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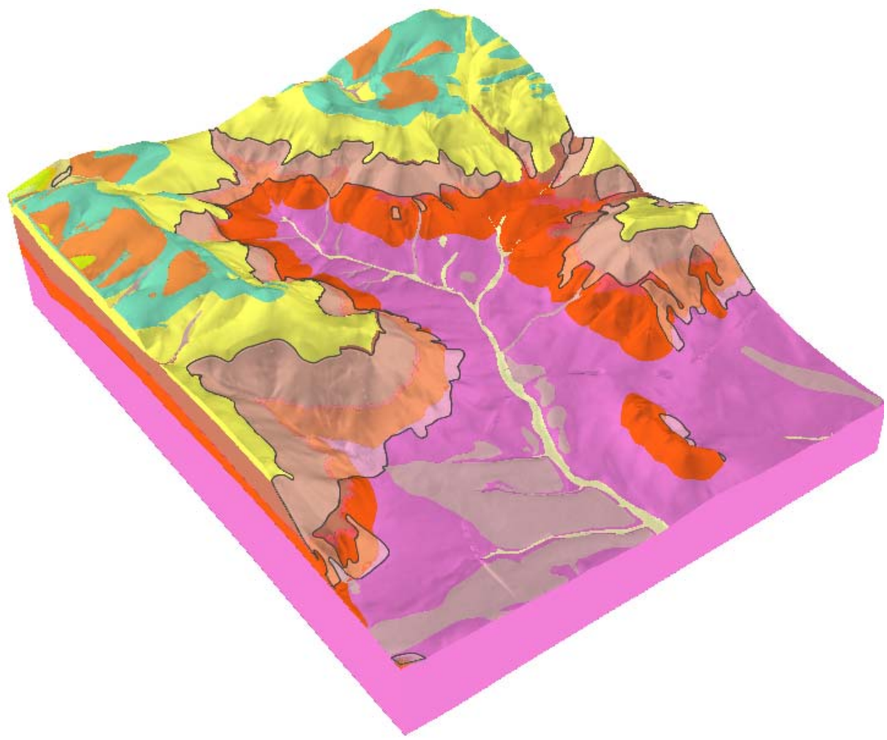
Model metadata report for Winchcombe 3D teaching model

Geological Modelling Systems Programme

Open Report OR/13/052



BRITISH GEOLOGICAL SURVEY

GEOLOGICAL MODELLING SYSTEMS PROGRAMME

OPEN REPORT OR/13/052

Model metadata report for Winchcombe 3D teaching model

H V Gow

Keywords

GSI3D, 3D geological model, Winchcombe, Cotswolds, teaching model, educational model.

Map

Sheet 217, 1:50 000 scale, Moreton-in-Marsh

Front cover

3D geological model of Winchcombe looking NE to SW.

Bibliographical reference

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Foreword

This report is the published metadata details of a 3D modelling study by the British Geological Survey (BGS), and is based on an area in the Cotswolds called Winchcombe. The model was developed under the 3D Models for Teaching project, part of the Geological Modelling Systems programme at BGS. 3D geological models have great potential as a resource for universities when teaching foundation geological concepts as it allows the student to visualise and interrogate UK geology. They are especially useful when dealing with the conversion of 2D field, map and GIS outputs into three dimensional geological units, which is a common problem for all students of geology. Today's earth science students use a variety of skills and processes during their learning experience including the application of schema's, spatial thinking, image construction, detecting patterns, memorising figures, mental manipulation and interpretation, making predictions and deducing the orientation of themselves and the rocks. 3D geological models can reinforce spatial thinking strategies and encourage students to think about processes and properties, in turn helping the student to recognise pre-learnt geological principles in the field and to convert what they see at the surface into a picture of what is going on at depth.

Acknowledgements

A number of individuals have contributed to the project. This assistance has been received at all stages of the study. In addition to the collection of data, many individuals have given their advice, and provided local knowledge. We would particularly like to thank the following:

Emma Ward

Ricky Terrington

Steve Thorpe

Mark Barron

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Summary

This report summarises the data, information and methodology used in the construction of the 3D model of Winchcombe. The model was constructed using GSI3D v2013 and is of mass-movement, superficial and bedrock deposits.

1 Modelled volume, purpose and scale

This model concentrates on the superficial and bedrock deposits of an area surrounding Winchcombe in the Cotswolds (figure 1). The area was selected from the 1:50,000 scale map sheet 217 Moreton-in-Marsh, as an area of classic British geology for teaching students geological concepts. As the geological deposits are not folded and relatively flat, students can use this model to explore and investigate in detail the relationships between the topography and outcrop patterns. Concepts can be introduced such as faulting, stratigraphy, outcrop v-patterns, outliers and inliers, hazard potential and tourism.

The model is suitable for use at 1:50,000 scale and shown to a depth of 100 m below OD. The depth range from the highest point to the base of the model is 430 m.

Figure 1 – Location of Winchcombe and modelled area

2 Modelled surfaces/volumes

Below is a list of units that have been modelled as volumes in the Winchcombe teaching model (LEX codes in brackets):

Landslip (SLIP)

Alluvium (ALV)

Head (HEAD)

White Limestone Formation (WHL)

Hampen Formation (HMB)

Taynton Limestone Formation (TY)

Fuller's Earth Formation (FE)

Chipping Norton Limestone Formation (CNL)

Salperton Limestone Formation (SALS)

Aston Limestone Formation (ASLS)

Birdlip Limestone Formation (BLPL)

Whitby Mudstone Formation (WHM)

Marlstone Rock Formation (MRB)

Dyrham Formation (DYS)

Charmouth Mudstone Formation (CHAM)

Only formation levels have been modelled in this project to provide a simplified conceptual model for teaching purposes.

3 Modelled faults

Faults were included in this model but were modelled using a superficial 'stepped' method rather than modelling the fault network in the GSI3D bedrock package.

Only the major faults were included that extended at surface for 1 km or more (figure 2). Smaller faults were excluded.

Fault dips and termination depths were taken from the image cross-sections on 1:50,000 series Moreton-in-Marsh 217 map sheet.

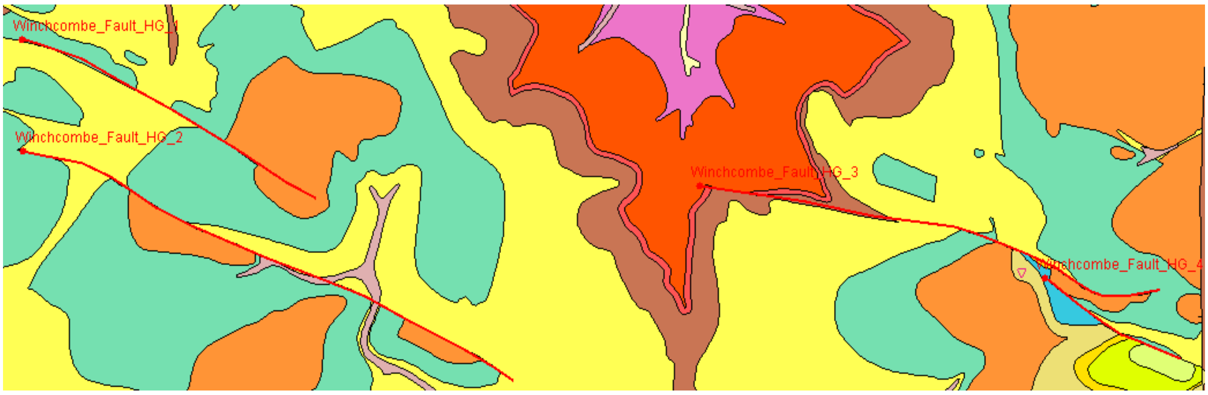

Figure 2 - Significant fault locations

4 Model datasets

General caveats regarding BGS datasets and interpretations are:

- Geological observations and interpretations are made according to the prevailing understanding of the subject at the time. The quality of such observations and interpretations may be affected by the availability of new data, by subsequent advances in knowledge, improved methods of interpretation, improved databases and modelling software, and better access to sampling locations.
- Raw data may have been transcribed from analogue to digital format, or may have been acquired by means of automated measuring techniques. Although such processes are subjected to quality control to ensure reliability where possible, some raw data may have been processed without human intervention and may in consequence contain undetected errors.

4.1 DIGITAL TERRAIN MODEL (DTM)

The model is capped by a 10 m DTM that was created via the GSI3D Terrain Creation tool, and subsampling the Bald Earth Model.

4.2 BOREHOLE DATA

Many boreholes in this location had previously been coded to the required standard for Cotswolds Upper Thames (CU) and Wormington-Saperton (WS) projects. These boreholes were given the highest priority in this project. The remaining boreholes were coded by Hannah Gow for the 3D Models for Teaching project (3D), using the Unlithified Deposits Coding Scheme (Cooper et al, 2006). The content codes CU, WS and 3D were used to extract the relevant data files needed for GSI3D.

4.3 MAP DATA

- BGS 1:50,000 superficial and bedrock DiGMap GB was used for outcrop and geological unit formation (Version 7.22, bedrock released 15/04/2013, superficial released 26/04/2013).
- OS 1:50,000 map data was used as the base topographical map.

4.4 GENERALISED VERTICAL SECTION (GVS) AND GEOLOGICAL LEGEND (GLEG)

Table 1 - GVS used in Winchcombe 3D model

Name	Stratigraphy	Lithology	LEX-RCS	Age	Description
SLIP-UKNOWN	SLIP	UKNOWN	SLIP-UKNOWN	Quaternary	Landslide deposits
ALV-XCZSV	ALV	XCZSV	ALV-XCZSV	Quaternary	Alluvium
HEAD-XCZSV	HEAD	XCZSV	HEAD-XCZSV	Quaternary	HEAD - CLAY, SILT, SAND AND GRAVEL [UDCS]
WHL-LMST	WHL	LMST	WHL-LMST	Jurassic	WHITE LIMESTONE FORMATION: including all g6 Oolite mapped north of R Frome on Gloucester
HMB-LMST	HMB	LMST	HMB-LMST	Jurassic	HAMPEN FORMATION
TY-LMOOL	TY	LMOOL	TY-LMOOL	Jurassic	TAYNTON LIMESTONE FORMATION. OOLM to LMOOL 3/11/11
EYF-LMST	EYF	LMST	EYF-LMST	Jurassic	EYFORD MEMBER, thin-bedded sandy limestones in the top of the Fuller's Earth Fm
FE-MDST	FE	MDST	FE-MDST	Jurassic	FULLER'S EARTH FORMATION
CNL-LMOOL	CNL	LMOOL	CNL-LMOOL	Jurassic	CHIPPING NORTON LIMESTONE FORMATION
SALS-LMOOL	SALS	LMOOL	SALS-LMOOL	Jurassic	SALPERTON LIMESTONE FORMATION: OOLM to LMOOL 3/11/11 (formerly 'Upper Inferior Oolite')
ASLS-LMST	ASLS	LMST	ASLS-LMST	Jurassic	ASTON LIMESTONE FORMATION (formerly 'Middle Inferior Oolite')
BLPL-LMOOL	BLPL	LMOOL	BLPL-LMOOL	Jurassic	BIRDLIP LIMESTONE FORMATION. OOLM to LMOOL 3/11/11 (formerly 'Lower Inferior Oolite')
WHM-MDST	WHM	MDST	WHM-MDST	Jurassic	WHITBY MUDSTONE FORMATION (formerly 'Upper Lias (Clays)'
MRB-FLMST	MRB	FLMST	MRB-FLMST	Jurassic	MARLSTONE ROCK FORMATION. LMFE to FLMST 3/11/11 (may be included at top of 'Middle Lias')
DYS-SIMD	DYS	SIMD	DYS-SIMD	Jurassic	DYRHAM FORMATION (formerly lower, majority part of 'Middle Lias (Silts)'
CHAM-MDST	CHAM	MDST	CHAM-MDST	Jurassic	CHARMOUTH MUDSTONE FORMATION (formerly 'Lower Lias (Clays)', but this may include Blue Lias Formation as lower part)

Table 2 - GLEG used in Winchcombe 3D model

SLIP-UKNOWN	DESCRIPTION	255	222	196	255
ALV-XCZSV	DESCRIPTION	255	255	176	255
EYF-LMST	DESCRIPTION	54	201	224	255
FE-MDST	DESCRIPTION	160	117	100	255
HMB-LMST	DESCRIPTION	224	255	0	255
CNL-LMOOL	DESCRIPTION	224	255	0	255
TY-LMOOL	DESCRIPTION	255	255	0	255
WHL-LMST	DESCRIPTION	224	255	117	255

ASLS-LMST	DESCRIPTION	117	224	176	255
SALS-LMOOL	DESCRIPTION	255	148	54	255
BLPL-LMOOL	DESCRIPTION	255	255	84	255
WHM-MDST	DESCRIPTION	201	117	84	255
DYS-SIMD	DESCRIPTION	255	84	0	255
MRB-FLMST	DESCRIPTION	255	84	84	255
CHAM-MDST	DESCRIPTION	237	117	201	255
HEAD-XCZSV	DESCRIPTION	224	176	176	255
ALV	DESCRIPTION	255	255	176	255
EYF	DESCRIPTION	54	201	224	255
FE	DESCRIPTION	237	224	117	255
CNL	DESCRIPTION	224	255	0	255
HMB	DESCRIPTION	224	255	0	255
TY	DESCRIPTION	255	224	0	255
WHL	DESCRIPTION	224	255	117	255
ASLS	DESCRIPTION	117	224	176	255
SALS	DESCRIPTION	255	148	54	255
BLPL	DESCRIPTION	255	255	84	255
WHM	DESCRIPTION	201	117	84	255
DYS	DESCRIPTION	255	84	0	255
MRB	DESCRIPTION	255	84	84	255
CHAM	DESCRIPTION	237	117	201	255
HEAD	DESCRIPTION	224	176	176	255
FLMST	DESCRIPTION	255	84	84	255
LMOOL	DESCRIPTION	130	201	220	255
LMST	DESCRIPTION	255	224	84	255
MDST	DESCRIPTION	160	117	100	255
SIMD	DESCRIPTION	255	84	0	255
XCZSV	DESCRIPTION	255	255	176	255

5 Dataset integration

All the data was brought together in the GSI3D modelling software package, where it can be viewed and interrogated in 2D and 3D.

6 Model development log

During the course of a modelling project, a running log is kept of the development, changes and decisions made by the modeller (figure 3). These records are kept as part of the model storage and metadata (QA) process and can be accessed as needed.

Winchcombe Development Log - HG

Originally started a project for an area around Moreton-In-Marsh but it was decided to move the area to Winchcombe as more features could be picked out for Emma's original teaching questions.

12/09/2013
Project set up
Added DTM 5 m bald Earth – Using GSI3D tools – DTM set to 10m resolution
Added raster backdrop images to cross sections taken from the Morton in Marsh 217 50k map sheet 2000 and 1981.
DigMap 50k bedrock and superficial added
GVS and GLEG taken from the Cotswolds Upper Thames 3D modelling project

18/09/13
Finished drawing EW sections
Winchcombe_v1.6.gsipr
Decided to only model the formations and not members
ROBA - ASLS
NGRV - ASLS
HFD - BLPL
SQAR - BLPL
CLCL - BLPL
LECK - BLPL
CRKY – BLPL
UTG – SALS
CG – SALS

Figure 3 - Example of a model development log

7 Model workflow

A standard GSI3D workflow for superficial geological models was followed according to Kessler et al (2009). The bedrock units were defined as superficial units in GSI3D for display purposes.

8 Model assumptions, geological rules used etc.

- Fault dips and depths were taken from the diagram cross-sections on the Moreton-in-Marsh 1:50,000 scale map sheet. These were assumed to be present and correct.
- To improve the calculation of the landslip unit, a depth of 5 m was applied to the DTM and exported as a grid of points. This grid was trimmed by the landslip surface distribution polygon (which was further buffered by 2 m around its outline). The resulting grid has been used to form the base of the landslip unit and makes the assumption that the slip is 5 m deep throughout the model.
- Assumption that Charmouth Mudstone Formation is present to the base of the model. The geology at this depth is largely unknown.

9 Model limitations

- The model does not reflect the full complexity of the geology in this area. This was limited by the data found within the boreholes and trial pits (figure 4).
- Only formation levels were modelled, members were 'dissolved' into their parent formation.
- Only significant faults were modelled, small faults were excluded.

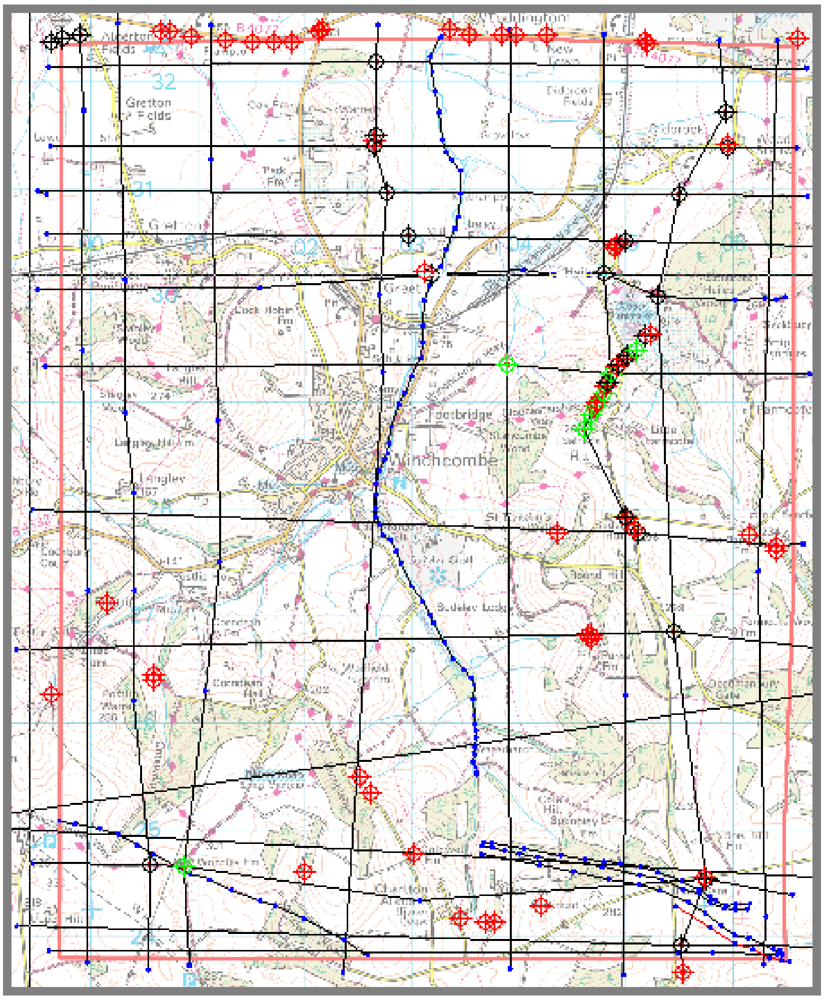

Figure 4 - Cross-sections and borehole locations

10 Model images

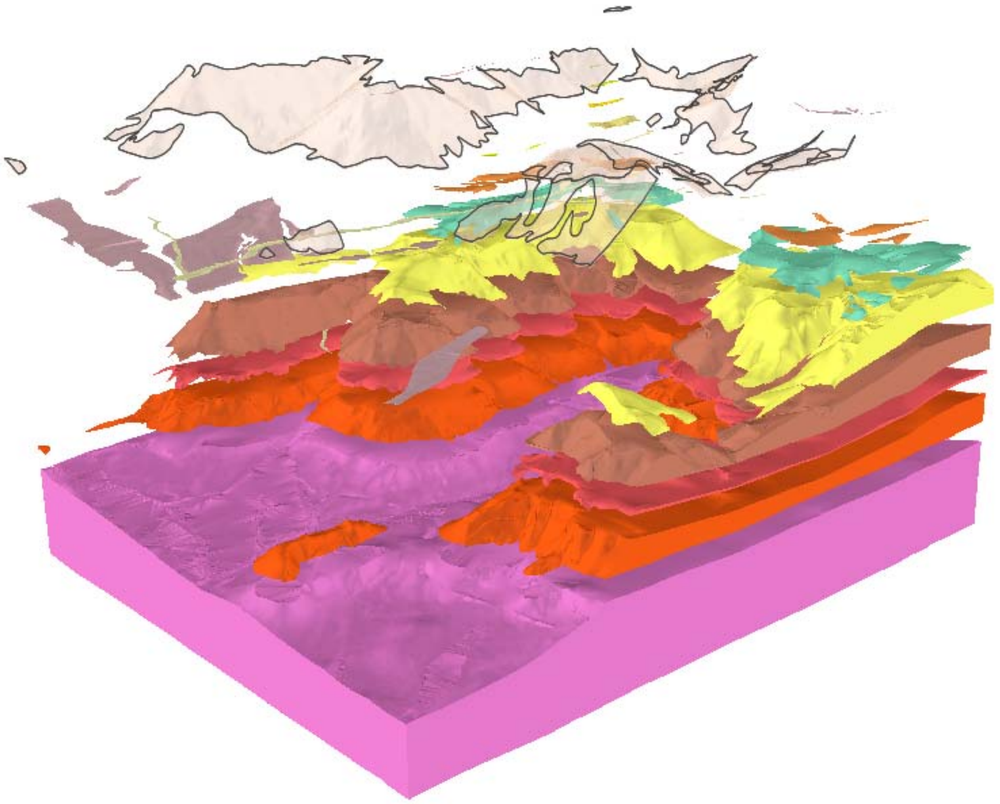

Figure 5 - Exploded view of Winchcombe model (x5 vertical exaggeration)

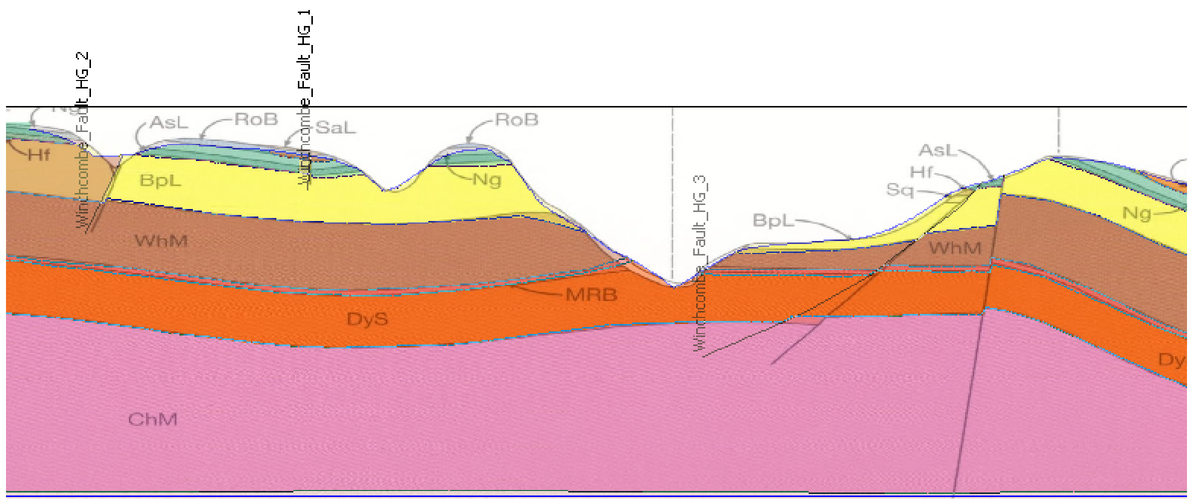

Figure 6 - Moreton-In-Marsh 1:50,000 scale map image as a backdrop in GSI3D cross-section

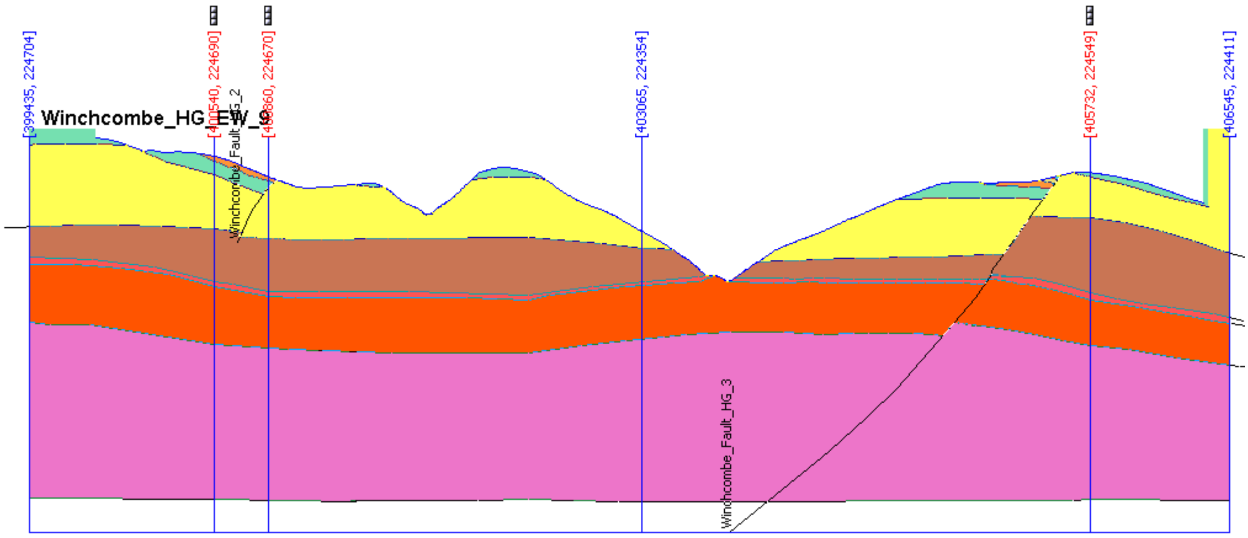

Figure 7 - Cross-section showing modelled geology and faults (x5 vertical exaggeration)

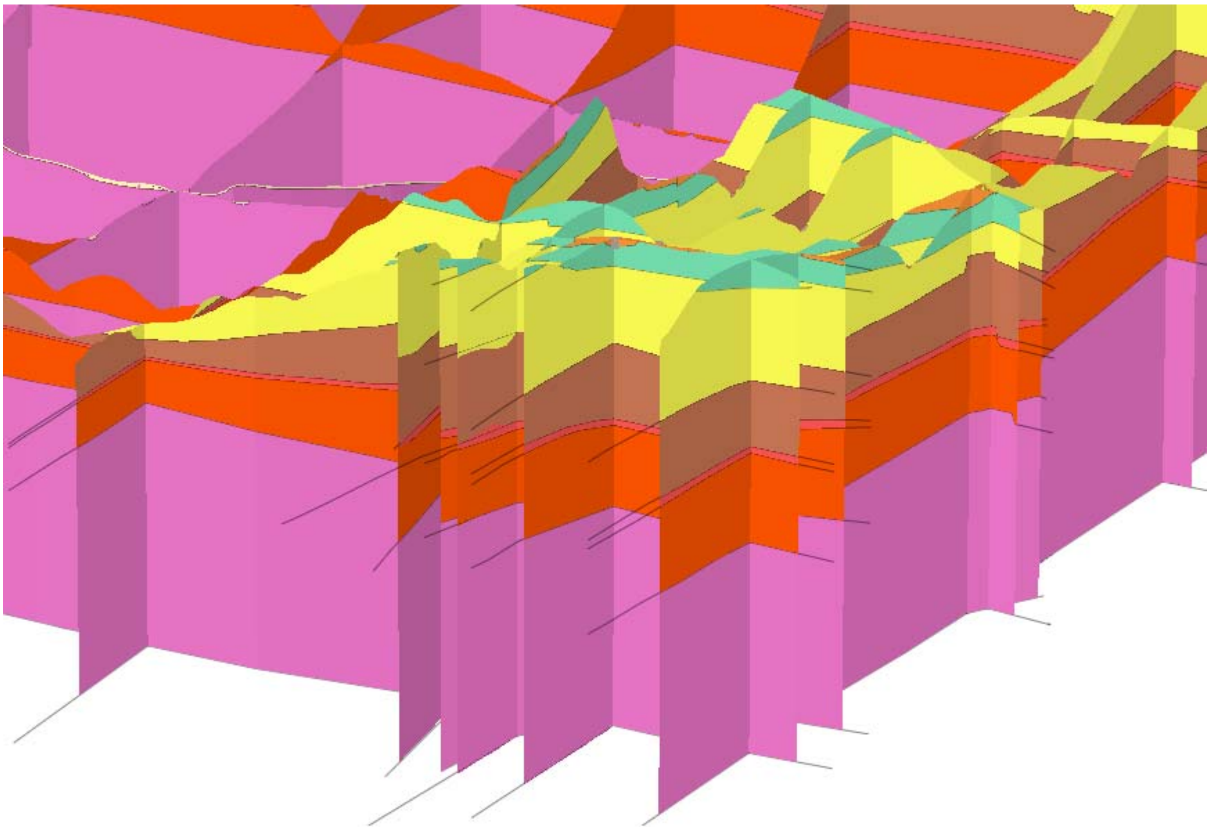

Figure 8 - Correlated cross-sections in 3D (x5 vertical exaggeration)

11 Model Uncertainty.

To date no attempt has been made to quantify the uncertainty in this model

Glossary

BGS	British Geological Survey
DTM	Digital Terrain Model – Model of surface of the solid Earth (generally the boundary between geosphere and atmosphere or hydrosphere). This is traditionally derived from OS contours and spot heights and should therefore exclude all buildings, trees, hedges, crops, animals etc. Sometimes also referred to as 'bald earth' models
GLEG	Geological legend file
GSI3D	Geological Surveying and Investigation in 3D
GVS	Generalised vertical section
LEX	Lexicon code. The Lexicon of Named Rock Units database provides BGS definitions of terms that appear on our maps and in our publications

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: http://geolib.bgs.ac.uk.

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