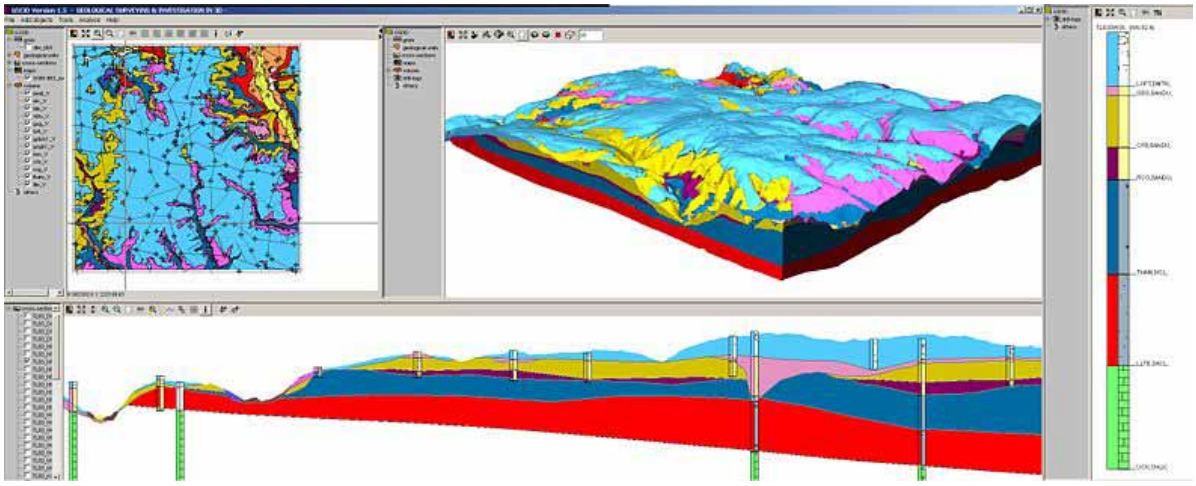
Second International GSI3D[1] Meeting[2] - Keyworth UK, September 2008



GSI3D's four panel display[3].

The Geological Surveying and Investigation in 3D (GSI3D) package is used by the British Geological Survey (BGS) and others to make, not just geological maps, but a 3D geology database. GSI3D is a component of a much larger initiative by BGS, 'DigMapGB' to move from traditional maps to the database. GSI3D aims to make geological information understandable to users with flexible 3D viewing. The tool also offers geologists a 'traditional' approach to capturing field data from boreholes and cross sections and other observations. Standard nomenclatures underpin the effort. Use cases show insights into glacial history moraines and palaeo sea levels and their impact on urban development. BGS' project manager Holger Kessler claims a 'paradigm shift' in the way geol survey communicates to whole population. 'Lithoframes,' 3D models of the subsurface are the 'natural successors to geological maps.'

Although not directly related to GSI3D, we include in this report a 'heads-up' on a significant development in geological mapping and data exchange – the announcement of the international OneGeology portal and its enabling technology, GeoSciML.

Highlights

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[1] *Geological Surveying and Investigation in 3 Dimensions http://www.bgs.ac.uk/science/3Dmodelling/gsi3d.html and http://en.wikipedia.org/wiki/GSI3D.*

[2] *Conference website on http://www.bgs.ac.uk/science/3Dmodelling/gsi3dMeeting2008.html*

[3] *Image courtesy BGS/Insight.*

TW0809_1 Introduction

The British Geological Survey (BGS) initiated a £5 million project in the 1990s to 'go digital' with a major project, the Digital Geoscience Spatial Model (DGSM). This led to the acquisition of a license to the GSI3D package developed for the Lower Saxony Geological Survey which has now been developed into both a front end/delivery mechanism for BGS' DGSM data and a 'doing tool' for geologists involved in survey work. There were 120 registered for the 2008 GSI3D user group (up from 30 at the last meet two years ago) and non BGS attendees have grown from 4 to 49. 3D geological modeling is essential to address future issues such as climate change and security of supplies (water, energy ..). 'We need to understand the shallow geosphere much better than we do today. This is an international challenge.' More on 3D Geology at the BGS from http://www.bgs.ac.uk/products/3d_geology.html. Abstracts from the meeting are available on http://www.bgs.ac.uk/downloads/browse.cfm?sec=1&cat=79.

TW0809_2 Past, present and future of GSI3D – Holger Kessler, BGS[4]

Hans Georg Sobisch of Insight Köln originally developed GSI3D[5] for the Lower Saxony Geological Survey. BGS bought a license in 2001 via its 3 year Digital Geoscience Spatial Model (DGSM) R&D program. There are two types of geomodeling – 'explicit' (using geostatistics) and 'expert controlled' (such as GSI3D). GSI3D uses traditional geological science/mapping techniques. These break down into elements such as digital terrain models, geological succession, boreholes, geological line work and maps. GSI3D acts as a front end for the BGS Data Portal – which serves data and software to BGS scientists. GSI3D can be learned in a two day training course. See also Lidar (for DTM). The package presents survey geologists with familiar workflows and tools for interactive cross section drawing, fence diagrams, envelope (coverage) construction and mapping. Outcrop data is extended with a triangulated mesh. The tool is also used by the Environment Agency for groundwater mapping etc. Kessler claims a 'paradigm shift' in the way the BGS communicates to the whole population. 'Lithoframes' are the 3D successors to geological maps. Models fit into each other – with low resolution data informing higher resolution models. More from www.wikipedia.org/wiki/GSI3D and the 2008 article in Computers and Geosciences (Kessler et al.)

TW0809_3 3D Digital Geoscience for Engineers – Keith Turner, Colorado School of Mines

CSM is not yet using GSI3D but is following the program 'with interest.' Technology has evolved so that 3D visualization is no longer a problem – but issues remain in accessing dynamic data. CSM uses Lynx Geosystems tool to illustrate modeling basics. But complex terrains may be a challenge. NURBS[6] can be used to reduce model size. CSM has worked on the LANL Yucca Mountain test site. Prediction involves a balance of risk and extrapolation. Other projects include an analysis of standard penetration test (SPT) blow count distributions in Boston's Big Dig using 3D Kriging. This revealed 'issues' with earthquake zones and liquefaction of fill (Boston is built out over the sea). 3D modeling is no longer a technology problem. It is possible to build very realistic models, incorporating lots of knowledge but issues remain regarding how to represent uncertainty and on data standards.

TW0809_4 Q&A

BGS – GSI3D represents a conundrum regarding software development, R&D and what should be the core competencies and expectations of a geological survey.

CSM – There has been a change for geological surveys from the collector and holder of information to a pro active 'fit for purpose' supplier. This is against a background of the problem of aging infrastructure – transport, water supply etc. and brownfield redevelopments. Geological surveys are in a key position as holders of societal knowledge. A bore hole database is unlikely to be done commercially. You still need professional understanding to convert raw records to usable information. You have to understand risk else all hell breaks out. The design of a recent Oregon new road to the coast was awarded to the lowest bidder which was 'totally incompetent' regarding geology. It took two years to stabilize the road and the contractor went bust. The tender has been re-issued to competent builders.

TW0809_5 GSI3D model in support of oil exploration – Andrew Newell, BGS

BG[7] Libya commissioned BGS to build a 3D geological model of the South Sirte basin, Libya. BG required the model to source groundwater for its drilling program. Newell noted that 'all ingredients for an overseas

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[4] *See also http://www.bgs.ac.uk/news/news/From_geological_maps_to_models.pdf for a backgrounder on the project (published in Kessler and Mathers (2004) Maps to models. Geoscientist, 14 (10). 4-6. A.)*

[5] *No website – but see also http://lithosphere-east.com/andreas_wollmann/home/lithosphere_eng.pdf.*

[6] *Nonuniform rational B-spline - http://en.wikipedia.org/wiki/NURBS.*

[7] *Formerly British Gas.*

3D model can be rapidly gathered over the internet,' along with paper data sources. The digital terrain model came from NASA's SRTM and InSAR's free global coverage. Previously such work would have involved much complex downloading and data re-formatting. Today, a Kings College London add-in for Google Earth lets you pull up SRTM data in ARC, ASCII or GEOTIFF format – providing 'high quality data for free.' The 90 meter grid Libya data was accurate to 'a few meters'. This is comparable with the NextMAP commercial coverage. Base maps in the form of Landsat ETM tiles are a one click download from https://zulu.ssc.nasa.gov/mrsid (14m pixels in mrSID compressed files.) Borehole data (on maps) is available from Libya's 'Great Man Made River' project. These are sufficiently accurate with latitude/longitude grids for scanning and georeferencing (ensuring that the CRS[8] is defined in the ESRI map catalog.) Gocad and GSI3D can be used side by side. Deliverables included well geology prognoses and contour maps of the main horizons. The model was built in six days. The model is now also used for prognosis of exploration wells. See also www.onegeology.org. Lots of is geology 'locked away' in BGS' international maps – this can be 'freed' with a judicious combination of Gocad and GSI3D.

TW0809_6 GSI3D Live Demo – Holger Kessler, BGS

GSI3D was initially conceived as a tool for superficial geological mapping. It is now being extended to bedrock mapping. BGS has tried other packages including GOCAD, Petrel, Vulcan, these are considered good for use by experts but 'GSI3D is for everyone.' The demo showed live data from the BGS' Lithoframe Data Portal to deliver reports, geological models etc. A synthetic borehole tool allows users to click on a map and generate a borehole – similar functionality exists to create cross sections for route analysis. Models can be exploded to show layers, zoomed and spun for visualization. Tri-mesh grids show data points and contour surfaces. GSI3D has a four panel display of borehole, map, section and 3D. Work is in progress to handle complex bedrock environments and faulting with push button fault network generation and tri meshes that honor faults. GSI3D links to ESRI GIS tools allowing users to access scanned images, Oracle tables, geotechnical data and to benefit from a 'GIS-savvy' user base. GSI3D should run on any Java runtime with Java 3D extensions but has only been tested on Windows.

TW0809_7 GSI3D Projects

TW0809_7.1 3D Geological modeling in London area - Kate Royse

Geological maps are made for geologists – not for normal people. We need to be able to deliver information in a usable form. So we build 3D models and populate them with geotechnical data. Characterization by bulk attribution of blocks of models or voxels may be too detailed for users or for their machines. There are some 78,000 boreholes in the London area. Royse advocates 'robust statistics' to plug gaps in incomplete data sets and alignment with BS5930 standard for engineering materials. Confidence values can be assigned using an inverse distance weight technique. The aim is to meet Rosenbaum's challenges – of poor shallow modeling tools and models that 'don't depict natural subsurface variations.'

TW0809_7.2 Thames Gateway Geology – John Ford

London is the largest urban area in the EU with a 14 million population. BGS produced its London Memoir on the geology of London in 2004 along with a model at 1:50,000 scale and a Thames Gateway model at 1:10,000 scale. GSI3D was used to show cross sections derived from the London model along with other data such as a seismic survey along the river Thames. Now that the superficial model has been created, BGS is working on a GSI3D bedrock model.

TW0809_7.3 Modeling Vale of York – Tony Cooper, BGS

This project, known as 'mapping the ice age,' revealed the extent of glaciation – when ice blocked the Humber and then retreated to form the York moraine. It showed compelling imagery from NextMAP[9] digital terrain model alongside 100,000 boreholes and BGS geological maps. A coding scheme for superficial deposits was developed. Borehole interpretations were stored in an Oracle database and lithology logs viewed in the GSI3D borehole viewer.

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[8] *Coordinate reference system.*

[9] *Because of the high cost of licensing digital terrain data from the UK's Ordinance Survey, Norwich Union commissioned Intermap to fly a LIDAR survey of the whole of the UK – 'NextMAP' at 5m spacing and 1m resolution. NextMap is marketed by Getmapping - http://www1.getmapping.com/webshop/Web/Business/Static/ProductsAndServices/getmapping3d.aspx.*

TW0809_7.4 Clyde basin – Joanne Merritt BGS

This study is in support of the Clyde Gateway project – a 25 year long, £1.6 billion urban renovation. A pilot study used GSI3D for superficial geology and Gocad for the bedrock. Now the whole area has been remapped in GSI3D, addressing quaternary history, sea levels, ice sheet maxima and flow, etc. The project includes the development of GIS tools for geotechnical and uncertainty modeling.

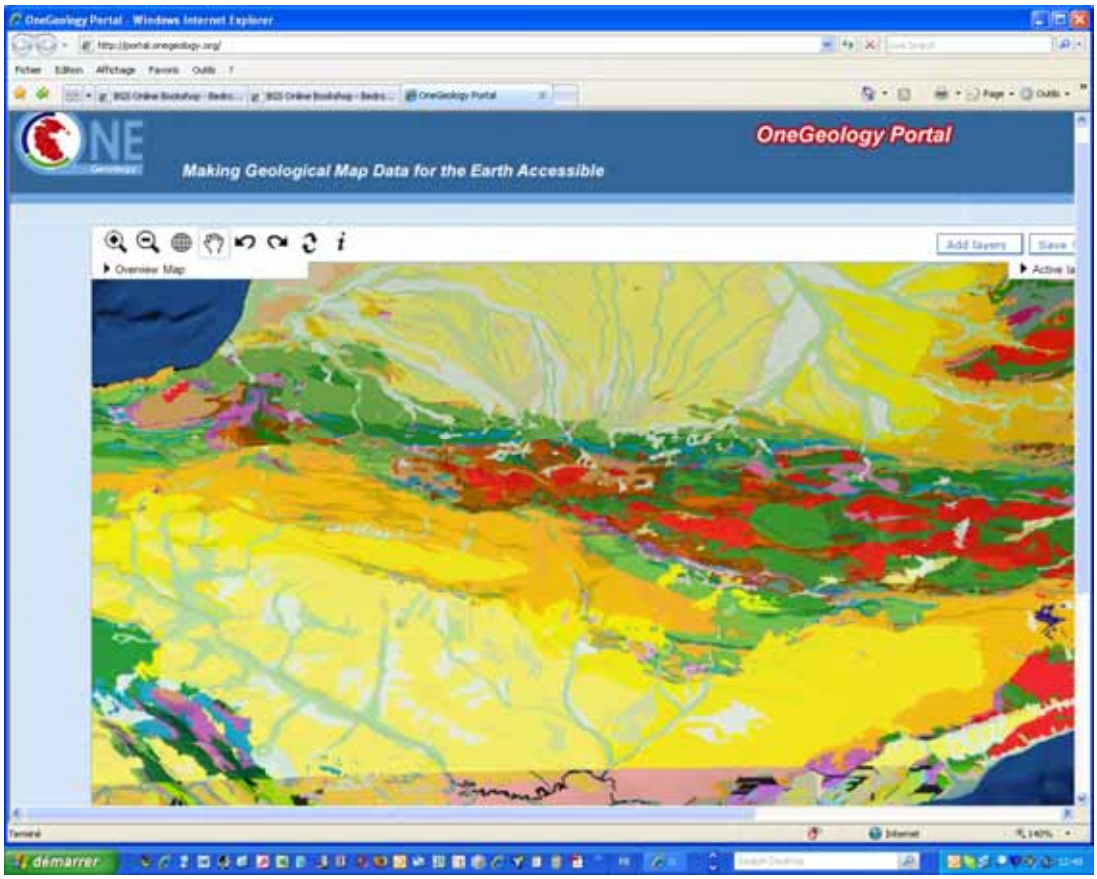
TW0809_8 Visionarium

BGS' visualization room runs the 'GeoVisionary' a 3D stereoscopic visualization package developed by Virtalis to browse BGS' multi-terabyte data set. The UK model has 70 billion triangles and 15 trillion pixels, (with 50cm imagery resolution and 5m grid elevation). More from www.geovisionary.com.

TW0809_9 GSI3D – commercial status

The commercial status of GSI3D is somewhat unclear at the present time. Development is in the process of migrating from Insight to the BGS, although IPR remains with Insight. There are no current plans for commercialization of the software. This is to be decided 'by 2010.'

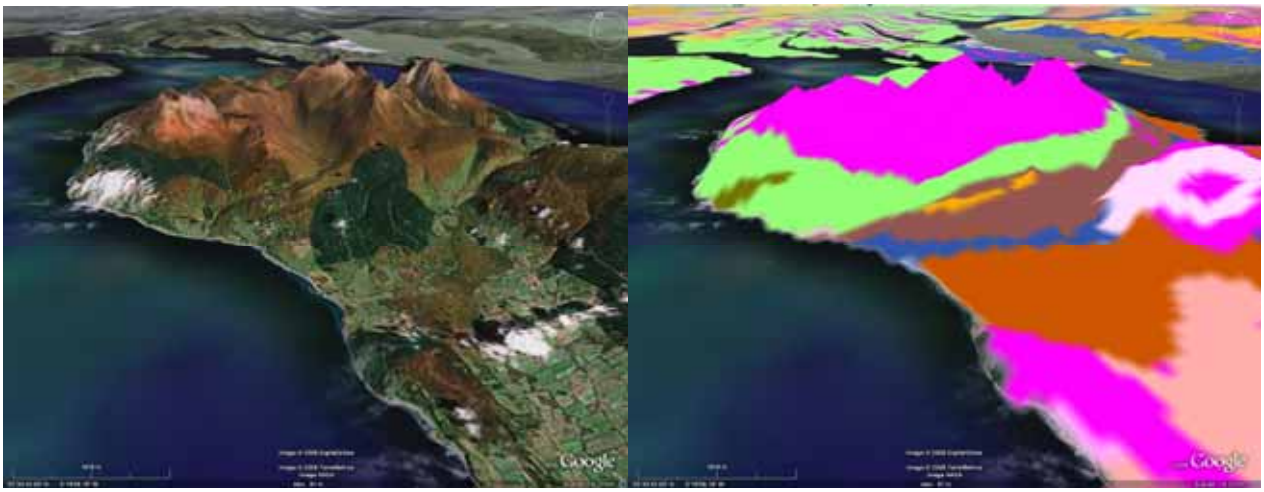
TW0809_10 OneGeology, GeoSciML and GSI3D



Trans-national geological mapping from the OneGeology Portal.

While not actually the subject of this meeting, BGS was a key player in the recently released OneGeology initiative announced at the 33rd International Geology Conference held Oslo in August. OneGeology, an international digital geological mapping initiative was presented by author Simon Winchester in the ICG plenary keynote. OneGeology has been made possible by the use of a new geological data description language GeoSciML – already used by BGS to serve its DiGMapGB data. GeoSciML leverages standards from the Open Geospatial Consortium(OGC) including Geography Markup Language (GML), Web Map Services (WMS) and the Web Coverage Service (WCS).

BGS is currently investigating methods of exporting a model produced using GSI3D to GeoSciML and also on importing data such as borehole information and DTM modes in GeoSciML into GSI3D.



DigiMapGB data in Google Earth[10].

OneGeology data (such as the BGS' DigiMapGB) can be saved as KML[11] and viewed in Google Earth. In fact the full 1:625,000 UK dataset can be downloaded as KML from the BGS website.

TW0809_11 The Data Room – Technology Watch subscription information

This report has been produced as part of The Data Room's Technology Watch reporting service. For more on this subscription-based service please visit the Technology Watch home page or email tw@oilit.com.

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[10] *Imagery courtesy Google, BGS and rights holders.*

[11] *Keyhole markup language – Google Earth's geographic markup language.*