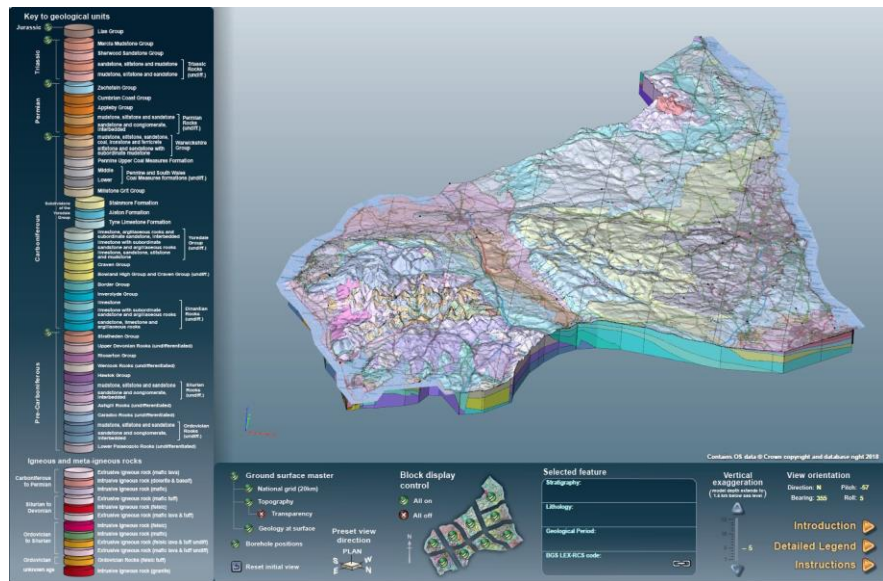




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Regional Geological Visualisation Models

National Geological Model Project
Open Report OR/18/046



BRITISH GEOLOGICAL SURVEY

NATIONAL GEOLOGICAL MODEL PROJECT

OPEN REPORT OR/18/046

Regional Geological Visualisation Models

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K Whitbread and C Ritchie

Keywords

UK3D; 3D model; visualisation.

Front cover

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Foreword

This report provides details of the development of the Regional Geological Visualisation Models, developed from the UK3D v 2015 national-scale network of cross-sections and BGS geological maps.

Acknowledgements

The Regional Geological Visualisation Models (GV Models) were constructed by a team of BGS geologists and digital cartographic specialists. Many BGS geologists have contributed over a number of years to the datasets used in the construction of the GV Models, including the national geological fence diagram (UK3D v2015) and the 1:625 000 scale bedrock geology map of the UK. For the additional geological work undertaken in the development of the GV Models the authors would like to thank Emrys Phillips, Alan Holden, Andrew Newell, and Oliver Wakefield. For QA and technical coordination, thanks to Steve Thorpe, Ricky Terrington, David Schofield, Jon Ford, Richard Haslam, Andy Farrant and Mark Woods. 3D pdf construction was undertaken by Calum Ritchie with support from Brian McIntyre. The development of the GV Models has been financially supported by Radioactive Waste Management Limited who recognise their value in communicating the 3D geology of the UK to non-technical audiences.

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Executive Summary

A series of 14 Regional Geological Visualisation Models (GV Models) for England, Wales and Northern Ireland have been produced to provide interactive, user-friendly tools for exploring the UK's geology in three dimensions. The GV Models are designed for use on desktop/laptop computers and complement the existing range of free-of-charge digital data, maps and models that are published online by the BGS.

The GV Models are based on the national fence diagram of the UK (UK3D v2015) with additional cross-sections developed along the regional boundaries, the BGS 1:625 000 scale digital bedrock geological map of the UK (DiGMapGB-625), and the BGS 1:250 000 scale marine bedrock map. These geological datasets have been combined with digital terrain, bathymetric and topographic data to develop 3D 'block models', displaying the bedrock geology of the upper 1.5 km of the crust.

Users can manipulate the model to explore the region's geology by switching on/off individual blocks, hiding or displaying groups of geological units, and zooming and rotating to view the blocks from any angle. The model legend provides information about the geological units, and select functions link to additional sources of information including the BGS Lexicon and scanned records of key boreholes that have informed the model's development.

The GV models can be downloaded via the following page of the BGS website:
www.bgs.ac.uk/research/ukgeology/nationalGeologicalModel/GVModels.html

1 Who are the Regional Geological Visualisation Models for?

The BGS makes available a range of free-of-charge digital resources covering the geology of the UK via www.bgs.ac.uk. These ‘open data’ resources are available for everyone with a personal, educational or professional interest in the UK’s geology.

Digital open-data resources delivered by BGS include geological maps, reports and conceptual 3D geological models. One of BGS’s flagship open data resources is UK3D v2015, the national fence diagram 3D bedrock model of the UK (Waters et al. 2015), which can be downloaded in a range of formats for incorporation in modelling and visualisation software.

UK3D has now been combined with digital geological maps to create a series of interactive three-dimensional (3D) visualisation models covering 14 regional areas of England, Wales and Northern Ireland. These Regional Geological Visualisation Models (the GV Models) are in 3D pdf format, and are intended to help both specialists and non-specialists alike access and interact with UK3D, and associated BGS datasets.

The GV Models depict the UK bedrock geology at regional to national-scale, and the interactive tools are designed to facilitate visualisation of the subsurface environment and enhance conceptual understanding. The representation of the geology provided by the models is indicative and should not be taken as a substitute for specialist interpretations, professional advice and/or site investigations.

2 What do the GV Models do?

The GV Models provide unique tools allow users to interactively explore the geology of the UK; discovering the diverse rocks and complex 3D structures that shape our landscape.

Fourteen separate models cover the different geological regions of England, Wales and Northern Ireland, as defined and described by the British Regional Geology (Regional Guides) Series. The GV models extend to the coast and include inland waterways, including the Solent and the Bristol Channel. In the Bristol Channel area and around the coast of Wales, the GV Models extend approximately 20 km offshore, showing the bedrock geology across the coastal zone (Figure 1).

The geology of each region is characterised as a set of 3D blocks, derived by combining geological maps depicting the distribution of rocks at the ground surface, with a network of cross-sections that show the geology down to 1.5 km depth (Figures 1 and 2). The model functions allow users to rotate, zoom, and turn on/off blocks, and isolate different parts of the geological sequence. Information on the rock units present in each region and their sequence, or ‘stratigraphic’ order, is also provided, and the model contains links to other BGS data sources including the Lexicon, the UK’s national ‘library’ of rock units.

The GV Models are published in pdf format, with each document comprising four pages with interactive links. The pages are as follows:

- an introductory page providing details about the model
- a geological model page providing interactive tools for exploring the model and a legend outlining the main geological units (Figure 2)
- an extended legend page with additional information about the geological units displayed in the model and
- an instructions page providing information on how to use the interactive tools and functions.

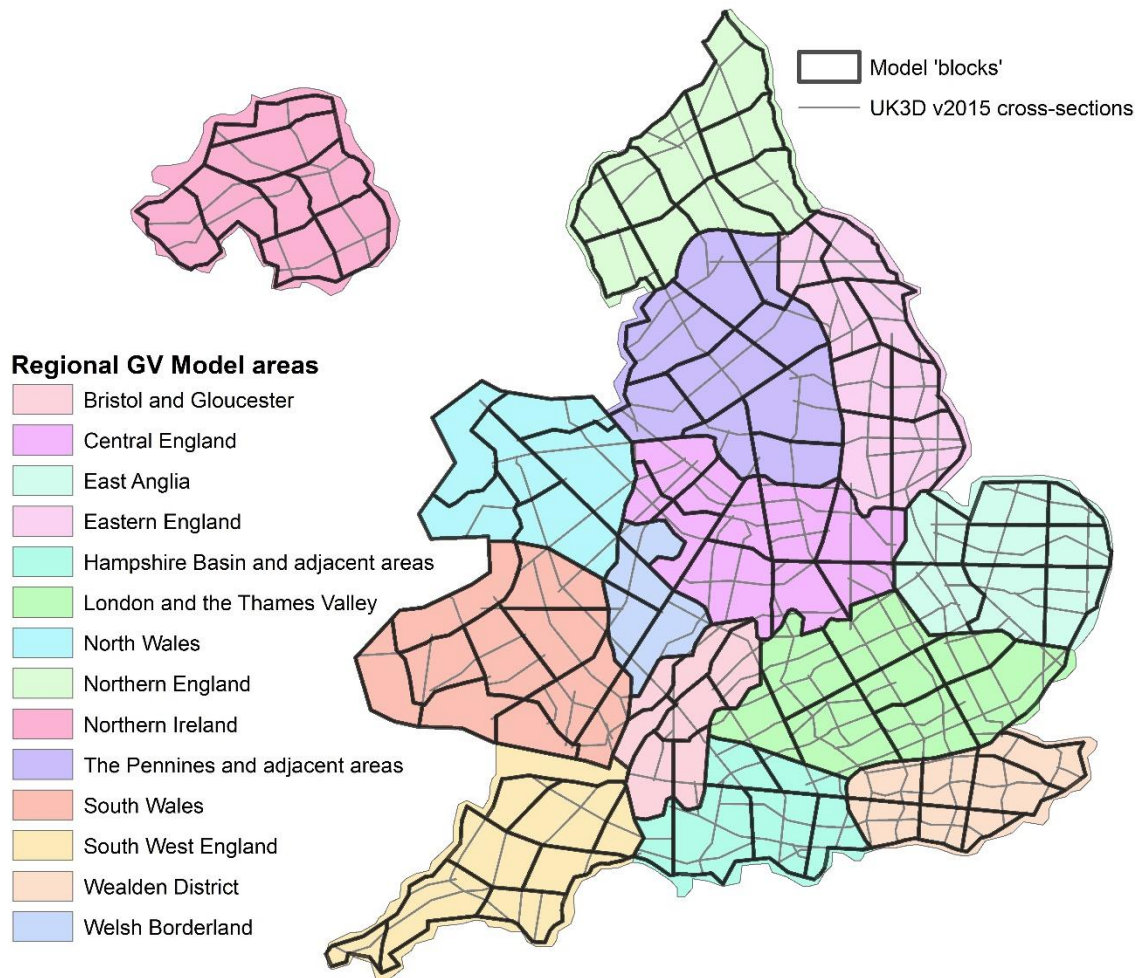


Figure 1 – Regional areas showing the locations of UK3D sections and the block structure for the GV Models. Created using ArcGIS. Copyright © Esri. All rights reserved.

3 What data are used in the GV Models?

The GV models are constructed from:

- the cross-sections from UK3D v2015
- new sections created as part of the GV Model development to complete the boundaries for each regional area
- the digital 1:625 000 scale bedrock geological map of the UK (DiGMapGB-625; BGS, 2007c)
- the digital 1:250 000 scale Marine Bedrock Map of the UK continental shelf (DiGRock250k; BGS, 2013) for coastal areas of Wales and the Bristol Channel and,
- digital elevation, bathymetric and topographic data.

UK3D v2015 is a national-scale fence diagram of intersecting sections developed by BGS through its NERC-funded National Capability programme and with support from Radioactive Waste Management Limited and the Environment Agency (Mathers et al., 2014; Waters et al., 2015). UK3D v2015 provides a regional- to national-scale geological characterisation of the bedrock in the upper 1.5 to 6 km of the crust that compliments DiGMapGB-625 (BGS, 2007c), the digital version of the 1:625 000 bedrock geological map of the UK (BGS, 2007a,b).

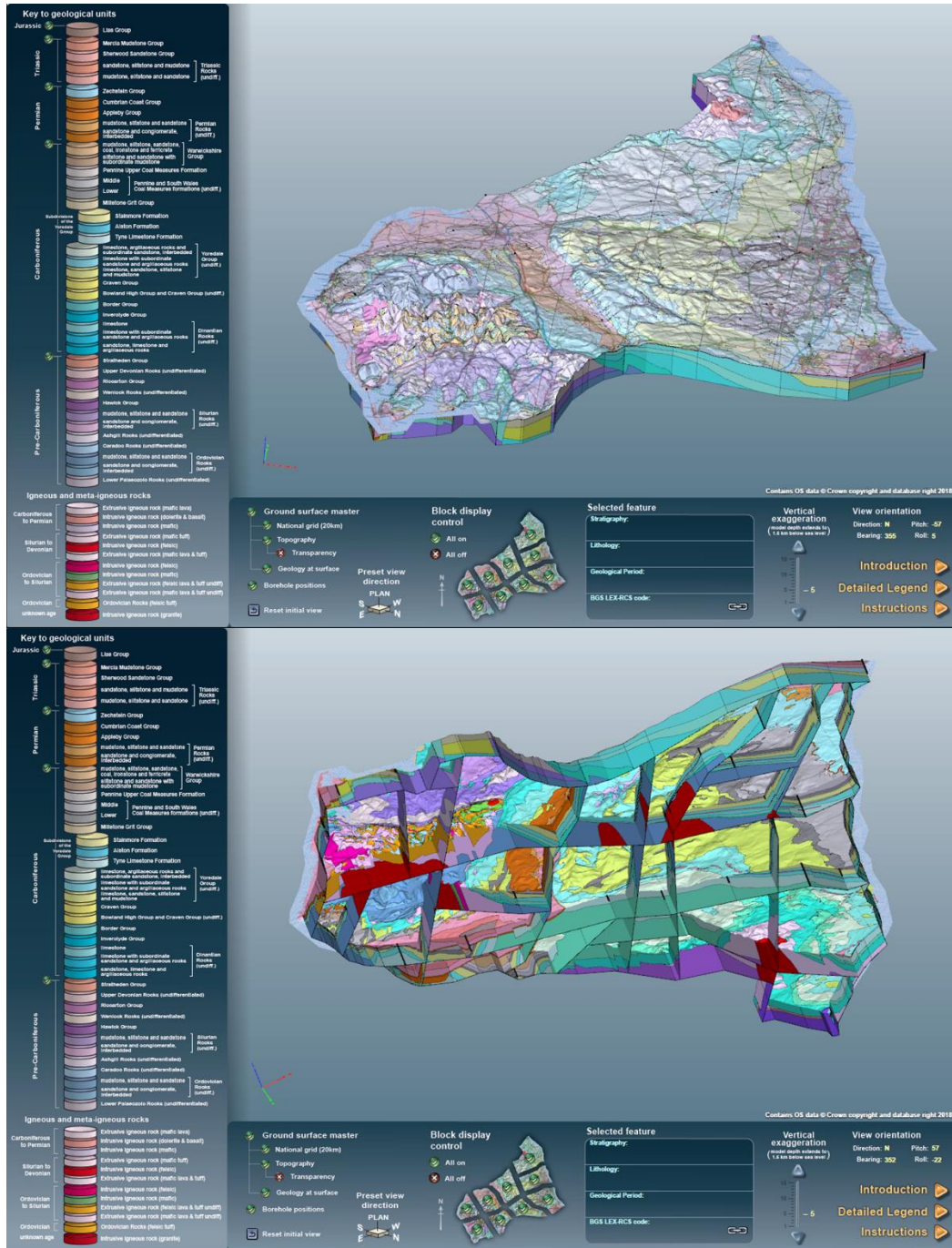


Figure 2 – Screen captures from the Northern England GV Model showing the 3D pdf (Adobe Acrobat™) block model format. Based upon British Geological Survey Geology DiGMapGB-625 and UK3D v2015 data. Contains Ordnance Survey data © Crown copyright and database rights 2018. Ordnance Survey Licence no. 100021290. Created using ArcGIS. Copyright © Esri. All rights reserved.

In addition to using the existing UK3D sections, new sections along the edges of each of the regional areas were constructed to provide complete bounding sections around each model area. These were developed following the same methodology as the UK3D v2015 model.

In coastal areas of Wales and the Bristol Channel, a simplified version of the BGS 1:250 000 scale DiGRock250 marine bedrock geology map (BGS, 2013) has been developed to show the distribution of rock types near the sea bed.

Topographic maps and terrain data have also been used in the model construction. Topographic maps for regions in England and Wales were derived from Ordnance Survey Open Data available

at 1:250 000 scale¹. For the Northern Ireland model, suitable open access topographic data was not available at the time of model development and 1:250 000 scale OS Northern Ireland (OSNI) topographic data has been used under licence².

The geological and topographic maps are draped over digital terrain data to form the capping surface of the models. Open access digital terrain model (DTM) datasets have been used for onshore areas of England, Wales and Northern Ireland in the models; the OS Terrain 50 DTM³ was used for England and Wales, and the OS Northern Ireland 10 m DTM⁴ was used for Northern Ireland. The Terrain 50 and OSNI 10 m DTMs were subsampled to 200 m and fitted to the UK3D sections.

4 How were the GV Models constructed?

The 3D block structure for each region was compiled from the digital geological map, topographic data and geological cross-sections in ArcGIS. These block models were then exported and converted for display within the Adobe Acrobat 3D pdf format. The 3D pdf documents were compiled for each region using the 3D model data and additional information including the Generalised Vertical Section (GVS) which is used for the key and extended legend.

5 What geology do the GV Models show?

Within UK3D v2015 and DiGMapGB-625, the geology is characterised using combined lithostratigraphic and chronostratigraphic frameworks consistent with the BGS Lexicon at the times of their publication (2016 and 2007 respectively). The succession of strata is typically at Group level, however Formation level strata are included in UK3D v2015 sections in some areas, providing additional detail for parts of the succession – notably in the Chalk of southern and eastern England. Note that the formation-level detail in the UK3D sections is not reflected in the geological map at the ground surface.

The UK3D v2015 sections postdate DiGMapGB-625. The geological framework used in the construction of the UK3D v2015 sections includes recent stratigraphical revisions that are not reflected in DiGMapGB-625. In most cases, the effect of differences in lithostratigraphical attribution of units between the map and the model is minor at the scale of the GV Models. In a few cases, the stratigraphical revisions have involved changes to the attribution of the Group Level stratigraphy, for example to the Yoredale Group and Millstone Grit Group in parts of northern England, and the Warwickshire Group replacing part of the South Wales Upper Coal Measures Formation in South Wales, leading to apparent discrepancies between the UK3D v2015 and DiGMapGB-625 distributions of these units.

Some structurally complex zones, particularly those associated with minor igneous intrusions, may be represented in the surface geological map but not in the UK3D cross-sections. This is due to the relatively small scale of many of these features and limited constraint on the geometry of such structures at depth.

Superficial deposits which occur as a relatively thin layer of recent sediments overlying bedrock in many onshore and offshore areas are not shown within the models. Superficial deposits are typically thin (< 10 m) in onshore areas, however thicker accumulations do occur locally. Sea bed sediments are also present in inshore areas, where they are typically considerably thicker than

¹ <https://www.ordnancesurvey.co.uk/business-and-government/products/strategi.html>

² <https://mapshop.nidirect.gov.uk/Catalogue/Digital-products/Raster-mapping/1-250-000-raster-mapping>

³ <https://www.ordnancesurvey.co.uk/business-and-government/products/terrain-50.html>

⁴ <https://www.nidirect.gov.uk/articles/10m-digital-terrain-model-height-data>

superficial deposits onshore. The absence of superficial deposits within the model represents a simplification of the geological system in the near-surface.

Selected boreholes were included within the UK3D v2015 sections, to help constrain the geological interpretation. The locations of these boreholes are shown as sticks within the GV Models (Figure 2). Original scanned logs and records for these boreholes, where available, can be accessed via hyperlinks in the model viewer. It should be noted that many additional boreholes were consulted by project geologists during UK3D v2015 construction to help constrain the model representation, this includes boreholes that are located off-section and therefore they are not shown explicitly in the GV Models.

6 Using the GV Models

The approved GV Models are available for general use via an Open Government Licence. The models can be downloaded directly from the BGS website via the following link: www.bgs.ac.uk/research/ukgeology/nationalGeologicalModel/GVModels.htm.

The GV Models are designed for use on desktop/laptop computers running Microsoft Windows / Apple operating systems and performance has been optimised for an adequate hardware level and graphics capability. The models are not designed for use on smart phones and tablets.

Model usage will require/be enhanced by adjusting the following settings within the 3D pdf document:

- Adobe Acrobat preference settings for JavaScript and 3D content should be enabled;
- When run on an adequate PC or laptop the 'Auto-Degrade', found in the pdf preferences settings for 3D & Multimedia, can be set to 'None' to give smoother display in view rotations;
- When viewing the document or interacting with the 3D geological model no other Acrobat tools are needed allowing the document to be viewed in full screen mode to utilise the full screen area.

Instructions for the use of the interactive controls to explore the geological model are provided on the final page of the GV Model document. This page can be accessed by clicking on the 'Instructions' link found on each page of the model.

7 Limitations and restrictions

The GV Models are designed to support conceptual understanding of the bedrock geology of England, Wales and Northern Ireland for visualisation purposes, generally consistent with scale of DiGMapGB-625. The representation of the geology provided by the models is indicative and should not be taken as a substitute for specialist interpretations, professional advice and/or site investigations.

Consistency in the geological characterisation between the UK3D v2015 sections and DiGMapGB-625 has been ensured wherever possible, however local differences between the sections and DiGMapGB-625 occur within the GV Models. These inconsistencies are due to: (1) changes in the stratigraphic framework used between development of DiGMapGB-625 and the UK3D v2015 sections, and; (2) limitations of the UK3D v2015 section resolution in relation to the depiction of complex structures.

Superficial deposits are not included in the GV Models. These deposits overlie bedrock over much of the UK (both onshore and offshore) but are typically thin (< 10 m) in onshore areas. Where

thicker accumulations of superficial deposits occur at the sea bed, and locally onshore, the GV Models represent a simplification of the geology in the near surface.

The GV Models have been designed and tested for use on modern desktop/laptop computers. The large data content of the 3D pdf models may affect usage and performance on computers running alternative operating systems (i.e. not Microsoft Windows / Apple) or with limited graphics or processing capability.

The GV Models are not designed for use on smart phones or tablets and will not function effectively on these devices.

The 3D pdfs utilise functionality provided by Adobe Systems Incorporated (Adobe). The 3D platform is currently supported by Adobe, and there is no indication of future restrictions in its use. However, BGS does not have control over future provisions of support by Adobe for the 3D pdf platform.

References

British Geological Survey holds most of the references listed below, and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at: <https://envirolib.apps.nerc.ac.uk/olibcgi>.

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