Explanation of the BGS Subsurface Viewer

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Abstract

The BGS Subsurface Viewer is a standalone software package that allows viewing of pre-defined and incorporated 3D geological models that can also contain many other varying properties of the geological structure.

This report summarises the key technological aspects of the software and gives an outline of the flexibility of, and methodologies involved in, its operation.

Introduction

The Subsurface Viewer is a package developed by INSIGHT Geologische Softwaresysteme GmbH for the visualisation and analysis of digital geoscientific spatial models.

The viewer has been developed following the popularity of INSIGHT's Geological Surveying and Investigation in 3D (GSI3D) software tool that is in use extensively inside the British Geological Survey (BGS) for the construction of systematic near surface models (Kessler and Mathers 2004; Kessler et al. 2005; Kessler et al. 2009).

These notes describe and display the use of the interface windows to the software.

A Geological Model is embedded within the Viewer as a means of publication and distribution to the wider world. In this way the constructed model can be examined and analysed to produce:

- models displaying the geology or other pre-selected applied themes (e.g. hydrogeological properties)
- geological maps (at surface and uncovered)
- user defined synthetic borehole logs
- user defined horizontal slices and vertical sections
- visualisation of the geometry of single and combined units

The model supplied with the Subsurface Viewer is encrypted and cannot be altered, nor can users add additional data as the viewer is a standalone package. The model and the necessary Java software and extensions are all included in the package. The model described herein (West Thurrock) is freely downloadable from the BGS website at:

http://www.bgs.ac.uk/science/thamesgateway/3dModels.html

Subsurface Viewer Interface

The Subsurface Viewer contains up to four windows for the visualisation of the model as shown in Fig. 1. Three windows open immediately within the software. These are the Map (plan view) shown alongside the 3D view, with the Synthetic horizontal section window underneath. A fourth window, the Synthetic borehole log viewer is activated separately and positioned by the user.

The model is displayed in the Map and the 3D window with its default settings. The horizontal Section window is empty until a section line is drawn. The Synthetic borehole log window opens by clicking on the borehole icon in the top left of the header bar.

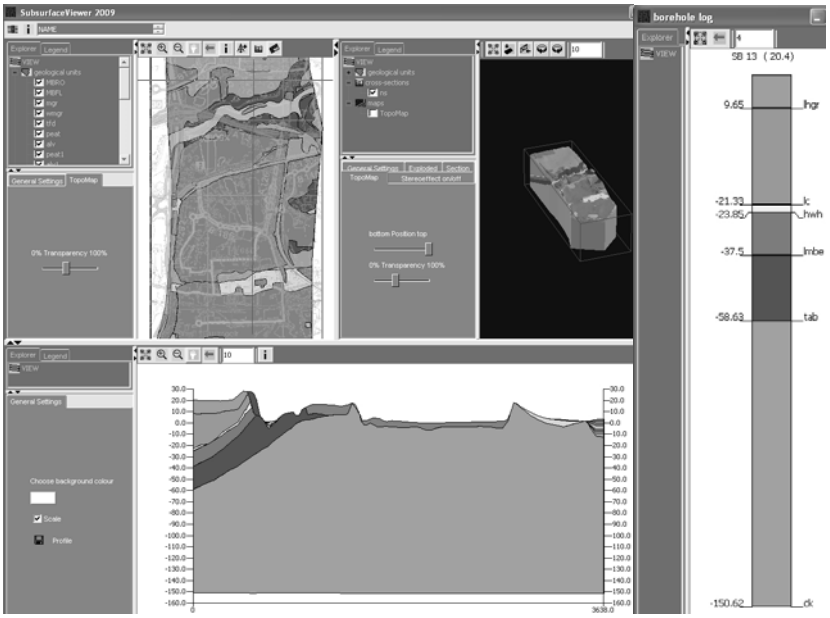
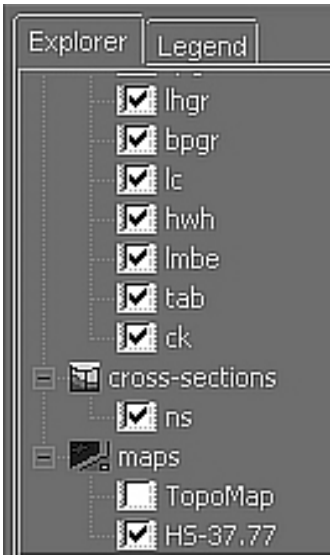


Fig. 1. Windows available in the Subsurface Viewer

In all display windows, the Explorer tab shows the table of contents and the Legend tab (not in Borehole log) reveals the colour key to the geological units in each of the three main windows. The layers that make up the model can be viewed by double clicking the left mouse button on the ‘View’ icon, with clicks on the ‘plus’ and ‘minus’ icons expanding or contracting the displayed menus.



Individual layers or units of interest can be turned on and off as intimated by Fig. 2. ‘X’ and ‘Y’ coordinates can be viewed in the bottom left of the interface when the cursor is placed in the Map (Co-ordinates will only appear when all maps in both the Map and 3D windows have been turned off). Additionally, a Z (depth in metres) value can be obtained when a synthetic cross-section has been drawn and the cursor is placed in the Synthetic section window. All the windows and tab boxes can be resized.

Fig. 2. Example Explorer and Legend tab

This paper will firstly describe some of the differing attribute themes available within the data, before continuing by outlining the functionality available within the individual windows.

Attribute themes

Fig. 3. Attribute theme selection box

The NAME menu shown at Fig. 3. is located at the top left corner of the software is from where the various attribute themes are selected and indicates which one is being displayed. Toggling the up and down arrows and clicking once on the attribute will define a new attribute and show it in the Map, 3D and Synthetic section windows.

The traditional, default appearance of the horizontal section (Stratigraphy-see Fig. 1.) is coloured by the standard BGS geological colours and shows a large area of chalk with a synclinal structure to the left primarily containing the Thanet Sand Formation, Harwich Formation and the London Clay.

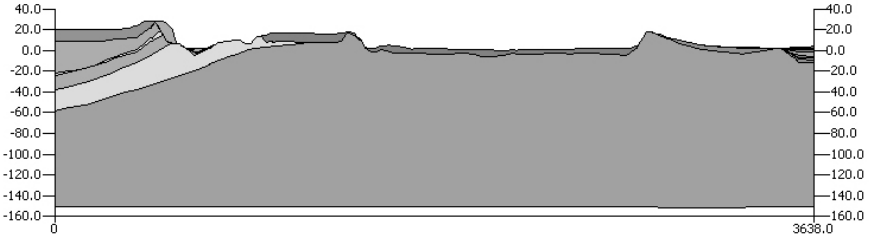


Fig. 4. Lithology of rocks

The same geological structure is illustrated by Fig. 4. but coloured with lithological colour values and are therefore becoming more suitable for users other than solely geologists used to a geological terminology.

Fig. 5. Permeability of rocks

The attribute of Permeability, illustrated in Fig. 5, along with those for Permeability type, Permeability_Max and Permeability_WFD and Sulphate potential, provide a specialised user with a guide to the hydrogeological properties of the rocks.

Fig. 6. Foundation conditions of the rock

This above image (Fig. 6.) shows the nature of the foundation conditions attributed to the rocks and gives an outline guide as to the ground units suitability for construction purposes.

Other themes available include Geological Age and an Engineering classification.

The Engineering geology attribution is based on the classification scheme developed in thematic mapping projects described elsewhere (Forster et al. 2004). The description provides an average value for each modelled formation.

The attributed 3D model provides a platform whereby the integration and visualisation of data from many different sub-disciplines can be achieved (Royse et al. 2008).

The Map Window

The Map Window enables the view of geological units in 2D (plan view), individually or collectively, as coverage's or contoured bases and tops. The Map Window can also display a pre-loaded raster map of the topography for reference, or maps indicating the uncertainty of the model.

In the Map Window the user can specify the location of synthetic boreholes and the alignment of synthetic cross-sections.

Synthetic borehole. 

After selecting the above button in the header bar, a synthetic borehole is created by clicking once at a location in the Map Window where required. To view the result immediately, the borehole window must have already been activated.

Synthetic cross-section. 

This is invoked by selecting the above button and clicking once on the Map Window. On moving the cursor again a line will appear, anchored to the point, from where the mouse was first clicked. A double-click at another location will complete the cross-section and a red line will appear showing the plan view of the section. A window will also open asking for the newly created cross-section to be named. Once named, the section appears in the Synthetic section window. A synthetic section can be constructed by using as many points as required, but there must be a minimum of two.

Synthetic Horizontal Slice. 

Activating this button will create a message box asking the user for a depth at which the 3D model will be sliced relative to Ordnance Datum (OD).

This extract, created from taking a horizontal slice through the model, is displayed in the 3D window.

Controls available to the user in this window give the option, by choosing the *General Settings* tab, to define the background colour from a palette, to toggle the outside frame and cross-hairs on and off and by clicking on the ‘save’ Map icon, to convert the view into a ‘.png’ raster.

Opening the *TopoMap* tab allows user adjustment to the transparency of the topographic raster image in the Map Window.

Properties of other maps can be controlled by right clicking on the map and then the transparency can be adjusted in the *Object* tab. A right click whilst over *Geological Unit>Properties* reveals the *Object* tab. The name or code of the selected unit is displayed in bold at the top and the user can select whether to contour the base or top of the unit and set the preferred contour interval in metres. The unit is shown in its pre-determined colour when the *extent of unit* control is ticked on.

The slider bar immediately below varies the transparency.

The *3D view settings* give the option to display the geological units either as floating contours, a triangulated mesh or colour shaded objects. The bottom slider bar varies the transparency of the 3D colour shaded object.

The Synthetic Section Window

The Synthetic section Window is populated and active once synthetic cross-sections have been selected in the Map Window using the *synthetic cross-section* tool.

The tool icons on the header bar to this window are identical to those in the Map Window, with one additional option available to specify the vertical exaggeration by a user chosen input.

As with the Map Window, the *Explorer* tab reveals the Table of Contents whilst the *Legend* tab displays the units present in the section.

A right click on the *General Settings* tab allows the user to define the background colour from a palette. A tick in the 'scale' box creates a scaled frame surrounding the synthetic section.

The save 'Profile' icon gives the option to save the current view as a *.png raster format.

A right click on any synthetic section in the table of contents enables the user to set the properties of the section using intuitive controls. The name of the section is shown in bold at the head of the tab.

Options include the ability to label with the names of the geological units and slider bar variability of the transparency of the section.

To view multiple synthetic cross-sections at the same time the user must enter the *3D Window*.

The 3D Window

The 3D Window enables interactive viewing of the model and uses the left and right mouse buttons for all navigation. The model can be rotated by holding down the left button and moving until reaching the required angle. Zooming in and out is achieved by holding down the right button and moving in an upward or downward direction. Panning is invoked by holding down both buttons and moving.

Additional tools in the header bar of the 3D Window offer the ability to spin the model and to show a vertical or horizontal view. Each geological unit can also be turned on or off. A right click on an individual unit gives the option to display the 'Object' properties tab.

The 3D window contains a number of tab menus enabling the user to control various aspects of the model appearance. Opening the *General Settings* tab allows the background colour to be selected from a palette. It also allows the models 'frame' and 'cross hairs' to be toggled on or off. The Save '3D view' icon gives the option to save the view in a *.png raster format.

Opening the *Exploded* tab presents a toggle box allowing the explosion of the model, i.e. the separation of individual geological units from others. The tab also allows an expansive directional control over the contents of the exploded view.

The *Section* tab allows the user to view horizontal slices of the model in a north/south direction and separately in an east/west direction. All geological objects must be hidden (geological units>hide all objects) to be able to view the horizontal slices.

Opening the *Stereo effect on/off* tab allows viewing of the model in 3D stereo with a choice of the colour of any stereo glasses available.

The *TopoMap* tab allows the position of the topographical raster in the model to be adjusted along with its transparency.

The Synthetic Borehole window

The borehole icon in the top left hand corner will open up the synthetic borehole viewer and the tools carry the same functionality as those in the Map and Section windows with the added ability to drag the borehole image to a user desired location in the display by holding down the left mouse button.

The borehole viewer display shows:

- The depth to the base of each geological unit relative to Ordnance Datum (OD).
- The OD and name of the synthetic borehole at top.
- The name of each of the modelled units.

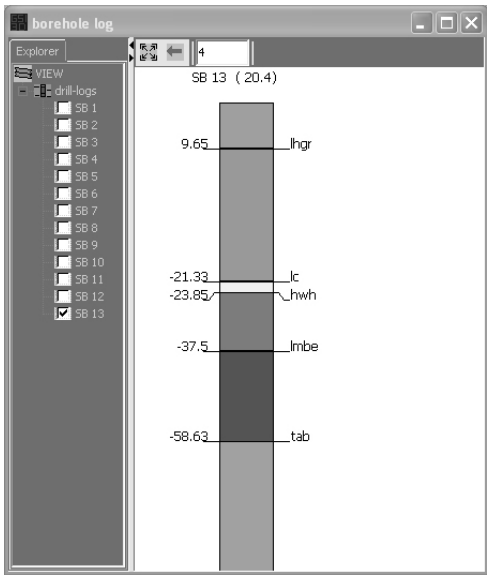


Fig. 7. Example synthetic borehole representation

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Glossary

Borehole Log A synthetic borehole drilled in a Z direction through the 3D geological model data.

Cross-section A vertical slice defined by a start and end point through the 3D geological model data.

Horizontal Slice A horizontal slice given at a Z depth level through the 3D geological model data.

Synthetic Cross-sections, boreholes or horizontal slices which are constructed using data from the triangulated surfaces stored in the Subsurface Viewer.

Topomap A map showing topographical features and landmarks of the Earth’s surface.

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