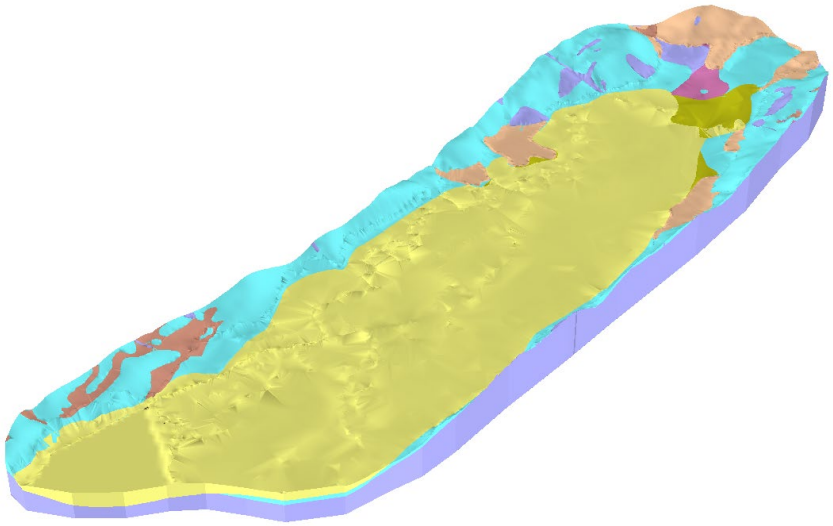
British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Model metadata report for Malltraeth Marsh 3D geological model

Geology and Landscapes Wales Programme

Open Report OR/15/025



BRITISH GEOLOGICAL SURVEY

GEOLOGY and Landscapes Wales PROGRAMME

OPEN REPORT OR/15/025

Model metadata report for Malltraeth Marsh 3D geological model

Burke, H. F.

Keywords

Malltraeth Marsh, Anglesey, 3D model, Superficial deposits

National Grid Reference

SW corner 239550,367540
Centre point 234000,999999
NE corner 247820,375120

Map

Sheet 105-6, 1:50 000 scale, Anglesey

Front cover

Malltraeth Marsh 3D model viewed from the south

Bibliographical reference

BURKE, H. F.. 2015. All fields on the title and cover should be amended by using File/Properties/Custom. *British Geological Survey Open Report*, OR/15/025. 15pp.

Keyworth, Nottingham British Geological Survey 2015

BRITISH GEOLOGICAL SURVEY

The full range of our publications is available from BGS shops at Nottingham, Edinburgh, London and Cardiff (Welsh publications only) see contact details below or shop online at www.geologyshop.com

The London Information Office also maintains a reference collection of BGS publications, including maps, for consultation.

We publish an annual catalogue of our maps and other publications; this catalogue is available online or from any of the BGS shops.

The British Geological Survey carries out the geological survey of Great Britain and Northern Ireland (the latter as an agency service for the government of Northern Ireland), and of the surrounding continental shelf, as well as basic research projects. It also undertakes programmes of technical aid in geology in developing countries.

The British Geological Survey is a component body of the Natural Environment Research Council.

British Geological Survey offices

BGS Central Enquiries Desk
Tel 0115 936 3143 Fax 0115 936 3276
email enquiries@bgs.ac.uk

Kingsley Dunham Centre, Keyworth, Nottingham NG12 5GG
Tel 0115 936 3241 Fax 0115 936 3488
email sales@bgs.ac.uk

Murchison House, West Mains Road, Edinburgh EH9 3LA
Tel 0131 667 1000 Fax 0131 668 2683
email scotsales@bgs.ac.uk

Natural History Museum, Cromwell Road, London SW7 5BD
Tel 020 7589 4090 Fax 020 7584 8270
Tel 020 7942 5344/45 email bgslondon@bgs.ac.uk

Columbus House, Greenmeadow Springs, Tongwynlais, Cardiff CF15 7NE
Tel 029 2052 1962 Fax 029 2052 1963

Maclean Building, Crowmarsh Gifford, Wallingford OX10 8BB
Tel 01491 838800 Fax 01491 692345

Geological Survey of Northern Ireland, Colby House, Stranmillis Court, Belfast BT9 5BF
Tel 028 9038 8462 Fax 028 9038 8461
www.bgs.ac.uk/gsni/

Parent Body

Natural Environment Research Council, Polaris House, North Star Avenue, Swindon SN2 1EU
Tel 01793 411500 Fax 01793 411501
www.nerc.ac.uk

Website www.bgs.ac.uk
Shop online at www.geologyshop.com

Foreword

This report is the published product of a study by the British Geological Survey (BGS) to create a 3D geological model of Malltraeth Marsh in Anglesey, north Wales, UK.

Acknowledgements

The author of this report wishes to thank the other members of the Angelsey mapping team, whose geological linework and field data were used to inform the Malltraeth Marsh 3D geological model.

Contents

FIGURES

TABLES

Summary

This report describes the 1:10,000 scale 3D geological model of Malltraeth Marsh in Anglesey, north Wales.

1 Modelled volume, purpose and scale

The Malltraeth Marsh 3D geological model covers an area of 25km^2 in the south west of the Isle of Anglesey. The model was constructed using scientific research funding in order to better understand the Quaternary deposits in the area. The model complements 1:10,000 scale geological map data compiled after a field survey of the Isle of Anglesey in 2009-2012. GSI3D software was used to construct the model, following the established workflow described in Kessler et al, 2009. The model comprises 51 correlated cross-sections constrained by 71 boreholes held in the BGS archive. In addition to borehole data, 89 detailed hand auger logs were also used in the model. **Figure 1** shows the distribution of boreholes, auger data and correlated cross-sections.

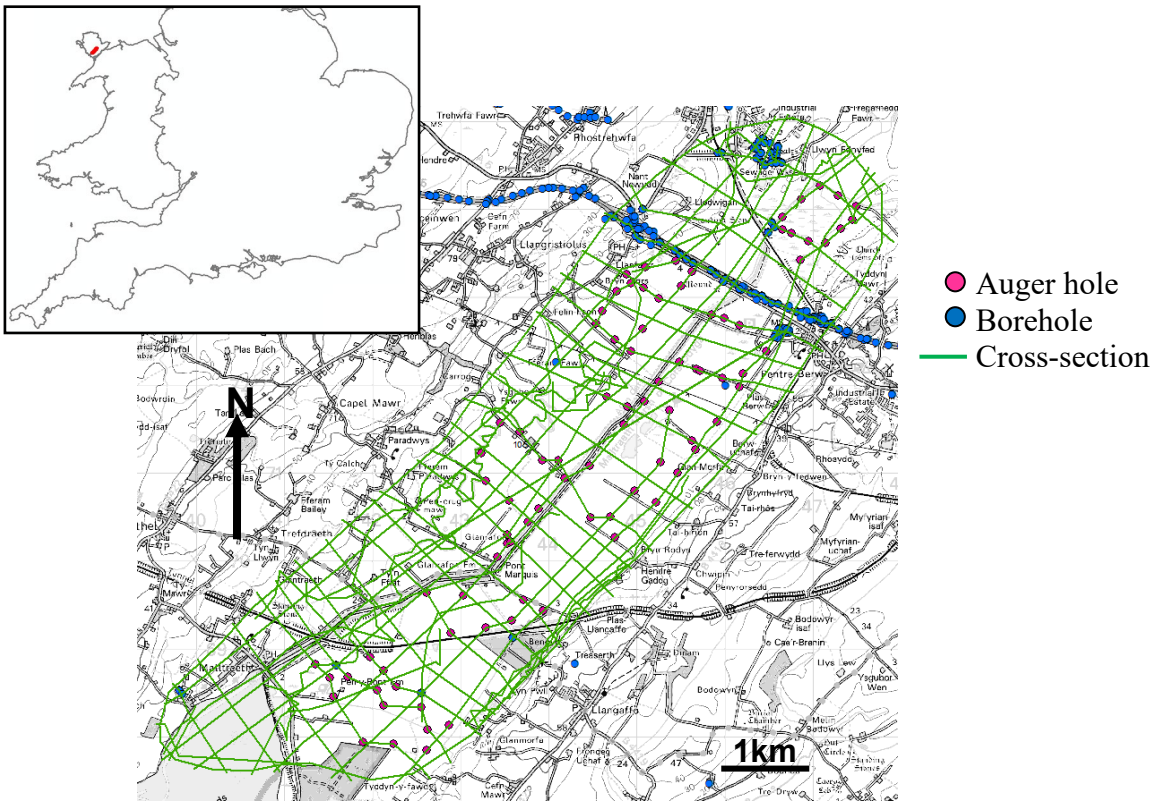


Figure 1 Distribution of hand auger logs and borehole records used to constrain the cross-sections constructed in the model. Inset shows the location of the model area.

2 Modelled surfaces/volumes

A total of 18 Quaternary units are modelled, which reach a maximum combined thickness of 35m and a maximum depth of -29m OD. Bedrock (undivided) is represented to a cut-off depth of -30m OD. The modelled geological units are described in **Table 1**.

Table 1 List of geological units modelled, in relative stratigraphic order

Geological unit	Age	Description	Legend
Lake deposits	Holocene	Modelled where modern-day lakes occur. No borehole/auger data to confirm composition. Max modelled thickness 3.6m.	
Peat	Holocene	Soft, yellow brown, grey brown or brown, can contain clay and/or silt. Forms isolated patches, mainly in the north of the model. Max modelled thickness 2.9m, thickens northwards.	

Alluvium	Holocene	Grey, peaty sand. Confined to the original course of Afon Cefni, forming a thin meandering tract. Max modelled thickness 3.7m.	
Tidal Reach Deposits	Holocene	Grey to brown-grey running sand, peaty in places. Occurs in the south of the model along Afon Cefni on the seaward side of a coastal barrier and east of Malltraeth Pool. Max modelled thickness 6.7m.	
Blown sand	Holocene	Yellow brown to yellow orange to brown sand. Forms large patches in the south of the model either side of Afon Cefni. Gently undulating surface. Max modelled thickness 7.4m.	
Tidal Flat Deposits: clay	Holocene	Mottled, grey, dark green-grey clay or grey brown, silty in places. Wide distribution in the south of the model, narrowing to the north. Max modelled thickness 3.8m.	
Tidal Flat Deposits: sand	Holocene	Yellow brown to yellow-orange sand, some mottling. Forms two discrete patches towards the middle of the model. Partly overlain by Tidal Flat Deposits clay. Max modelled thickness 1.9m.	
Intertidal Deposits: clay	Holocene	Yellow brown to olive grey silty clay to silt, sandy in places, some mottling. Wide distribution, especially in the eastern half of the model. Max modelled thickness 11.9m, thickest in the north.	
Intertidal Deposits: sand and gravel	Holocene	Loose grey brown gravelly sand. Occupies a small isolated patch in the north of the model. Max modelled thickness 1.8m.	
Intertidal Deposits: sand	Holocene	Grey sand, clayey and silty in places, particularly in the north. Wide distribution. Generally thickens southwards and towards the centreline of the model, rests on bedrock in some areas. Max modelled thickness 22.0m.	
Intertidal Deposits: organic clay	Holocene	Soft grey, occasionally black, peaty clay. Sandy and silty in places, occasionally laminated. Wood fragments and shells recorded in some boreholes. Wide distribution in the northern half of the model. Max modelled thickness 10.6m	
Colluvium	Holocene	Stiff, brown to grey-brown sandy clay with fine to coarse gravel. Forms patches along the northern, eastern and western margins of the model. Generally thickens towards bases of slopes. Max modelled thickness 8.0m.	
Glacial silts and clays	Devensian	Forms isolated patches around the edges of the model. No borehole/auger data to confirm composition. Max modelled thickness 5.6m.	
Upper till	Devensian	Firm to very stiff, brown to brown-grey, red brown in places, sandy gravelly clay. Present through most of the modelled area. Max modelled thickness 15m, thickest in the south-west of the model.	
Upper glaciofluvial sand and gravel	Devensian	Medium dense to dense grey brown to red brown sandy gravel with cobbles, clayey in places. Patchy distribution in the north and south of the model. Max modelled thickness 9.9m.	
Glacial lake deposits	Devensian	Stiff to very stiff, brown laminated silty, sandy clay. Modelled as two discrete patches, one in the north and one in the south. Max modelled thickness 10.7m.	

Lower glaciofluvial sand and gravel	Devensian	Dense, grey-brown sandy gravel with cobbles. Modelled as two isolated patches, one in the north and one in the south. Max modelled thickness 5.2m.	
Lower till	Devensian or Anglian	Very stiff, brown to green brown sandy clay with gravel and cobbles. Modelled as two isolated patches, one in the north and one in the south. Max modelled thickness 4.0m.	
Bedrock (undivided)	Carboniferous aged Coal Measures Group and Millstone Grit Group rocks with Palaeogene aged igneous intrusions. Faulted against Cambrian schists. Not subdivided in the model.		

To add greater detail than can be displayed on the geological map, and to increase our understanding of the Quaternary succession in Malltraeth Marsh, several units are subdivided using lithological differences. For example, Tidal Flat Deposits are represented as a single unit on the geological map, but are subdivided into an upper clay component and a basal sand in the model. Similarly, Intertidal Deposits are also mapped as a single unit, but are modelled as four lithologically distinct units.

3 Modelled faults

Although several geological faults occur within the modelled area, none have been modelled because the emphasis of the model is on the Quaternary. Bedrock is included in the model for representation only and has not subdivided into individual units.

4 Model datasets

Derivation and processing of (including date and by whom):

- Digital Terrain Model (DTM) – the model is capped by the Bald Earth DTM, which represents the ground surface. The Bald Earth DTM is a UK-wide ground elevation model that uses NextMap elevation data spliced with Ordnance Survey Landform Profile data for wooded areas. The Bald Earth DTM used in the model has a cell size of 10m.
- Borehole data – 71 borehole records constrain the Malltraeth Marsh geological model. To enable these borehole logs to be viewed in the 3D modelling software, the downhole information recorded them was entered into corporate databases according to corporate guidelines and standards. Scans of all non-confidential borehole logs held in the BGS archive can be accessed on-line using the Onshore GeoIndex on the BGS web site at http://www.bgs.ac.uk/geoindex/home.html. Every borehole and auger log within the model area has been used to inform the cross-sections.
- Auger data – in addition to the boreholes described above, 89 detailed hand auger logs were used in the model. These auger records were recorded during a field survey of the area in 2010-2012. These auger logs reach a maximum depth of 2m and were particularly useful where gaps occur in the borehole data.
- Geological map data – currently unpublished 1:10,000 scale geological map data was used to inform the model. This geological map data results from a field based re-survey of Quaternary sediments on the Isle of Anglesey between 2009 and 2012.

5 Model development log

The Malltraeth Marsh 3D geological model was constructed using GSI3D software according to corporate standards and methodology. This involves databasing borehole records, correlating cross-sections using geological map data, borehole and auger records to constrain the modelled units. The spatial distribution of each unit is based on geological map data for those that crop out at the surface and the cross-sections are queried for the distribution of concealed units. A development log of modelling metadata compiled during the construction of the model can be found in Appendix 1; the actual model files are listed below.

Borehole files: the location information (National Grid co-ordinates and start heights) of the boreholes and auger logs used in the model are stored in the file *Malltraeth_SOBI.bid*. The downhole information is stored in the file *Malltraeth_BOGE.bid*.

Generalised Vertical Section (GVS): this file tells the 3D modelling software the stratigraphic order of modelled geological units. The Malltraeth Marsh 3D model uses the file *Malltraeth_v4.gvs*.

Legend file (GLEG): this file tells the 3D modelling software which colour to use for each geological unit. The Malltraeth Marsh model uses the file *Malltraeth_v4.gleg*.

GSI3D model file (GSIPR): the final version of the Malltraeth Marsh model file is *Malltraeth_56.gsipr*.

6 Model workflow

Standard GSI3D modelling workflow and procedures were followed during construction of the Malltraeth Marsh 3D geological model.

7 Model assumptions, geological rules used etc

The Malltraeth Marsh 3D model uses the same stratigraphy used in the corresponding 1:10,000 scale map data, but some units, such as Tidal Flat Deposit and Intertidal Deposits are subdivided using lithological differences recorded in borehole and auger logs. Units that are less than 1m in thickness are not modelled individually. For example, where the upper clay unit in the Tidal Flat Deposits is less than 1m it was included with the underlying sand unit. Similarly, peat horizons in the organic clay of the Intertidal Deposits were not separated out.

8 Model limitations

The focus on the Malltraeth Marsh model is on the Quaternary, which has been modelled in greater detail than shown on the corresponding 1:10,000 geological map data. Bedrock is represented to a cut-off depth of -30m OD, but has not been subdivided into individual units and geological faults are not modelled.

The major limitation of the model is the distribution of available borehole data, as shown in **Figure 2**. Boreholes are concentrated around the A55 dual carriageway, which crosses the northern part of the model, and in the south of the model, near the coast. Between these areas the only available logs are shallow hand auger records. These are very useful for modelling units that crop out at the ground surface, but are not suitable for modelling the deeper geological units

such as the glacial deposits. The distribution of deeper concealed units is biased towards the borehole data, when in reality these units may cover a much wider area because it was decided to only model geological units where proven (**Figure 2**).

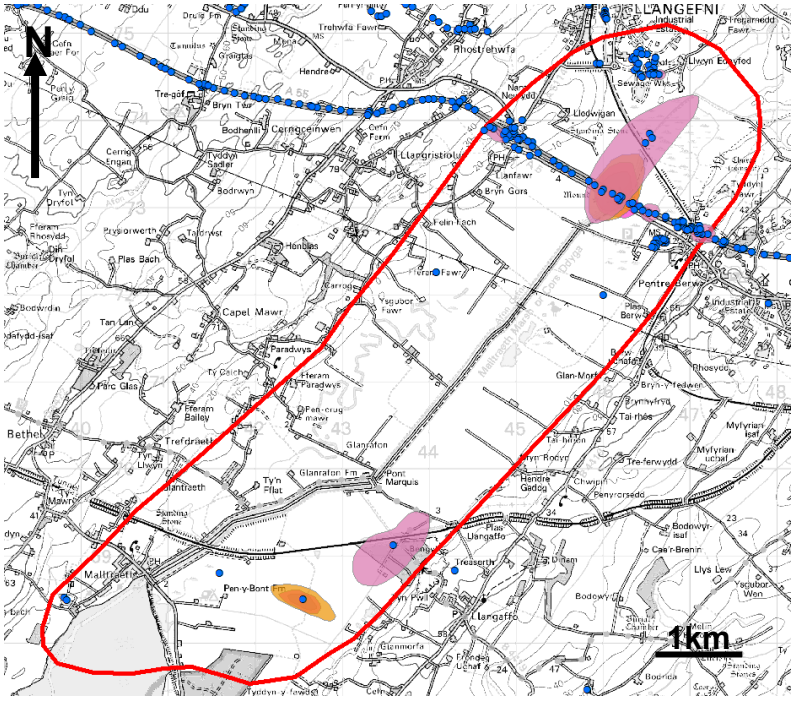


Figure 2 Distribution of the four deepest units in the model (upper glaciofluvial sand and gravel, glacial lake deposits, lower glaciofluvial sand and gravel and lower till), set to transparent to show overlaps. These units have a patchy distribution, which closely follows the location of borehole records (shown in blue) that prove them. However, these units may be more widespread in reality. The geological units are transparent to show overlap areas. Key as per Table 1.

9 Model images

Figure 3 through to **Figure 5** are 3D views of the Malltraeth Marsh 3D geological model; **Figure 6** shows a superficial deposits thickness grid, which is derived from the model.

Figure 3 is a 3D view of cross-section *Malltraeth_1*, which crosses the northern part of the modelled area from west to east along the A55 dual carriageway. This correlated cross-section is constrained by 30 borehole logs, 26 of which reach rockhead.

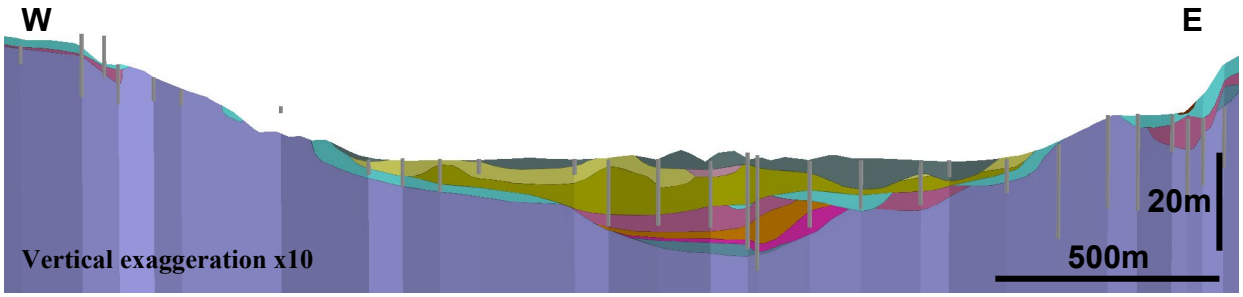


Figure 3 3D view of cross-section *Malltreath_1*, which runs along the A55 dual carriageway, crossing Malltraeth Marsh from west to east. This cross-section is particularly informative because it is well constrained with borehole data (shown in grey). Key as per Table 1.

Figure 4 is an 'exploded' view of the Holocene deposits looking north, showing the distribution of geological units that comprise the Tidal Flat Deposits and Intertidal Deposits to reveal concealed units.

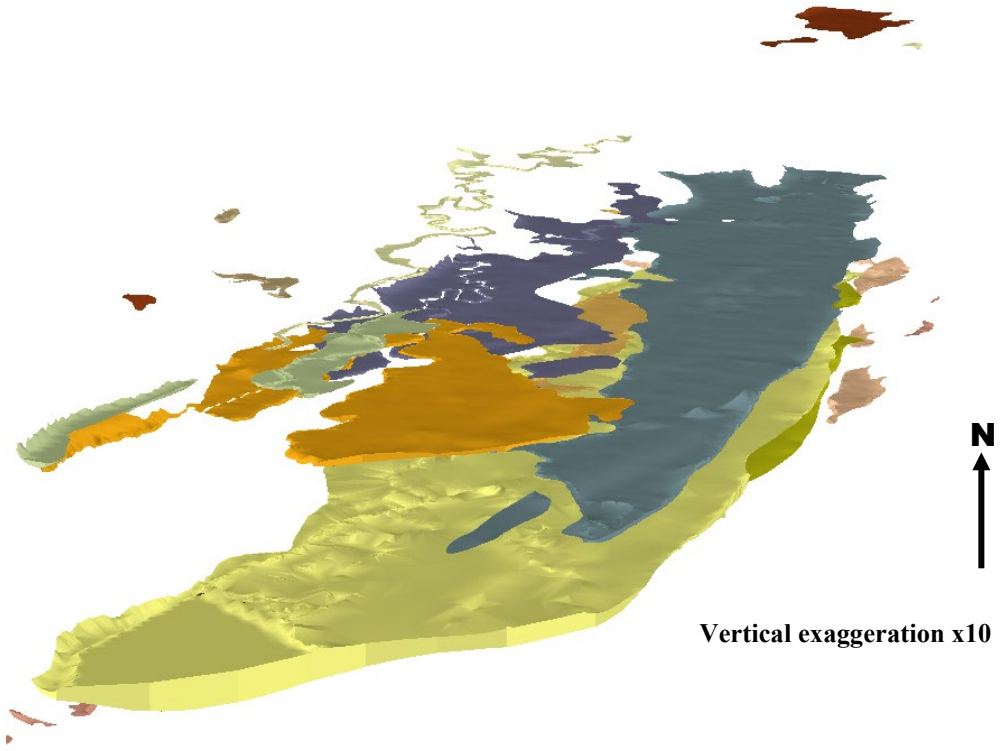


Figure 4 'Exploded' 3D view of the Holocene deposits, showing the distribution of geological units that make up the Tidal Flat Deposits and Intertidal Deposits. Colluvium, peat and lake sediments are also shown. Key as per Table 1.

Figure 5 is an 'exploded' 3D view of the glacial sediments in the model, looking north. The upper till unit is set as transparent to reveal the deeper units underneath. These deeper units have a patchy distribution because they are modelled only where proven in boreholes, but may be more laterally persistent in reality.

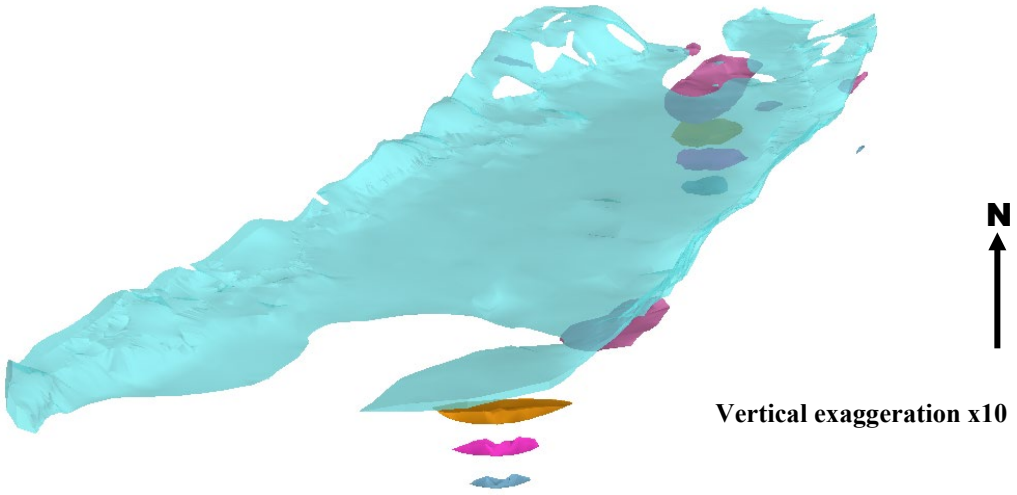


Figure 5 'Exploded' 3D view of the glacial sediments in the model, looking north, with the upper till unit set to transparent to show the underlying units. Key as per Table 1.

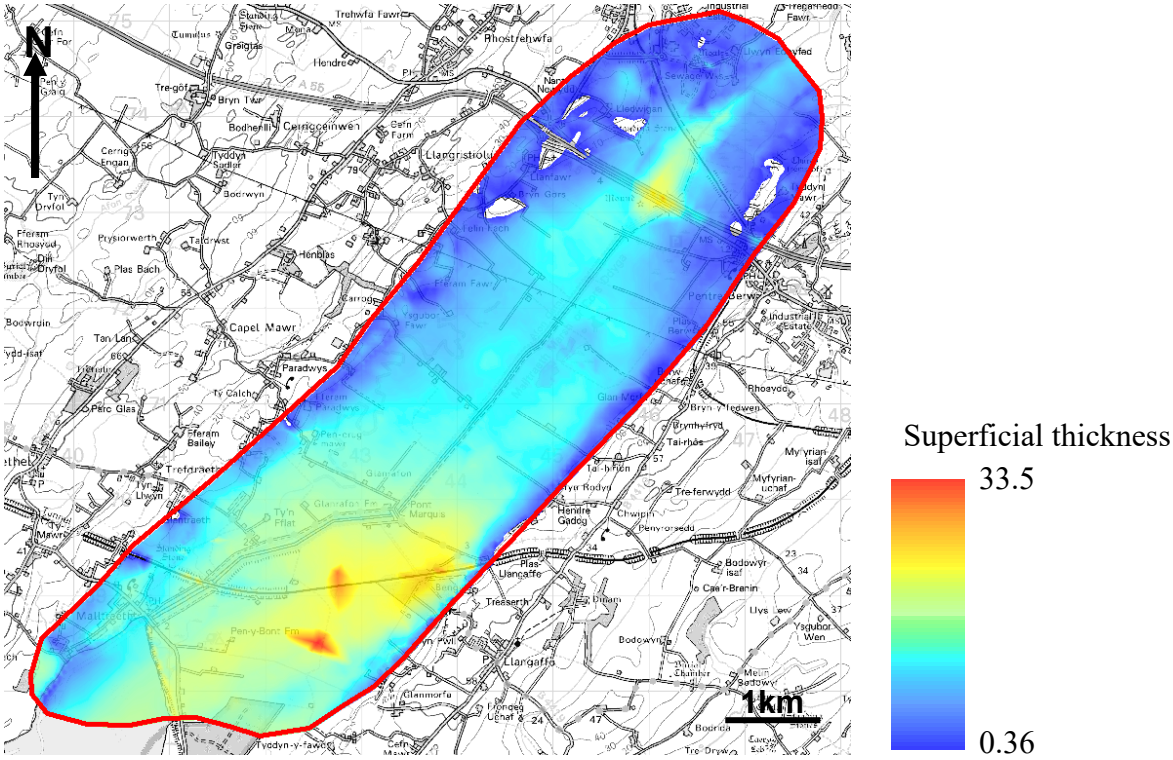


Figure 6 Superficial deposits thickness grid derived from the model, clipped to the model area. This is shown with a red to blue colour ramp; white areas represent bedrock at surface.

10 Confidence

Confidence in the model varies vertically and laterally through the model. Recent geological mapping and systematic hand augering has enabled the units at the model surface to be well constrained. The distribution of borehole data also influences confidence in the model. The cross-section *Malltraeth_1* is modelled with a high level of confidence because it uses 30 fairly closely spaced boreholes, all but 4 of which reach rockhead. However, boreholes are sparse in the rest of the model, making deeper units particularly difficult to model with a high degree of certainty. For this reason, the deeper units are only modelled where proven in boreholes.

Appendix 1 Malltraeth Marsh modelling metadata

Downloaded boreholes and added auger data to borehole downloads
Malltraeth_BOGE.blg – downloaded 08/04/11
Malltraeth_SOBI.bid – downloaded 08/04/11

Boreholes coded using Natural Superficial Deposits Coding Scheme, and the AQ content code (Anglesey Quaternary)

Downloaded a 10m Bald Earth DTM (GSI3D unable to cope with 5m due to memory capacity)
MalltraethDTM10.asc

Boreholes hung on DTM during section construction as augers have no start height

8/10/10
Completed first cross-section, Malltrath_1 along the A55 across the marsh
Started/edited the GVS and GLEG
Downloaded a clip of the geology for easier recognition in boreholes
Malltraeth_10.gsipr

11/10/10
Plotted out another 14 cross-sections with fairly even spacing.
Malltraeth_11.gsipr

12/10/10
Completed a couple of sections, but getting bogged down with all the detail.
Malltraeth14.gsipr

13/10/10
Started coding for the whole DTM extent after Emrys suggested extending the 3D model coverage to match.

13/1/11
Simplified the GVS to make modelling easier after discussing with JRLEE. Main units are: inorganic clay, organic clay, 3 sand units. Looking at coding in section 1, added a lower till unit, a lower glacial gravel and a glacial lake clay unit.

18/1/11
First pass completed and passed to Emrys for review (v_23).

Notes:
Surface silt unit not separated out, included with inorganic clay for now
Peat layer above organic clay not correlated
Thin peat layer at base of till not correlated
DTM/TIN needs trimming to project area

Jan-Feb 2013:
New Quaternary linework imported into the model, and the model matched to it.
Additional helper sections needed to help the model calculate

Apr 2013
Docking sections added
26 Helper sections added to aid the calculation of various units

Latest version: Malltraeth_56.gsipr

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.

Onshore GeoIndex: web based GIS of BGS data, including borehole scans, accessible via the BGS web site: http://www.bgs.ac.uk/geoindex/home.html

Kessler, H., Mathers, S.J. & H.-G. Sobisch, 2009. The capture and dissemination of integrated 3D geospatial knowledge at the British Geological Survey using GSI3D software and methodology. Computers & Geosciences, **35**, 1311–1321
http://dx.doi.org/10.1016/j.cageo.2008.04.005