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3D Geological Modelling at the British Geological Survey using the GSI3D software and methodology.

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BACKGROUND

As a national geological survey organisation the British Geological Survey (BGS) has produced paper maps of Britain's geology at a series of scales for the past 175 years. Over time these have become more detailed with the one-inch (1:63 360) scale being the standard output in the mid 19th Century whereas today 1:10 000 is considered appropriate for modern needs over most of Britain's landscape.

In 1815, twenty years before the establishment of BGS, William Smith was already addressing the need to present the third dimension of the geology as well as the surface arrangement of units on 2D paper maps. Over time, cross-section drawing became more refined, resulting in outputs such as fence, ribbon and block diagrams to reveal the 3D structure, while contoured surfaces or thicknesses (isopachs) were used to show the spatial position of individual units such as major unconformities or sequences. Geological maps often require another geologist to understand them fully; the surveyors' spatial ideas, models and concepts can never be properly represented in a 2D map output, and so, until recently, much knowledge has been lost to the science and to the users.

In 2000 BGS began the translation of their traditional 2D geological map outputs into fully interactive 3D geological models of the subsurface. This was possible because, by 2000, the Survey had digital geological maps at scales effective for modelling (Jackson & Green, 2003), licensed, nationwide high-resolution Digital Terrain Model (DTM) coverage, and databases of both, borehole index and downhole data supported by corporate dictionaries for lithological and stratigraphical terminology.

MODELLING SOFTWARE & METHODOLOGY

The Geological Surveying and Investigation in 3 Dimensions (GSI3D) software tool and methodology has been developed over the last 15 years. The initial software was developed by H-G Sobisch as a tool for modelling shallow superficial-Quaternary sequences using a cross-section-based approach. From 2001-05 BGS became involved in the accelerated development of the GSI3D software and methodology, initially through the Digital Geoscience Spatial Model (DGSM) project (see Smith *et al*. 2005). The advantage of GSI3D is that it has been designed to use all common types of digital BGS data, and combine these with the wealth of knowledge otherwise trapped within the scientists' brain, to produce 3D geological models (Kessler & Mathers 2004).

BGS now builds its general deep regional models at 1:1 Million, and 1:250 000, resolution using GOCAD, a software tool particularly favoured by the oil industry, whilst GSI3D is mainly used to produce 1:50 000 and 1: 10 000 resolution models of the near-surface terrains characterised by artificial ground, superficial deposits and straightforward bedrock geology. As the two modelling packages can also exchange files they have been used together successfully in the construction, validation and delivery of some models.

GSI3D MODELS

To-date detailed GSI3D models have been constructed for areas such as Greater London and the Thames Gateway Development Zone, parts of southern East Anglia, Manchester, Merseyside and Glasgow. (Figures 1 & 2 below).

GSI3D is also frequently used in building 3D models as commercial contracts for clients such as the Environment Agency of England and Wales (EA), the UK Water Sector and Local Government (Figure 1). These are usually constructed to the clients' specifications and have been mainly utilized for groundwater management, recharge, aquifer protection, groundwater flooding, archaeological assessment and planning (see Mathers, 2008 for further examples). Many of these models have focussed on important aquifers such as the Chalk and Sherwood Sandstone. Currently released versions of GSI3D are limited to modelling in areas of simple bedrock with normal faulting corresponding roughly in Britain to

Triassic and younger strata (Figure 1) and Quaternary deposits.

CONTINUOUS DEVELOPMENT

In 2007 BGS embarked on a 3-year R&D project to extend the use of the GSI3D software and methodology to most styles of bedrock geology, notably faulting (normal, reverse, strike-slip, scissor, thrusts-nappes), folding, intrusive and cross-cutting bodies and overturned - overfolded strata. Initial results from this development are encouraging and are focussed on testbed models of faulted Palaeogene and Mesozoic strata beneath London and folded and faulted Lower Palaeozoic rocks in Plynlimon, Central Wales. BGS hope to roll out a beta version of the new GSI3D bedrock software early in 2009.

MODEL DELIVERY

Customers can obtain BGS models in several ways. Geological models can be served via the web in form of Flash animations and 3D PDFs giving the users a pre-view of the model and some interactive functionality. BGS also uses a Java based 3D viewer that forms a sub-set of the GSI3D software called the Sub-surface Viewer. In these viewer applications the user can create synthetic boreholes and sections, change the theme properties of the model, create contour maps as well as explode the model for detailed analysis These calculations are performed on the user's PC so only the data has to be transmitted via the web or CD-ROM. Data can also be delivered to customers in many other requested formats such as scattered x,y,z points, ASCII grids, ESRI shapes and grids and VRML surfaces (Kessler, Mathers & Sobisch, 2008).

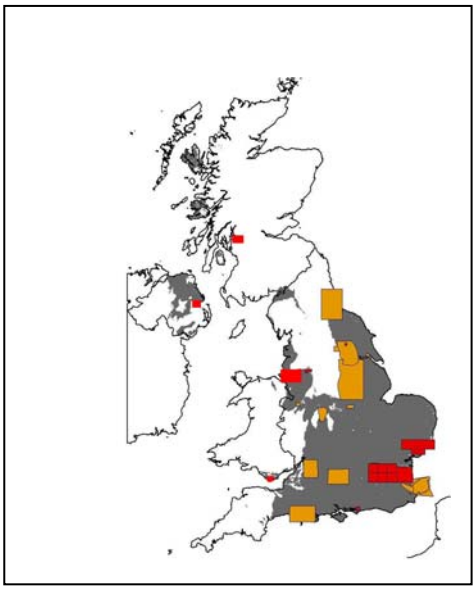

Figure 1 – Availability of 1:50 000 and 1: 10 000 resolution BGS models, standard models are shown in red and commercially built models in amber. Triassic and younger rocks are depicted in grey.

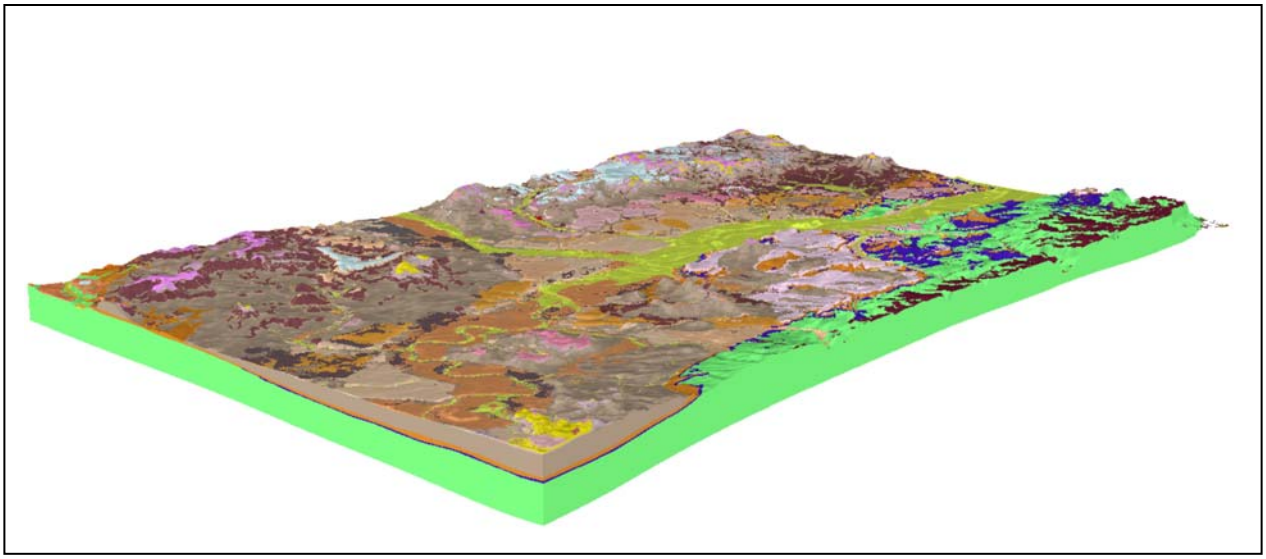

Figure 2 – 1:50 000 scale geological model of Greater London viewed from the southwest. The Chalk bedrock is shown in green. The area covers 60 x 40 km to a depth of up to 300m..

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