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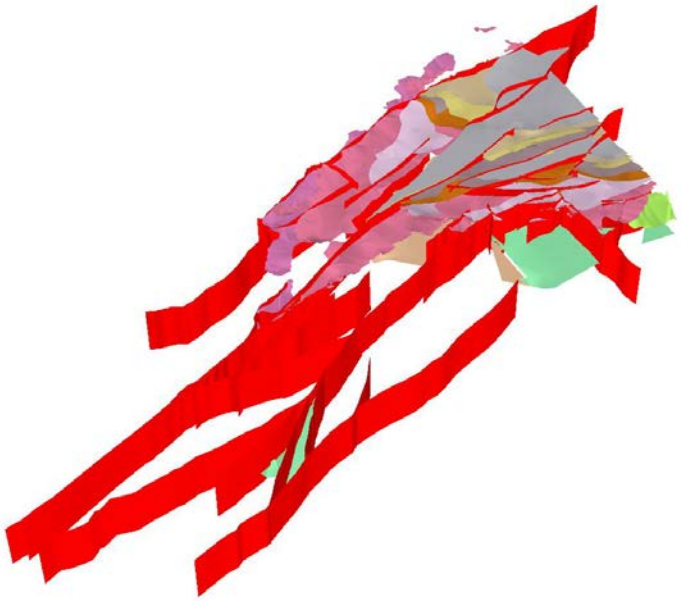
Model metadata report for the Great Glen – Moray Firth GSI3D Faulted Bedrock Model

Geology and Regional Geophysics Scotland

OR/14/058



BRITISH GEOLOGICAL SURVEY

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Model metadata report for the Great Glen – Moray Firth GSI3D Faulted Bedrock Model

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Front cover

Image from GSI3D window showing geological units and faults.

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Summary

This report describes the model of faulted bedrock of the Lower Cretaceous to Lower Devonian sedimentary sequence found within the Great Glen corridor, including the upper reaches of the Moray Firth, (Figure 1).

1 Modelled volume, purpose and scale

The model was based initially on sections drawn for the GB_3D to test and develop GSI3D's bedrock capabilities in complex geological terranes and to improve our geological understanding of the geology/structure of the area for the Lower Devonian – Cretaceous sedimentary succession. The model is suitable for use at scales between 1:250 000 – 1:750 000 and to a depth of 3,000 m.

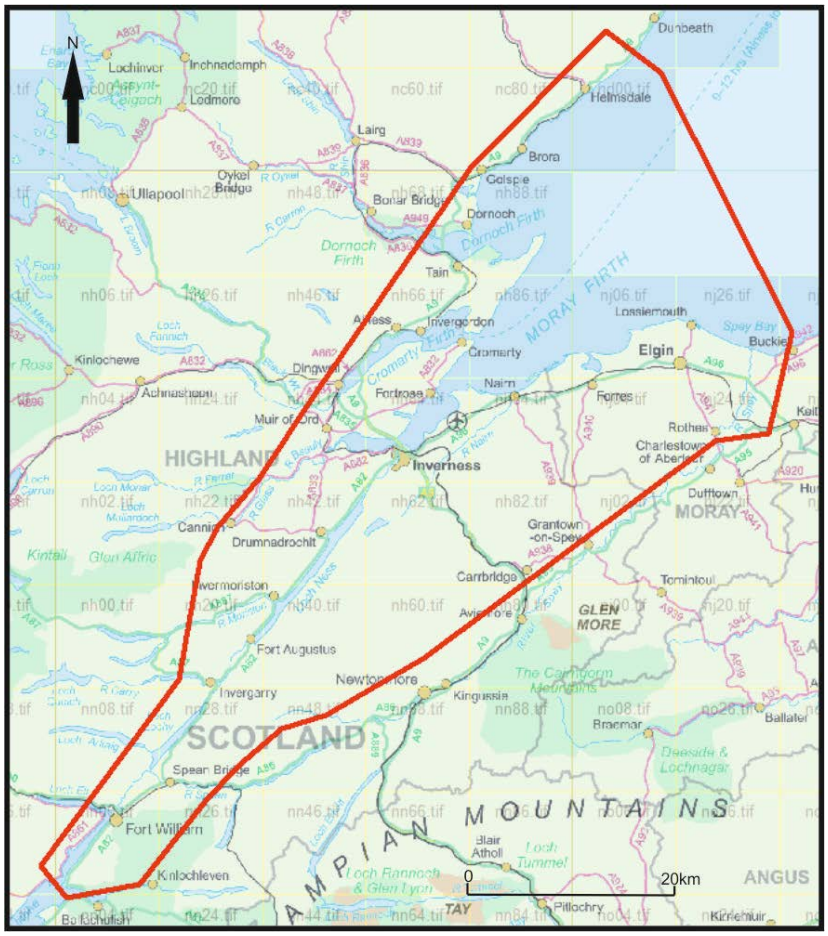

Figure 1: Location of modelled area, outlined in red

2 Modelled surfaces/volumes

The sedimentary sequence consists of 9 geological units:

Units modelled		**Offshore equivalents**	
LOCR-SSML	Lower Cretaceous	CRKN-ARG	Cromer Knoll Group
JURU-SDSM	Upper Jurassic	HMBG-ARSL	Humber Group
JURM-MDSL	Middle Jurassic	FLDN-SMC & JURM-ARSM	Fladen Group – Middle Jurassic Rocks
LI-MSLS	Lias,Lower Jurassic	LI-SDAR	Lias Group
NRS-SDBC	Permian-Triassic	PRMT-SDAR	Permian and Triassic Rocks (undifferentiated)
UDEV-SCON	Upper Devonian	UORS-SDST	Upper Old Red Sandstone
MDEV-SCON	Middle Devonian	MDEV-COSD	Middle Devonian (undifferentiated)
LORS-CSSM	Lower Devonian		
ORS-CSSM	undifferentiated Devonian,slices within fault zones		

Table 1: Geological units modelled

The onshore geology is based on the BGS 625 000 geological map. The offshore geology is based on the BGS 250 000 map. All units are labelled with BGS LEX-RCS codes, see Figures 2 and 3.
Geological units modelled are as used in the GB_3D sections on which the model is based.
Offshore units were merged into their onshore equivalents, as shown in Table 1.

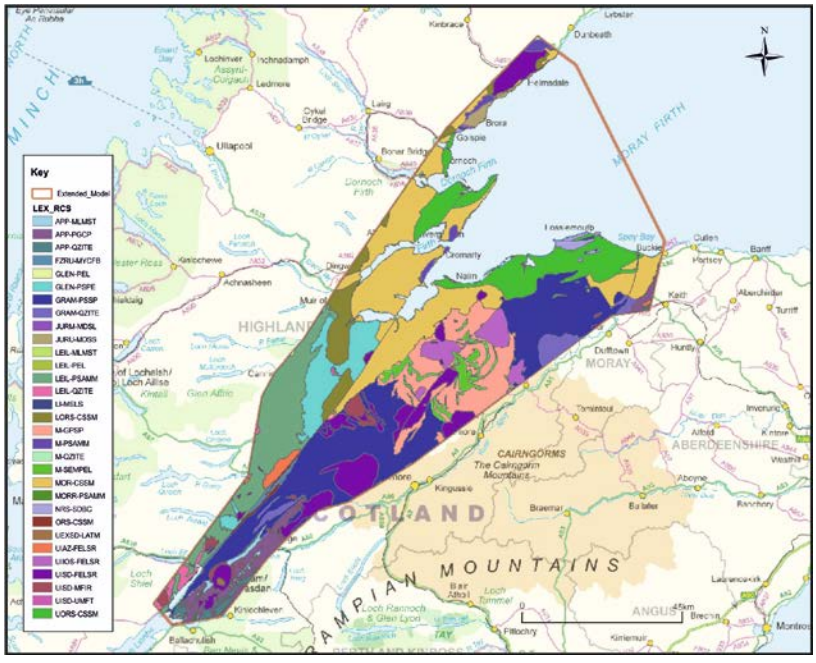

Figure 2: Onshore geology based on the BGS 1:625 000 onshore geological map

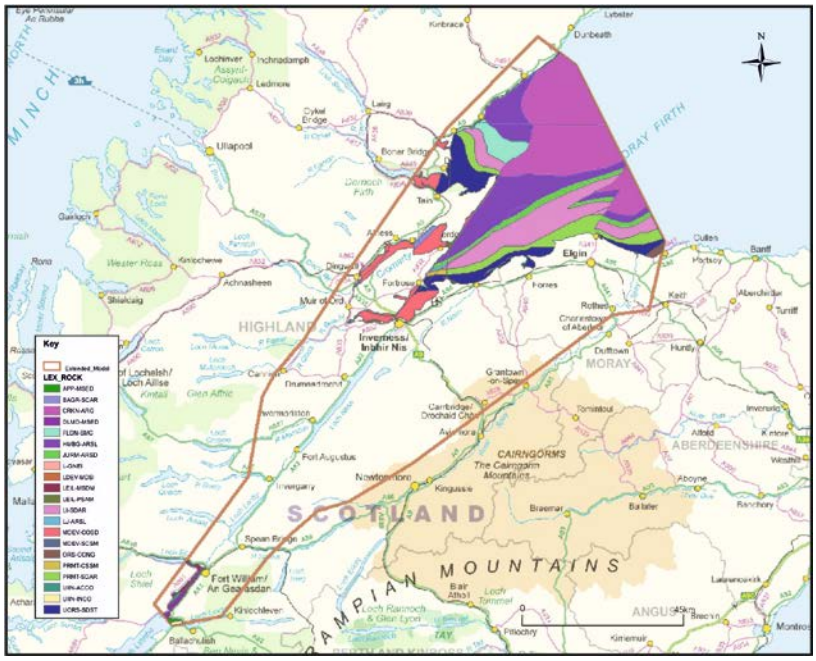

Figure 3: Offshore geology based on the BGS 1:250 000 offshore geological map

3 Modelled faults

Seven faults were initially included in the model from the GB_3D project, (Figure 4). Fault selection included the largest faults known in the area. Where fault zones exist they have been simplified to a single fault. All faults have been modelled as planar structures with a steep dip. Two of the faults which extended way beyond the project area were clipped so their extent is within the model DTM. Some of the fault lines were edited to better fit with the geological map. Crossing faults were checked for complete overlap at depth, and that a single node extended beyond the crossing fault. Fault helper sections were drawn at the end of faults which pinched out within the project area. During the course of the work an additional 31 steeply dipping faults were modelled, (Figure 5).

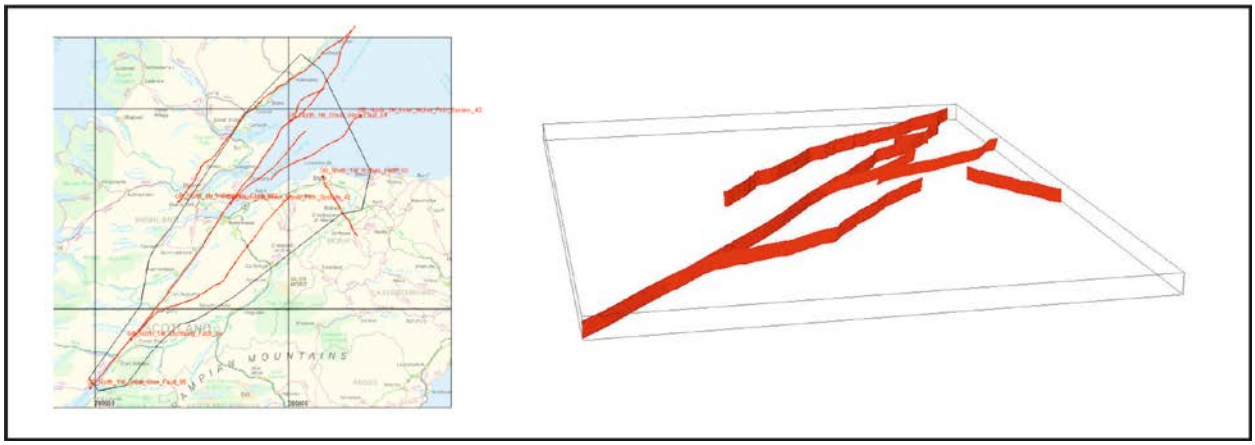

Figure 4: Faults modelled as shown in the GSI3D map window and 3D window from the GB-3D project.

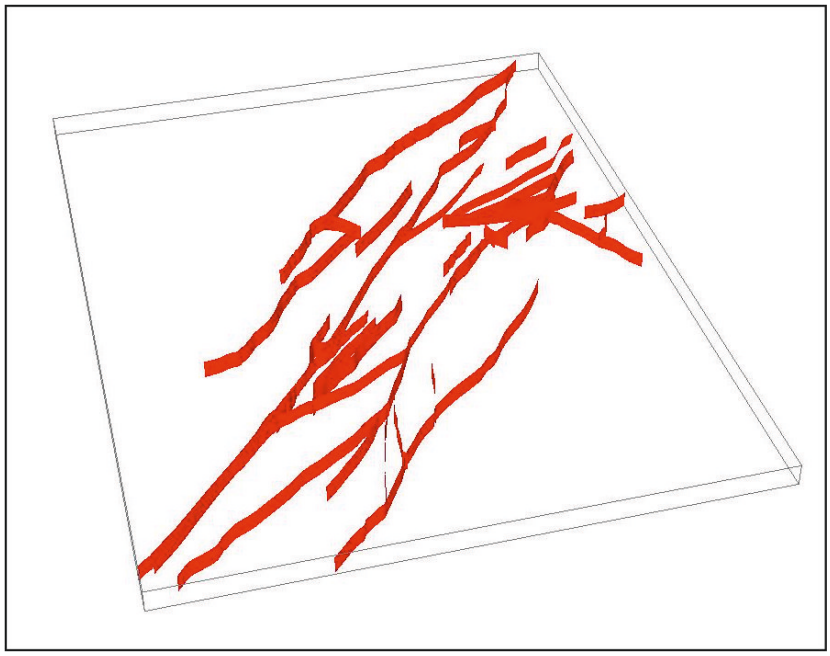

Figure 5: Additional steep dipping faults as shown in the GSI3D 3D window.

4 Model datasets

4.1 BOREHOLE DATA

No borehole data has been used in the construction of the model. Although there are a number within the area, the majority are either too shallow or not detailed enough to help with this model.

4.2 MAP DATA

- Topographic map, 1:1 000 000 scale, clipped from the GDI, with attached world file.
- Onshore geological information, 625 000 bedrock, superficial and faults, clipped from the GDI.
- Offshore geological information, 250 000 bedrock and faults were clipped from the GDI. The data was re-projected to British National Grid to be compatible with the onshore datasets. The offshore map data does not colour up in GSI3D as it has different LEX-RCS units to those in the GVS/GLEG.

4.3 DTM DATA

The ‘Bald Earth’ DTM was extracted at 250 m resolution and is stored as a TIN within the GSI3D workspace. A model limitation is that bedrock units are drawn up to Bald Earth DTM rather than to the base of the superficial deposits (rockhead surface).

4.4 EXISTING SECTION DATA

Currently 37 existing sections have been used: (Figure 6):

- The model is based on geological information shown in 9 sections imported from the GB_3D project. These sections were drawn by 'regional geologists' and have been largely unchanged, only minor edits were made in places to provide consistency, in addition to snapping to crossing sections and outcrops/subcrops.
- A section on the Moray-Buchan 250 000 map across the Moray Firth was scanned, saved as a raster and imported as a backdrop image to a section to help give some control on the thicknesses of units in that area. Sections on the onshore 50 000 maps are shallow and deemed not worth importing.
- An additional network of 13 sections was used to constrain the model.
- 4 Sections bound the model edges.
- 6 Fault helper sections were drawn where faults pinch out within the project.
- 4 Additional helper sections were needed to ensure there is a section passing through each polygon shown on the geological map such as several small Permian and Devonian outliers in the south-east of the model.

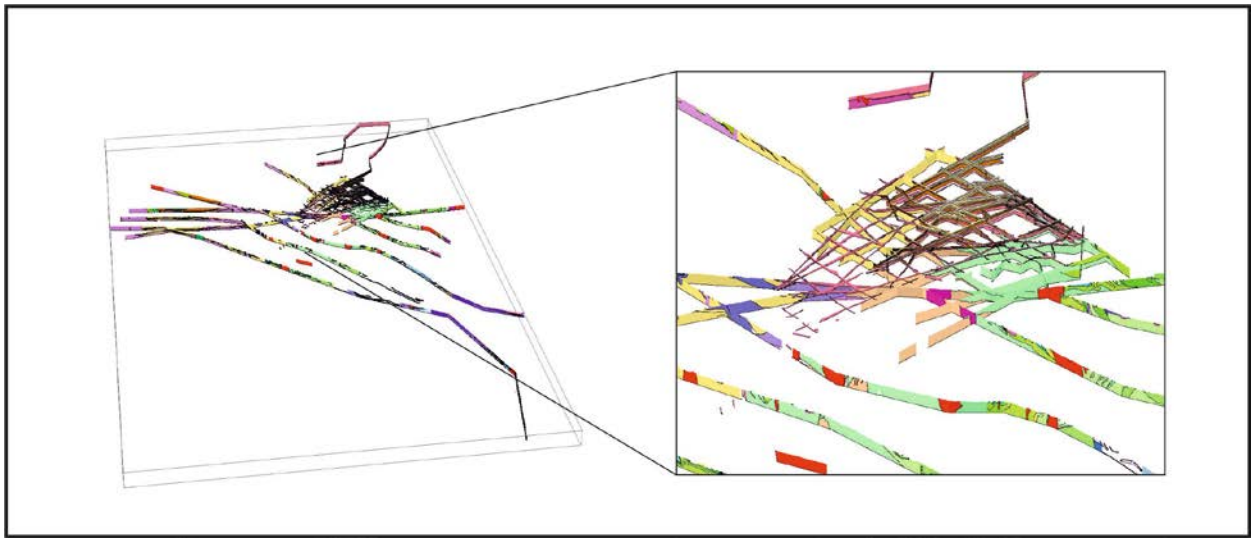

Figure 6: Cross-sections as seen in GSI3D window, left for original model. Close up view of cross sections, right. Note that many of the longer sections only contain data within the model area for Devonian and younger rocks: older strata from GB-3D lines have been removed as they have been superseded by more recent versions.

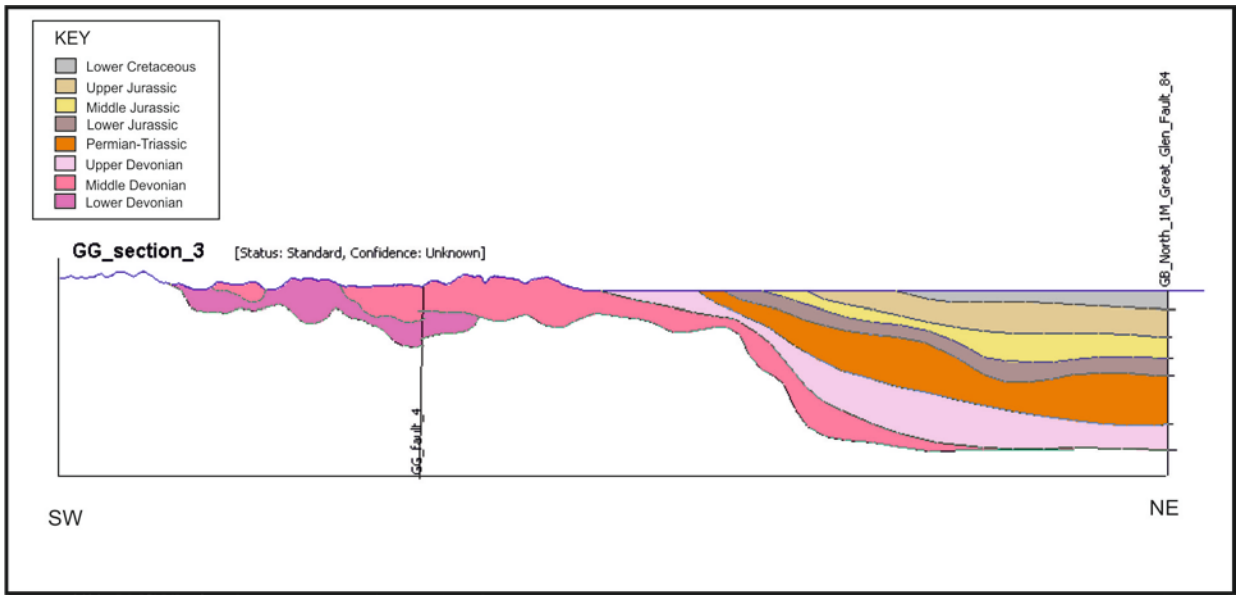

Figure 7: Cross-section GG_section_3 from GSI3D cross-section window showing Devonian and younger rocks, vertical exaggeration x5

4.5 GVS AND GLEG

The GVS and GLEG are used in the GB3D project, see Appendix 1.

5 Dataset integration

Each piece of information was added individually as and when required, then removed to retain a small file size and fast calculation time.

6 Model development log

Modelling was completed by Sarah Arkley in September/October 2011. The model was subsequently checked for snapping and consistency in 2014. Additionally, the pre-Devonian interpretations were removed since they have been superseded by the newer 'crustal model', the GB-3D interpretations may have been superseded since modelling, and these older units did not have constraining baselines.

Final version of the model is located at:

W:\Teams\QES\QMMP\Data\MorayNessBasin_Data\GSI3D Great Glen to Moray Firth\GREAT GLEN-MORAY FIRTH Regional Model\Great_Glen_bedrock_approved\Final_model_files

7 Model workflow

- The project workspace was created by copying the latest version of the GB_3D project, dated 15th Sept 2011, (GB_3D_Completed_Sections_v30_GL_v7.gsipr). The faults and sections which lay out with the Great Glen – Moray Firth project area were stripped out. The GVS and GLEG were retained and a new DTM was created.
- Small edits were made to the faults before calculating the 'fault network'.
- Existing GB_3D sections were correlated and new sections were drawn.
- Baselines were drawn for each geological unit based on the relevant geological map.
- Geological units were calculated.
- Numerous edits to sections were completed in an attempt to obtain fully calculated surfaces.

The fault network calculates correctly. However whilst the bedrock surfaces can be calculated to produce a surface (Figure 6), most surfaces have holes (uncalculated portions), Figure 7. The GSI3D software was under development for bedrock at the time of modelling. Subsequently the development was stopped and so the issue of holes within the calculated surfaces was not resolved. The model is therefore submitted to the National Geological Model as a 'cross-section only' project

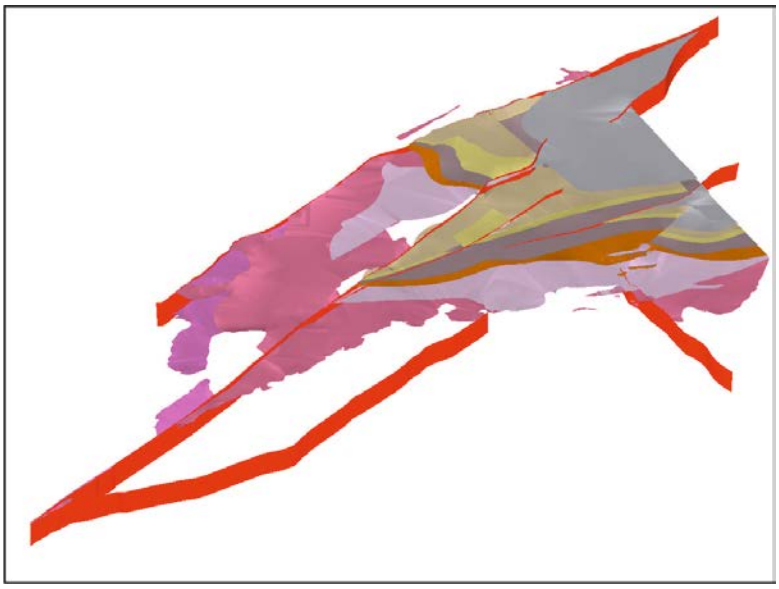

Figure 8: Surfaces of each geological unit displayed in the 3D window, as calculated in 2011.

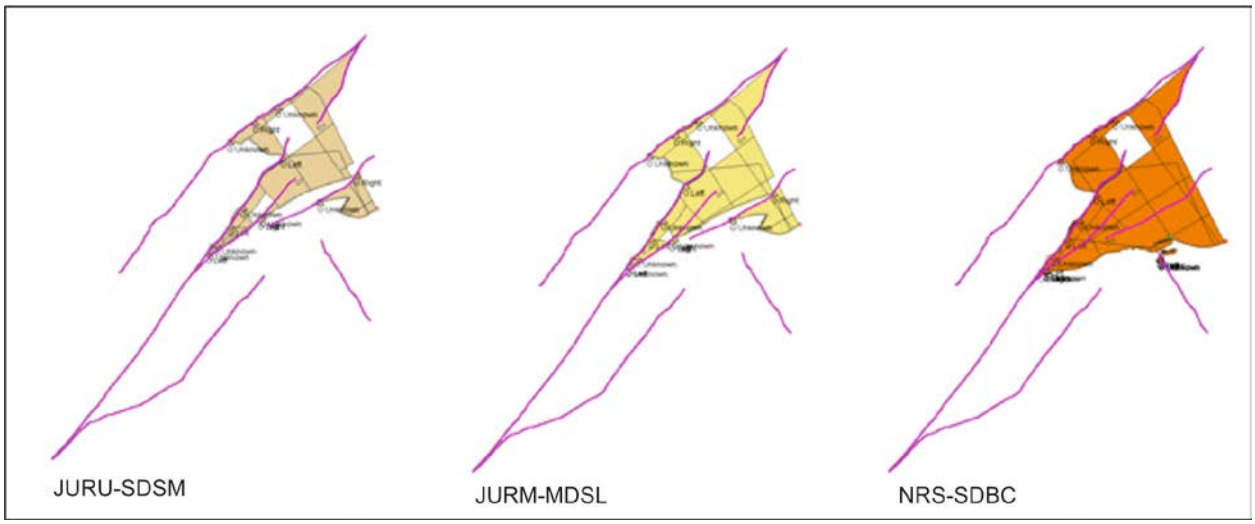

Figure 9: Extent of geological unit with 'holes' as calculated in 2011

8 Model assumptions, geological rules used etc

- All faults have been drawn planar with a steep dip
- There was little control on the thickness of units, thus a constant unit thickness was assumed in most places onshore with some thickening towards the basin centre in the Moray Firth

9 Model limitations

- No ‘superficial geology’, ‘water’ are currently modelled, thus the bedrock units are modelled to the DTM rather than to rockhead.
- Only selected faults are included in the model and some of these are simplified. More faults could be added and existing faults could be better shaped to provide a fault network which is more geologically realistic and better portrays our current understanding of the structure of the area.
- Blank section lines extend far beyond the project area because they were imported from GB-3D, truncating the sections did not prove successful.
- The project is to be treated as ‘cross-section only’ due to problems with calculation as discussed above.

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.

Kessler, H., Mathers, S.J., Sobisch, H-G and Neber, A..2008. GSI3D – The software and methodology to build systematic near-surface 3-D geological models. (Version 2) *British Geological Survey Open Report*, OR/08/001 144pp.