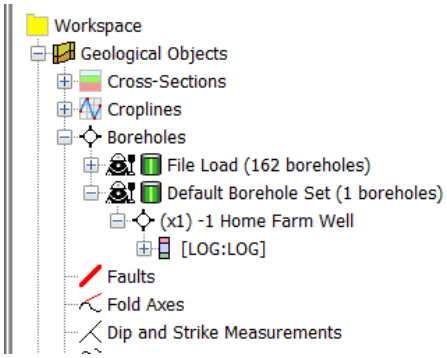
To edit the above collar information at any time, or to edit the collar information for an existing loaded borehole, simply right-click on it either in the map or in the entry in the object tree and select ***Edit Borehole***.



Next you can attach a log to the borehole position. Right-click on the borehole in the map or in the object tree and select ***Create New Log***.



The log will be given a default label of "LOG".

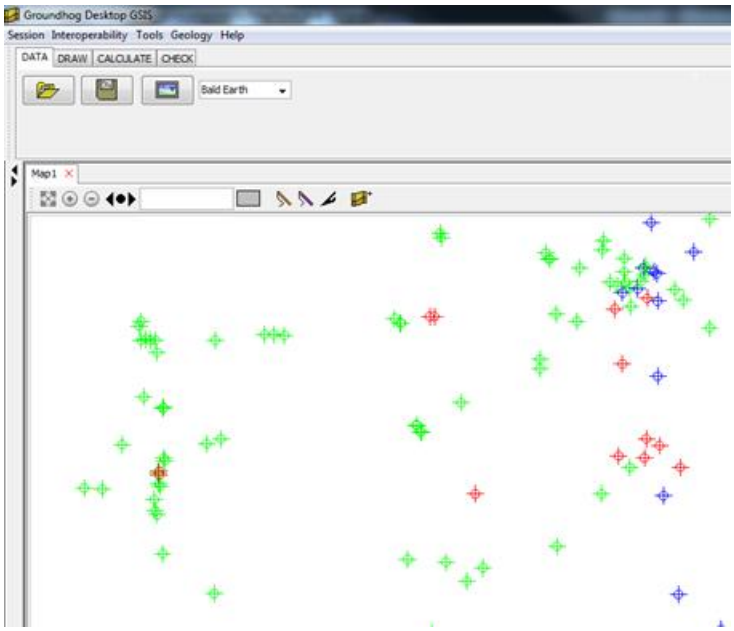


A dummy log is created coded as 1m of "ROCK". For details of how to edit logs refer to the **Log View** chapter of this document.

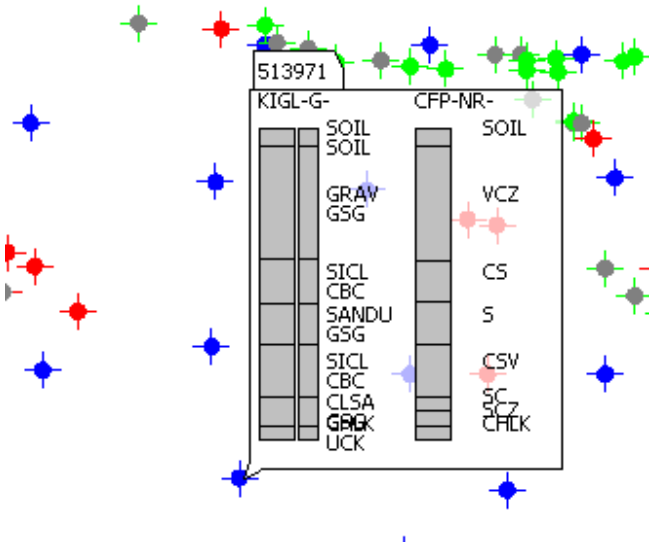
3.5.2 Importing Boreholes Into The Map

Refer to the **Import > Borehole Data (*.dat)** section of the manual for details on loading borehole data from a spreadsheet. Once the borehole data has been loaded, it can be found under ***Geological Objects*** > ***Boreholes***.

To display in the map window, expand the borehole tab in the data tree and right mouse click on the borehole dataset to select View all boreholes in map window…



If borehole interpretations are attached to a borehole, it is also possible to display a quick view of the attached interpretation(s) within the map window by holding down the **SHIFT** key and hovering over the borehole:

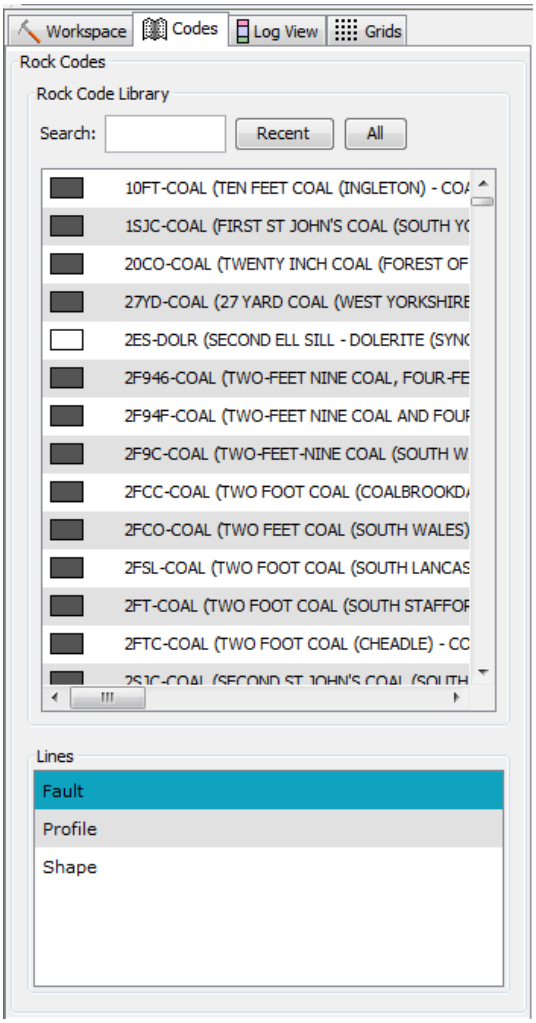


When you save the session to a project file the borehole data will be included.

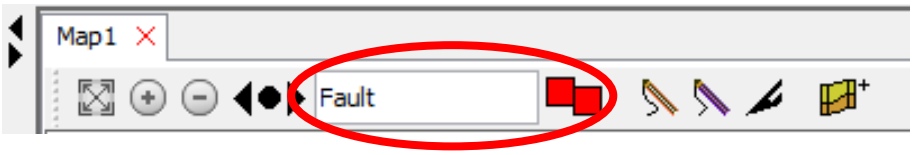
3.6 FAULTS

To draw a new fault line:

(1) First select the **Codes** tab from the left hand object reference window taskbar and select Fault from the Lines area at the bottom of the window:



This will then be displayed in the map window toolbar:

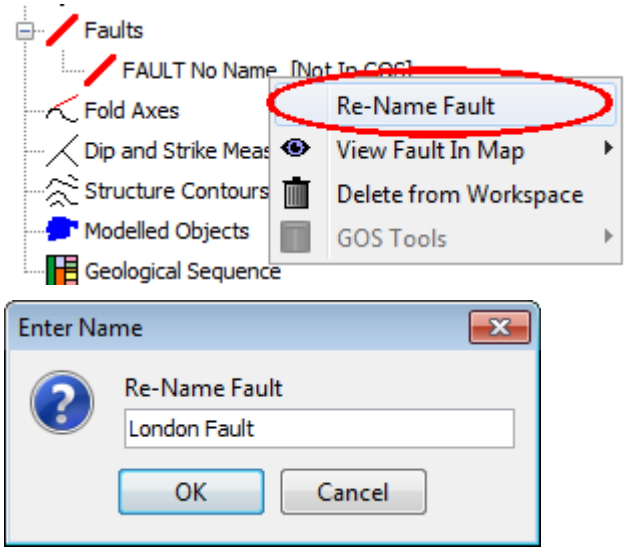


(2) To start drawing a new fault line, select one of the two pen tools in the map window toolbar:

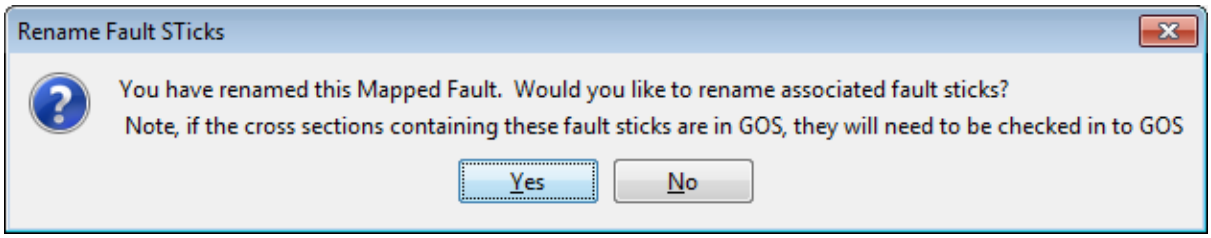
Drawing and editing is then the same as for Croplines – please refer to the earlier section on Croplines for further detail on basic linework editing techniques.

3.6.1 Naming Faults

You can specify the name of a fault via ***right-click > Re-Name Fault*** on the fault object in the object tree.

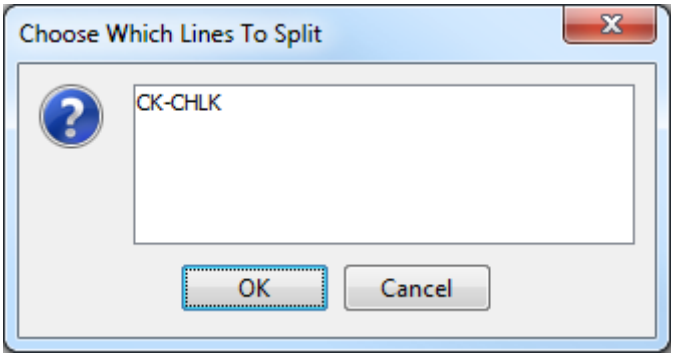


You will be given the option to also name any fault sticks in the cross-sections that are attached to this fault trace on the map.

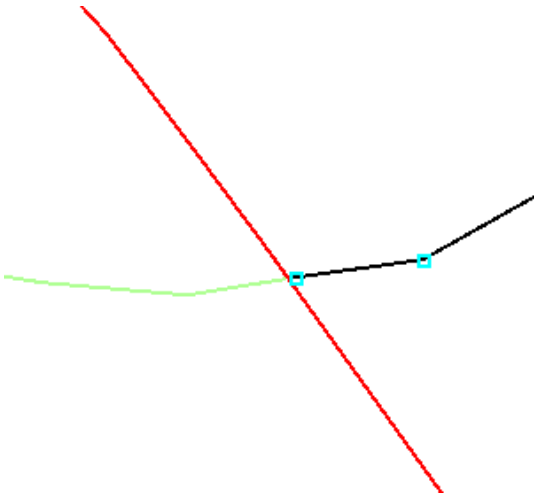


3.6.2 Splitting Croplines Using Faults

To split any croplines that intersect with a fault line, right mouse click on the fault line and select **Split intersecting croplines**. This will display a dialog listing all the croplines that intersect the fault line allowing you to choose which lines to split:

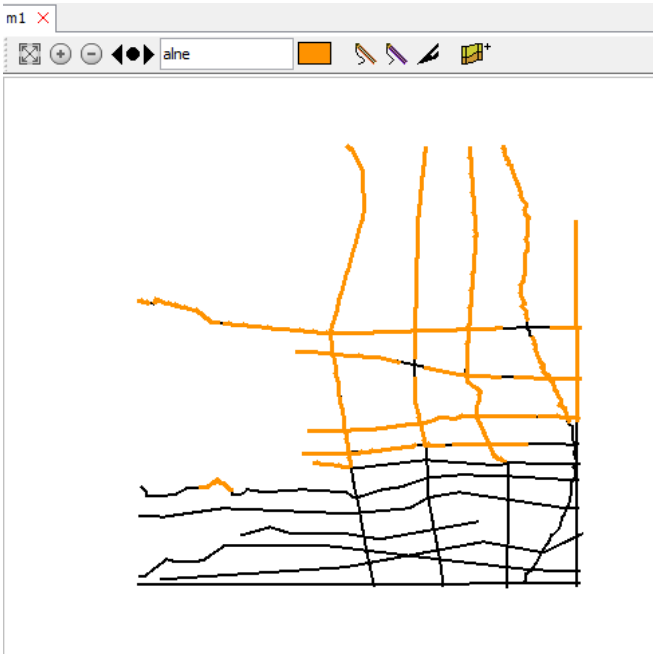


Depending on the nature of the fault and whether it comes to the ground surface you may want to only choose a subset of Cropline rock codes to split with the fault. Once selected, click OK and the corresponding croplines will be split at the point where they intersect the fault line:



3.7 DISPLAY CORRELATED EXTENTS

With cross-sections visible in the map window it is possible to see the spatial distribution of the correlation of a particular rock unit. This is achieved simply by setting the active rock code – when this happens its map distribution in cross-section will appear as thick coloured lines along the lines-of-section. The active rock code can be set from the Codes tab, from the Recent Codes panel of the DRAW ribbon, or by picking up a code from a piece of linework by holding CTRL and hovering the mouse over the line;

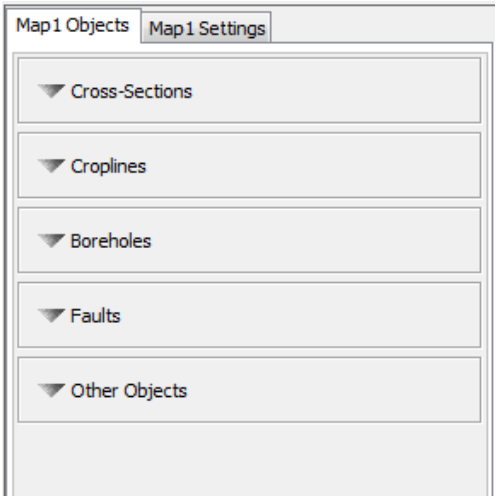


Map showing distribution of an orange-coloured rock unit "alne" in cross-sections towards the north of the project.

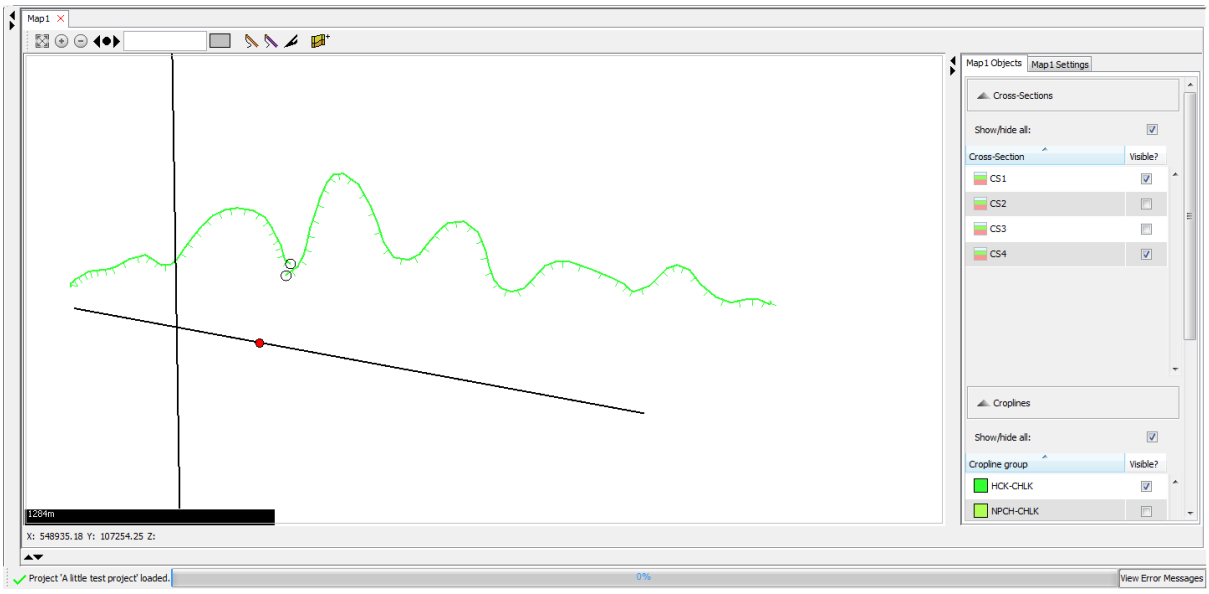
A nice feature of this function is that you can quickly see the relative distribution of layers across a project by displaying a representative cross-section in a cross-section window, holding CTRL, and dragging the mouse across the section vertically to pick up each code in the geological sequence one after the other. The map will respond by displaying the distribution of each code as you scroll across the section with the mouse.

3.8 SHOWING/HIDING MAP WINDOW OBJECTS

On the right hand side of each map window is the **map contents panel**:

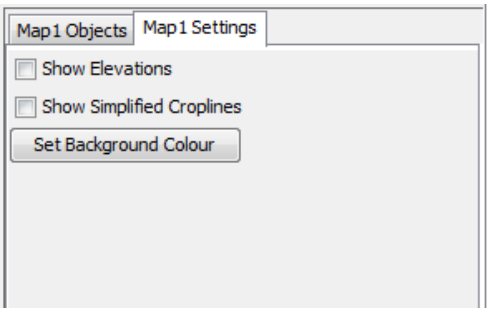


When a new object is added to the map window it will also be inserted under the relevant object type listed on the **Objects** tab. Expanding out each object type heading by clicking on the arrow located on the left hand side of the object label allows you to see what is currently loaded into the map window. From here it is also possible to turn the visibility of objects within the map window on/off. To show or hide all objects of a particular type, check or uncheck the Show/hide all checkbox.



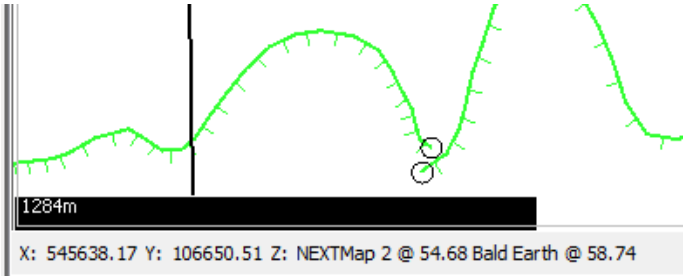
3.9 MAP WINDOW SETTINGS

The settings for the map window can be viewed and changed by clicking on the **Settings** tab of the map contents panel located on the right hand side of the map window:



3.9.1 Elevations

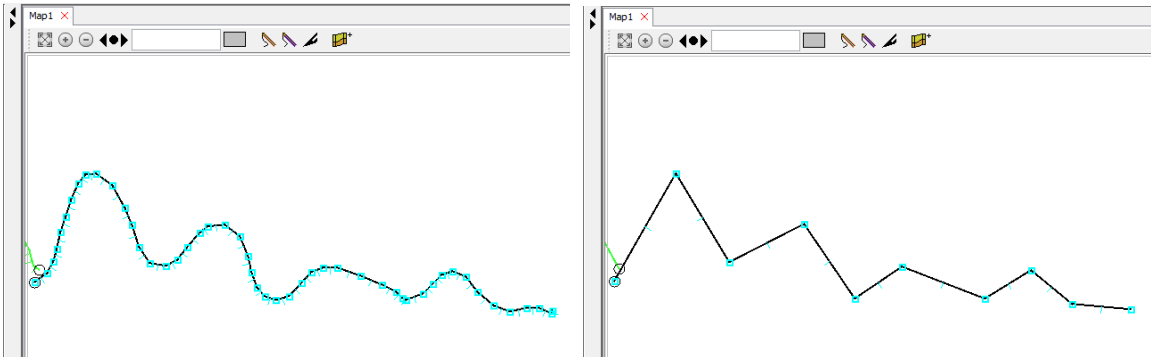
Ticking the checkbox labelled **Show Elevations** will display the elevation from the loaded DTM(s) in the lower left corner status bar of the map window for the mouse cursor location as it passes over the map window:



Unticking the checkbox will return to displaying only the x and y coordinates in the lower left corner of the map window.

3.9.2 Simplified Croplines

Ticking the checkbox labelled **Show Simplified Croplines** will graphically simplify any croplines displayed in the map window using a distance tolerance of 50 to remove nodes from the line. It is useful when working with large detailed projects as it speeds navigation by making the map window more responsive;



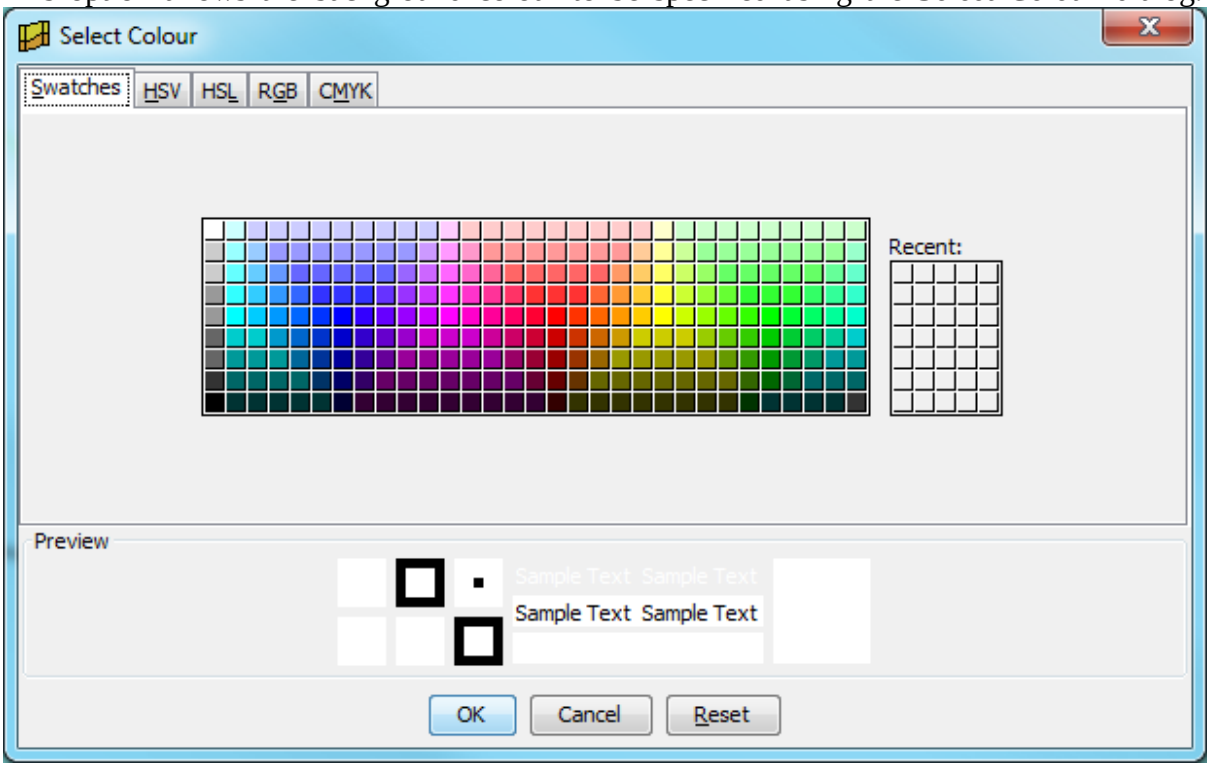
To display the simplified croplines after ticking the checkbox, move the mouse cursor over the map window in order to force the window to refresh.

Ticking the checkbox only removes nodes for graphical display. All original nodes are retained on the cropline object. Unticking the checkbox will return to displaying all the original nodes. Again, once you have unticked the checkbox, move the mouse cursor over the map window in order for the window to refresh.

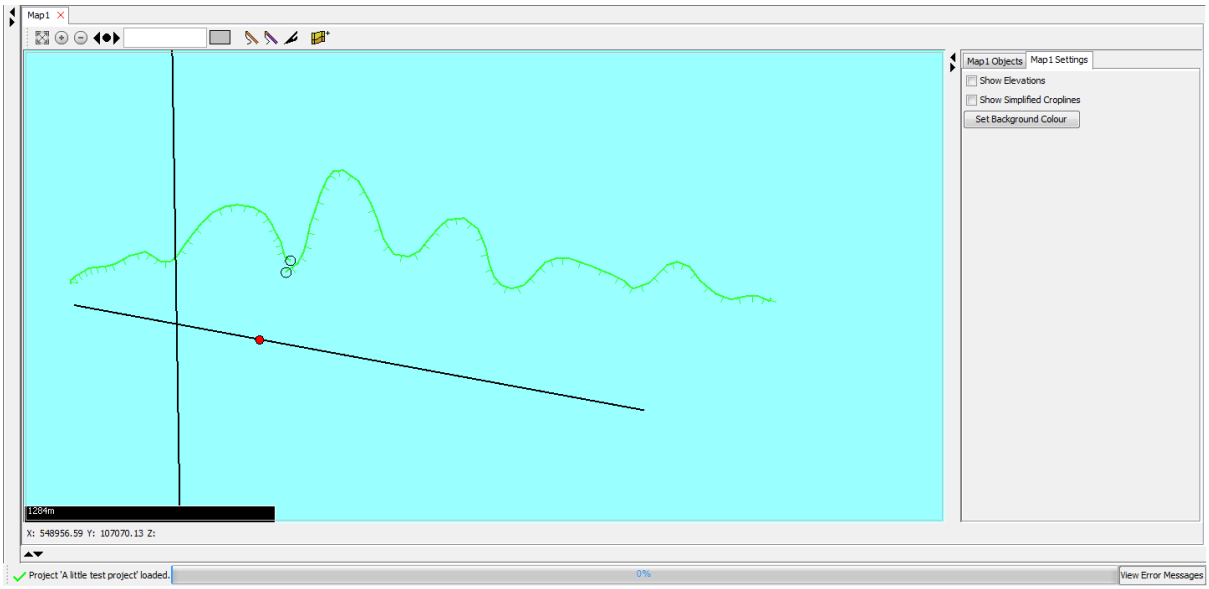
NOTE: This feature should be disabled when editing linework

3.9.3 Background Colour

This option allows the background colour to be specified using the ***Select Colour*** dialog.



After choosing a background colour, the map window is displayed with this colour as the background:



4 Cross-Section Window

Cross-section windows display individual cross-section objects. You can open as many as you like, and even open the same cross-section in two separate windows.

4.1 ZOOMING AND PANNING

Panning is achieved by a single left mouse click and drag in the relevant direction.

Zooming in and out can be done by either:

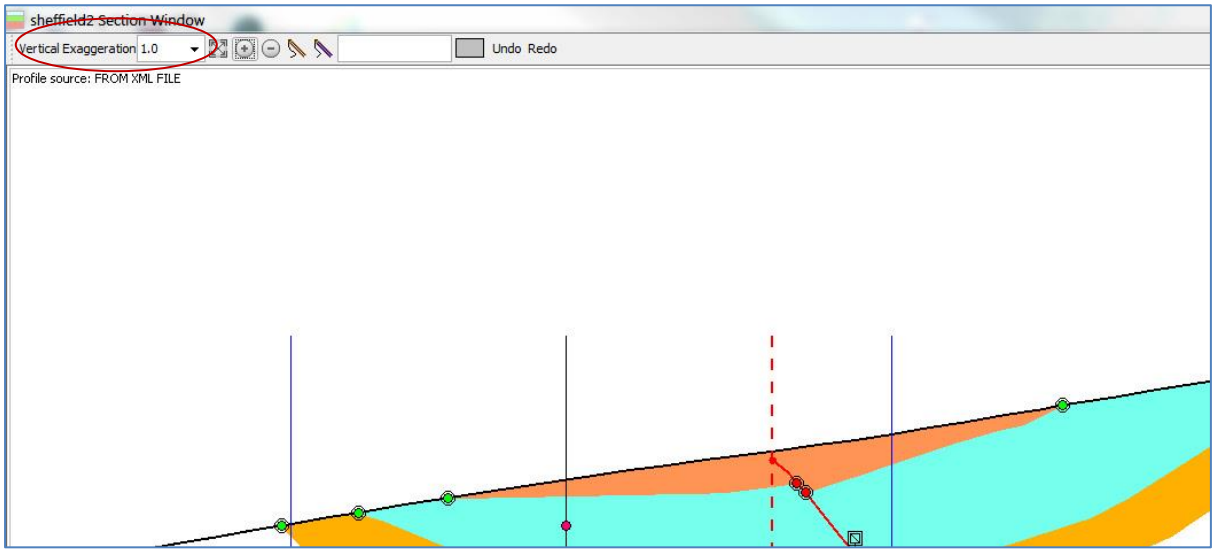
1) using the mouse wheel (given you have a mouse with a wheel), or
2) using the + and – buttons on the toolbar . Here pressing minus will zoom out, but pressing the plus button works differently; it allows you to draw a bounding rectangle (marquee) by click and drag which then auto zooms in to that area.

To zoom to the full extent of the window use the button  .

The mouse wheel zoom is programmed to re-focus on the current mouse cursor position which makes zooming into a point of interest very quick and easy.

4.2 VERTICAL EXAGGERATION

To adjust exaggeration in the vertical axis use the drop down list as shown below. Type in specific values and hit ENTER key if they do not exist in the default list.



Adjust until you reach a comfortable level according to the vertical depth range of the stratigraphic units.

4.3 UNDO/REDO

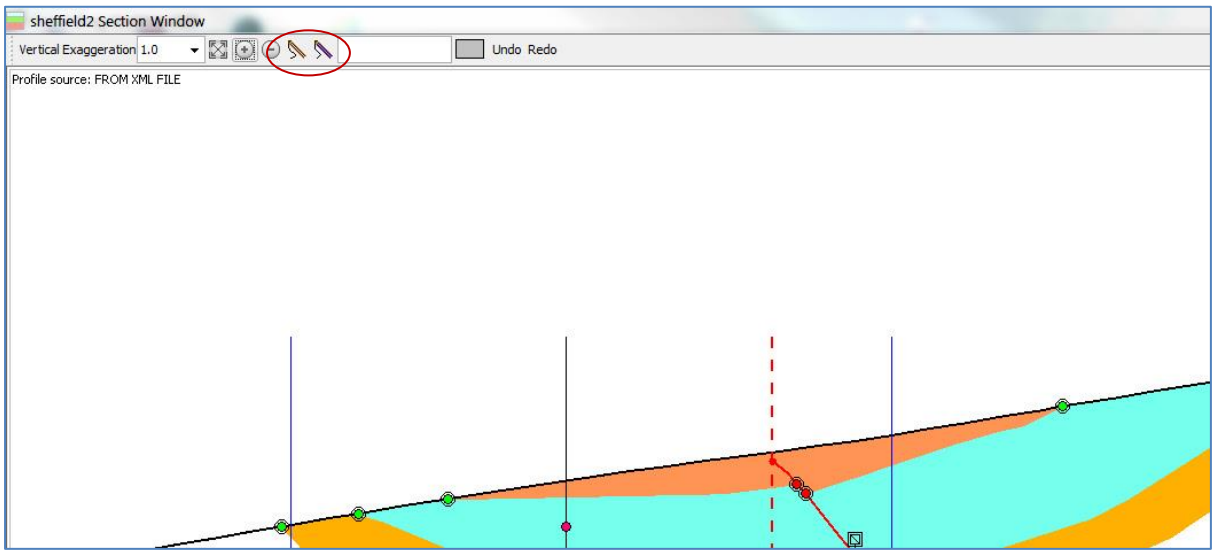
The cross-section window supports a rudimentary level of undo/redo capability, although this is still in development it should be enough to get out of most problems. To undo or redo any changes made use the Undo/Redo buttons on the right hand side of the taskbar.

4.4 DRAWING CORRELATION LINES

To start drawing, choose the DRAW option from the main taskbar giving you the drawing 'ribbon'. Then choose the type of geological line you wish to draw either by selecting from the 'Codes' tab in the left hand object reference tree, by selecting from the Recent Codes panel in the DRAW ribbon, or by holding CTRL and dragging the mouse across an existing line to pick up its code.

1. For correlation lines representing the bases of units, choose the relevant Lithostratigraphy/Lithology combined code from the Rock code library. This will then appear in the (currently) blank text box in the section window taskbar, indicating the labelling for the current working line.
2. For all other types of geological object, Fault, Profile or Shape, choose from the 'Lines' option at the bottom of the Code tab in the object tree.
   2.1. **Fault**. Draw a line representing a fault stick.
   2.2. **Profile**. Draw a terrain profile. Note here that a DTM will normally be available and a profile will be loaded automatically. If not available draw from scratch by choosing profile and drawing line. If is available you can delete the pre-loaded line and draw your own.
   2.3. **Shape**. Draw an irregular shape such as a lens or sketch over an image etc. This feature is intended for rough sketching in a separate "layer", with the idea that geological attribution could be added later on, although this feature is still in development.

To draw a new line between points of reference click on one of the two pen tools in the section window taskbar as shown below.



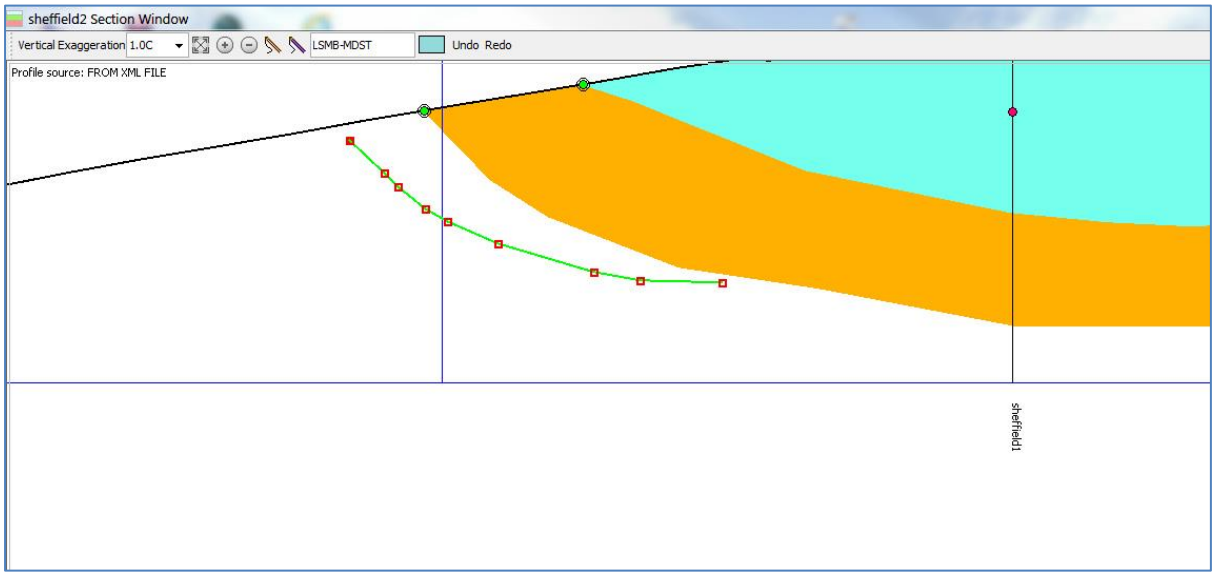
The left hand **pen** tool allows you to draw a new line by holding the left mouse button down and dragging the pen across the section window until the mouse button is released. Nodes are added automatically, the density of which can be adjusted in the DRAW ribbon by using the slider marked 'Pen tool node density'. Note that the line can subsequently be smoothed once drawn using the 'Vertex edit smoothing' slider in the DRAW ribbon and moving the nodes around.

The right hand **digitizing** tool allows you to draw the line one node at a time, giving greater control over node positioning along the line. Use where positioning of nodes is more critical. Again smoothing is possible by later editing.

4.5 EDITING LINES

To edit a line you must first make the line active by clicking on it with the left mouse button. The nodes are then displayed as shown below, and the line itself will appear green. Nodes can then be moved as appropriate with the option to smooth the line to different levels using the slider 'Vertex Edit Smoothing' in the DRAW ribbon. Line end nodes can be snapped by dragging a node to another (snap enabled) line such as another correlation line (see under snapping in next section).

New nodes can be added by double clicking at the appropriate position along the line.



To remove a node double click that node. To add a node double click anywhere on the line outside existing ones.

To delete a whole line right mouse click on the line and a dialogue box will appear for confirmation. Choose yes and the line is deleted.

To move a whole line position place mouse arrow over the line, hold down the shift key plus left mouse button and drag the line to its new position and then release the mouse button.

4.6 SNAPPING

Definition: attaching one line to another in an unambiguous way by creating a single, common node.

Snapping is necessary in order to create complete, watertight polygons in the section and avoid uncertainties in the connections between lines by spatial proximity alone.

Snaps can be identified by the double circle drawn around the join. The centres are coloured according to the type of snap node.

The following types of snapping are available in the section window:

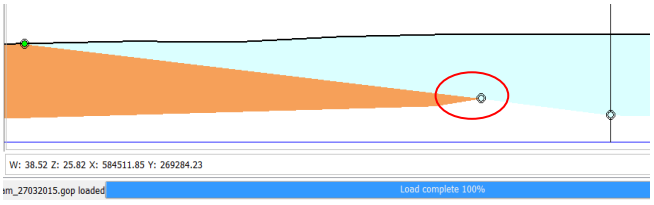
1. correlation line to correlation line.
2. correlation line to fault
3. correlation line to profile
4. fault to fault
5. fault to profile
6. correlation line to intersecting section

7. correlation line to outcrop/subcrop/faultcrop
8. correlation line to end of section
9. fault to mapped fault
10. subdivision marker at the end of a line

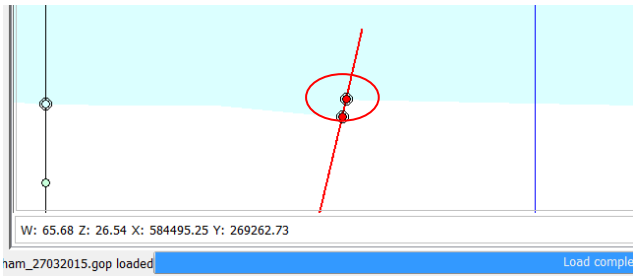
To snap two lines together is normally a case of dragging the end node of one line towards the other object. When they reach a certain proximity the two objects will be "snapped" together. Once snapped together the two lines can be edited together using a single operation.

In order to unsnap a node, the CTRL key is held down simultaneously with the node being dragged away from the snapped node. This option is available to all types of snaps.

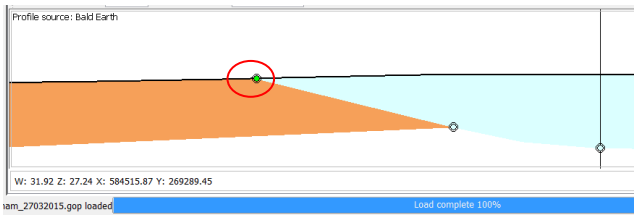
Different types of snaps behave differently when trying to drag without the CTRL key being used. These differences are explained below. In all cases, one of the lines must be made active before attempting to edit.



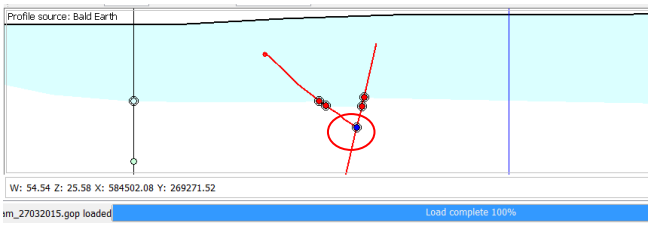
Correlation to correlation line snaps can be moved by holding the left mouse button down over the node and dragging the node. This causes the matching snapped line node to also move. The inner circle is coloured to show the colour of the rock code to which the line is snapped.



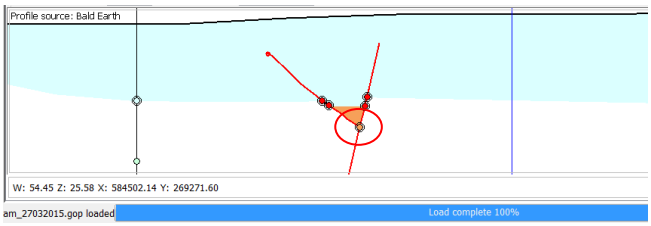
Correlation line to fault snaps can be moved by holding the left mouse button down over the node and dragging the node. This causes the matching snapped line node to also move. The inner circle is coloured red to show this type of snap is FAULT STICK.



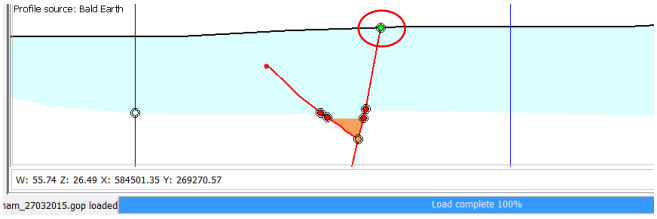
Correlation line to profile snaps cannot be moved. If the snap is invalid and needs to be changed, the snap must be removed by dragging away using the CTRL key, then re-snapped in the correct position, or the node can be deleted. The inner circle is coloured green to indicate PROFILE SNAP. IMPORTANT: when snapping a correlation line to the profile, if a GRID object is set as the model cap, Groundhog will query the grid layer to obtain an exact profile elevation at that position and will insert it into the profile automatically. In some cases this is not desirable – if you wish to prevent this from happening then check **Freeze Profile** in the section window settings panel on the right.



Fault to Fault snaps can be moved by holding the left mouse button down over the node and dragging the node. This causes the matching snapped line node to also move. The inner circle is coloured blue when this type of snap is first created to indicate Y-FAULT SNAP.

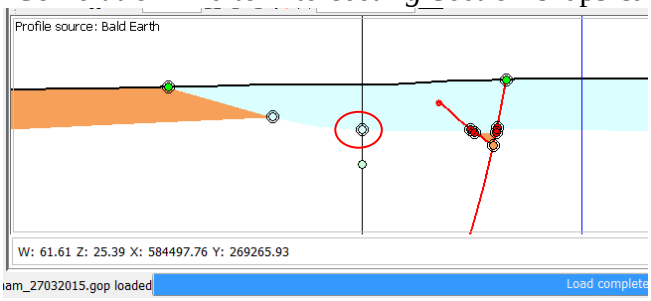


However, by making either line active and right-clicking on the snap node at the Y-intersect, the rock code that should be used to colour the area at the base of the Y can be selected from a list. The inner circle now changes to show the colour for the chosen rock code.

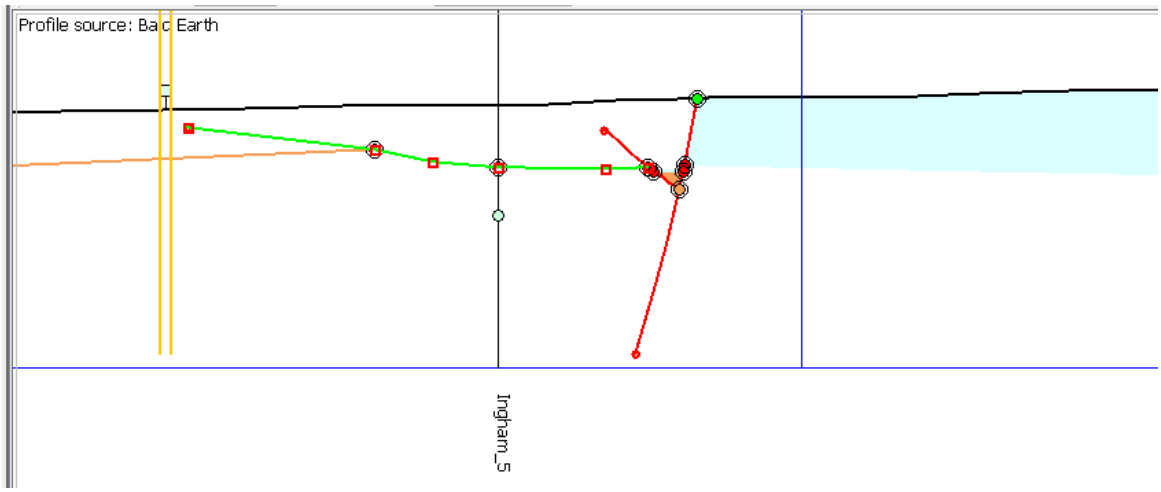


Fault to Profile snaps cannot be moved. If the snap is invalid, the snap can be unsnapped using the CTRL key, then re-snapped in the correct position, or the node can be deleted. The inner circle is coloured green for this type of snap.

Correlation line to Intersecting Section snaps cannot be moved in the W direction, i.e. from side to side. However, they can be moved in the vertical direction, up or down. This is provided that the corresponding section is also loaded into the workspace. If it is not loaded, the node cannot be moved, only unsnapped or deleted. An edit in one section will be automatically mirrored in the crossing section.

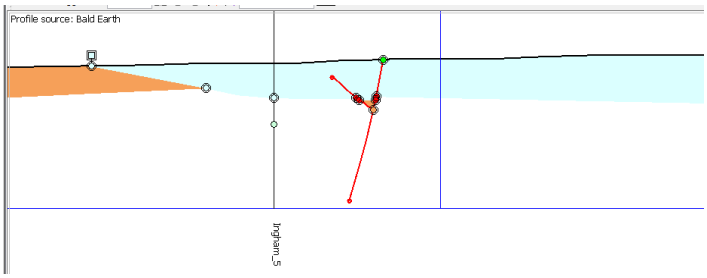


Outcrop/Subcrop/Faultcrop snaps are special snaps that are snapped to croplines in the map window. A cropline marker shows the position on the profile where corresponding to the position in the map window. To display the cropline markers click on Show/Hide Cropline Markers in the section window settings panel on the right.

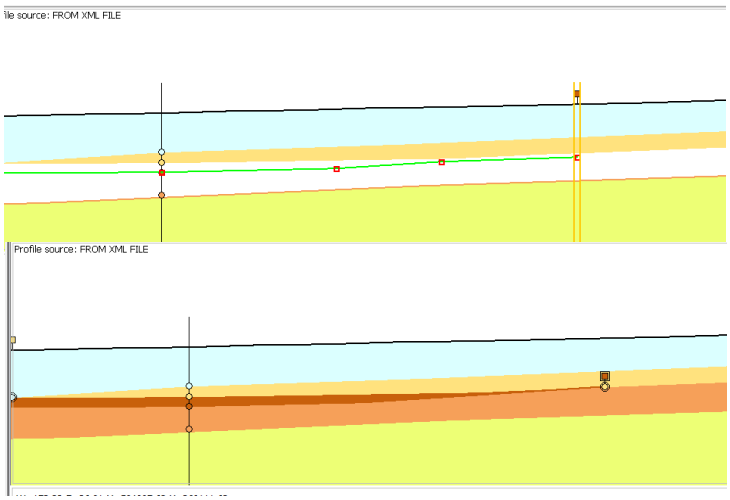


Outcrop snap.

As the end node of the correlation line is dragged towards position on the profile corresponding to the cropline for this rock code, two parallel vertical lines appear in the colour of the matching rock code, marking the area where the node should be snapped. Within this vertical region, drag the correlation line node up to the profile to snap exactly to the corresponding Cropline position.



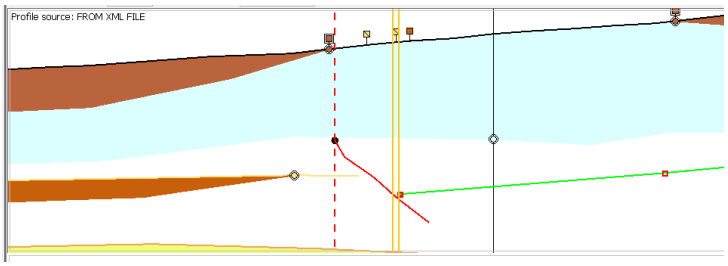
Once the node is snapped, it cannot be moved, only unsnapped. The marker now has a double line around the square to show that it is snapped.



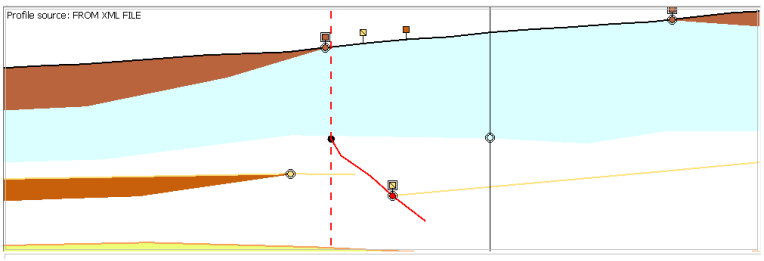
Subcrop snap

As the end node of the correlation line is dragged towards the cropline position for this rock code, two parallel yellow lines appear, marking the area where the node should be snapped.

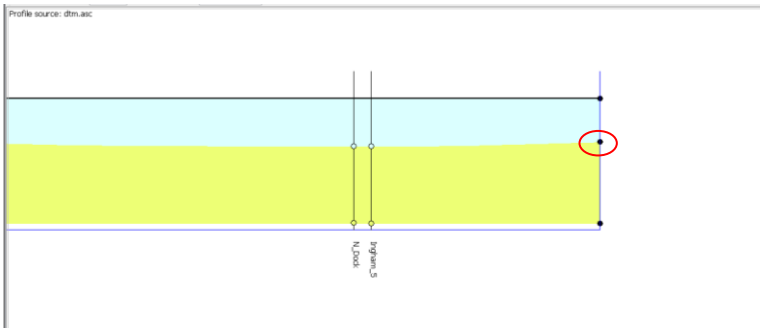
Once the node is snapped, it cannot be moved, only unsnapped. The marker moves down onto the correlation line to which the line has been snapped and now has a double line around the square to show that it is snapped.



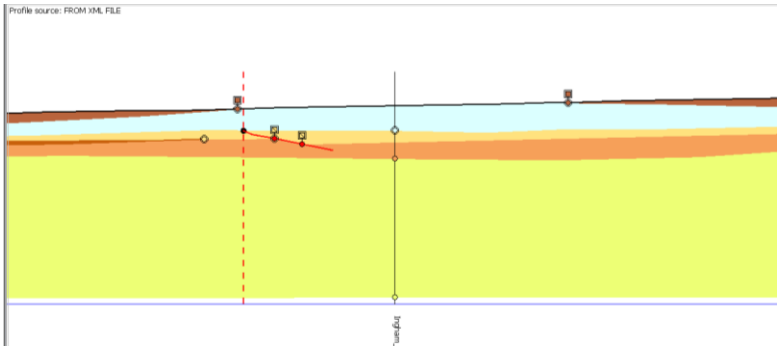
Fault crop snap. As the end node of the correlation line is dragged towards the cropline position for this rock code, two parallel lines appear, marking the area where the node should be snapped.



Once the node is snapped, it cannot be moved, only unsnapped. The marker moves down onto the fault and now has a double line around the square to show that it is snapped. Fault crop snaps also have a diagonal line across them, to distinguish them from other crop snaps



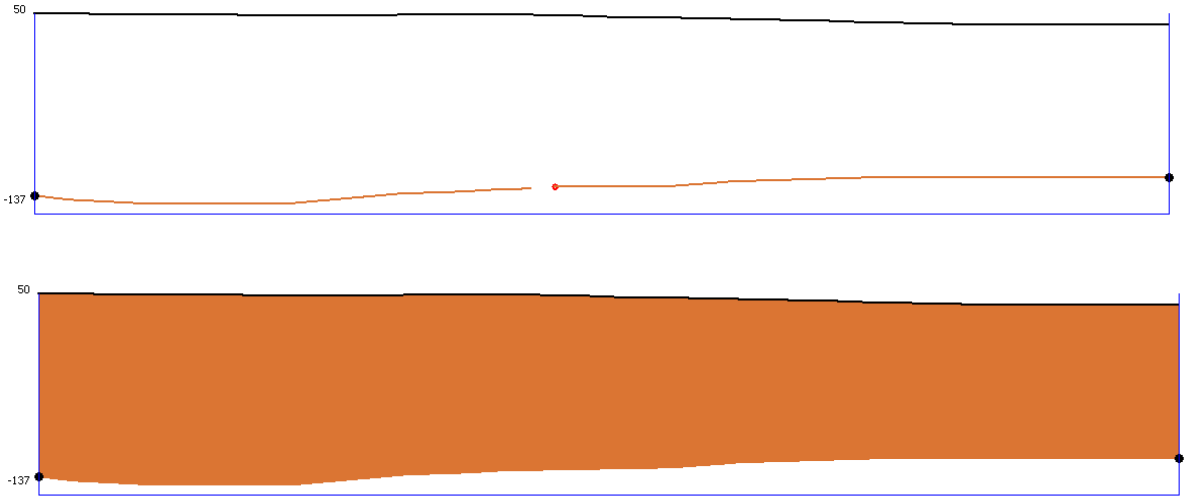
Section End snaps are slightly different from other snaps in that they can be unsnapped without using the CTRL key. The snap marker is a large black dot. It is important that correlation lines be snapped to ends of the section for clean linework.



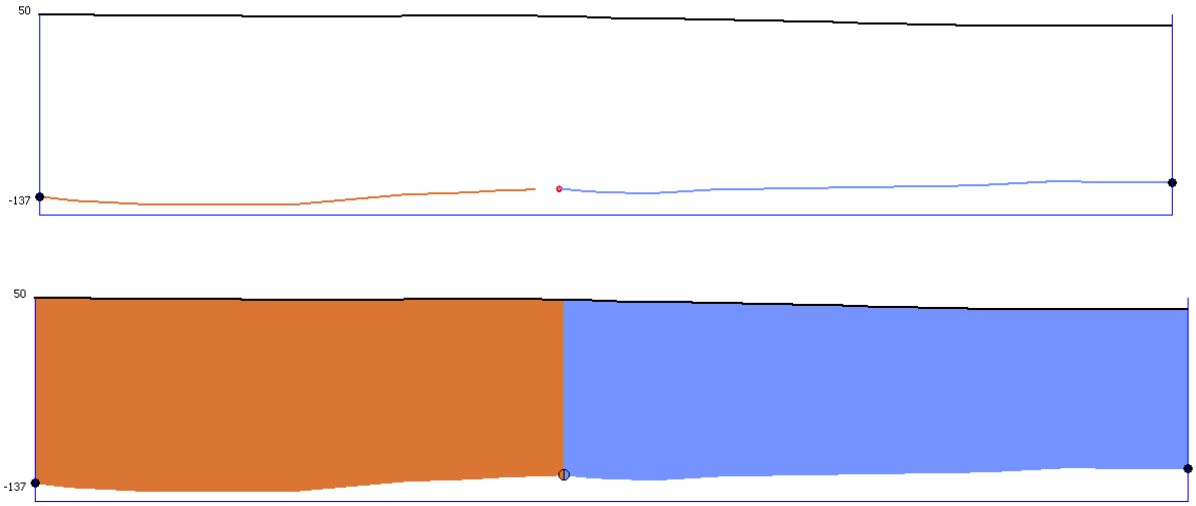
Mapped fault snap. This type of snap snaps the fault drawn in the section to the fault drawn in the map window. The position where the fault line drawn in the map window, cross the section, is shown by the dotted, red, vertical line. It can be unsnapped without using the CTRL key.

4.7 JOINING CORRELATION LINES

To join two lines together simply drag one end node towards the other end node. This creates one single line where the geological attribution is the same – i.e. the two lines will be merged into a single geometry.



If the join is between correlation lines with different rock layer codes then the two lines remain as separate objects with a 'JOIN' snap node between the two as shown below.



Such dis-cordant joins are currently displayed as a sharp vertical boundary. Future versions of the software may enable configurable graphical representation as a zig-zag or graduated transition.

4.8 DELETING LINES

To delete a line simply make the line 'active' by clicking on it, then either right click and respond to a yes/no dialogue box for confirming deletion, or hit the delete key and respond in the same way to the dialogue box.

Note that deleting a line is undoable.

4.9 EDITING THE PROFILE

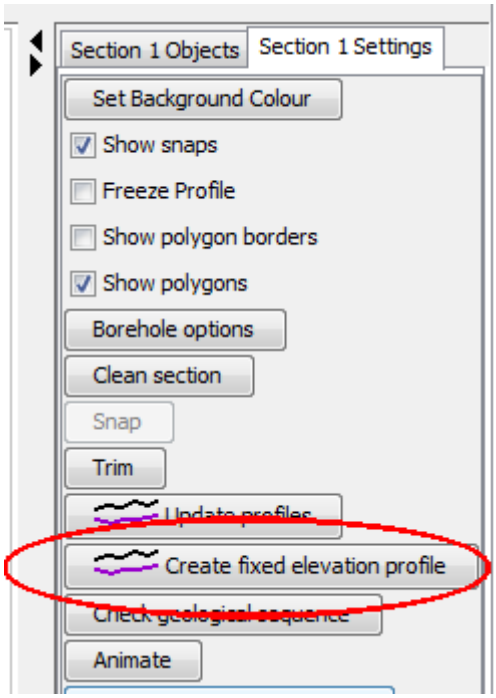
To edit the profile line, first click on it to make it active. Then drag and add nodes as described earlier (see editing lines).

This is useful where you need to add fine detail such as a new artificial ground area, or say a channel which had been obscured when original DTM was recorded, or is only visible at finer detail than seen currently

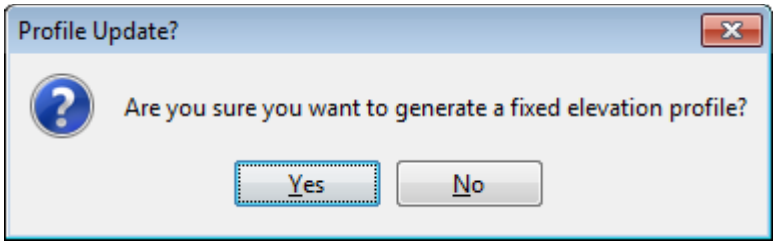
Note that the freeze profile option mentioned under the settings section does not prevent editing of the line, but is rather to control the snapping to profile of geological line work.

4.10 GENERATING A TERRAIN PROFILE

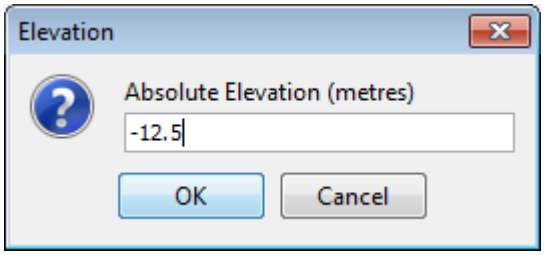
In cases where no digital terrain model is available, or where a manually created cross-section profile is desired (for example where you wish to digitize over an image), it is possible to create one interactively. Click on the "Create Fixed Elevation Profile" button in the cross-section settings panel.



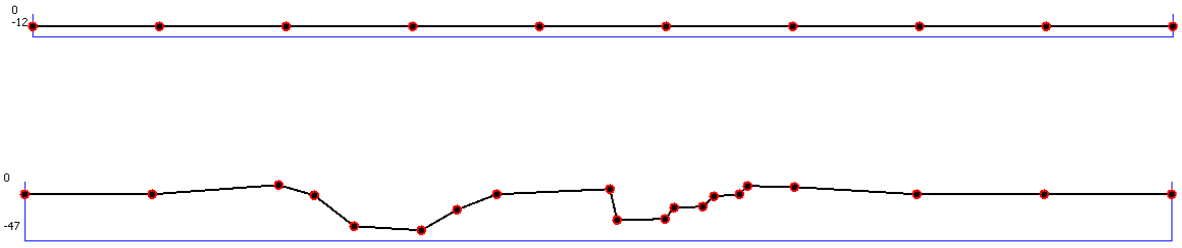
Confirm that you wish to generate a profile.



Enter the desired elevation value (for negative values, prefix with a minus sign).



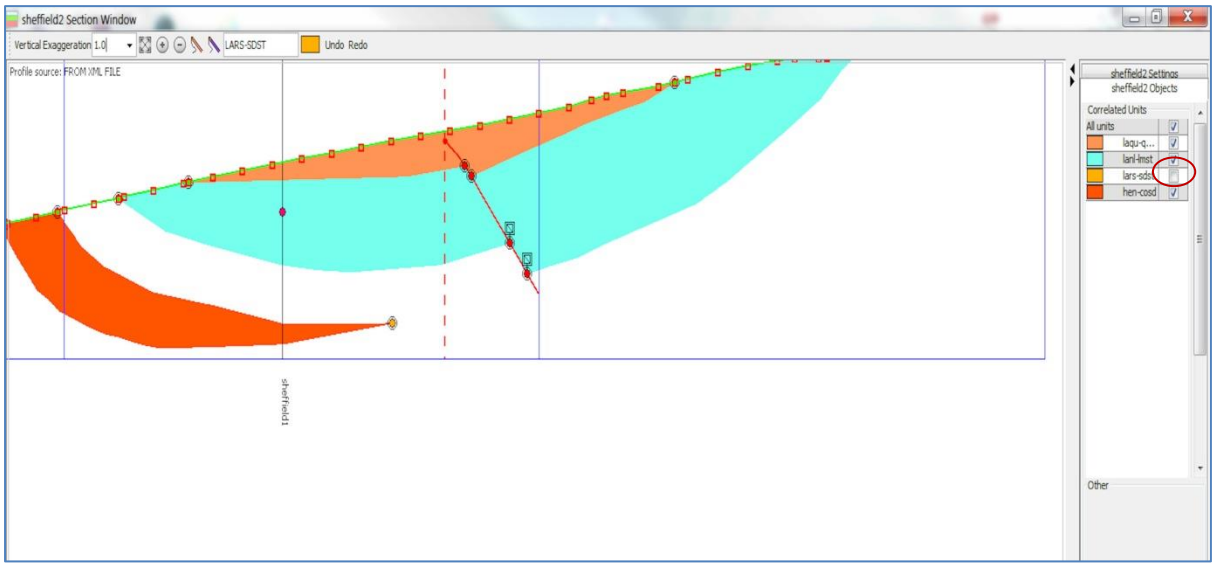
A fixed profile with ten vertices is generated at the specified elevation and can then be manually shaped as desired.



IMPORTANT: Bear in mind that if a terrain model grid is loaded into the workspace and set as the Model Cap, if you snap a correlation line to a manually created or edited profile, the value from the grid layer will still be queried. To prevent this from happening make sure to check on "Freeze Profile" in the cross-section settings panel.

4.11 SHOW/HIDE LAYERS

To make lines visible or invisible tick the relevant box in the <section name> objects -> Correlated units list in the right hand side Settings and Objects window. Ticking a box makes that unit visible, with un-ticking making it invisible. Example shown below.



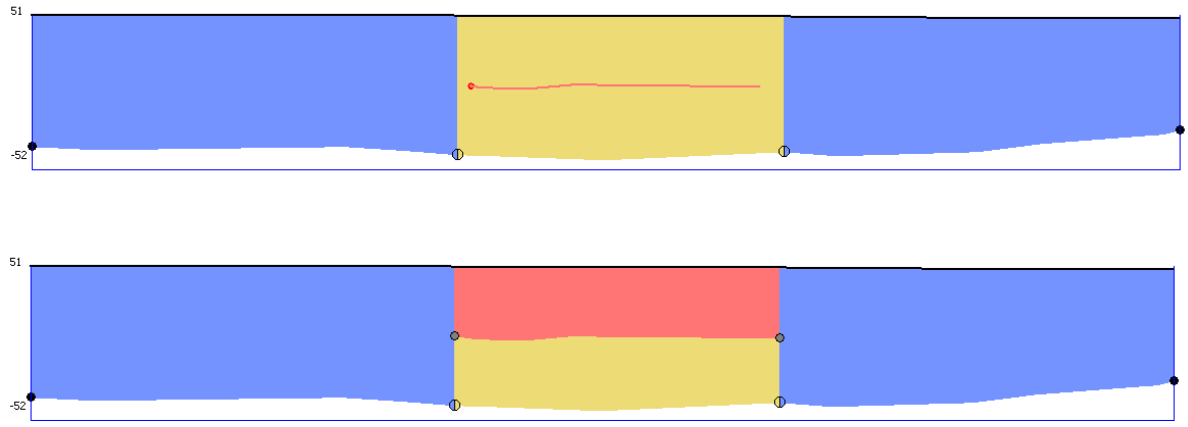
4.12 DRAWING SUB-DIVIDED STRATIGRAPHY

It is possible to sub-divide stratigraphy in a basic way within Groundhog Desktop. There are two scenarios, but the basics are the same.

1) Where the base of the parent horizon is itself already subdivided,
2) Where the base of the parent horizon is attributed with a single rock code.

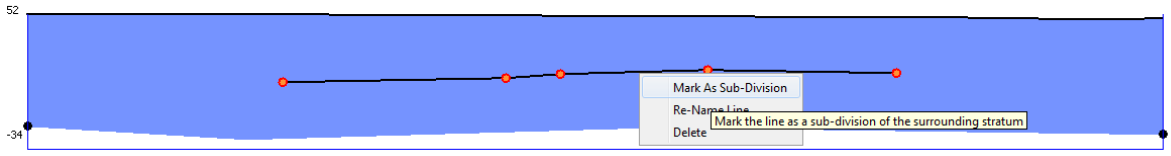
4.12.1 Parent Horizon Is Sub-Divided

In this case, the base line is already comprised of more than one line joined together. Simply draw in the sub-division base, and then drag each end of it across the join position in the parent base horizon to snap to the appropriate location.



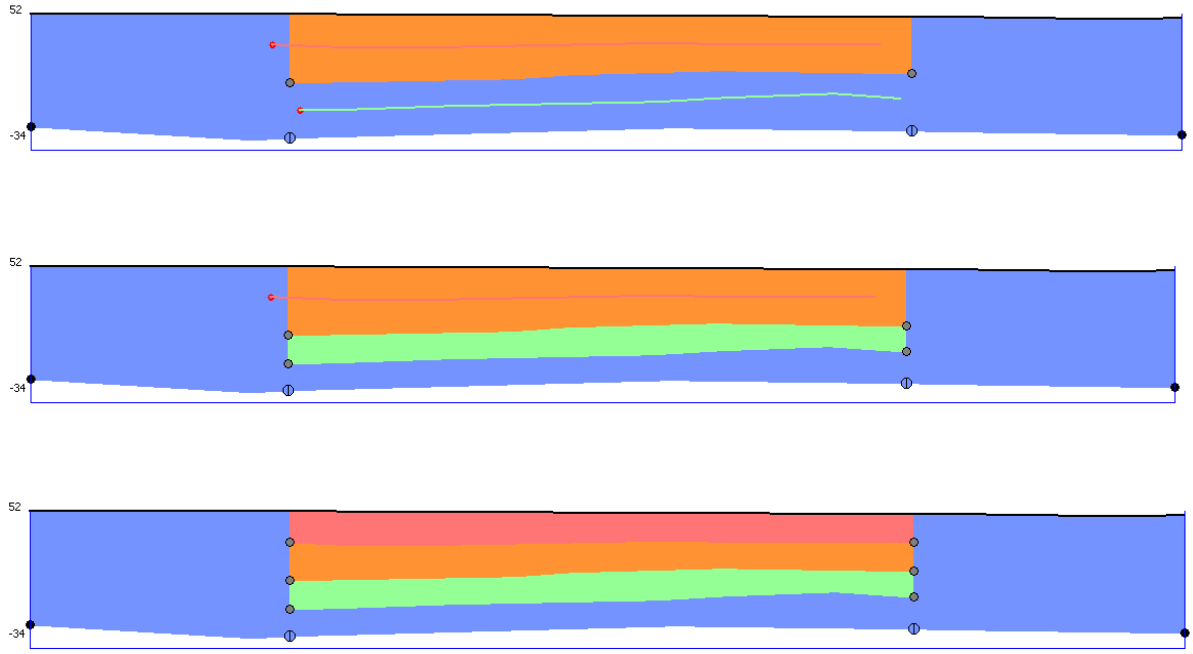
4.12.2 Parent Horizon Has A Single Code

In this case, simply draw the sub-division base within the parent horizon's polygon, then make the line active and use ***Right-click > Mark As Sub-Division***.

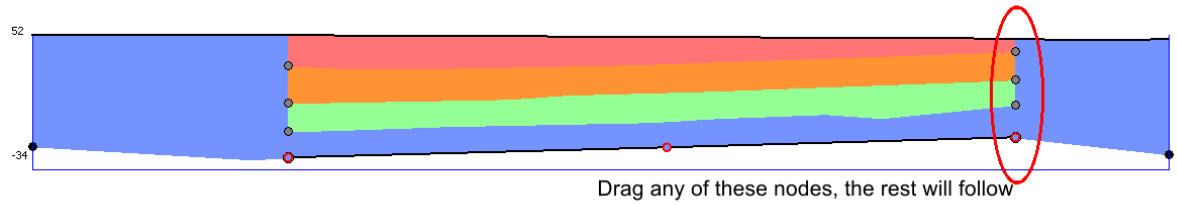


The parent line below is actually split into separate lines using a JOIN-type snap object. The sub-division line has sub-division marker snaps nodes attached at both ends.

You can now draw additional child layers either above or below the existing one. To conect them to the same sub-division level, drag their end vertices towards the end of the existing sub-divions (from left to right). When they get close they will snap to the correct position.



Moving either a join position in the parent base, or a sub-division marker at the end of a child horizon will cause the other to follow. To dis-connect, hold down CTRL key and drag one of the snapped nodes away.

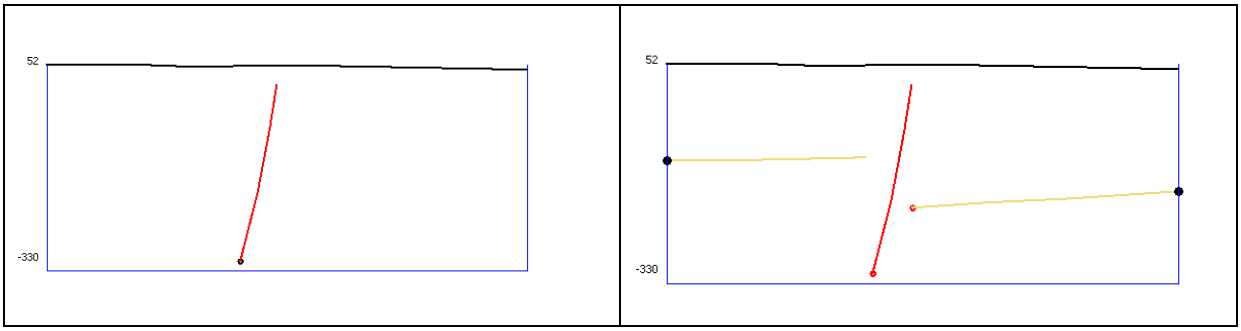


4.13 WORKING WITH FAULTS IN SECTION

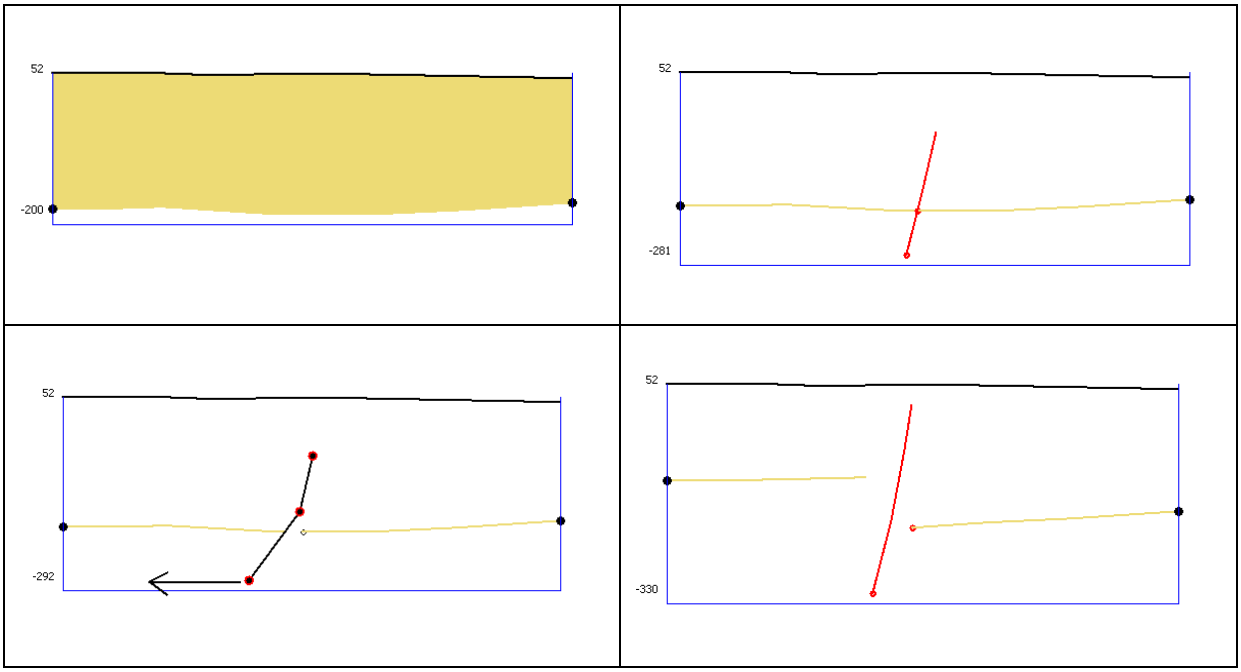
The expression of a fault plane within the plane of the cross-section is captured by drawing a line referred to as a Fault Stick. To draw a fault stick, select the code “Fault” from the codes panel, and start drawing.

Correlation lines must be split across the fault sticks, and then snapped to either side, usually with an offset representing the displacement on the fault. This can be done either by drawing the fault first, and then drawing two correlation lines either side, or by drawing a single correlation line, and then drawing a fault line through that line to split it.

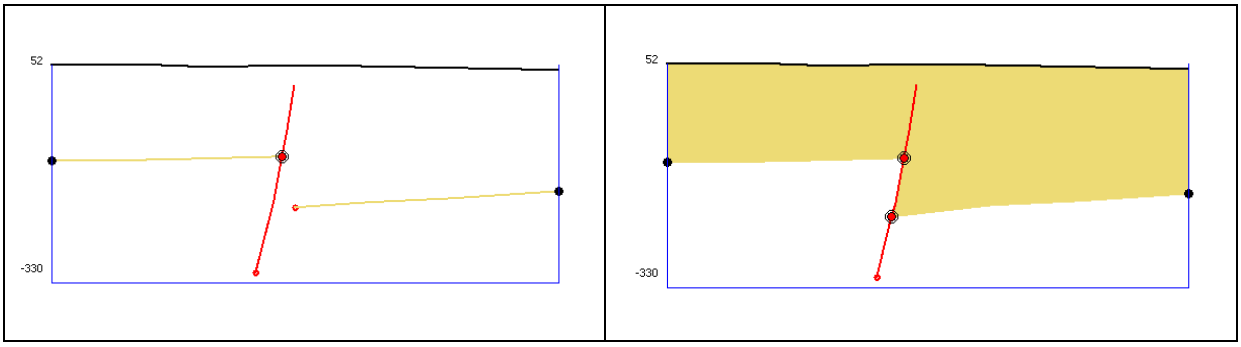
Draw fault stick, followed by two correlation lines.



Alternatively, draw correlation line, then draw fault stick through the line to split it. Carefully dragging the end node of the fault stick will actually push back the correlation line. Alternatively, just drag the ends of the correlation lines away to create the gap.



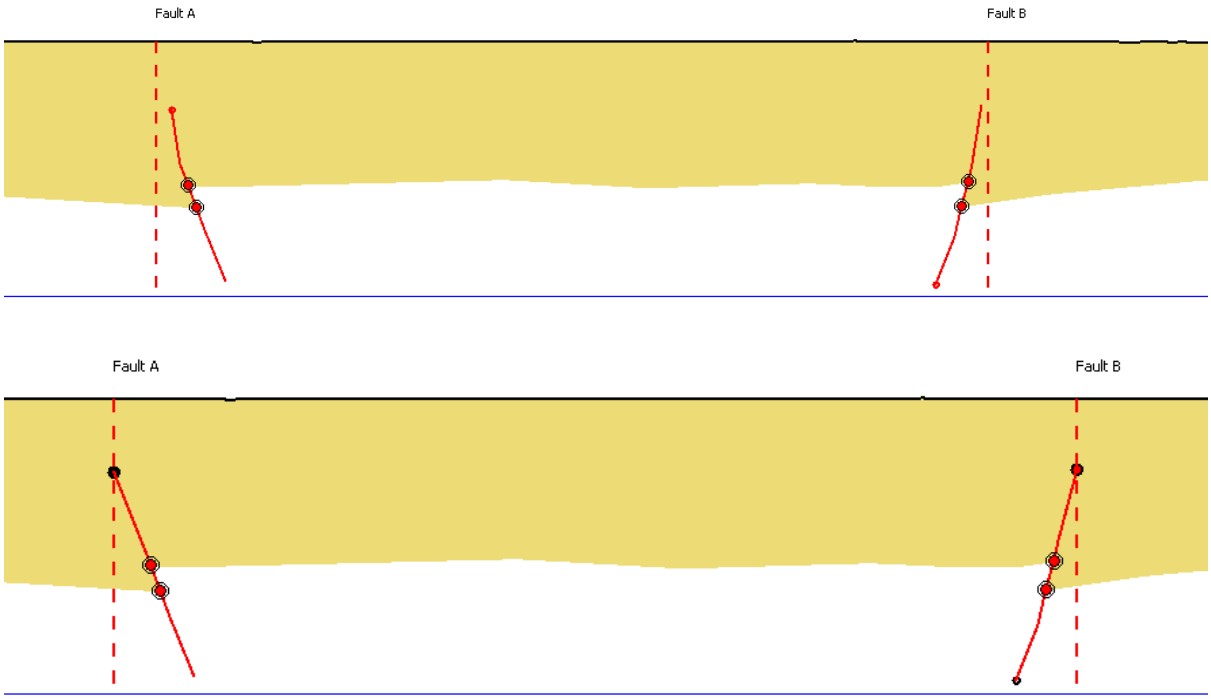
Snap the two correlation lines to the fault stick to represent the displacement on the fault plane. Faults can be drawn normal or reverse. Once snapped together, the snapped node can be dragged to update both lines simultaneously.



4.13.1 Referencing Mapped Faults

Any faults drawn in the map window (fault traces) which intersect the line of the cross-section will be displayed as a vertical dashed marker line. If the faults are named they will also be labelled. The top of a fault stick can be attached to this marker to make a connection between the two objects. This is helpful when grouping fault sticks by-fault, for example if you wish to export the geometries to a 3D or CAD package for meshing or modelling.

Simply, drag the top vertex of a fault stick towards the fault trace marker to make the connection. Once connected the top vertex can only be moved vertically. To remove the connection, hold down the CTRL key and drag away.

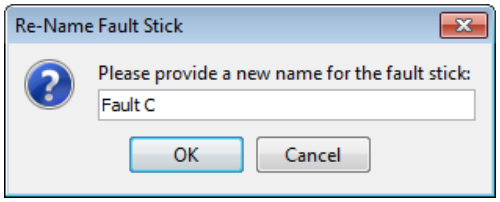


4.13.2 Naming Faults

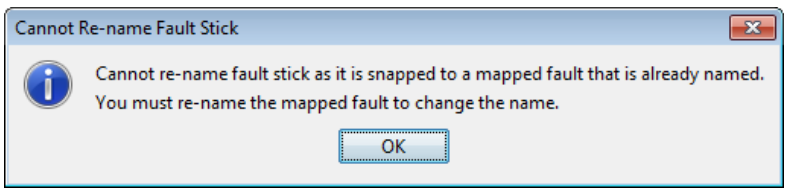
Mapped faults and fault sticks can have names associated with them. This can be useful if you have a fault naming scheme you wish to use for ease of identification.

To name a mapped fault (fault trace), right-click on its entry in the object tree and choose Re-Name Fault. You will be prompted to also name any fault sticks that are attached to this fault in cross-section. In general, the name of the mapped object over-rides the name of individual fault sticks, so a re-name here will re-name the associated fault sticks, even if they were previously named.

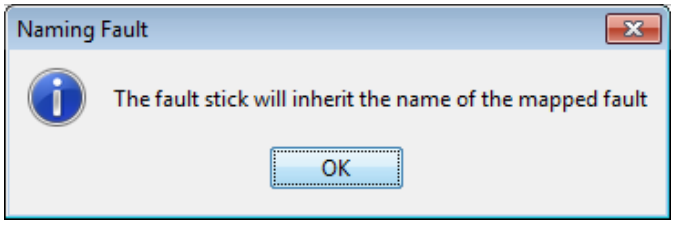
To name a fault trace, make the line active in the cross-section, and use right-click > Re-Name Fault Stick, and enter a name in the dialog.



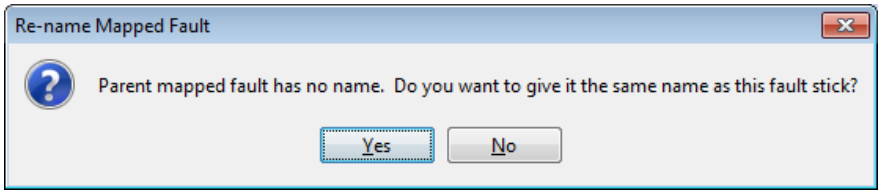
If the fault stick already has a name that is inherited from a connection to a mapped fault, you will not be able to rename the individual stick and will see this message.



If you connect a fault stick to a mapped fault marker and the mapped fault (fault trace) already has a name you will be prompted to confirm that the fault stick will inherit the name label of the mapped fault.

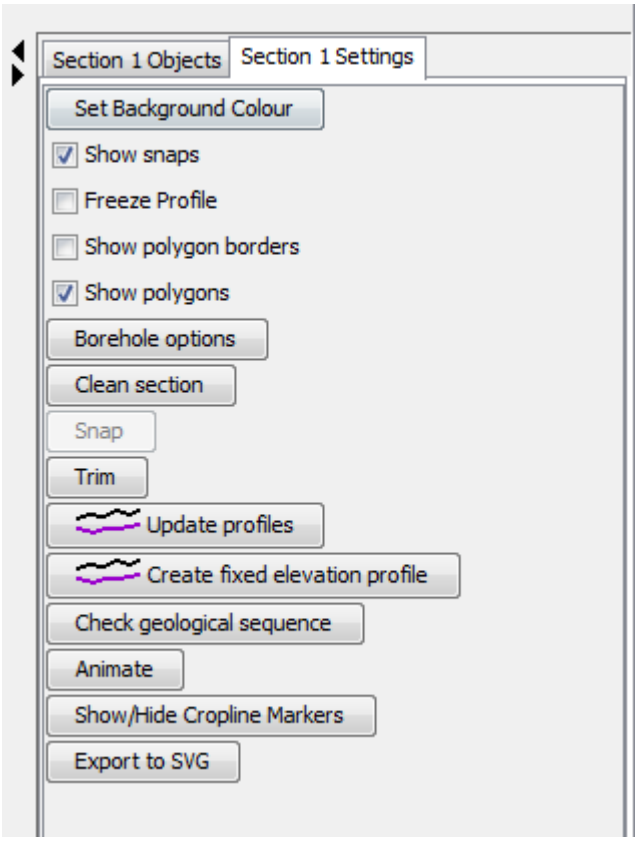


If you connect a named fault stick to the marker of an un-named mapped fault (fault trace), or if you name a fault stick that is already connected to the marker of an un-named mapped fault (fault trace) you will be prompted to name the mapped fault using the same name.



4.14 WINDOW SETTINGS

In the same right hand side Settings and objects window, click on the settings tab. This brings up a series of buttons and checkboxes. As shown:



4.14.1 Background Colour

To set the background colour click on button labelled same and choose a colour in the new pop-up window. Click OK after choosing colour. The colour is now applied to the backdrop of the section.

4.14.2 Show/Hide Snaps

Tick or un-tick the checkbox labelled show snaps to switch between visible and invisible for the snap nodes.

4.14.3 Show Polygon Borders

This will draw black borders around the polygons. This can be useful to highlight the stratigraphy, especially if several similar colours are in use in the legend.

4.14.4 Show Polygons

This is checked on by default, and simply provides a way to switch off the polygon rendering should you wish to work with the raw linework only.

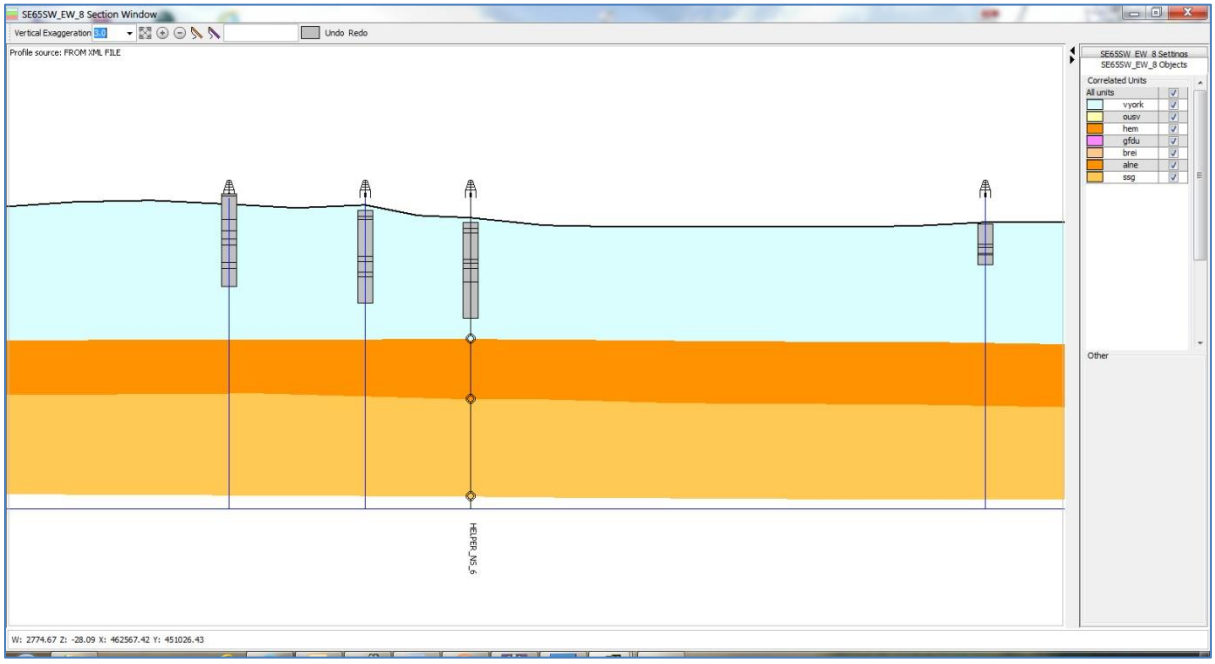
4.14.5 Freeze Profile

The software will automatically resample the DTM when snapping correlation lines work to the terrain profile, in order to get the highest resolution on the snap position. However this is not always desirable. To freeze the DTM profile line so that re-sampling is NOT applied on snapping, check the box with same name.

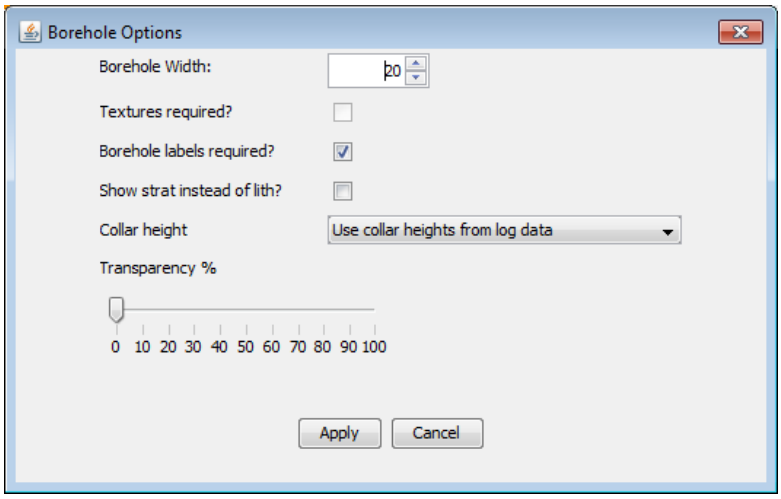
When the box is un-ticked the profile will be re-sampled to finer detail as the snapping takes place, when this is appropriate (not already at highest resolution). This allows exact snapping to a DTM without the need for full resolution detail along the entire profile.

4.14.6 Borehole Options

Boreholes will automatically appear in the section if your section drawn in the plan window includes boreholes as node points (coincident in space).



To alter the display characteristics of the borehole choose <section name> settings from the RHS menu. Click on Borehole Options and you will get the dialogue box:



Borehole Width – sets the graphical width in the section display

Textures – not yet implemented

Labels – shows/hides labels

Show strat instead of lith – toggles between lithology codes and lithostrat codes (if available) for borehole rendering and labelling

Collar height – set the collar height mode; 1) use heights from data only 2) hang boreholes with missing collar heights off the terrain profile 3) hang ALL boreholes off the terrain profile. Note that logs hung off the terrain display with red borders and labels in the section window for clarity.

4.14.6.1 CLEAN SECTION

This button cleans up the Section linework by 1) removing invisible duplicate vertices (including vertices closer together than the tolerance set by the software), the presence of which can prevent the colouring up of the section polygons, 2) removing zero-length lines (lines with only a single vertex) and 3) adding a 3rd vertex to the mid-point of lines with only two vertices as lines with only two vertices are difficult to snap correctly.

If you find that your section is not colouring up in full, this option will resolve the issue in cases of node duplication.

4.14.6.2 TRIM

Trims lines back to section extent. Useful for cleaning up imported cross-sections where the correlation lines extend beyond the line-of-section.

4.14.6.3 UPDATE PROFILES

This button reloads the DTM profile in the section by re-querying the grid layer that is current set as the Model Cap. The layer can be changed by selecting it from the pull-down options in the main toolbar, or by right-clicking on a grid layer in the reference objects tree and selecting “Set as model cap”.

Choose a different DTM from the LHS object reference menu under the 'Workspace' tab, under which appears the expandable node 'Reference Objects'. Expanding this shows another expandable node – 'Grid Coverages'. Under this node is a list of DTMs which you can use as a section cap.

IMPORTANT: You should only use this option if you need to switch to a different terrain model for the cross-section profile. Once you have done this you will need to re-snap any linework that is drawn up to the old profile.

4.14.6.4 CROPLINE MARKERS

Markers are placed along the profile where a cropline on the map crosses the section line in plan. This allows for section linework (e.g. correlation line) to be kept spatially coincident with map linework of the same unit. The linework in the two 2D 'planes' are then tied together. This is achieved by snapping the line in the section to the cropline marker (see section on snapping).

Such croplines can be both surface crops and sub-surface, the latter being where a unit sub-crops against another unit.

Switch cropline markers on and off using the button 'Show/Hide Cropline Markers'.

4.14.6.5 EXPORT TO SVG

This button allows you to export the section to XML based Scalable Vector Graphics format. This vector format is supported by many graphics packages and can be useful for producing high-quality report graphics.

4.14.6.6 FIXED DISPLAYED ELEMENTS

Other elements displayed on the section are fixed. These include:

1. Crossing sections.
   Modelling involves the building up of fence diagrams which consist of individual sections in a mesh. Each section in the meshwork that crosses the active one will be displayed as a black vertical line with a label (section name) at the base.
2. Fault positioning lines.
   These appear as vertical dashed lines in red. They are used as an aid in 'attaching' a fault stick in the section to a fault drawn in the map window (see section on Faults). This then ties together this fault stick with the larger 'parent' fault drawn on the map (a fault is made up of several such sticks drawn in different sections in the fence meshwork).

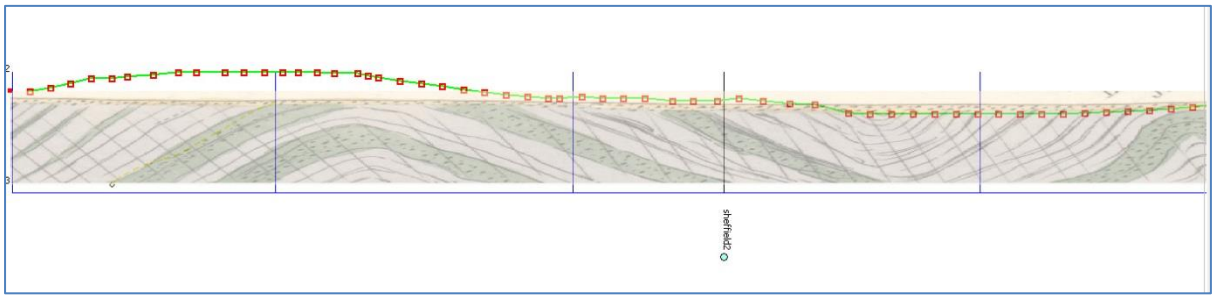
4.15 ATTACHING AN IMAGE

When creating a new section it can be useful to overlay an existing image to act as a backdrop when drawing linework. Good examples would be seismic traces, in the field quarry/cliff face images etc.

Follow steps below:

1. Load the image into the workspace. On the top menu go to **Session -> Load referenced object -> Image**. The image then appears under the LHS referenced objects window under workspace -> Images.
2. Bring the image into the section window by right clicking on the section in the same reference objects window and choose '**Attach Image'**. In the dialog presented choose the desired image from those loaded in the session.

3. The image will appear at a small default size. Click and drag to expand to the required size. The top left node on the image is used to position the image (drag to position), and the bottom right node is used to stretch it (drag to resize).



Now draw linework over the image.

4.16 SECTION COLOURING UP – TROUBLESHOOTING GUIDE

Within the section window, areas of rock (polygons) are coloured with the colour associated with the rock code. For the polygon colouring to work correct the linework must be clean and properly snapped, otherwise the correlation linework will appear just as lines. There are a number of rules that must be understood, in order to make the colouring work correctly:

Coloured polygons will only exist where snapping has taken place, so there is a proper link between lines. Snap nodes must exist on both lines that are snapped together. Occasionally, one of the snap nodes may be lost, so it is important to check that this has not happened. It is easy to tell because each correct snap will have two circles, an outer black circle and a smaller inner filled-in circle of various colour.

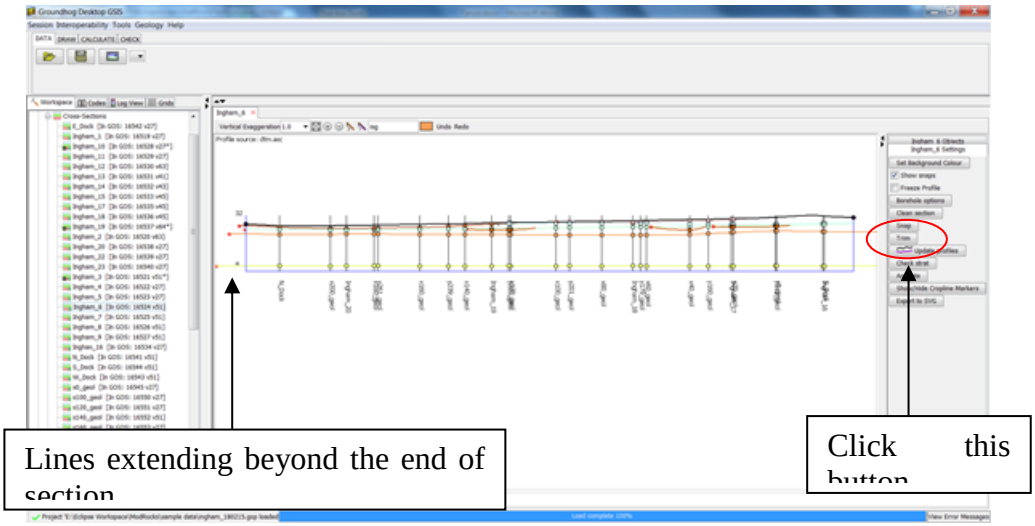
It is also important that correlation lines that go to and beyond the end of the section are snapped to the end of section. If your section has many lines running beyond the section extent use the **Trim** button in the settings panel.

When troubleshooting colouring up of a section, always try the *Clean Section* button in the section window setting panel. This looks for common problems and addresses them automatically.

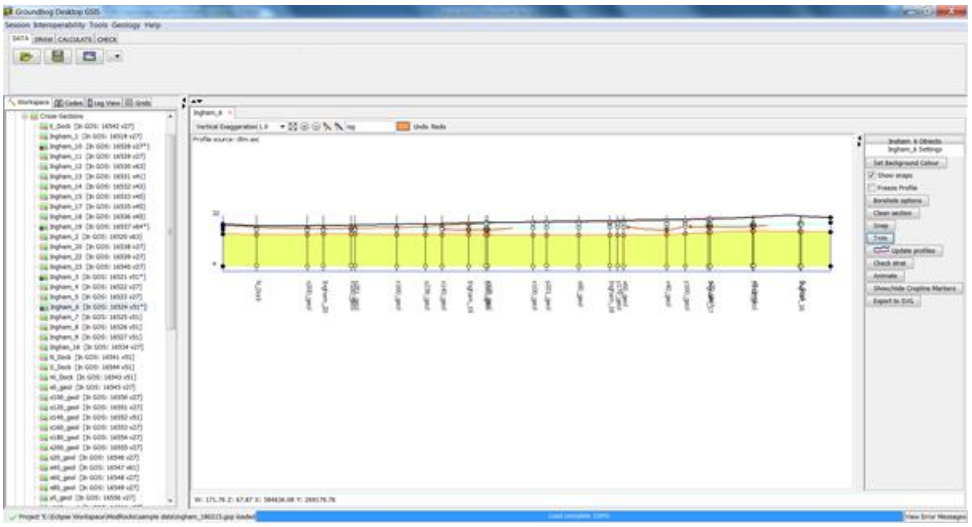
There are a number of reasons why coloured polygons are not always created. These include:

- Duplicate nodes – in order to check this, moving each node in the polygon should reveal whether or not there is another node underneath it. However, to simply remove all duplicate nodes, click on the ***Clean section*** button on the Settings tab (see example below)
- Disordered nodes – sometimes there are two nodes at the end of the section, with different Z values. One of these needs to be removed.
- Crossing lines – if lines cross, polygons cannot be formed. All polygons must be **simple** polygons http://en.wikipedia.org/wiki/Simple_polygon .
- Nodes very close to each other – these can produce strange angles and have a similar effect to crossing lines. Moving a node slightly solves the problem.
- Lines that run back on themselves for a small segment.
- Lines that look like one, but are actually comprised of several lines that need to be merged ("joined").

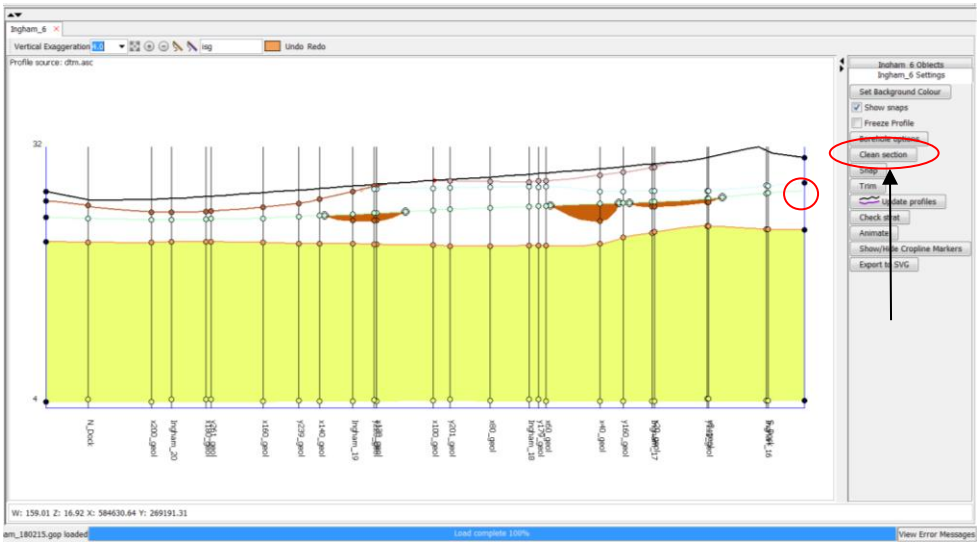
The following diagrams illustrate some of these problems:



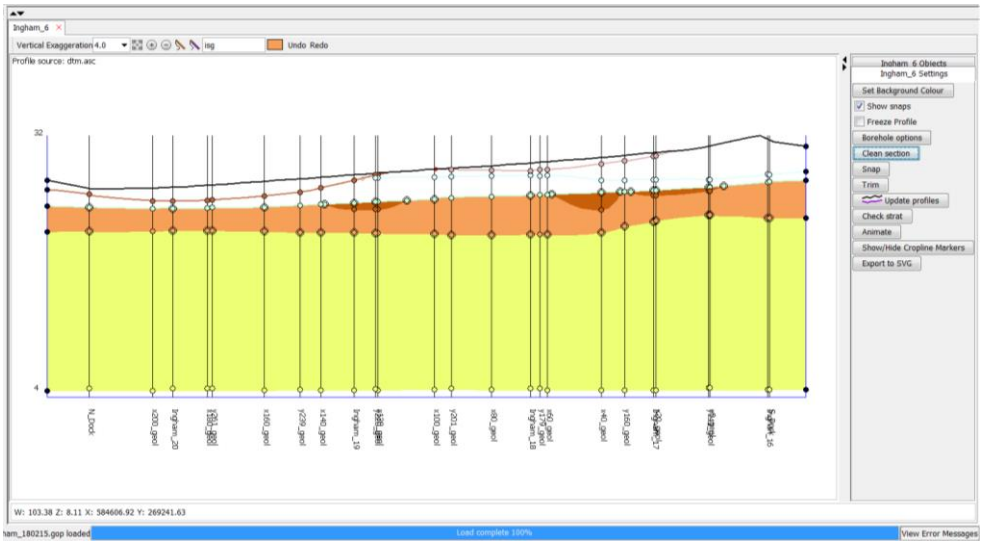
Using the trim button has cut all the lines back to the section boundaries and solved some of the problems:



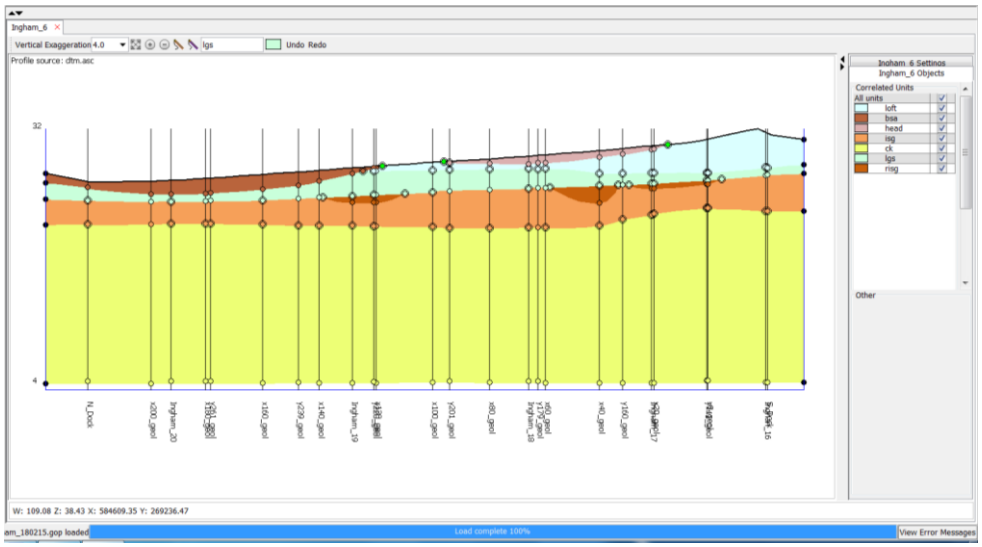
However, after snapping some of the nodes, there is still a problem and the area above the chalk (yellow) is still not colouring up. The section below has been vertically exaggerated to show the problem more clearly.



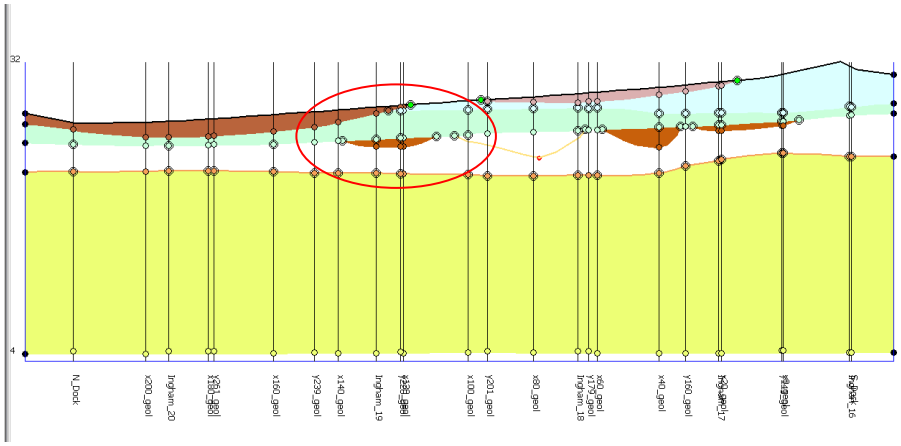
One of the correlation lines does not quite reach the end of section, as demonstrated within the red circle. Also, if there are duplicate nodes along some of these lines. Clicking the Clean section button solves this problem.



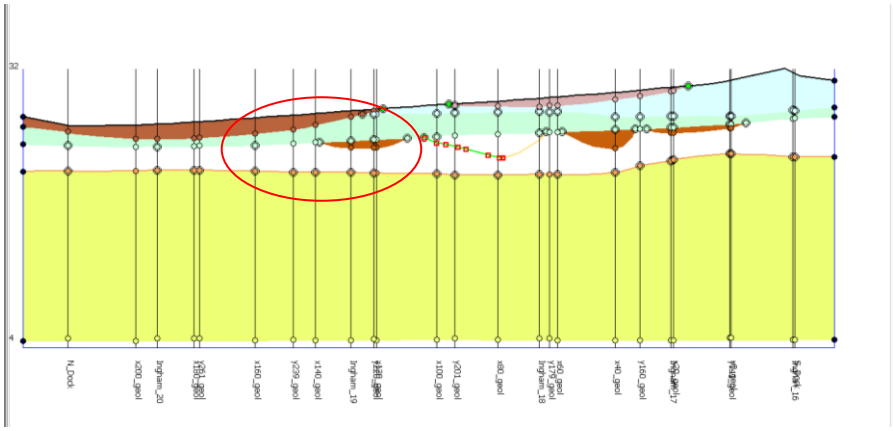
After snapping the remainder of the unsnapped nodes, the section is now coloured correctly:



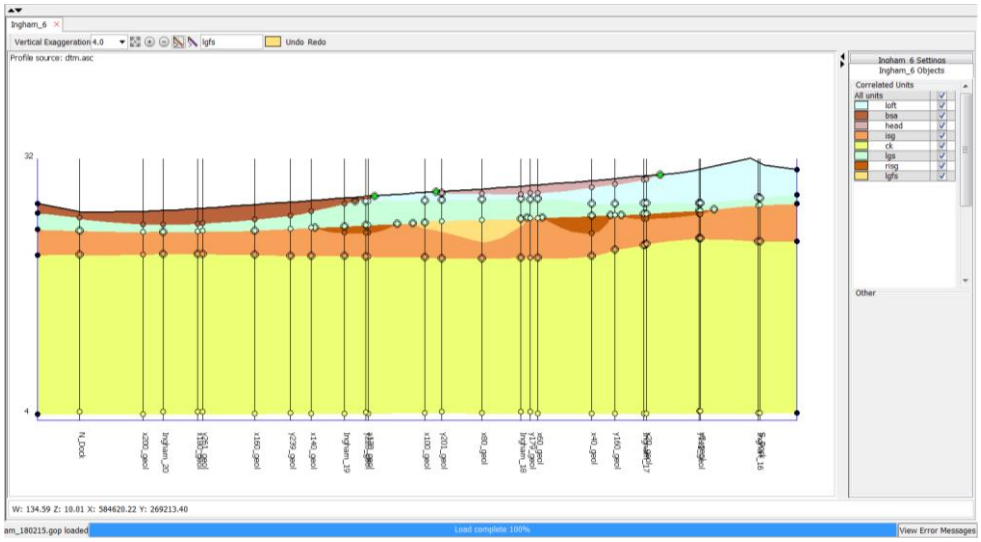
In the following section the yellow line looks like it is one correlation line:



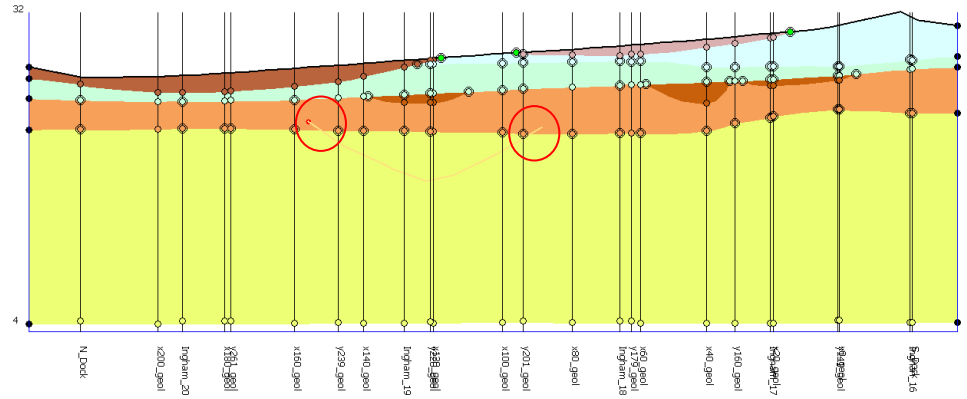
In fact it is two lines, which is causing some polygons to fail.



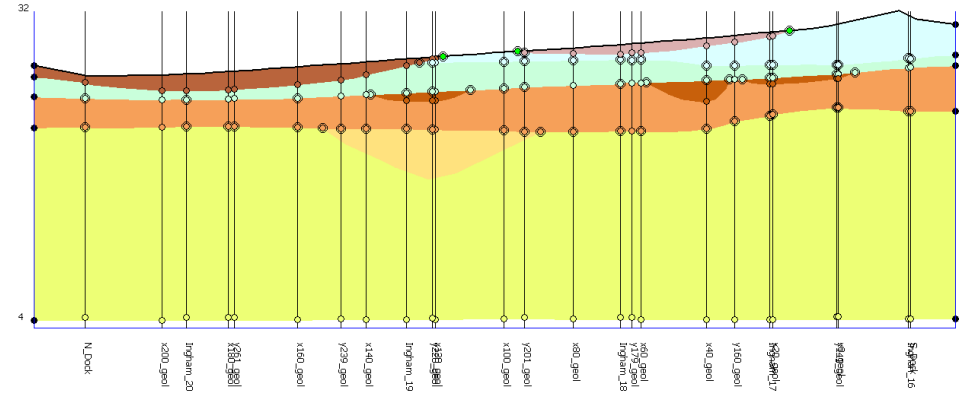
These two lines, which have the same rock code attribution, need to be joined together, by dragging one of the end nodes of one line towards the end node of the other line. Note that simply joining these two lines has fixed two polygons – the yellow one and the more laterally extensive brown polygon.



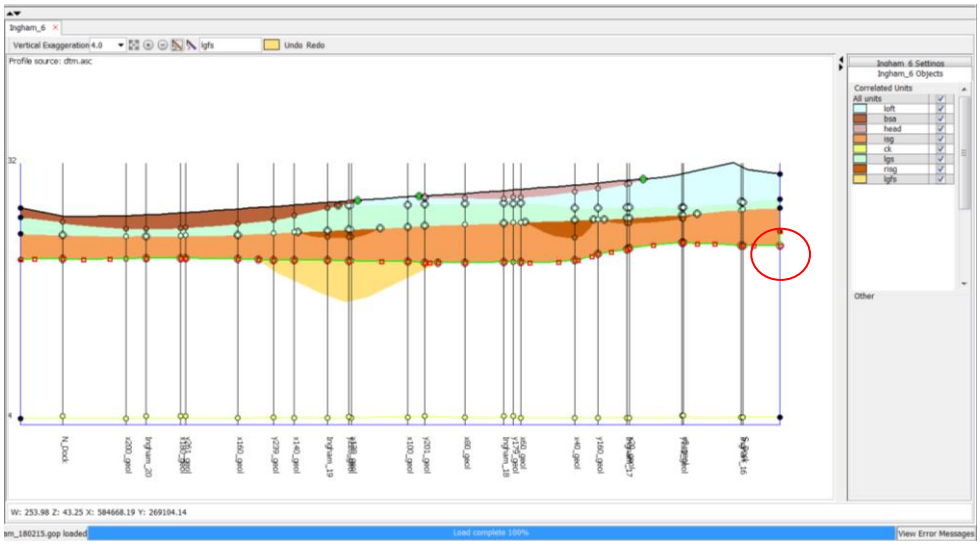
If two lines cross the section will not colour up properly



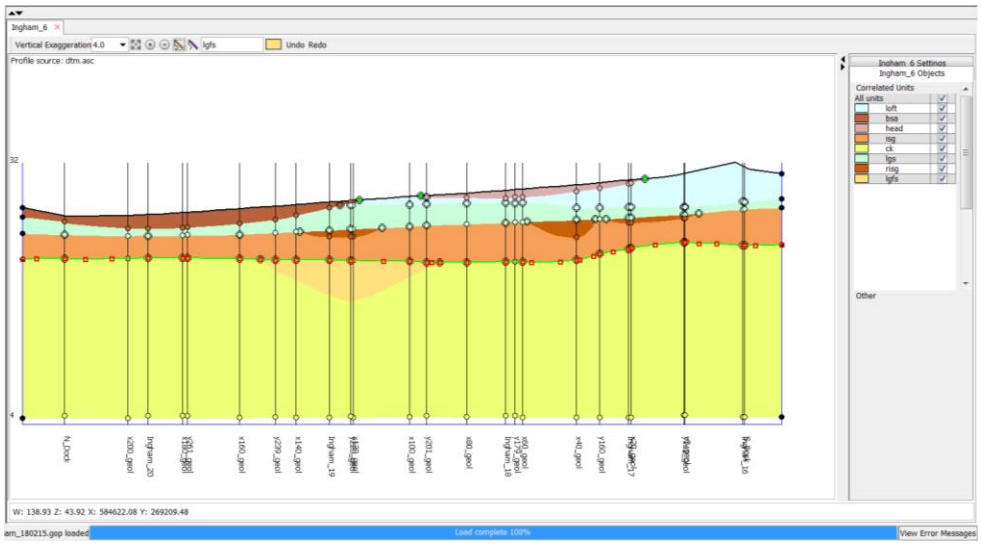
Snapping the lines back to the other line, solves the problem



Having two nodes on the end of section boundary for the same line, causes a problem



Deleting one of these nodes solves the problem. This situation is not always obvious, so if you have a problem polygon always try an un-snap and a re-snap at each end of the line – this may reveal duplicate nodes and other issues that are not graphically apparent.



5 Log View

The Log View window component is known as 'Porcupine', which is a sub-component of Groundhog that is designed to also operate stand-alone for other purposes. It can be found in the Log View tab of the workspace panel. It is a combined borehole viewer and editor. It is linked to the BGS SOBI and Borehole Geology databases. You can use it to:

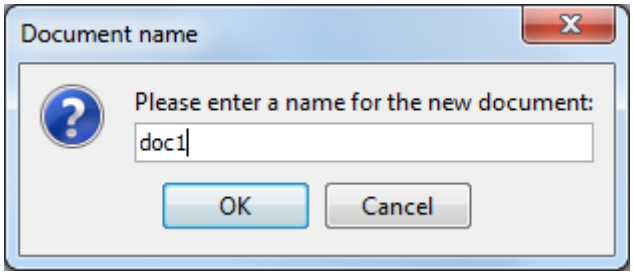
- Visualize borehole logs and customize their appearance,
- Make changes to borehole log interpretations (or create new interpretations).

At present you cannot use Porcupine from within Groundhog to commit changes back to the Oracle (BoGe) database – that capability is still being tested and will be released in the non-BETA version.

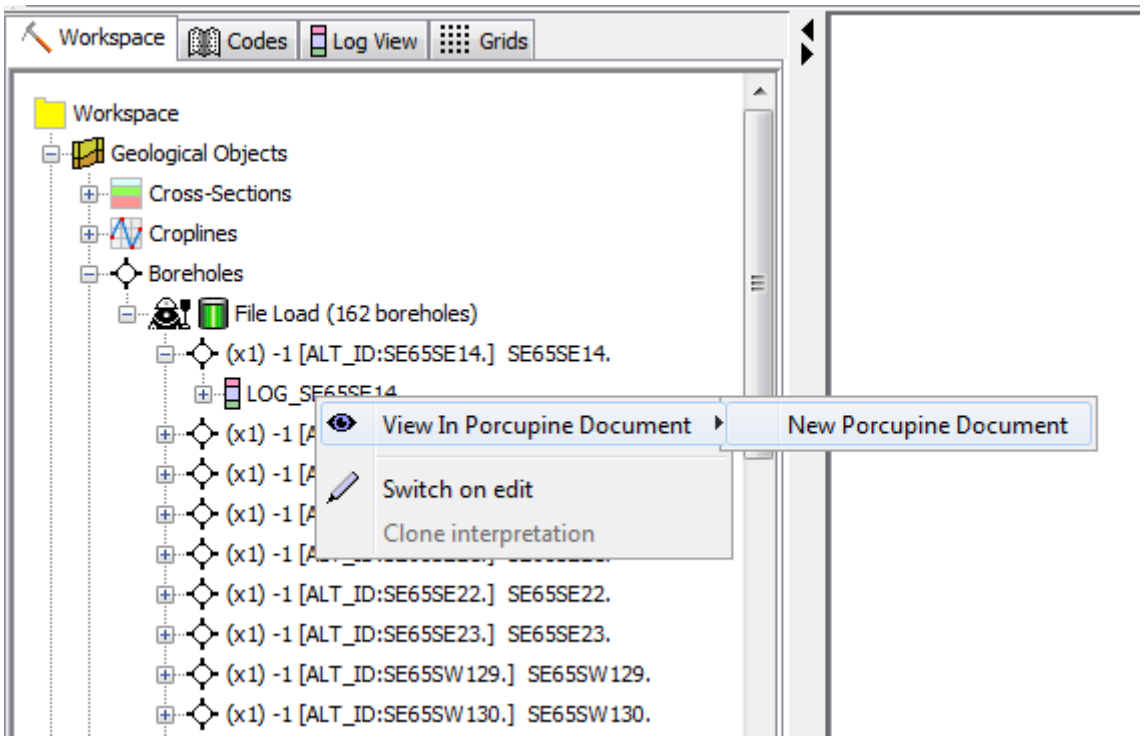
5.1 DISPLAYING BOREHOLE INTERPRETATIONS

5.1.1 Viewing Logs

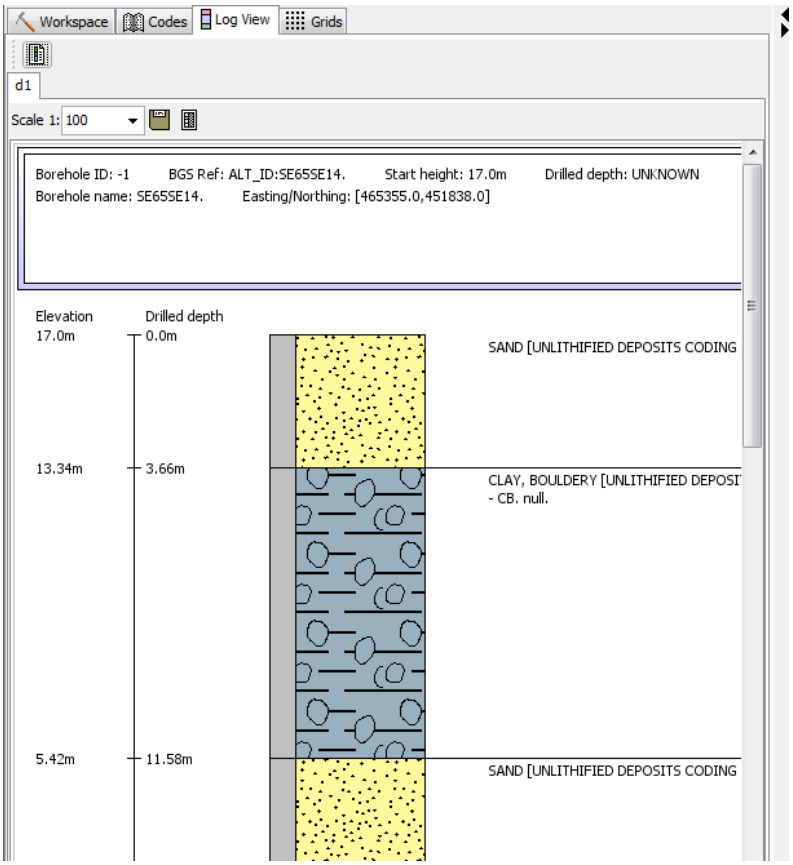
Create a new blank document using the ***Create new document button***  on the Porcupine toolbar and give the document a name. The document will appear as a blank canvas in the Porcupine desktop.



To add an interpretation to a document, right click on the interpretation in the dataset tree and select ***View log in document > [DOCUMENT NAME].***

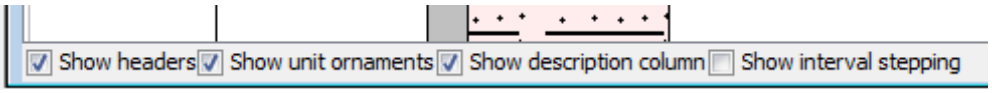


The interpretation will then be added to the document as a graphical log.

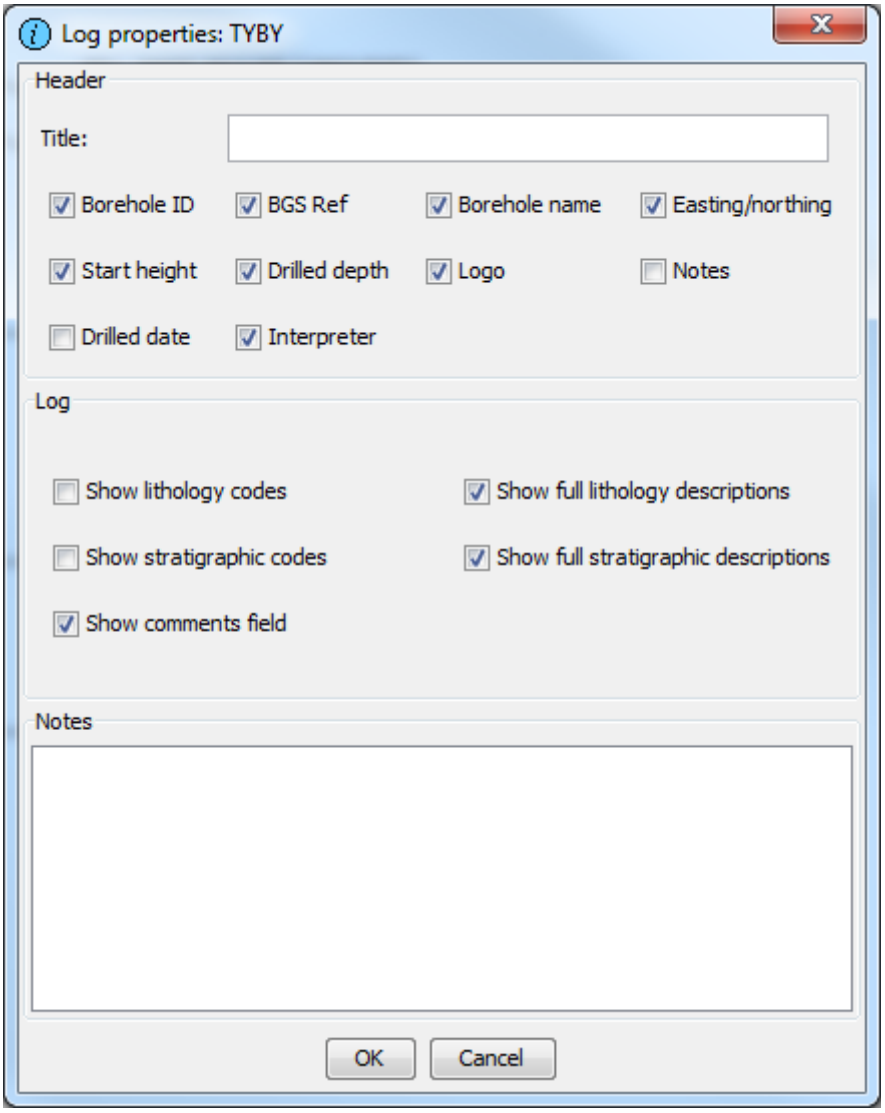


5.1.2 Setting Log Display Properties

General document display properties can be controlled using the check-options along the bottom of the document window. From here, the log headers, ornaments, descriptions and stepping can be switched on and off.



To edit the display properties for an individual log in more detail open the display properties dialog for that log by either ***double-clicking*** in the log's header at the top of the document, or by ***right-clicking*** on the log itself (make sure to right-click on the actual log interval column rather than the scale or description columns) and choosing ***Log properties***

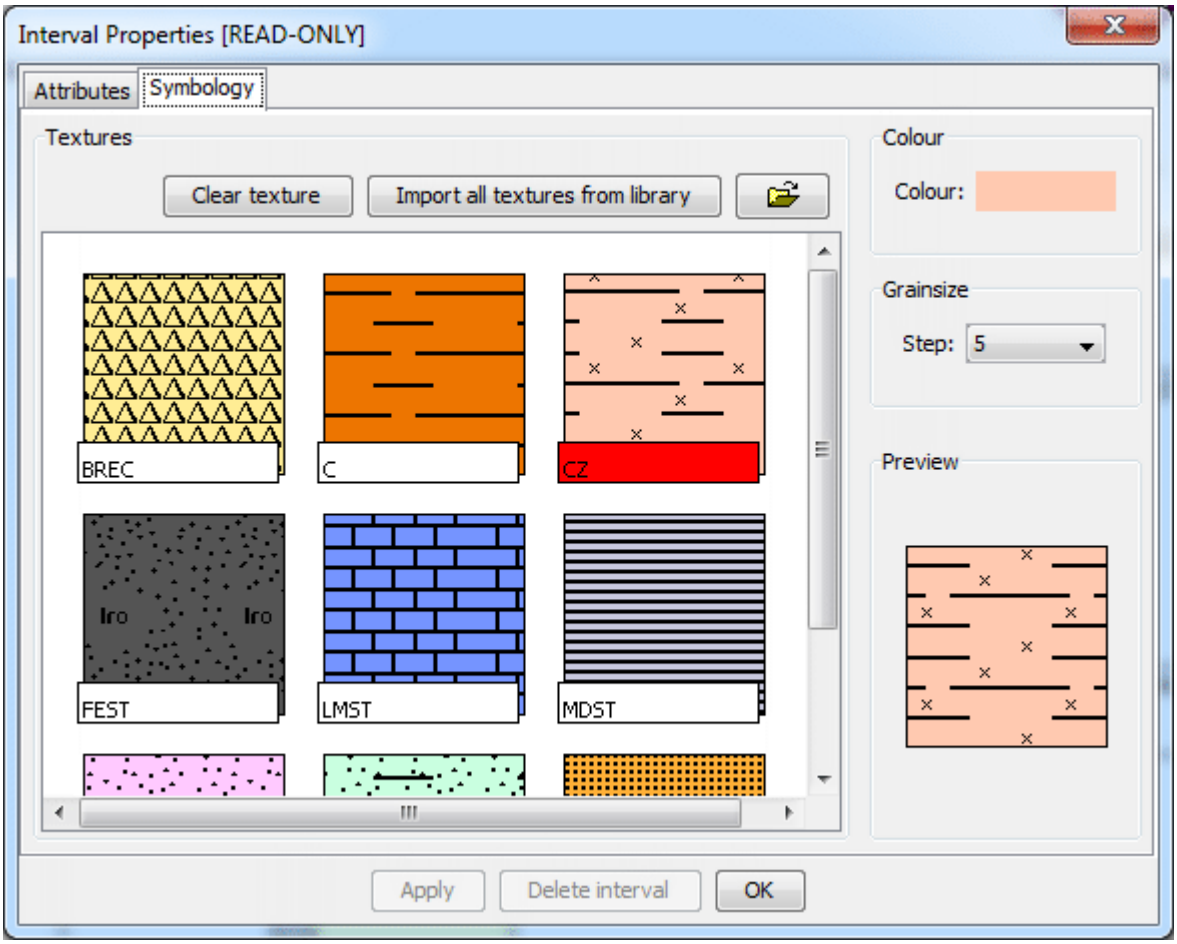


Fields can be added to or removed from the header and a title and notes added. Additional options can also be selected to display extra properties in the description area of the log to include or exclude lithology and/or lithostrat as full descriptions and/or codes.

5.1.3 Setting Colours And Ornaments - "Symbology"

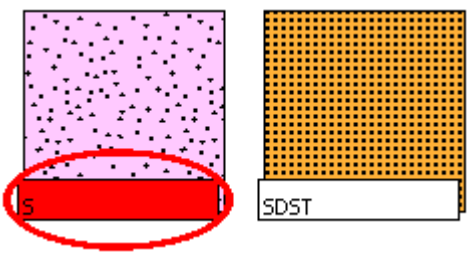
Porcupine will apply its own set of colours and ornaments automatically using the matching values in the workspace legend. For more details on setting up a colour legend, refer to the Workspace section of this manual.

The colour and ornament of an individual log interval can also be edited manually via the interval properties dialog, which will manually over-ride the automatically applied legend values. To open the dialog for a desired interval, ***double click on the interval box in the log***. The interval properties dialog has two tabbed panels - choose the tab marked "Symbology".



The textures panel displays a list of any currently displayed ornaments.

NOTE: Porcupine only loads a list of texture files that match the codes currently present in the loaded log data. If the interval you are currently editing is using one of the currently loaded textures as its ornament the name label will be highlighted in red.



To display a **full list** of all available texture images in the library click the ***Import all textures from library*** button. This will load all available images from the *texture_library* folder.

5.1.4 Choosing And Applying An Ornament

To set an ornament for the interval, left-click on the desired entry in the texture listing - its label will turn blue to indicate that it is selected and the selected texture will appear in the preview panel in the lower right of the dialog. If you are happy with the selection, click ***Apply***.

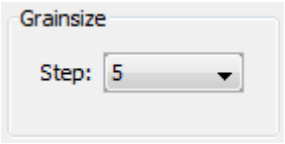
To clear the ornament texture from the interval click the ***Clear texture*** button at the top of the texture listing panel

5.1.5 Choosing And Applying A Colour

To set the colour on the interval, use the ***colour button*** in the upper right of the dialog to open a colour chooser dialog, select the desired colour in the dialog and click ***OK***. The selected colour will be applied in the preview panel in the lower right. If you are happy with the selection click ***Apply***.

5.1.6 Choosing And Applying A Stepping Value

To set the stepping class for the interval (between 1 and 5) use the ***"Grainsize" selector*** on the right of the dialog to choose a classification for the interval. A smaller value will result in a narrower graphical display for the interval. Note that stepping is not automatically displayed in the document window; to switch stepping on use the ***Show interval stepping*** check-box control along the bottom of the document window.



5.1.7 Viewing Borehole Scans

Scans of the borehole driller's reports are available on the intranet for many of the SOBI entries. With some boreholes loaded into the session, these scans can be accessed from within Porcupine via a link to the Intranet scans application. Individual scans can be accessed via ***Right-click > View scan*** on the borehole in the Workspace object tree (note that scans are attached to the boreholes, not to the individual interpretations belonging to the boreholes). Scans are loaded in a web browser by linking to the Intranet scans application.

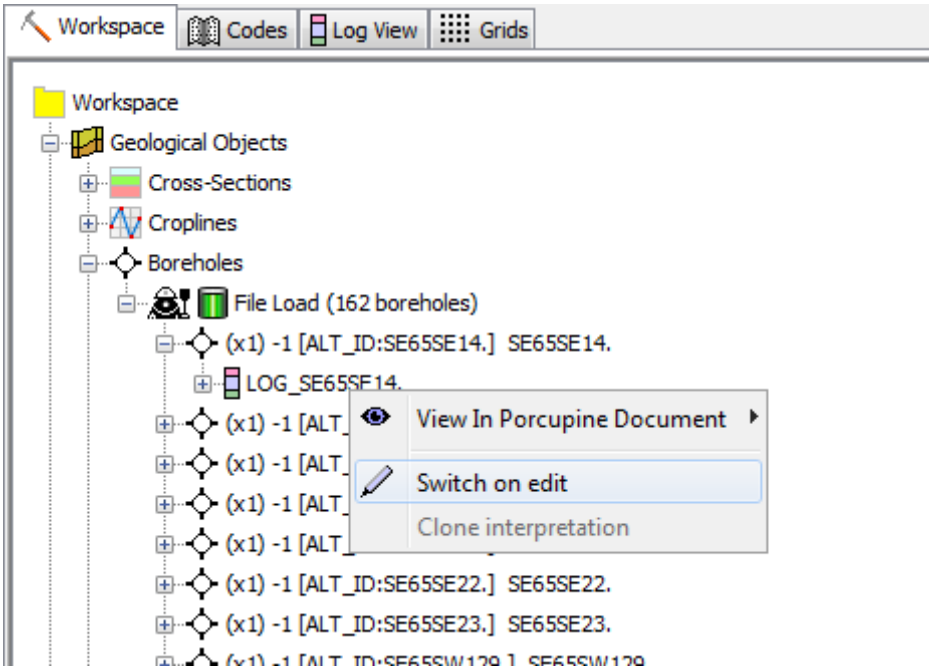
NOTE: this function is not reliable on all machines and some scans might fail to load, in which case hit refresh in the problematic browser window. This is not a problem with Groundhog/Porcupine but with the browser and/or the PDF plug-in for the browser.

5.2 EDITING INTERPRETATIONS

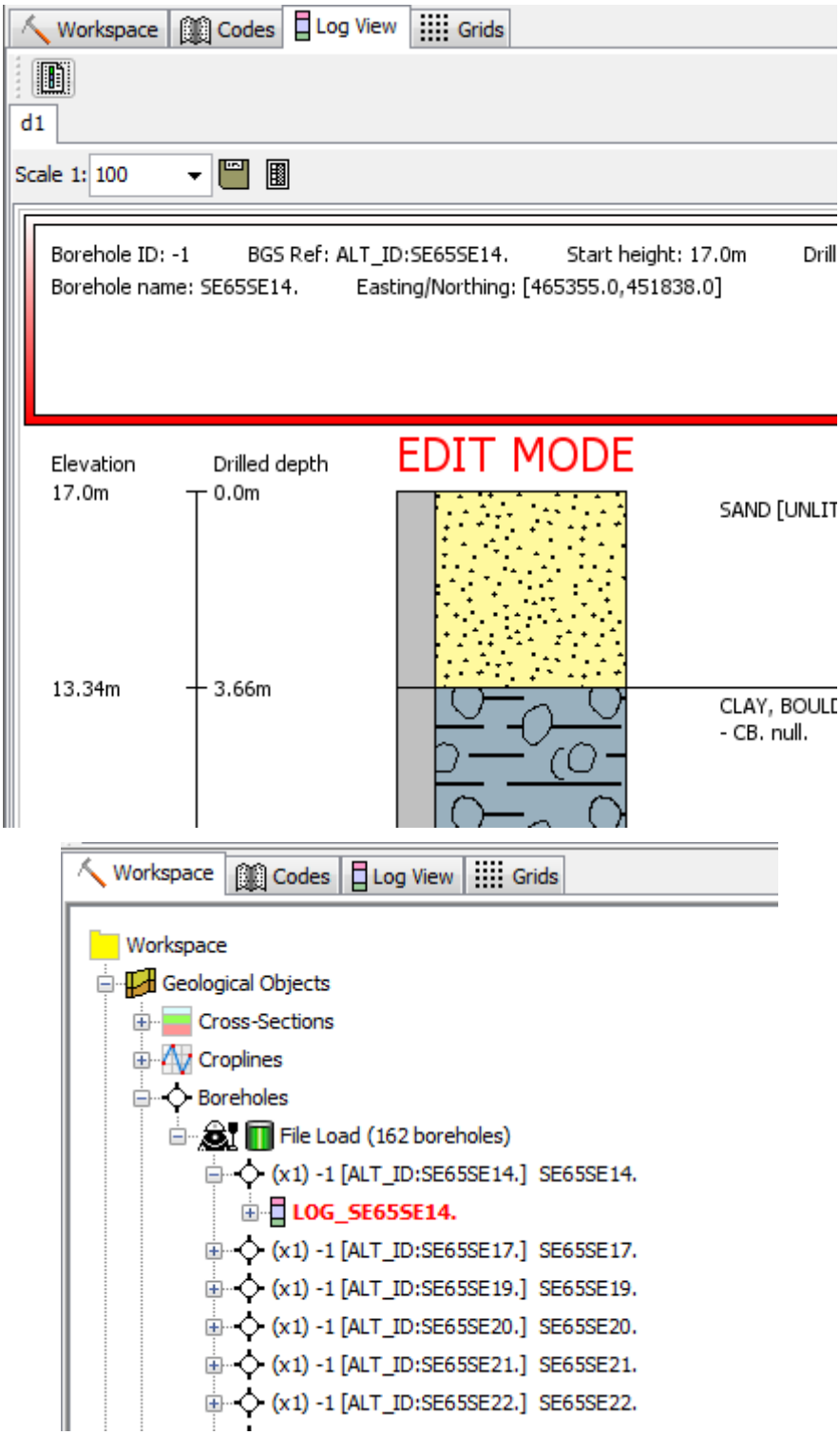
You can use Porcupine to edit your borehole interpretations and then save your Groundhog project to store the interpretation in XML data files. You can also use Porcupine to edit any borehole interpretation simply for graphical display if you wish.

5.2.1 Editing Log Intervals

Switch the interpretation into edit mode either via ***Right-click > Switch on edit*** on the interpretations' entry in the object tree, or via ***Right-click > Switch on edit*** on the interpretations' actual log or header in the document window.



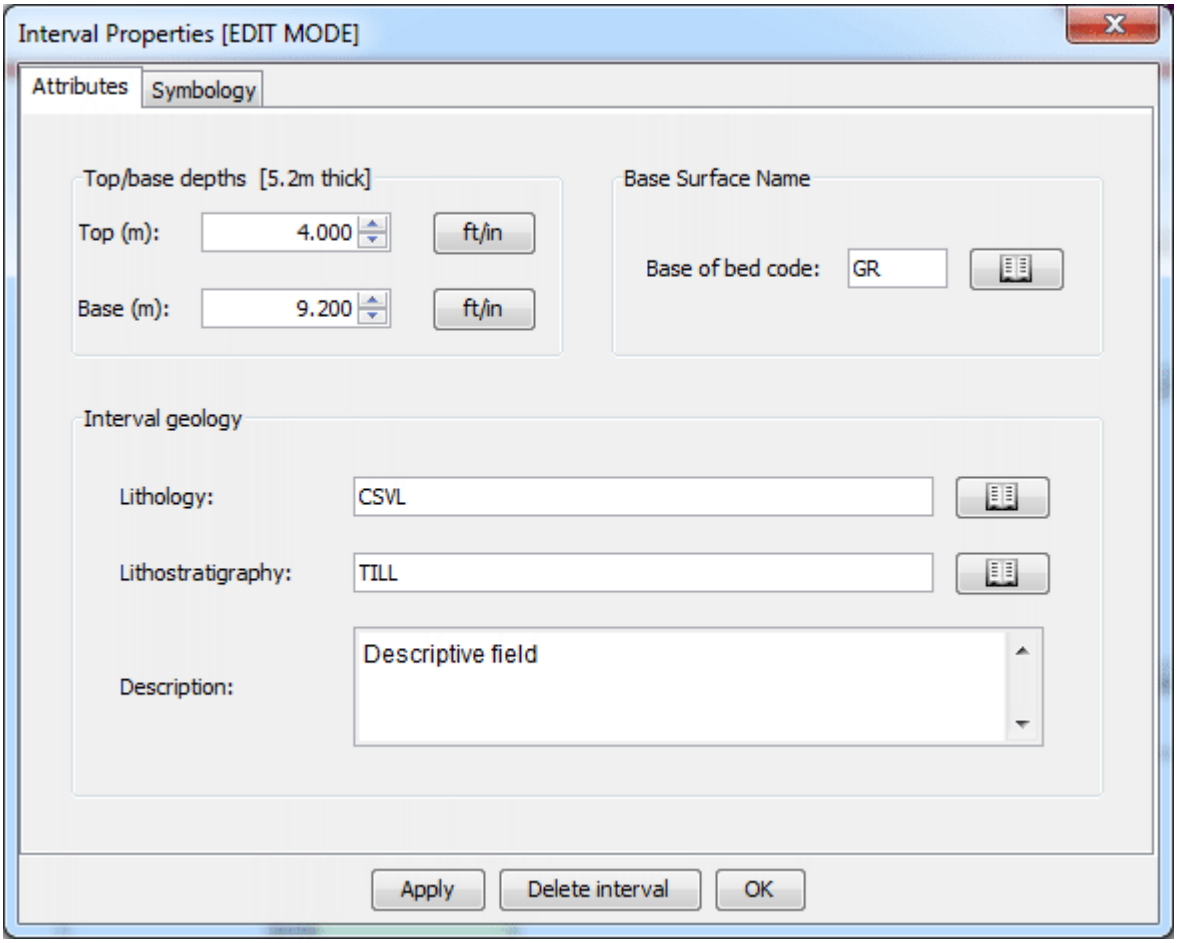
If the header is visible its border will be displayed in red, and also a red "Edit Mode" label will appear above the log in the document window to signal that the log is currently editable. The interpretation label in the object tree will also turn red.



With the interpretation now in edit mode, ***double click on the interval to be edited*** to open the ***Interval Properties*** dialog. Under the ***Attributes tab***, changes can be made to the intervals attributes (top and base, base bed code, lithology, lithostratigraphy and descriptive field) and applied by clicking the ***Apply*** button. Clicking apply at this stage applies the changes within the Porcupine session and does not save the change to the XML data files.

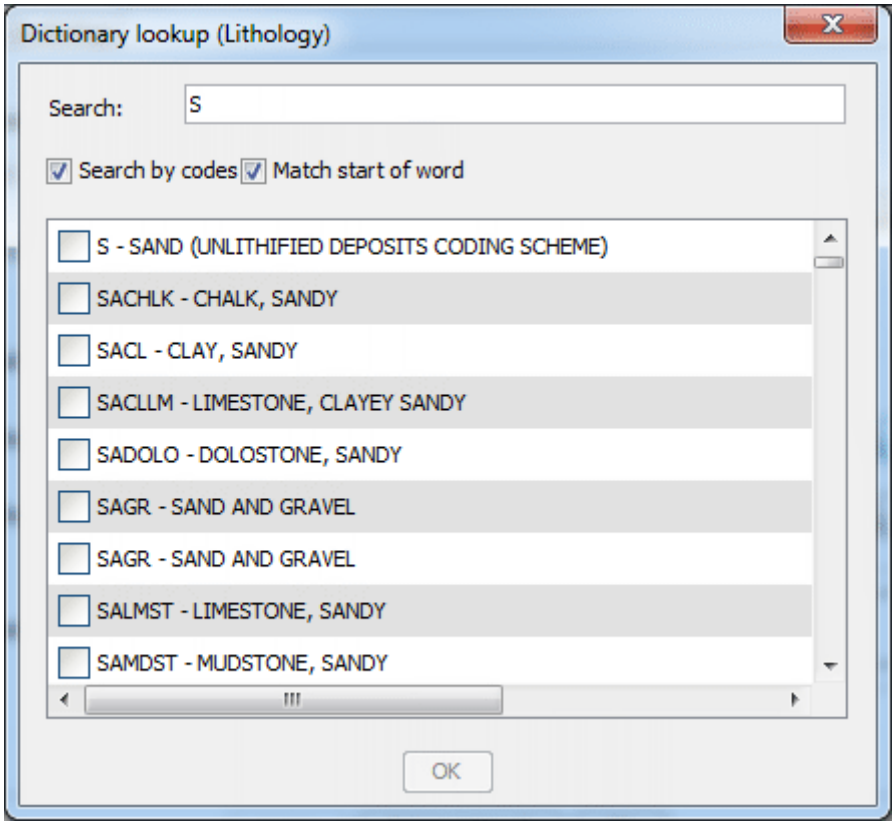
NOTE: Edits can only be made in the interval properties dialog if the interpretation is in **edit mode**. If the interpretation is not in edit mode the various fields will be greyed-out and non-editable.

Under the Symbology tab of the Interval Properties dialog, changes can be made to the colour, ornament, and stepping used to display the interval in the document. See above for more detail on the options under this tab.



Any values entered for base bed code, lithology and lithostratigraphy are dictionary-linked (i.e. they must correspond with an entry in the appropriate Dictionary for lithology or lithostrat – refer to the Dictionaries section of this manual for further details). The fields expect the dictionary CODES rather than the full descriptions because the full descriptions are often too long to fit usefully in a small text field. To see the full description for the code in each text field, simply hover the mouse cursor over the field - the full description will appear as a popup tooltip. Hover over the base bed, lithology and lithostratigraphy fields in the image above to see an example of the tooltips (works in most browsers).

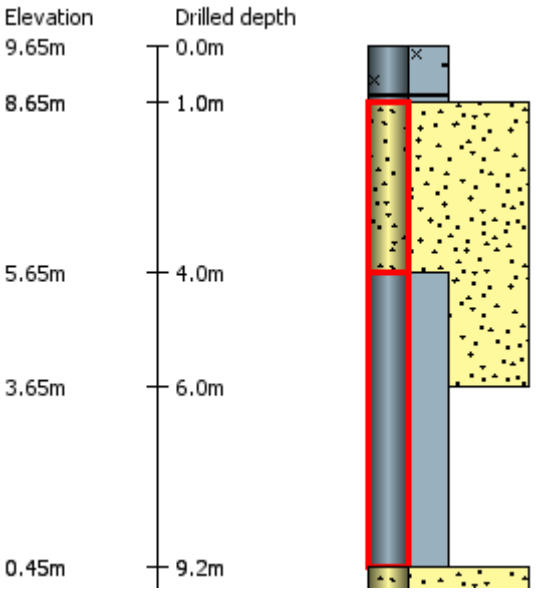
If you do not know the exact dictionary code required for your coding you can use the ***Dictionary*** button  to open the ***Dictionary lookup*** dialog for the field. Begin typing into the Search field to see a list of matching entries in the dictionary. Check the desired entry and click OK to populate the code into the field. If you want to search by full description rather than just by the code, un-check the ***"Search by codes"*** option at the top of the dictionary dialog.



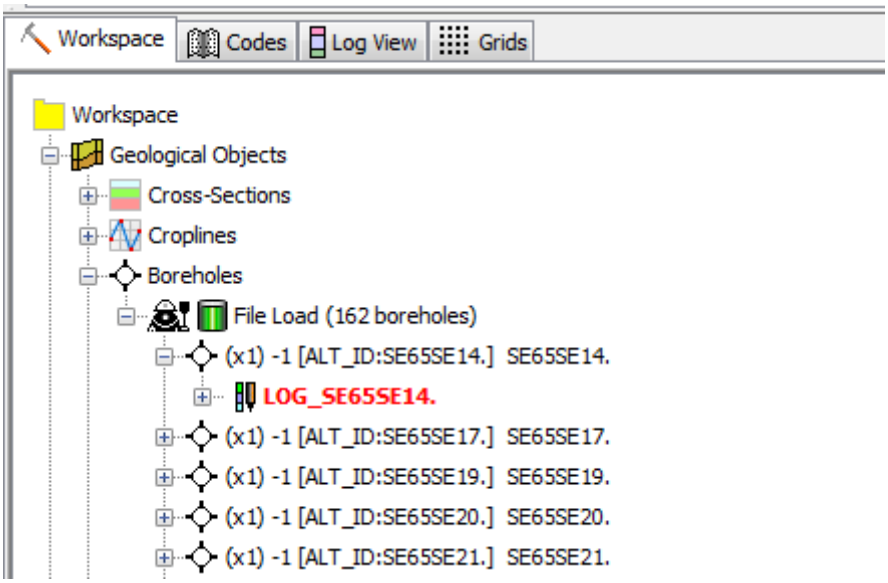
NOTE: The dictionary dialogs "remember" recently used codes and display these automatically when re-opened to save time when applying the same sub-set of codes repetitively across a number of borehole interpretations.

Changes can be made to the top and base depth values for the interval. The ft/in button alongside each of the two fields allows the depths to be entered in imperial - Porcupine will automatically convert them to metric and place them in the appropriate field.

If changes are made to the top and base values without consideration of any adjacent intervals, an overlap may occur. This will be shown graphically as a red border in the strat column for any intervals with overlapping problems. To resolve the overlap the top and base values of adjacent intervals will need adjusting or, alternatively, overlapping intervals can be deleted and removed completely:

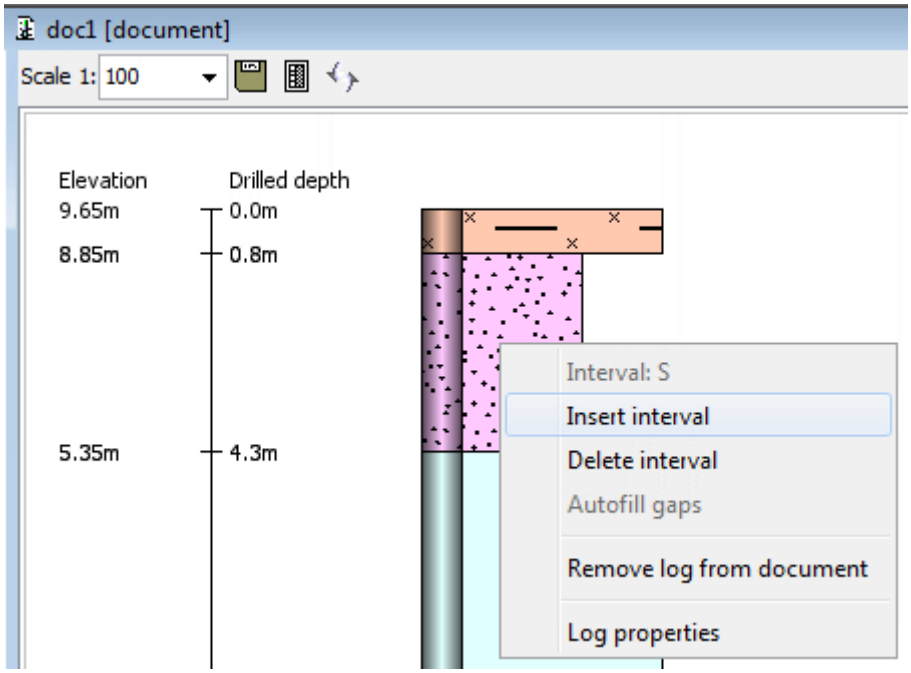


When an interpretation has been modified the borehole and interpretation icons will change in the dataset tree to indicate that changes have been made (a pen icon appears alongside the standard interpreter icon). Remember - edits are only held in the Porcupine session and not automatically applied back to the data files or the Oracle database. If Porcupine is closed without committing edits back to the database then the changes will be lost. For more detail on committing changes back to the database refer to the later section.

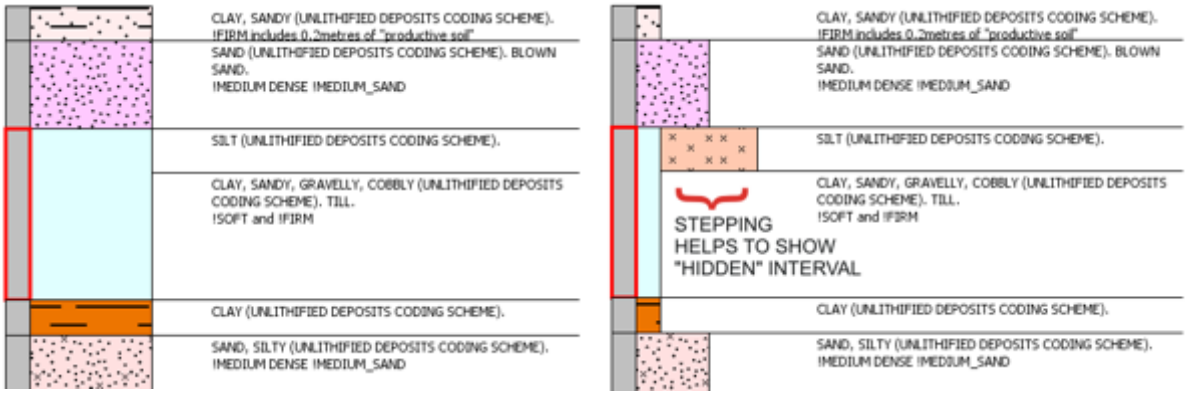


5.2.2 Inserting And Deleting Intervals

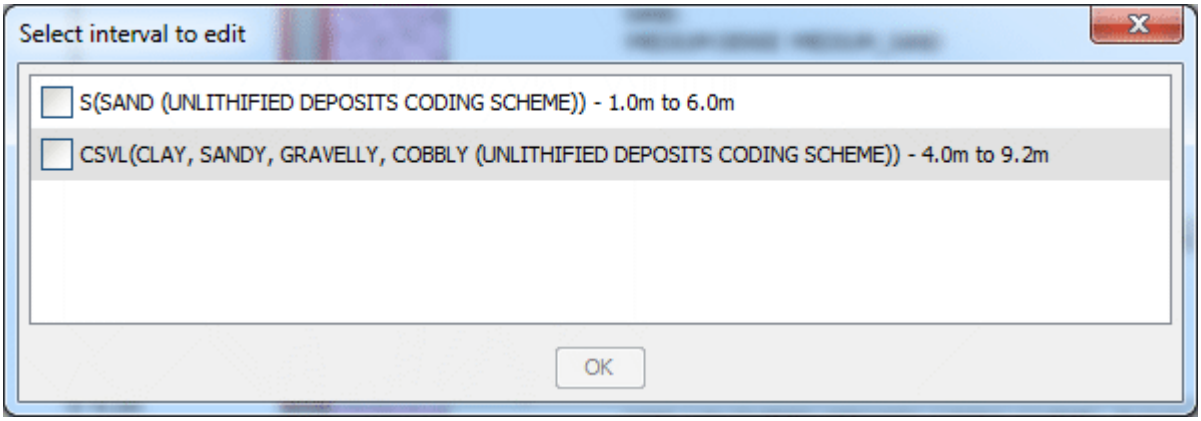
New intervals can be inserted into an interpretation by ***right-clicking*** on an existing interval and selecting ***Insert interval***:



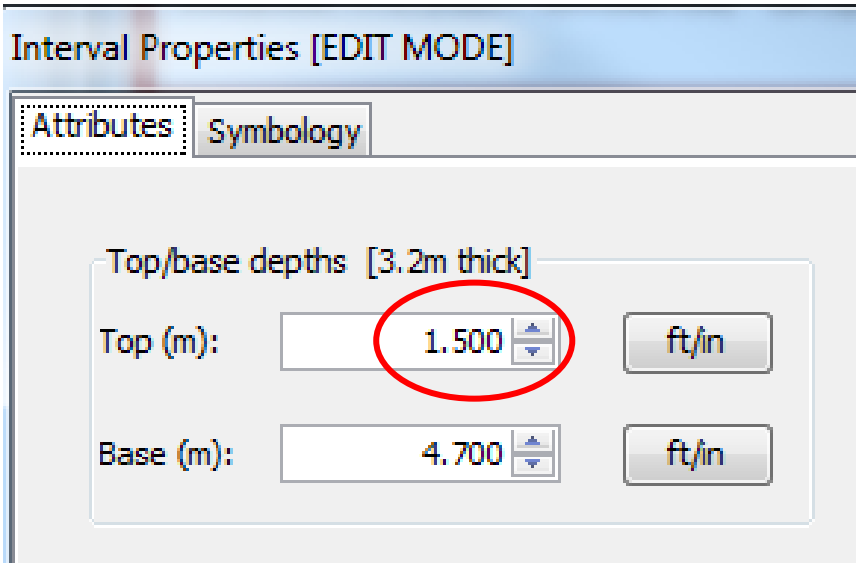
This will open the ***Interval Properties*** dialog allowing the attributes and symbology to be set for the new interval. The top depth value of the new interval will be set using the base value of the clicked-on interval (i.e. the new interval will be inserted below the clicked-on interval). Unless the new interval is being inserted at the base of the interpretation or into a gap in the interpretation, an overlap with adjacent intervals will occur. Overlap situations are highlighted by a red box in the strat column. Overlaps can be easier to see if log stepping is enabled (compare below images).



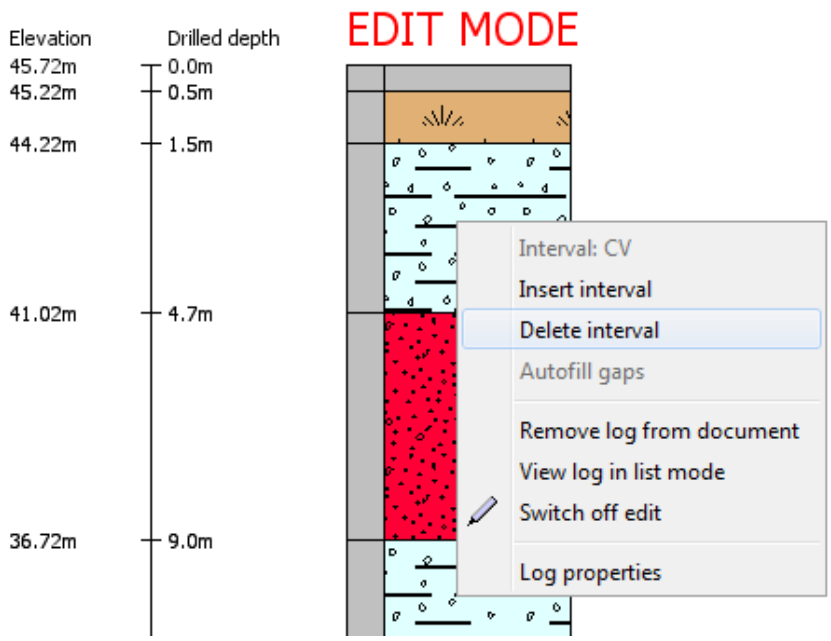
To resolve the overlap the top and base values of adjacent intervals will need adjusting or, alternatively, overlapping intervals can be deleted and removed completely. ***Double-clicking on an overlapping region*** will present a selection dialog allowing you to decide which of the two overlapping intervals to change in order to reconcile the overlap. Check the interval you want to edit and click ***OK***.



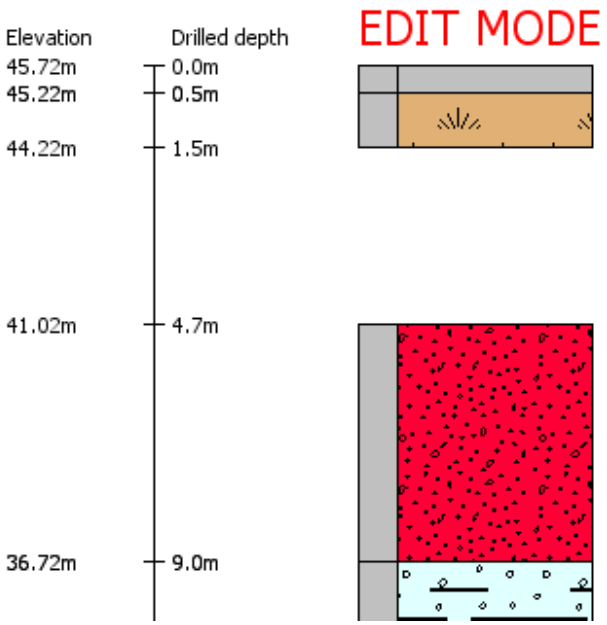
Edit the depth values as appropriate to remove the overlap and click ***Apply > OK***:



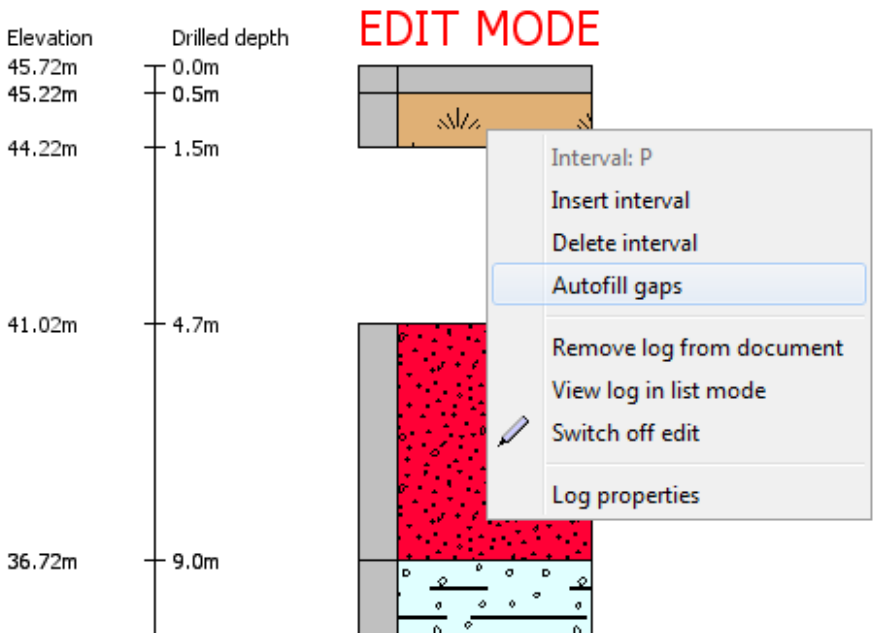
To delete an interval from the interpretation, ***right-click*** on the interval to be removed and select ***Delete interval***:

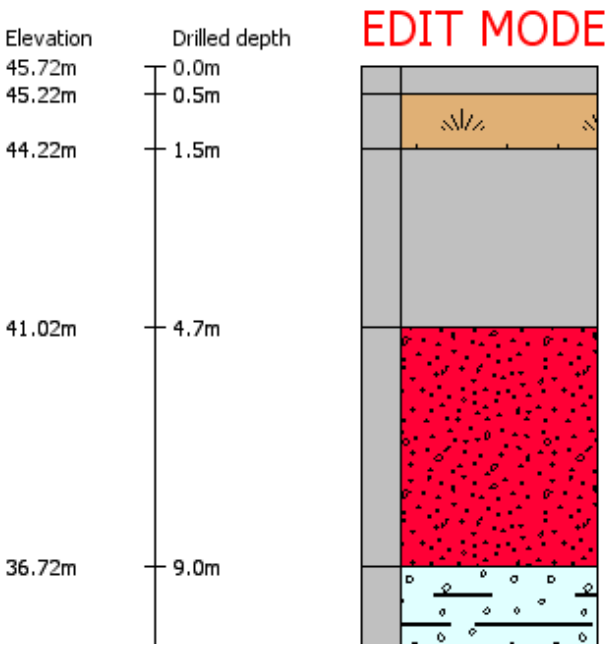


This will create a gap in the interval, which will need to be filled by either inserting additional intervals or by editing the top or base values of the adjacent intervals:



Gaps can also be auto-filled by ***right-clicking*** on the interval above the gap and selecting ***Autofill gaps***. If **above** rockhead the autofill will apply a generic **DRFTU** code (generic superficial/drift code from the Oracle dictionaries) and if **below** the rockhead a generic **ROCK** code will be applied.





5.3 FILTERING

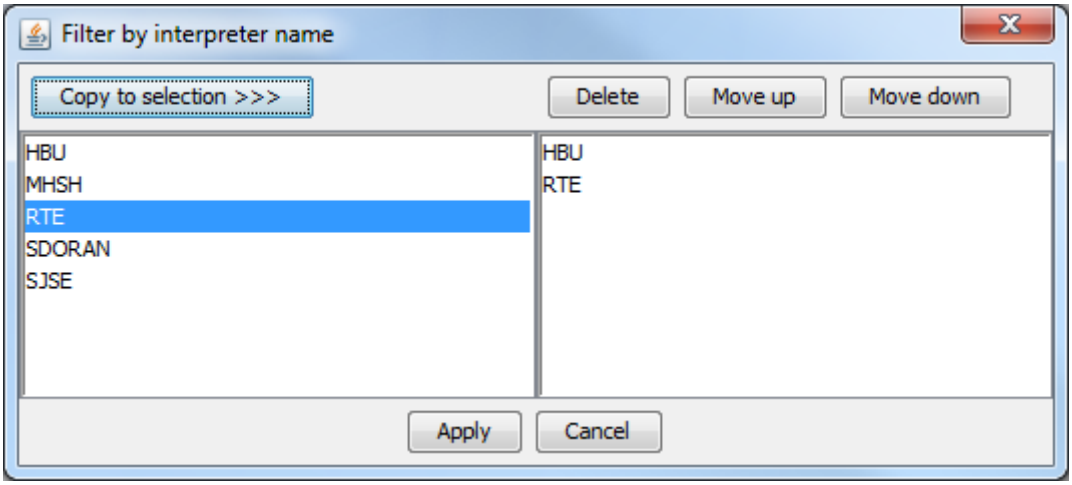
Data sets can be filtered interactively within Porcupine. The filters are under a ***right-click (on the data set entry) > Filter dataset***.

5.3.1 Remove Boreholes Without/With Logs

These two options allow you to remove logs without logs (interpretations), or remove those with existing logs. The first is useful to filter out borehole records with no downhole data, the second is useful to see which borehole have yet to be interpreted.

5.3.2 Cascading Interpreter Filter

If the name of the intepreter is available within the borehole dataset, this presents a list of interpreter id's (i.e. geologist names or drillers names) on the left. Click on an entry to highlight it and use the ***Copy to selection*** >>> button to copy it to the selection list on the right. Build the selection list up in order of preference, with the preferred interpreter at the top of the list. To re-order the list, highlight an entry and use the ***Move up*** and ***Move down*** buttons. When you are happy with the selection click ***Apply***.



The filter will use the list to filter the data set in Porcupine. For each borehole it will look for your preferred interpreters in list order – if the first one is available it will be used, otherwise the second, otherwise the third etc... If a borehole has no matching interpreter it will be deleted from the data set completely.

5.3.3 Cascading Project Code Filter

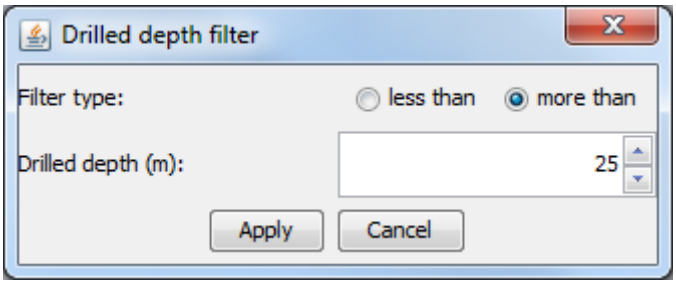
If the name of the project is available within the borehole data, this operates in the same way as the cascading interpreter filter, but uses the ***CONTENT_CODE*** field (a.k.a project name field) of the interpretation for the filtering.

5.3.4 Cascading Interpreter + Project Code Filter

This operates in the same way as the cascading interpreter filter, but filters by unique combination of ***INTERPRETER*** and ***CONTENT_CODE***.

5.3.5 Drilled Depth Filter

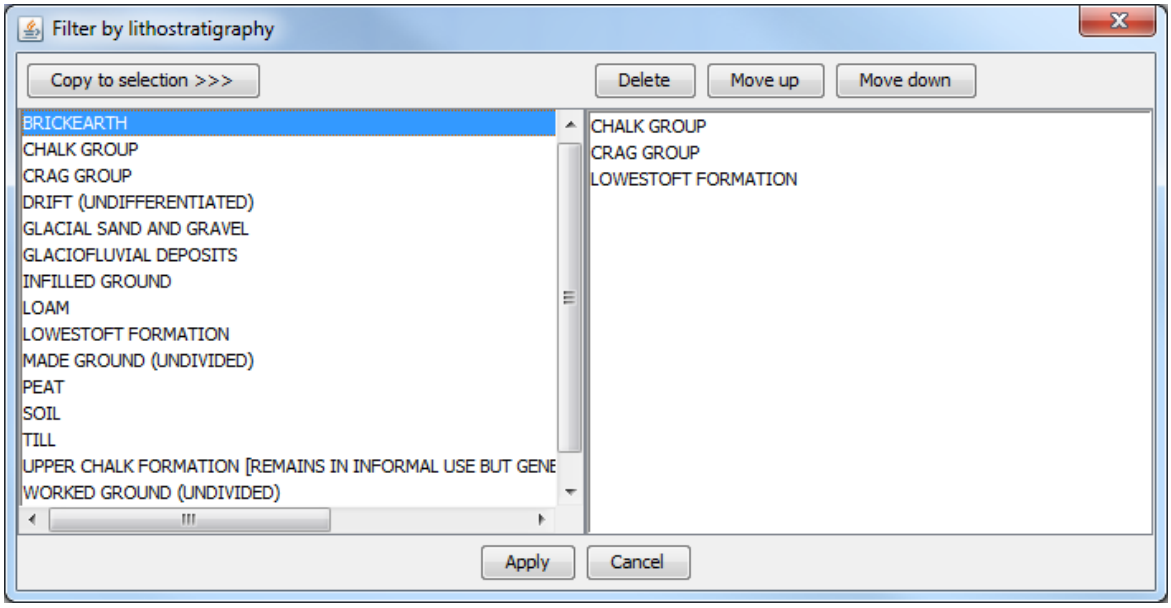
This allows you to filter by ***drilled depth*** and can be applied either as a ***more-than*** or ***less-than*** filter depending whether you are interested in only deeper or shallower boreholes. The settings below would retain only those interpretations that have a drilled depth of 25m or more.



5.3.6 Lithostratigraphy Filter

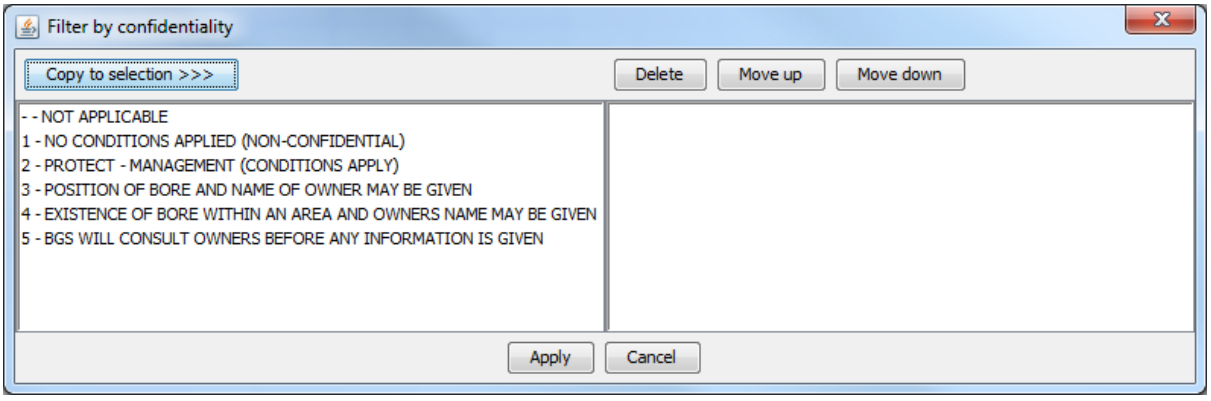
This allows you to filter based on ***lithostrat codes***. The unique list of lithostratigraphic coding is presented on the left and can be copied to the select on the right by selecting the entry and using the ***Copy to selection*** >>> button.

The order of the list on the right is not important, so there are no sorting options. The list is not cascading. Porcupine will use an OR test on this list when deciding whether to retain an interpretation – in the example below the filter would retain all interpretations that have CHALK GROUP ***or*** CRAG GROUP ***or*** LOWESTOFT FORMATION coded anywhere in them.



5.3.7 Confidentiality Filter

This allows you to filter on the ***confidentiality code*** of the borehole entry, if such a field is populated in the borehole data. There are 5 numeric codes:



You can find the confidentiality of a particular borehole by ***hovering*** over it in the dataset tree and reading the tooltip that appears. Also, if a borehole is level 2 or 3 you will see an amber asterisk to the right of the log icon – if it is a level 4 or 5 the asterisk will be red.

The filter gives you the option to remove levels of confidentiality from the dataset. Simply select the levels you wish to ***retain*** and click ***Apply***. For example, if you do not want any

confidential boreholes in your dataset, only select “1 – NO CONDITIONS APPLIED (NON-CONFIDENTIAL)”.

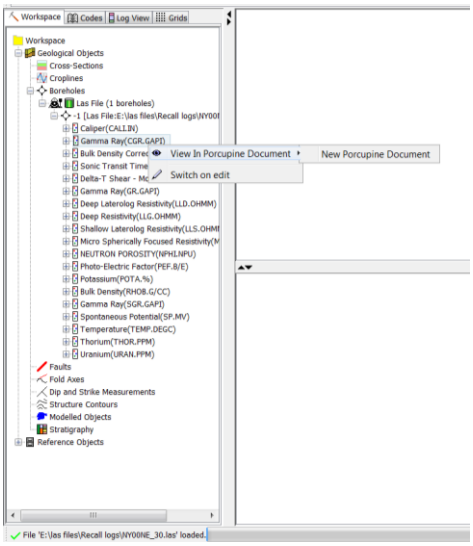
5.3.8 Filter Chaining

The filters can be applied successively against the same data set to refine it. For example, if you were only interested in having borehole interpretations with a drilled depth of more than 10m which have CRAG GROUP coded in them preferably by HBU but failing that by RTE then you could apply three successive filters to achieve this.

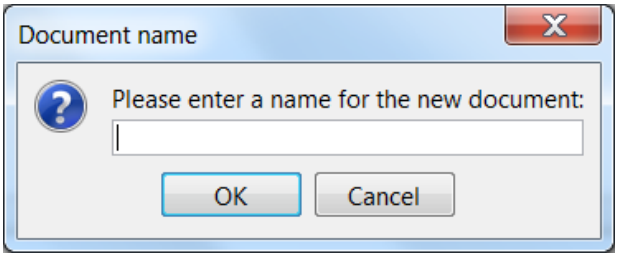
5.4 VIEWING CURVE LOGS

How to load Well Log data into the workspace is described under the **Interoperability** section of this manual. Once the data has been loaded, it can be viewed graphically using the Log View. Each set of measurements is displayed within its own Log Track, but several Log Tracks can be viewed alongside each other within a Document. One or more Documents can be loaded into the Log View and can be viewed by clicking on the tab with the document name.

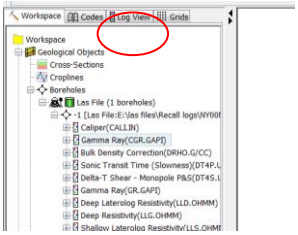
To view a set of Las file measurements, right click against the measurement heading in the tree structure and select ***View In Porcupine Document*** > ***New Porcupine Document***. If a Porcupine document has already been created, this can be used as an alternative to creating a new one.



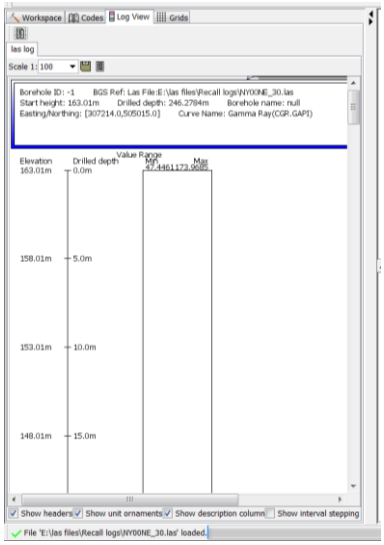
If a new Porcupine document is created, it is given a name here.



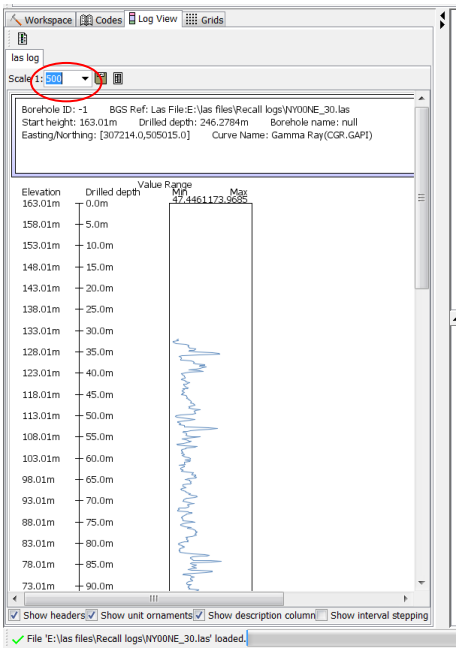
Once the document has been created it can be viewed by clicking on the ***Log View*** tab.



Details of the Las file are shown in the document. The Las file shown below does not have any measurements until after 15 metres, so nothing is shown here.

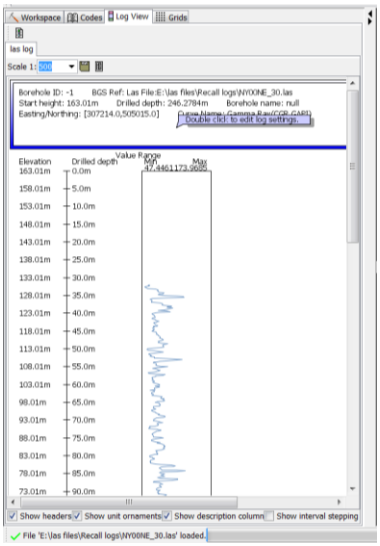


If the scale is changed to 1:500, measurements can now be seen.

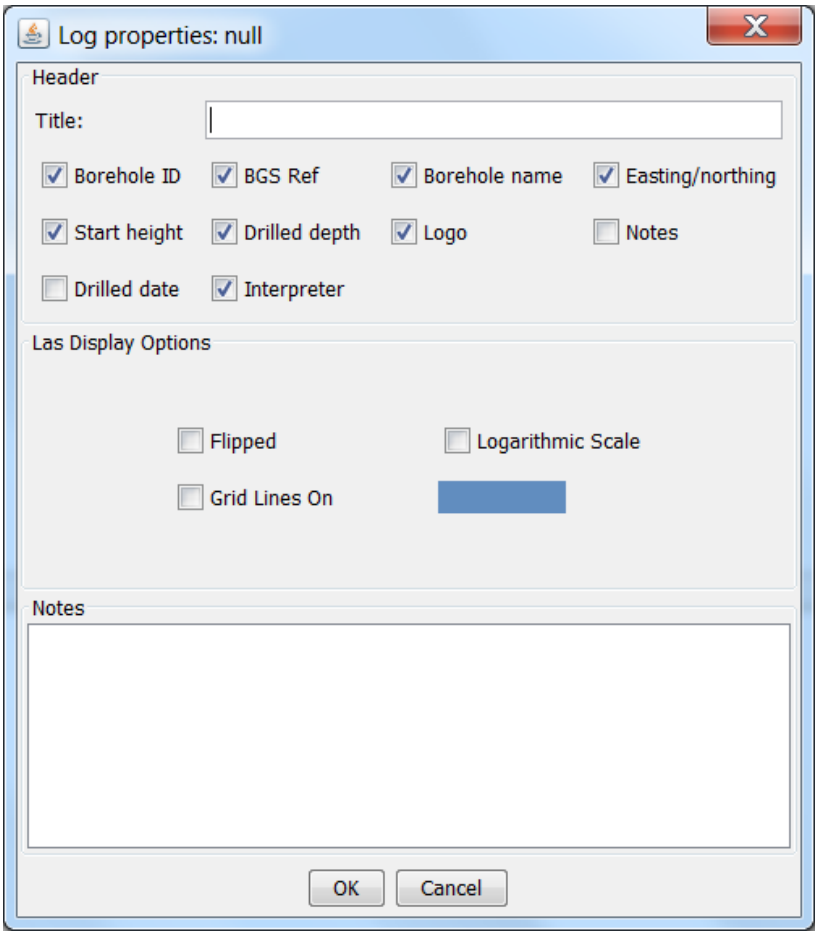


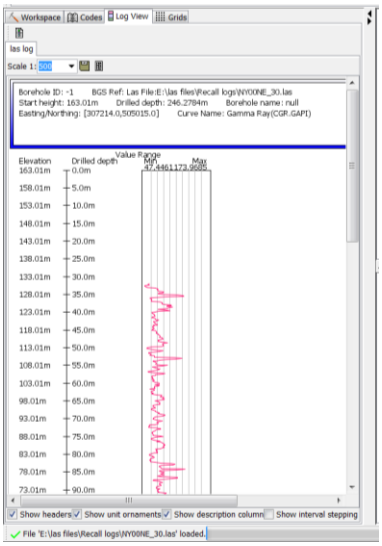
A scroll bar allows the full log to be viewed.

At the top of the document, the heading details can be seen. These vary, depending on the source of the Well Log, but will normally include location and depth details. Double-clicking in the heading area, enables curve log settings to be changed, via a dialog box.



The information that is viewed in the heading can be enabled or disabled with a tick in the checkbox. It is also possible to change the colour of the curve, which has initially been set randomly, or to show grid lines, flip the diagram so that it is a mirror image of itself or show the curve using a logarithmic scale.





Las file data can be viewed alongside other borehole data.

6 Workflows

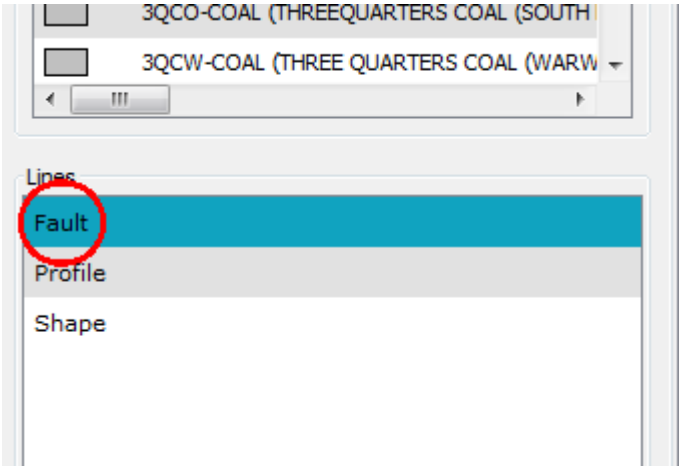
6.1 FAULT CONSTRUCTION

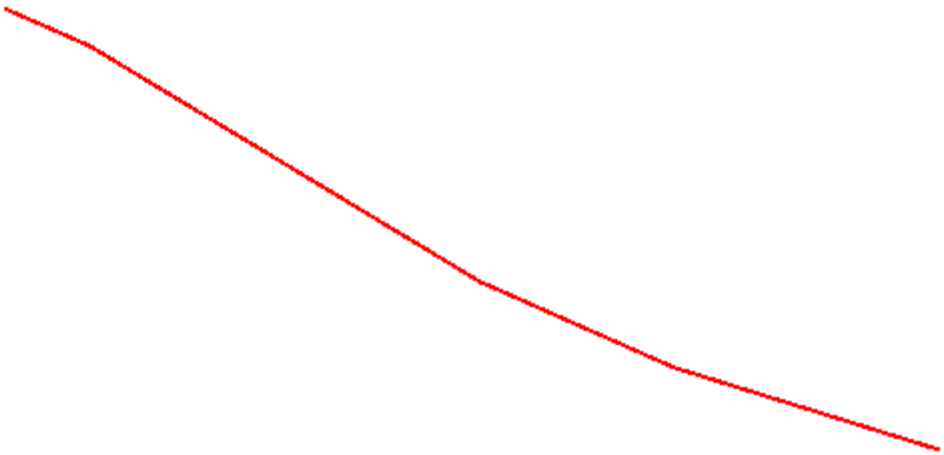
Faults can be constructed in both map and cross-section as fault linework. Where fault linework is created in the map these are referred to as **Fault Trace** objects; where fault linework is created in cross-section these are referred to as **Fault Stick** objects. Fault information is also attached to some map **croplines** and cross-section **correlation lines**.

6.1.1 Fault Traces

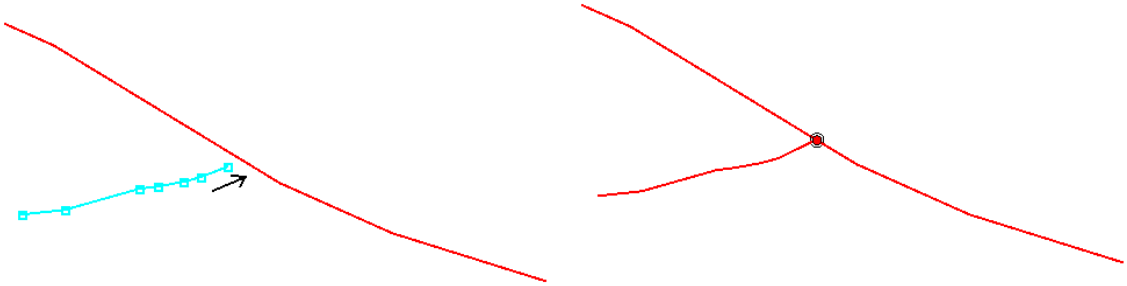
Fault traces represent the top of a fault plane in the map as a simple line. These lines serve mainly as a reference to the surface or subsurface expression of the top of the fault plane, and are used to associate a series of fault sticks together from cross-sections.

To draw a fault trace, pick the **Fault** code from the lower panel in the object tree **Codes** tab and use the pen or digitizing drawing tools to construct the line on the map.



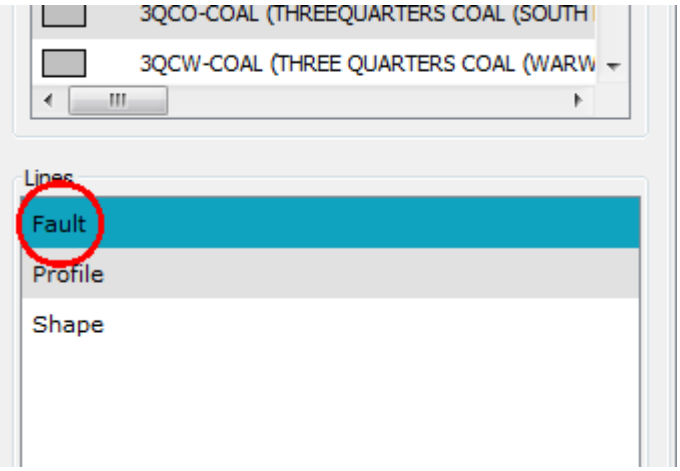


Fault trace networks can be constructed by snapping fault trace lines together. Simply drag the end node of a fault trace towards the other trace.

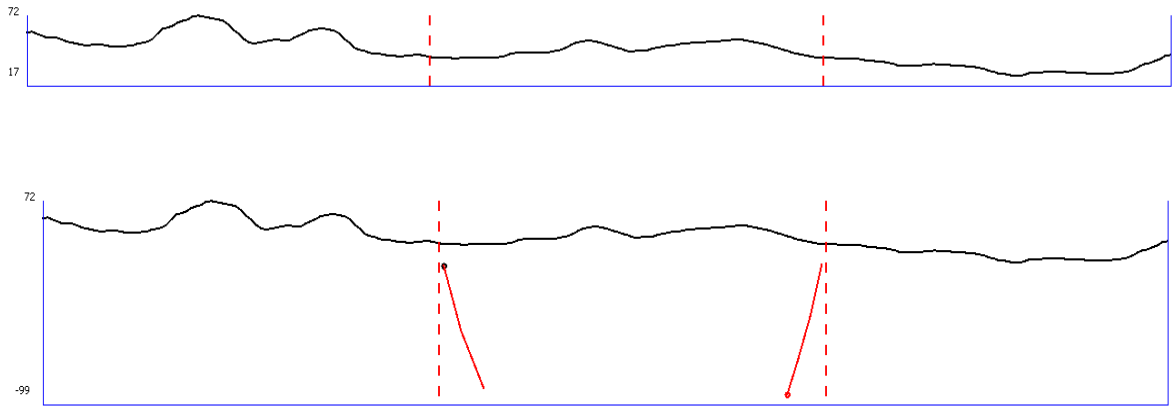


6.1.2 Fault Sticks

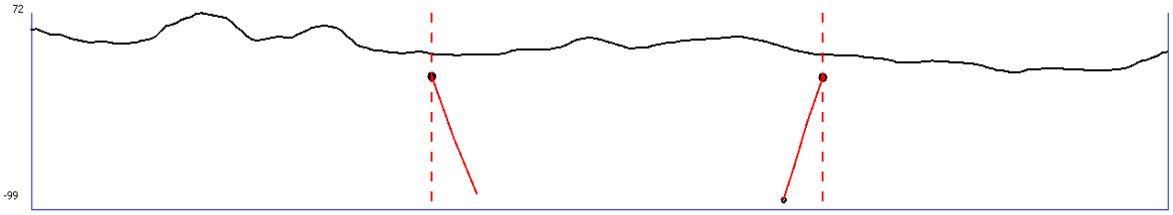
Fault sticks represent the fault plane in cross-section. They are constructed much like a normal correlation line. To draw a fault stick, pick the **Fault** code from the lower panel in the object tree **Codes** tab and use the pen or digitizing drawing tools to construct the line in the cross-section.



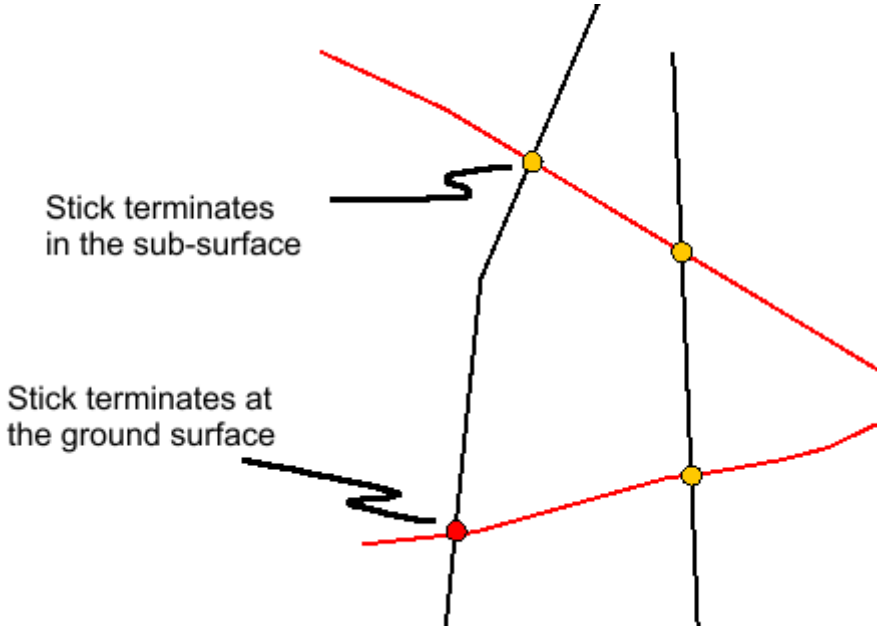
Positions where fault traces cross the section are shown as dashed vertical markers. This aids you in positioning of fault sticks to tie-in with the map traces.



Drag the top node of the fault stick towards the vertical marker to snap it.



Note that fault sticks do not have to come up to the terrain profile – they can terminate within horizons. In the map view the top node of a fault stick is shown as a dot. If the stick reaches the terrain profile the dot will be red, if it terminates at depth it will be orange.



Once fault sticks are constructed, correlation lines can be snapped to them, as described in general editing in the main Cross-Section Window part of this manual.

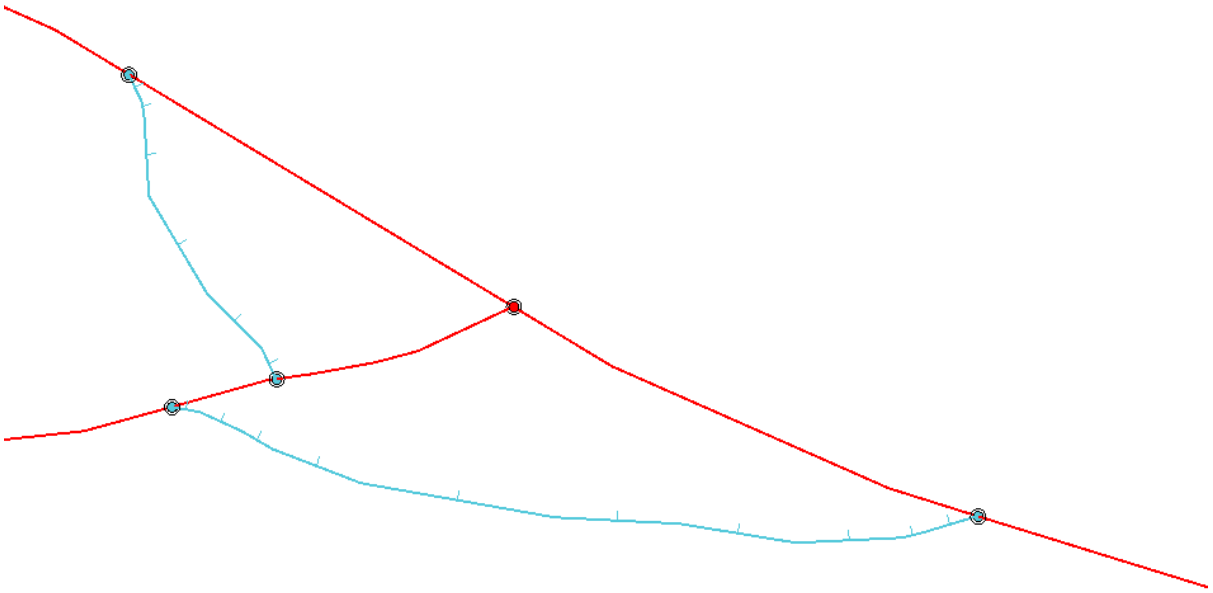
6.1.3 Fault-attributed Croplines

Croplines can honour faults in two ways;

6.1.3.1 1 - SNAP TO FAULT TRACE

Croplines can be snapped to fault traces in the map. This is not always desirable, depending on the nature of the geology however. Two scenarios where it ***does*** make geological sense are;

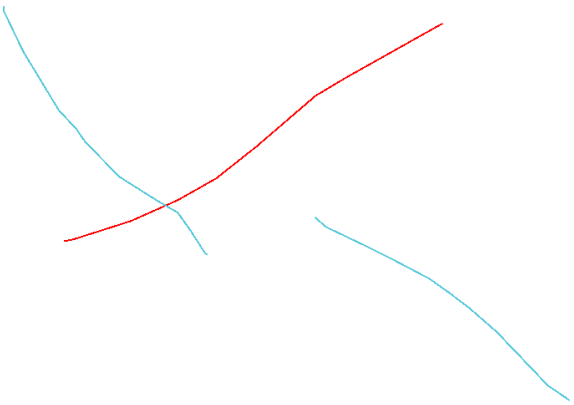
1) Where the fault plane is exactly vertical,
2) Where the fault comes to the surface **and** the cropline is at outcrop.



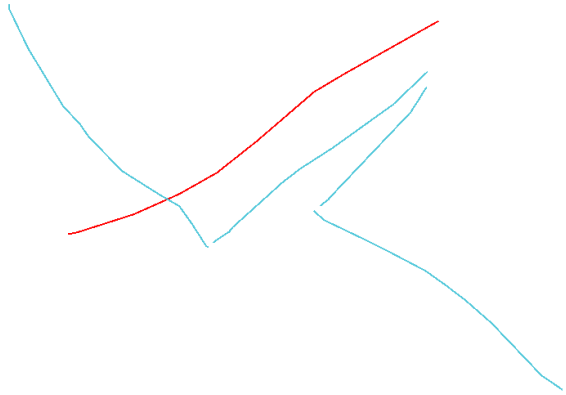
6.1.3.2 2 – CONSTRUCT FAULT CROP

Where the cropline runs into the fault plane at depth it often makes no geometric sense to snap the cropline to the fault trace, especially if the fault plane is non-vertical. In these cases, construct a cropline to represent the crop of the horizon on the fault plane.

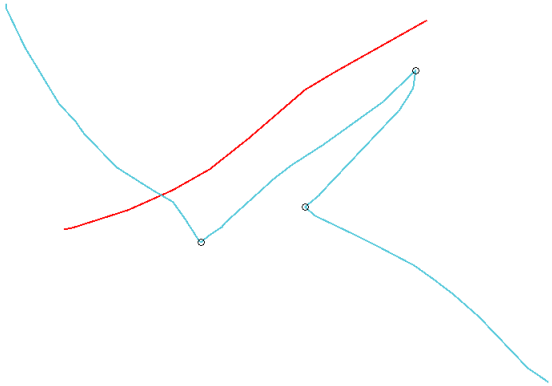
Consider the following map;



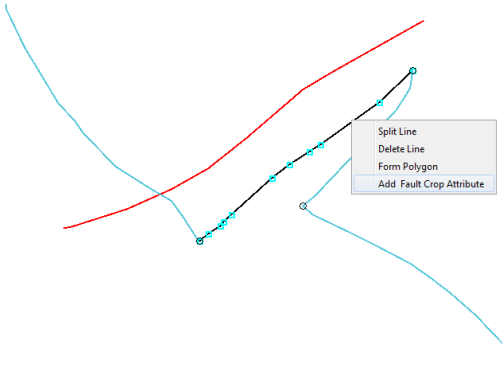
Sketch the “fault crop” as two additional lines (implies the fault is dipping to the South East in this example)



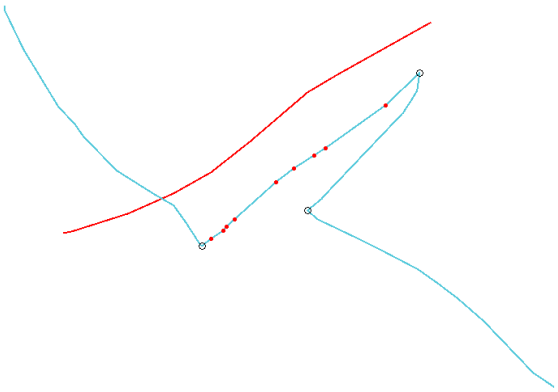
Join the croplines together by dragging their end nodes together.



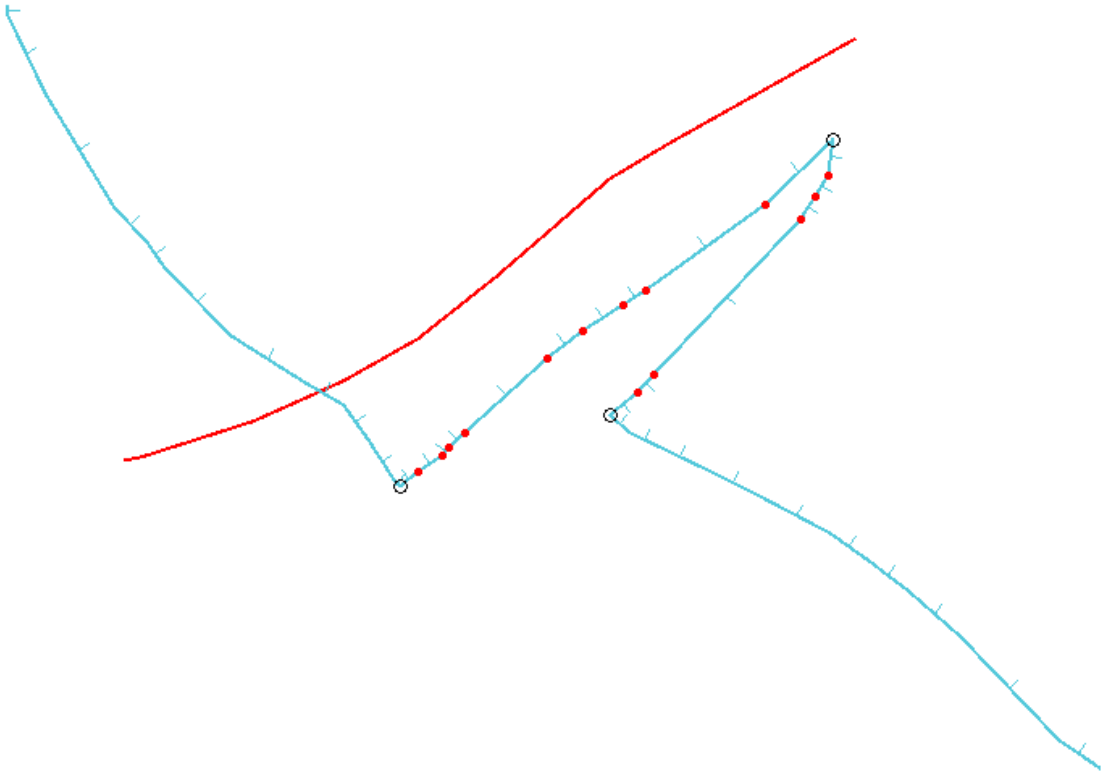
Right click on the cropline segments which run along the fault crop and choose **Add Fault Crop Attribute**. This flags the cropline as a “***fault crop***” – note that for this approach to work the croplines on the fault crop must be separate objects – if necessary, split down existing croplines to achieve this.



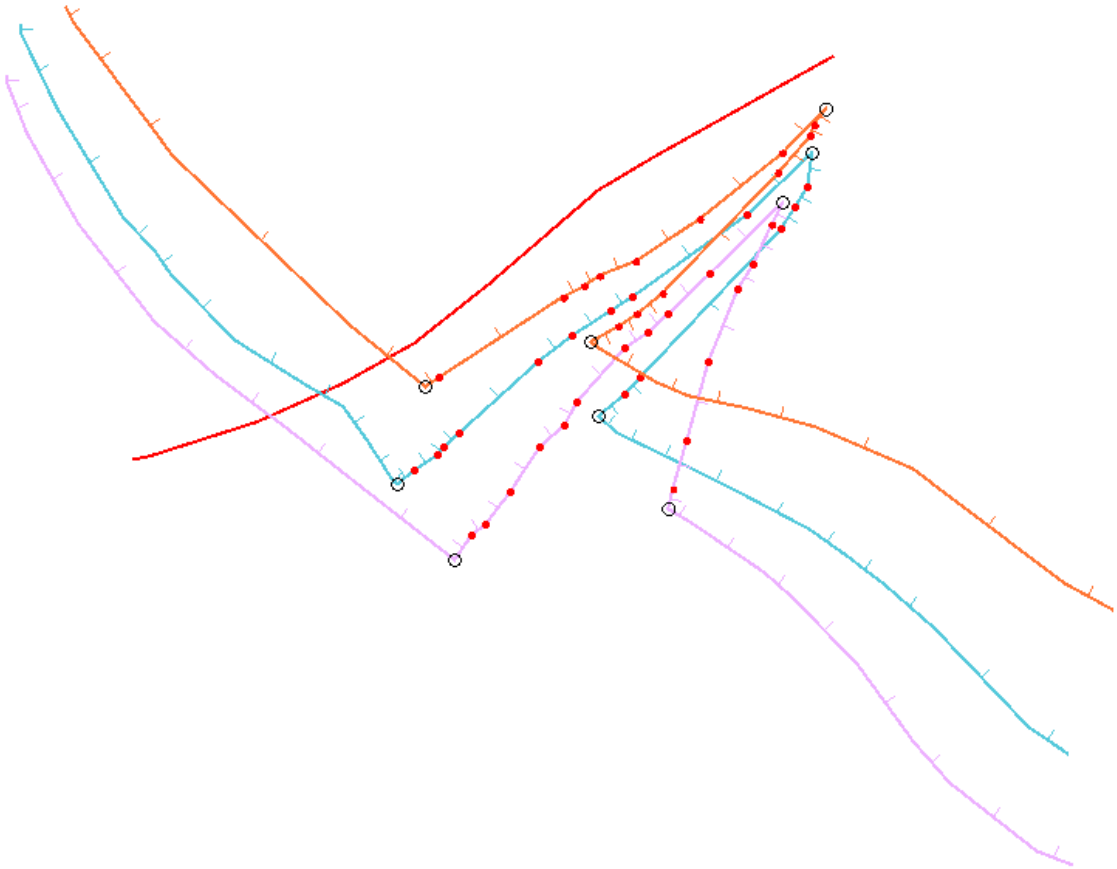
Fault crop attributed cropline shows with red nodes to indicate fault crop;



Completed linework for the blue horizon, showing two segments of fault crop (hangingwall and footwall crops), two other segments of normal cropline. Presence side seeds have been set here too (refer to editing croplines general section in the manual for more detail);



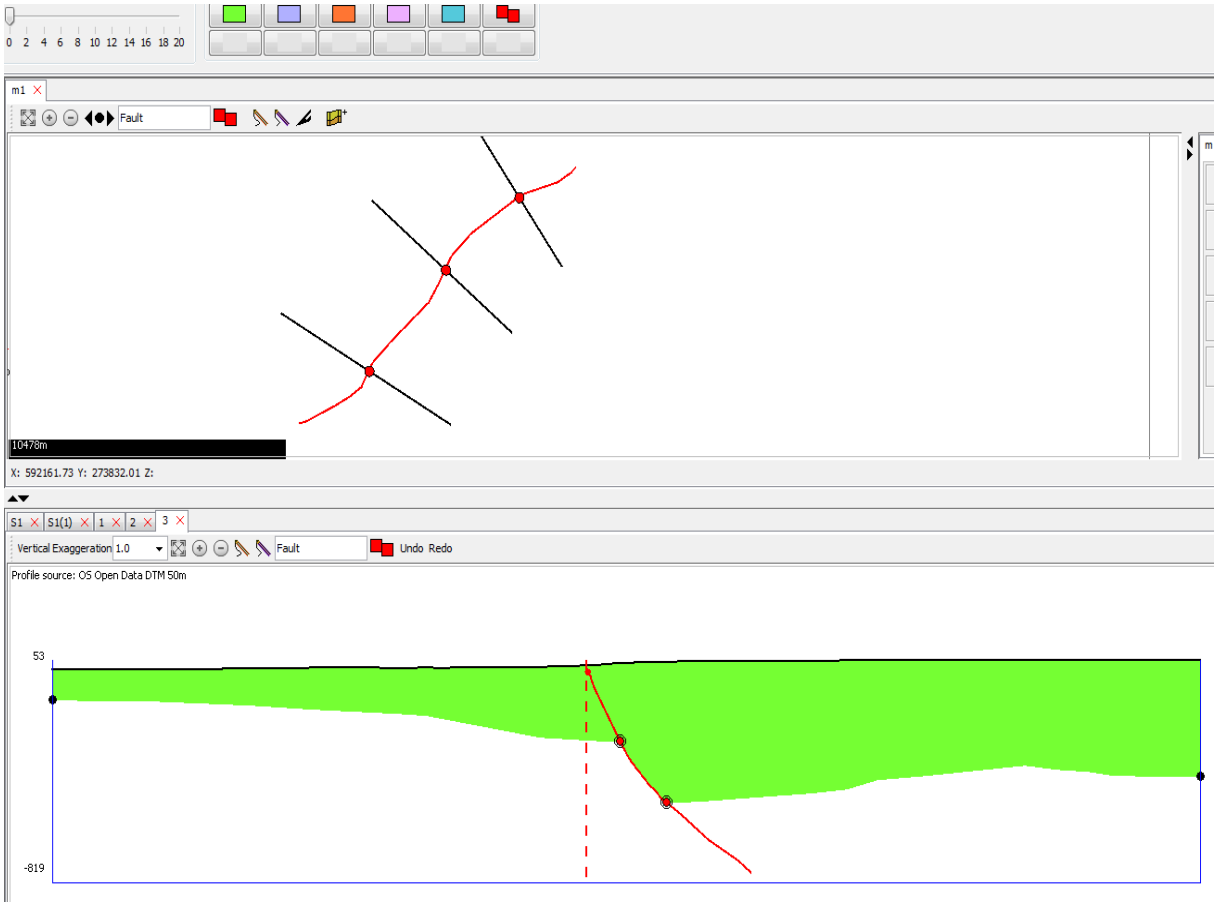
Repeat for other horizons.



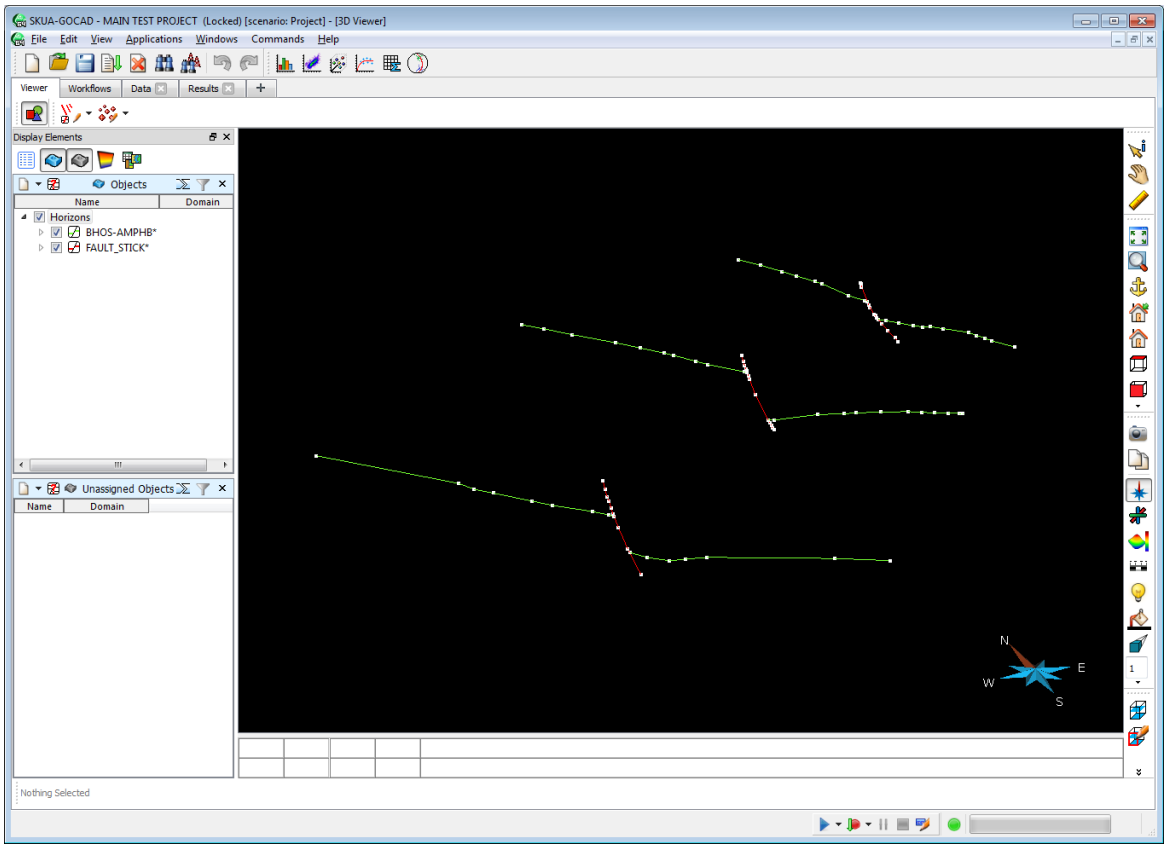
If you need to drag the end of a cropline across a fault trace without it snapping, hold down the CTRL key as you drag.

6.1.4 Fault-attributed Correlation lines

By snapping correlation lines to fault sticks in section you can start to build up the relationships and throws on the fault planes.



Three sections above displayed as 3D linework in SKUA-GOCAD;



7 Interoperability

7.1 IMPORTING PROJECTS FROM GSI3D

Groundhog currently has no direct support for loading directly from GSI3D, and a conversion of the data is therefore required. For advice on how the conversion can be done please contact groundhog@bgs.ac.uk

7.2 IMPORT

All the imports described below are selected via the import menu, which is reached by selecting ***Interoperability*** > ***Import.***

7.2.1 2D ASCII Grid (*.asc)

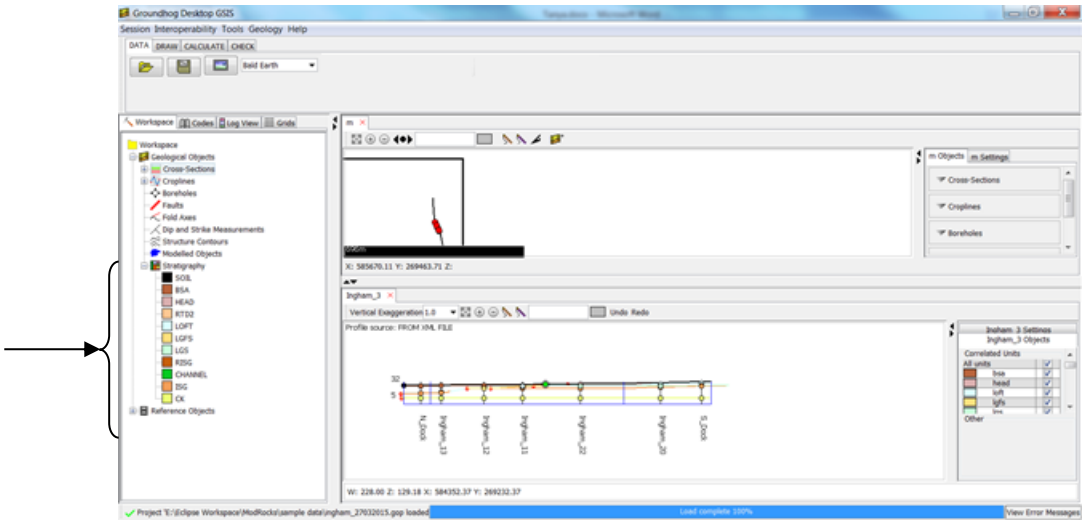
This import function allows a different 2D ASCII Grid to be loaded into the work area. Selecting this option from the menu, provides a ***Select grid file for import*** dialog box which allows the grid file to be found and selected.

Once the grid has loaded, it can be found in the tree structure, under ***Reference Objects*** > ***Grid Coverages***. To set it as the model cap, right click on it and select ***Set As 'Model Cap'***.

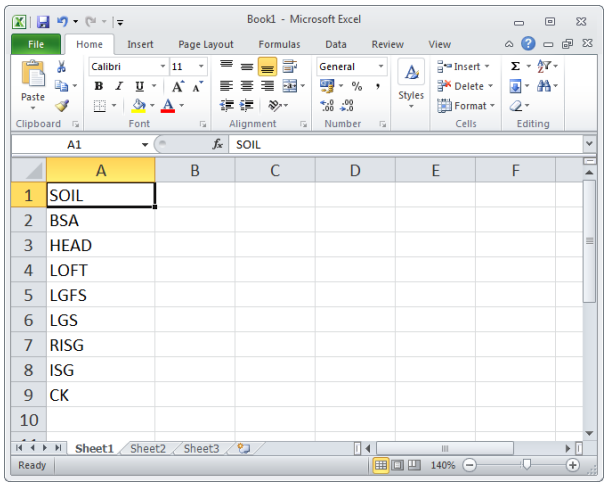
7.2.2 Import Geological Sequence From Spreadsheet

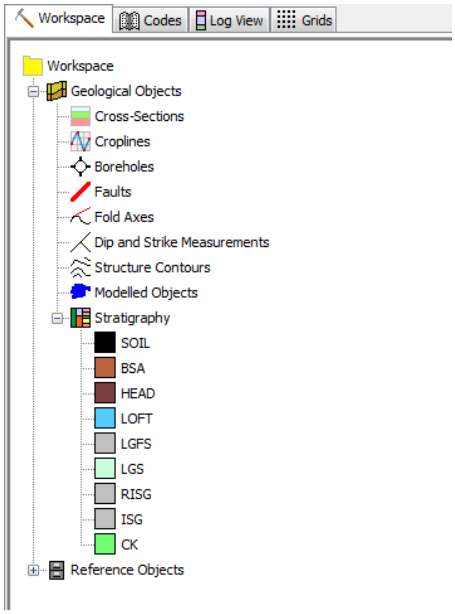
This import function allows a Geological Sequence (stratigraphy) file to be loaded into the work area. Selecting this option from the menu, provides an ***Open geological sequence file*** dialog box which allows the stratigraphy file to be found and selected. The stratigraphy is not directly used for anything at the moment, but could be a useful reference.

Once the file is loaded, the information can be found in the tree structure, under ***Geological Objects*** > ***Geological Sequence***

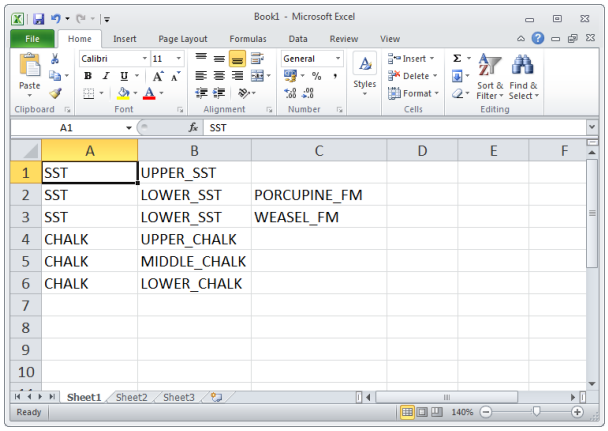


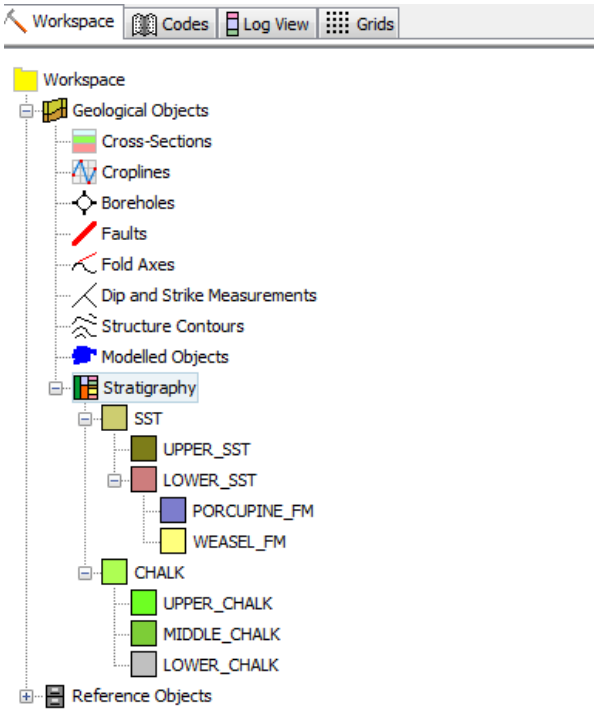
The import supports a simple list, which is a spreadsheet with a single column listing the sequence (strat) codes, or a hierarchical sequence via the use of multiple columns.





Simple stratigraphic sequence





Hierarchical stratigraphic sequence

7.2.3 Import GOCAD TSurf (*.ts) File

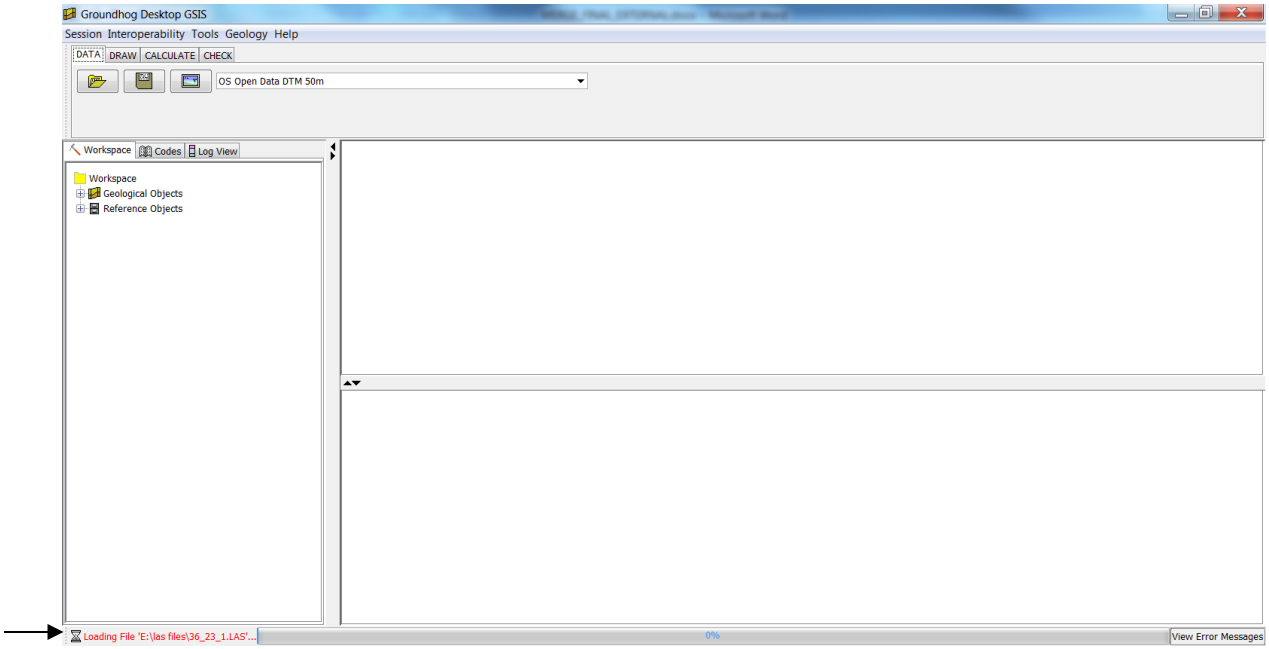
This import function allows a TSurf file to be loaded into the work area. Selecting this option from the menu, provides a ***Load GOCAD TSurf file*** dialog box which allows the TSurf file to be found and selected.

Once the file is loaded, it can be found in the tree structure, under ***Reference Objects*** > **Meshes.**

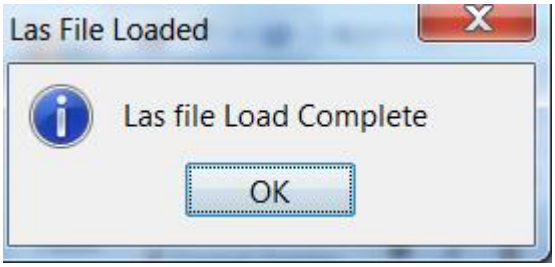
7.2.4 Import Well Log Data (*.las)

This import function allows a LAS file to be loaded into the work area. Selecting this option provides a ***Load LAS File*** dialog box, which allows a LAS file to be found and selected.

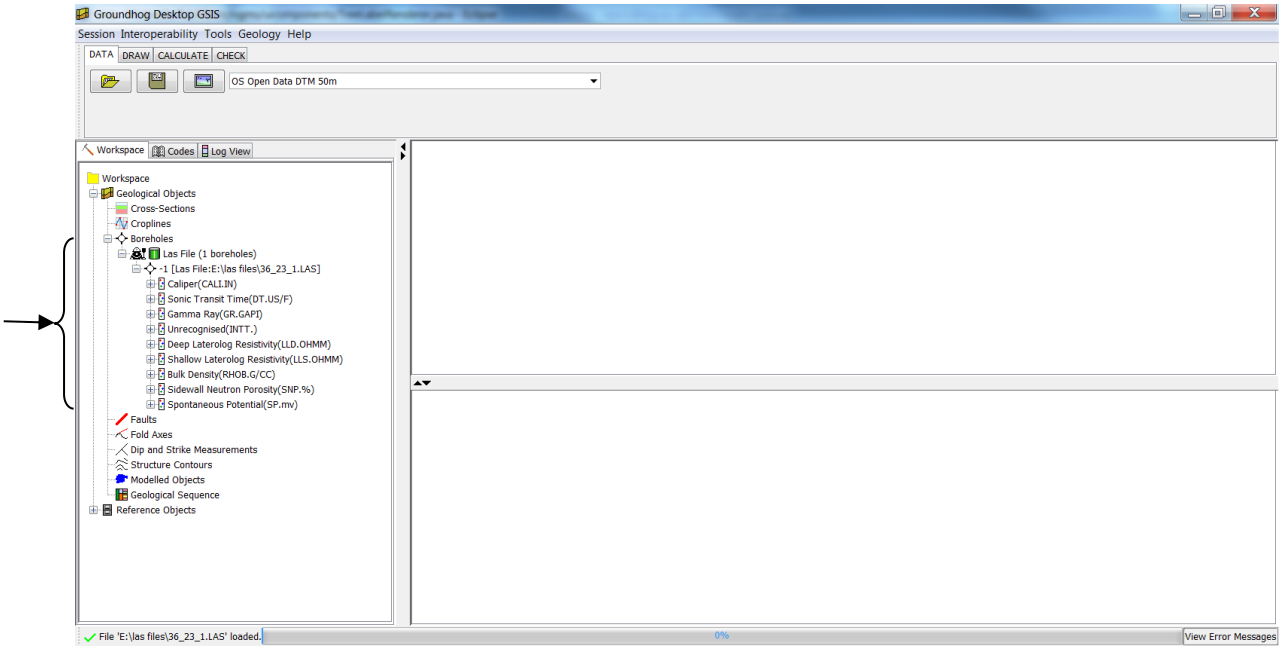
This load can take a little time to run, so following selection of the file full functionality of Groundhog Desktop is restored, but the LAS file may be still be loading for a time. A message is displayed in the bottom left corner of the window, whilst the load is taking place.



On completion of the load, the following box is shown:



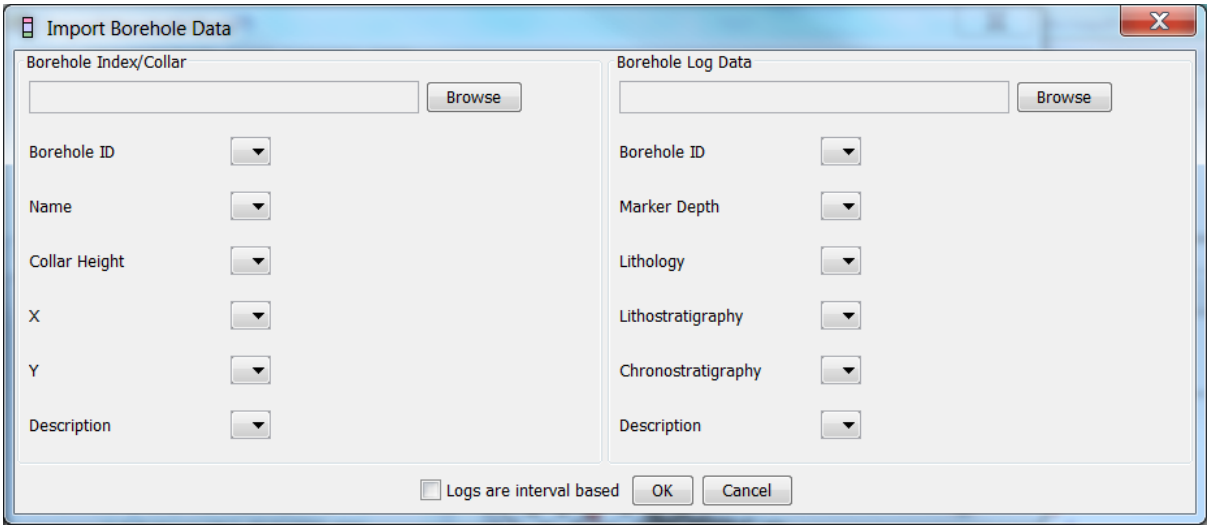
Las data is stored as a series of "pick based" boreholes within Groundhog Desktop. Once loaded, it can be viewed in the tree structure, under ***Geological Objects*** > ***Boreholes***.



Individual measurements can be seen by expanding the items using the + signs. They can also be seen as curve diagrams, by right clicking against an entry and selecting ***View In Porcupine Document***. This is described in more detail in the Log View section of this manual.

7.2.5 Borehole Data (*.dat)

This option enables borehole files to be loaded using any text-based, tab separated format. The files may or may not contain column headings. On selecting this menu option, a dialog box requests information about the files to be loaded:



The **Borehole Index/Collar** file should contain at least an identifier for the borehole, a collar height (start height) in metres relative to O.D/sea-level or site datum, an easting (X) and a northing (Y). Here is an example file with a header line;

```
ID      START_H      EAST   NORTH
1       10.2         206783       345165
```

The **Borehole Log Data** file should contain at least an identifier for the borehole (i.e. ones that will match with the identifiers from the index file), a marker depth (base of layer) as a "drilled-depth" (i.e. relative to the collar height), and some form of geological coding value

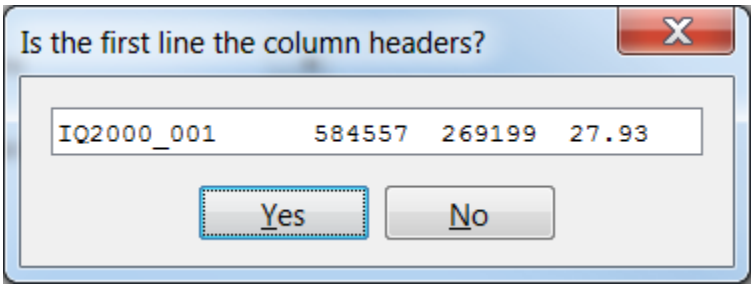
(lithology and/or lithostrat). The file should contain one row per-marker/horizon. Here is an example file with a header line which specifies two markers associated with borhole "1";

ID	D_DEPTH	LITH
1	2.4	SAND
1	3.2	CLAY

If all of your data is in a single file simply pick the same file twice. A combined data file must contain one row per-marker/horizon, meaning the index data will be duplicated if the log has multiple markers, e.g.

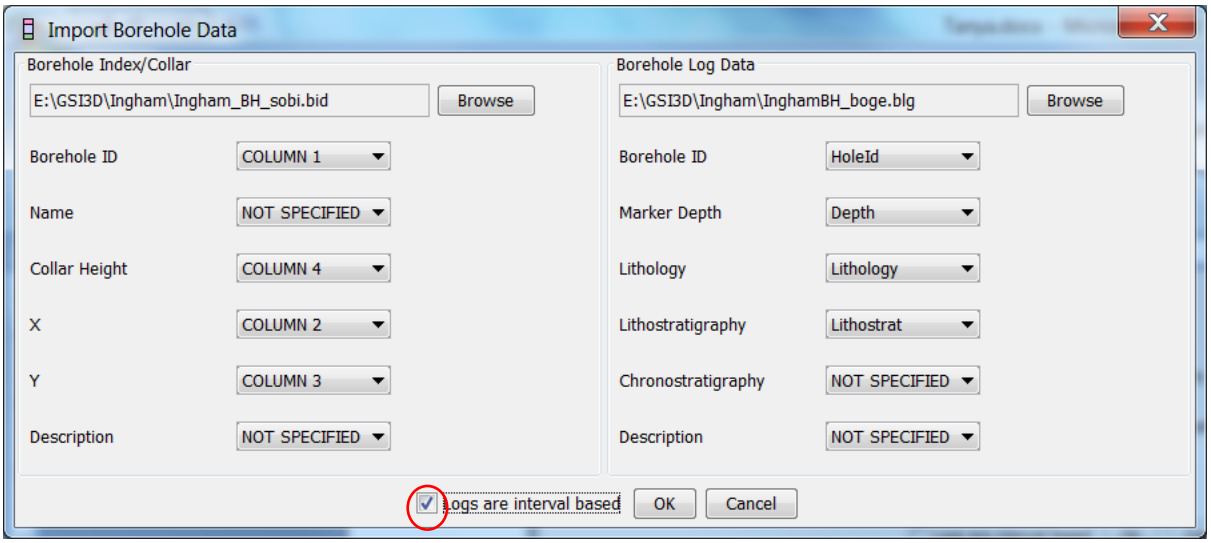
ID	START_H	EAST	NORTH	D_DEPTH	LITH
1	10.2	206783	345165	2.4	SAND
1	10.2	206783	345165	3.2	CLAY

On supplying a file name for either file, the following dialog box, with the first line of data from the file, is shown:



In this case, the answer would be ***No*** (the first line is clearly data), but a file can be loaded which does have column headings.

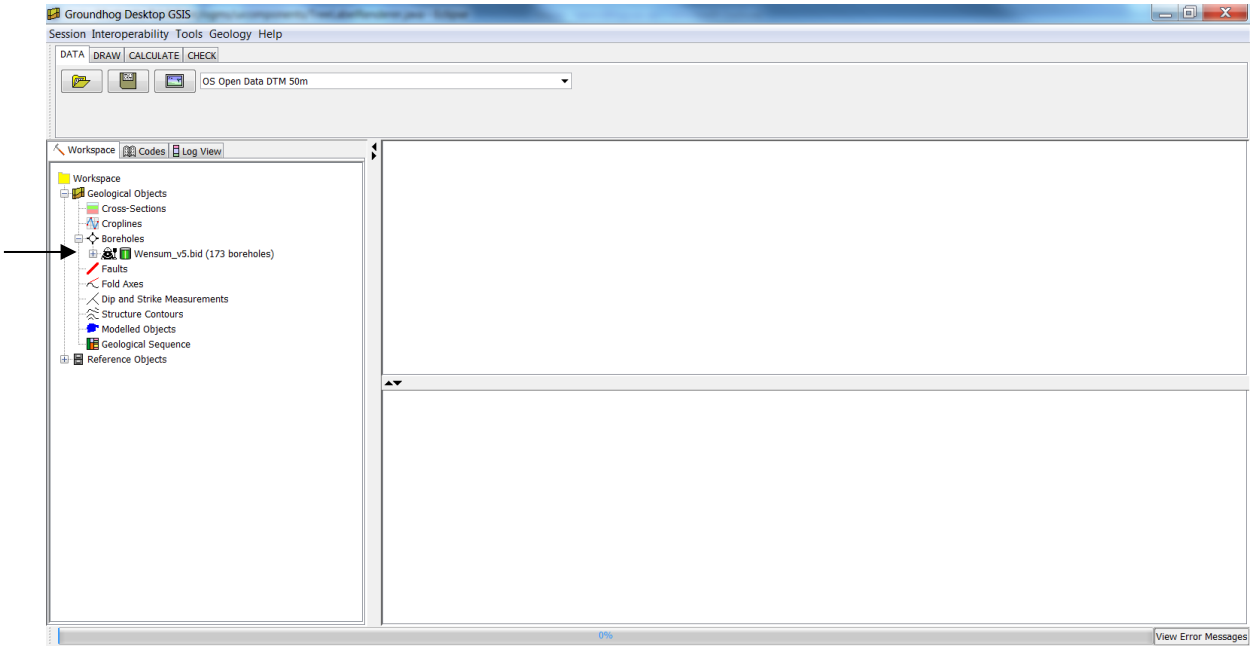
Once the information has been supplied, the dialog box looks something like this:



The Index data file used here has no header, so the columns are selected by their number. The Borehole Log Data file used here did contain headers, so these header names were used to specify which column holds which data. Any columns not present in the data file, or not desired for the import should be left as "NOT SPECIFIED".

Note the tick in the box ***Logs are interval based***. It is important to tick this, where appropriate, if the log data is really a range from the previous depth to the current depth, denoting one horizon.

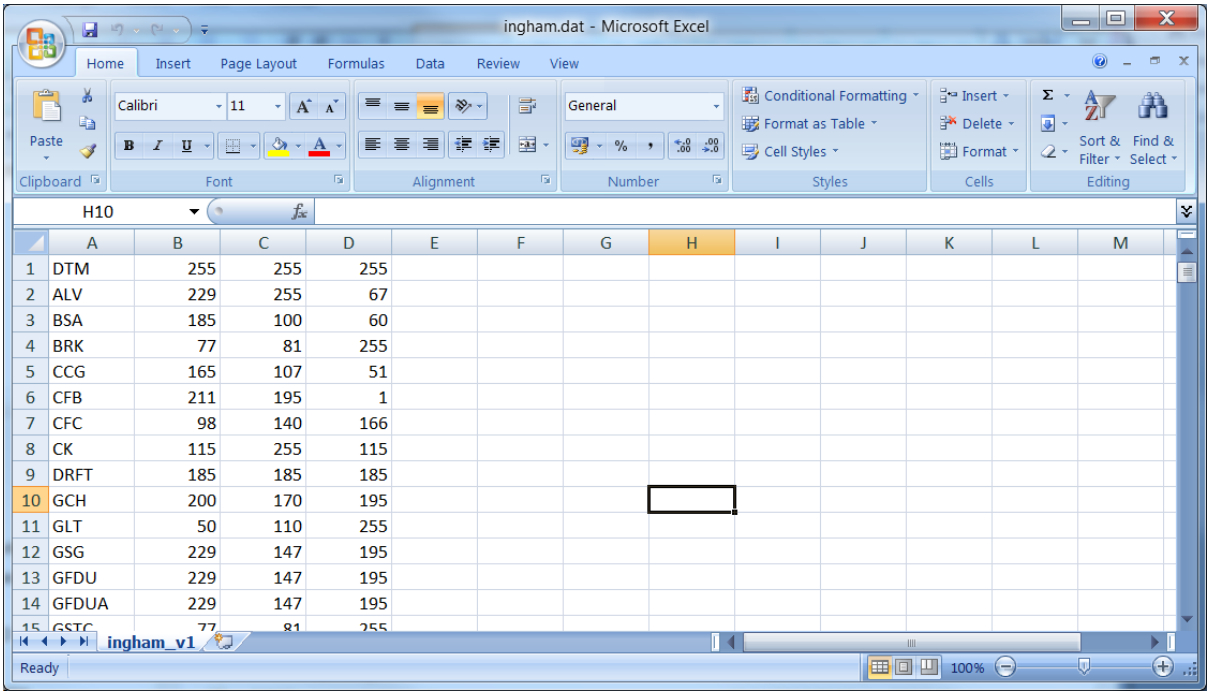
Once the borehole data has been loaded, it can be found under ***Geological Objects*** > ***Boreholes***.



Individual logs can be viewed, by expanding the + signs. Boreholes can also be shown in one or more map windows or viewed using the Log Viewer. If boreholes are used to construct a new line-of-section, they will also appear in the section window. When the project is saved the borehole data will be saved to the XML data files for the project.

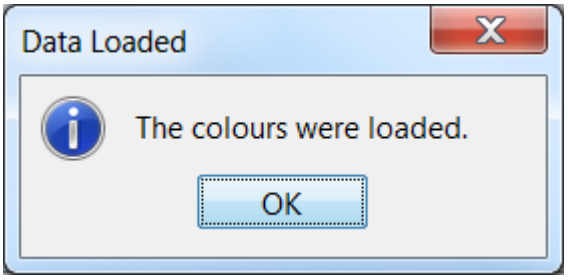
7.2.6 Import Colours

Additional legend colours can be loaded using this import option. The default file type is a .dat file and it should be tab-separated. The format is, as shown here i.e. [NAME RED GREEN BLUE]:



	A	B	C	D
1	DTM	255	255	255
2	ALV	229	255	67
3	BSA	185	100	60
4	BRK	77	81	255
5	CCG	165	107	51
6	CFB	211	195	1
7	CFC	98	140	166
8	CK	115	255	115
9	DRFT	185	185	185
10	GCH	200	170	195
11	GLT	50	110	255
12	GSG	229	147	195
13	GFDU	229	147	195
14	GFDUA	229	147	195

Once the file has been loaded, the following message is displayed:



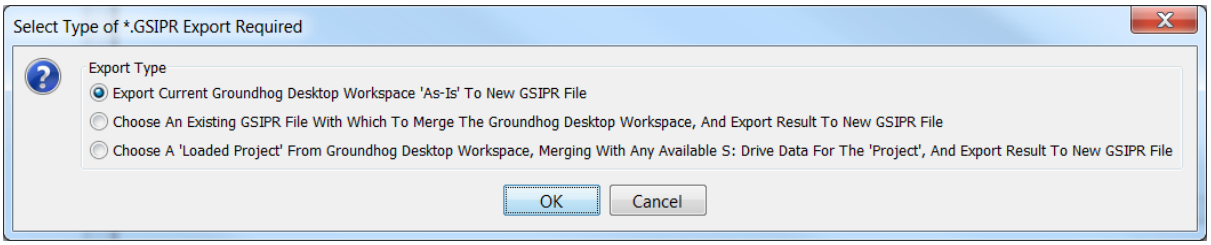
A GSI3D .gleg file, with the standard layout, can also be loaded directly using this import.

7.3 EXPORT

7.3.1 Export Project To GSI3D Format

This export enables the currently loaded Groundhog Desktop workspace to a GSI3D v2013 format .gsipr file. On selecting this option, a ***Save Export to GSI3D Project File*** dialog box allows the output destination and file name to be specified.

A dialogue box then offers three options for how the file is to be created:

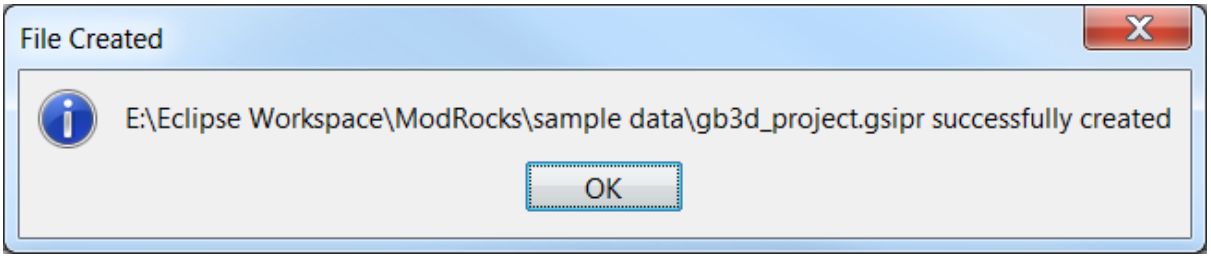


The first option creates a .gsipr file, containing only the information held within the loaded data in Groundhog Desktop. This will mean that some project information, for example project file names such as the .gvs file, will be missing from the .gsipr file and will need to be supplied when the project is loaded into GSI3D.

Option 2 requests an existing .gsipr file to be specified using the ***Open Existing GSI3D Project File*** dialog box. This will then merge some project information e.g. the .gvs file name and location, with the Groundhog Desktop data to create a new file containing all this information.

Option 3 – this option should be ignored for now, as it will only become relevant once the Geological Object Store (GOS) is available;

Once the file has been created, the following message is displayed:



7.3.2 Export Project To GOCAD Format

This option provides the ***Select A Folder To Export To*** dialog box, which enables a file location to be specified. This export currently supports only the cross-sections. Map and borehole are still in development.

One Pline (*.pl) format file is created for each Cross Section loaded into the current workspace. These are placed in the location that has been specified. If files already exist in the given location with the same names as the ones produced by this function, they are overwritten by the new files.

At the moment this export only operates on the cross-section objects and not on the map linework – this second feature is in development.