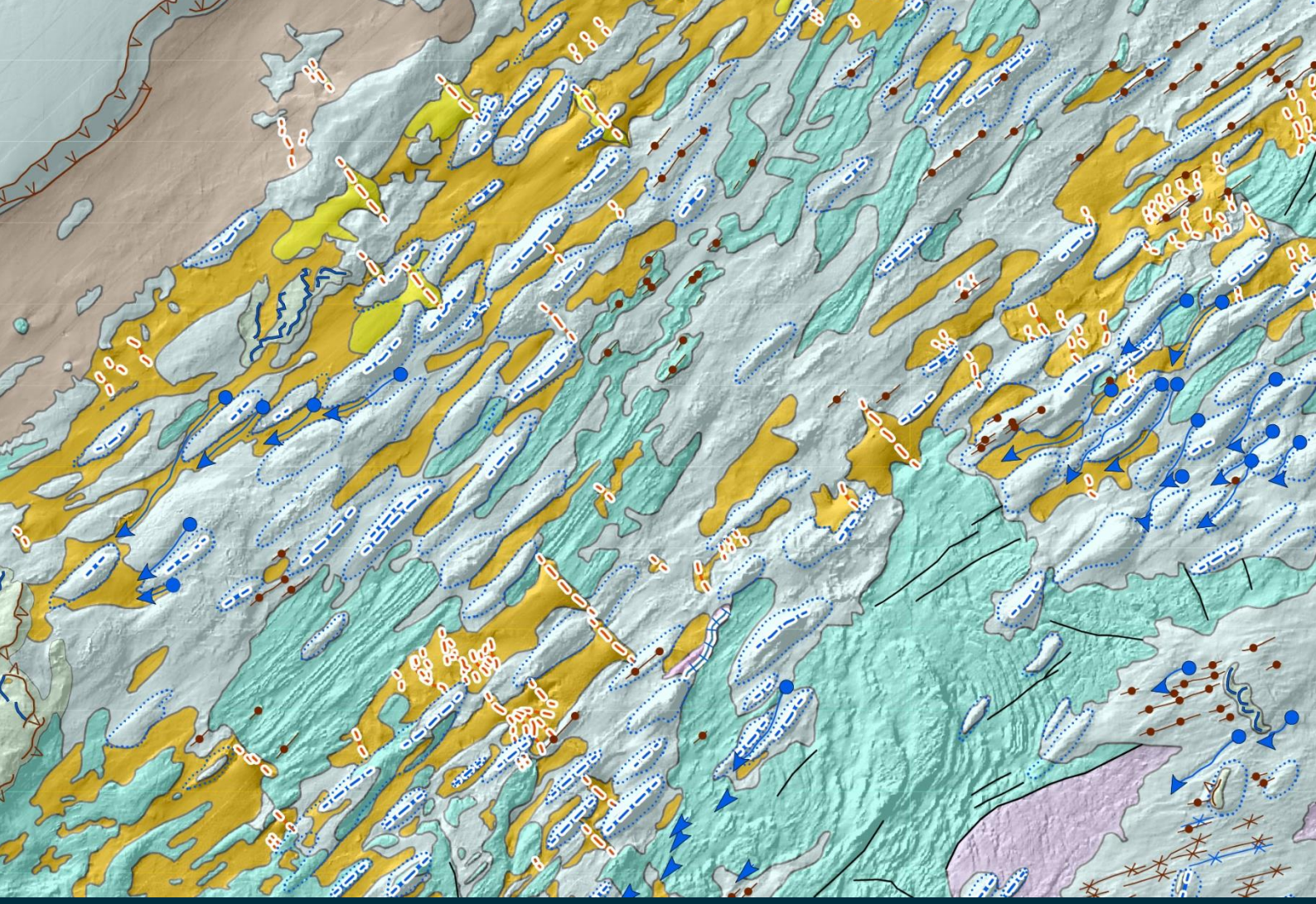

DIGITAL PROGRAMME

User Guide for BGS Seabed Geology 10k: Anglesey

Open Report OR/22/059

British Geological Survey

BRITISH GEOLOGICAL SURVEY

DIGITAL PROGRAMME

OPEN REPORT OR/22/059

User Guide for BGS Seabed Geology 10k: Anglesey

British Geological Survey

Keywords

Anglesey, Seabed Geology, Offshore bedrock, Seabed Sediments, Structural Geology, Geomorphology.

Map

Seabed Geology 10k: Anglesey

Front cover

Extract from Seabed Geology 10k: Anglesey dataset showing the bedrock geology and superficial deposits. Hillshade image derived from bathymetric data acquired by the MCA © Crown Copyright 2022, released under OGL.

Bibliographical reference

British Geological Survey 2022. User Guide: BGS Seabed Geology 10k - Anglesey. *British Geological Survey Open Report*, OR/22/059. 23pp.

Edinburgh, British Geological Survey, 2022

BRITISH GEOLOGICAL SURVEY

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Foreword

The British Geological Survey (BGS) is a world-leading geological survey, focusing on public-good science for government, and research to understand earth and environmental processes.

We are the UK's premier provider of objective and authoritative geoscientific data, information and knowledge to help society to:

- use its natural resources responsibly
- manage environmental change
- be resilient to environmental hazards

We provide expert services and impartial advice in all areas of geoscience. As a public sector organisation, we are responsible for advising the UK Government on all aspects of geoscience as well as providing impartial geological advice to industry, academia and the public. Our client base is drawn from the public and private sectors both in the UK and internationally.

The BGS is a component body of the Natural Environment Research Council (NERC), part of UK Research and Innovation (UKRI).

DATA PRODUCTS

The BGS produces a wide range of data products that align to government policy and stakeholder needs. These include baseline geological data, engineering properties and geohazards datasets. These products are developed using in-house scientific and digital expertise, and are based on the outputs of our research programmes and substantial national data holdings.

Our products are supported by stakeholder focus groups, identification of gaps in current knowledge and policy assessments. They help to improve understanding and communication of the impact of geo-environmental properties and hazards in Great Britain, thereby improving society's resilience and enabling people, businesses, and the government to make better-informed decisions.

Acknowledgements

The BGS Seabed Geology 10k: Anglesey digital map portrays the distribution of the different geological substrate units (either bedrock or superficial deposits) that have been interpreted to represent on the dominant geology within the top 1-2 metres of the seabed. The geological interpretation and mapping were carried out at 1:10 000 scale in 2020-21 by Andrew Finlayson, Emrys Phillips, Rhian Kendall, Gareth Carter, Jeremy Everest and Melanie Marochov.

This mapping was based primarily on the high-resolution multibeam echo-sounder (MBES) bathymetry data collected in 2012 and 2013 during the Civil Hydrography Programme (CHP) surveys managed by the Maritime and Coastguard Agency (MCA) and a candidate Marine Conservation Zone (MCZ) survey for the Department for Environment, Food and Rural Affairs (Defra).

We would like to thank several individuals who have contributed to the digital compilation, review and release of the BGS Seabed Geology 10k: Anglesey digital map, in particular Joana Gafeira, Helen Burke, Leanne Hughes and Dayton Dove.

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The BGS Seabed Geology 10k: Anglesey digital map portrays the distribution of the different types of bedrock and sediments that are interpreted to represent the dominant geology within the top 1-2 metres of the seabed to the north-west of Anglesey, at a scale of 1:10 000. It also includes the distribution of the main seabed morphological and geomorphological features (*e.g.,* drumlins, pockmarks) and the principal structural features observed at rockhead (*e.g*., fractures).

This digital map is the result of the interpretation of two high-resolution, multibeam echo-sounder (MBES) bathymetry datasets: (i) the Off Skerries HI1420 survey, collected by Net Survey in 2013 as part of the Civil Hydrography Programme (CHP) surveys managed by the Maritime and Coastguard Agency (MCA) for the UK Hydrographic Office; and (ii) the North St George's Channel candidate Marine Conservation Zone (rMCZ) survey, collected jointly by JNCC and Cefas in 2012 for the Department for Environment, Food and Rural Affairs (Defra). MBES backscatter, physical samples (*e.g.,* grabs, cores, and boreholes), academic papers and previous BGS geological interpretations at broader scales (250k and 50k scales) were used to further inform this geological interpretation.

The bedrock is divided into three units: (i) Neoproterozoic to Palaeozoic age metamudstones and metasandstones of the Monian Supergroup; (ii) undifferentiated Lower Palaeozoic age rocks (mudstone, volcaniclastics, siltstone, slate); and (iii) limestone and sandstone of the Carboniferous Limestone Supergroup. The superficial deposits are composed of various types of glacial sediments (*e.g.,* glacial till and morainic deposits) that were deposited underneath and around the margins of the last British-Irish Ice Sheet, and also more recently deposited marine sediments.

The map citation, metadata and overview can be found here: British Geological Survey (2022): BGS Seabed Geology 10k: Offshore Anglesey version 1.0. (Dataset). https://doi.org/10.5285/d2f2f8e8-8e97-40fb-9207-875563d0fec0

The information provided in this user guide is intended to provide a quick-start guide to using and understanding this BGS digital product.

1 Introduction

The BGS Seabed Geology 10k: Anglesey map portrays the distribution of the different types of bedrock and unconsolidated superficial deposits that have been interpreted to represent the dominant geology within to the top 1-2 metres of the seabed, at a 1:10 000 scale. It also includes the distribution of the main seabed morphological and geomorphological features (*e.g.* lineaments, drumlins, iceberg ploughmarks, sand waves) and the principal structural features observed at rockhead (fractures).

The bedrock geology in the mapped area is divided into three broad stratigraphic units: (i) Neoproterozoic to Palaeozoic age metamudstones and metasandstones of the Monian Supergroup (oldest); (ii) undifferentiated Lower Palaeozoic age rocks (mudstone, volcaniclastics, siltstone, slate); and (iii) limestone and sandstone of the Carboniferous Limestone Supergroup (youngest). The superficial deposits have been interpreted as: (i) till – a diamicton comprising firm to stiff mud (and may be locally cemented in areas of gas release) with varying proportions of sand and gravel; (ii) morainic deposits (mixed sediment: mud, sand, gravel); (iii) ice contact deposits (gravel); (iv) glaciofluvial ice contact deposits (gravel); (v) marine deposits (with varying classes based on the estimated grain size).

The interpretations presented in this dataset are estimation of the dominant geology that makes up the top 1-2 metres below the seabed. The mapping results are therefore different from seabed sediment maps, especially where strong currents have resulted in lag deposits with higher proportions of coarser sediment at the seabed surface.

The map is arranged into three geological themes: *Substrate Geology*, *Geomorphology* and *Structural Geology* (Figure 1). Each theme is provided as distinct layers for viewing within a Geographic Information System (GIS). The *Substrate Geology* represents the bedrock and superficial deposits as a series of polygons, *Structural Geology* represents the structural features observed at rockhead as a polylines layer, whereas *Geomorphology* consist of a polylines layer and a points layer to portray the main seabed morphological and geomorphological features.

Attribute information is provided for every record in each layer, with each field of attribution specific to the layer and the characteristic of the feature being described. Attribution may include information as the age of a geological unit, its lithology, links to further resources (such as hyperlinks to BGS webpages) and metadata about the dataset (e.g., the scale, version, release date of the data). Information about the types of geological attribution available in BGS Seabed Geology 10k: Anglesey is provided in the attribute descriptions in section 3.3.

The distribution of exposed bedrock and superficial sediments are of importance to a range of stakeholders connected to sea fisheries, aquaculture, renewable energy (wind, wave and tidal power), marine communications, dredging, and aggregate industry. This detailed geological digital map is intended as enabling resources to better inform multiple offshore activities, research, and management of the marine environment in the Offshore Anglesey area.

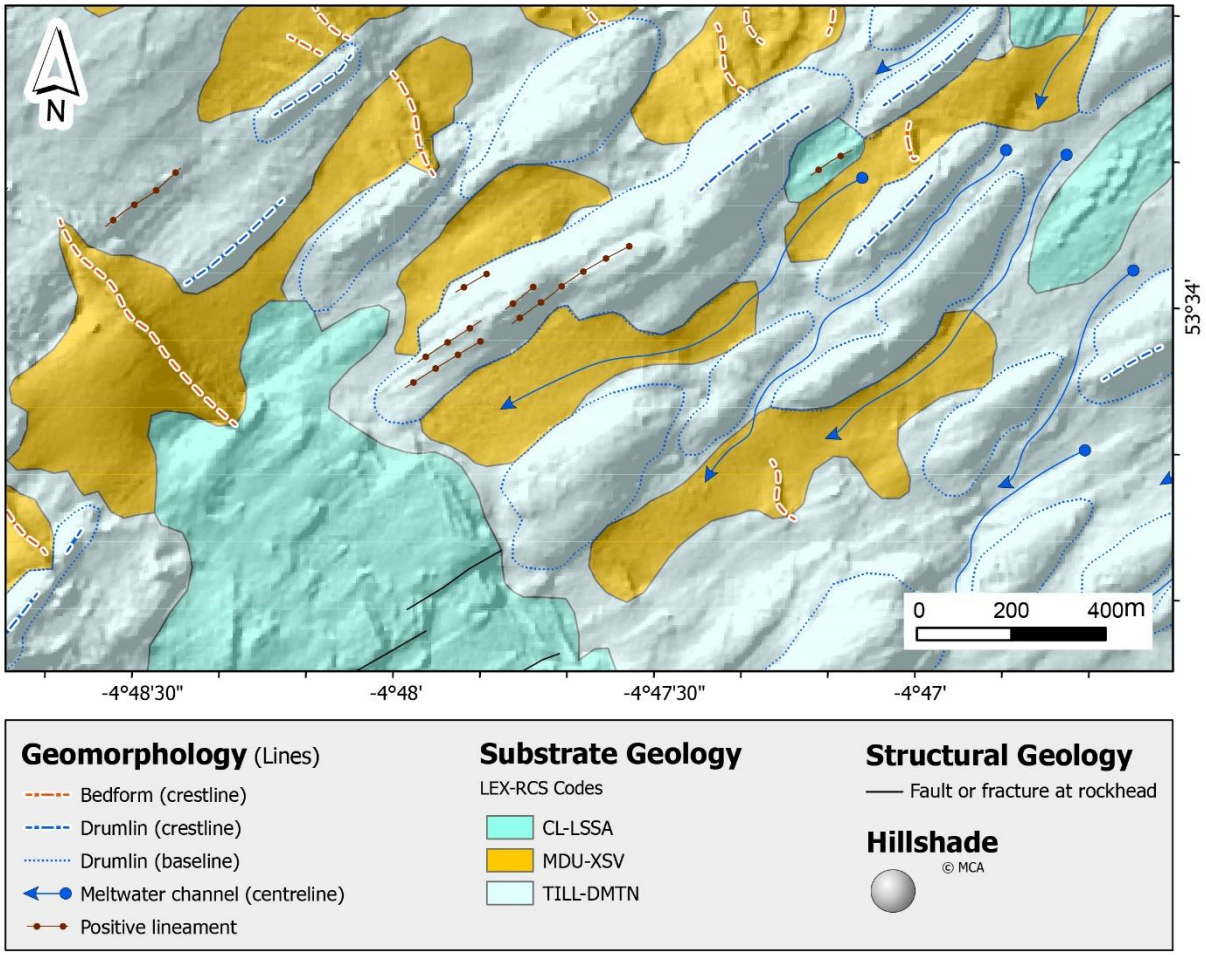


Figure 1 - Extract of the BGS Seabed Geology 10k: Anglesey digital map showing three layers of the dataset (*Substrate Geology*, *Geomorphology* and *Structural Geology*). Note that the legend only shows the features visible in the map extract.

The underlying hillshade image is derived from bathymetric data acquired by the MCA © Crown Copyright 2022, released under OGL.

2 Methodology

The information provided in the BGS Seabed Geology 10k: Anglesey map has been compiled via a process of geological interpretation and domain analysis, digital capture of seabed topographic features, and data processing and harmonisation.

2.1 SOURCE DATA OVERVIEW

The geological mapping is based primarily on two high-resolution multibeam datasets (Figure 2). The Off Skerries (HI1420 survey) MBES dataset (4 m resolution) was collected by Net Survey in 2013 as part of the Civil Hydrography Programme (CHP) surveys managed by the Maritime and Coastguard Agency (MCA) for the UK Hydrographic Office, and was made available via an Open Government Licence. The North St George's Channel candidate Marine Conservation Zone (MCZ) dataset (3 m resolution) was collected jointly by JNCC and Cefas for the Department for Environment, Food and Rural Affairs (Defra) in 2012 and was also made available via an Open Government License (https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/).

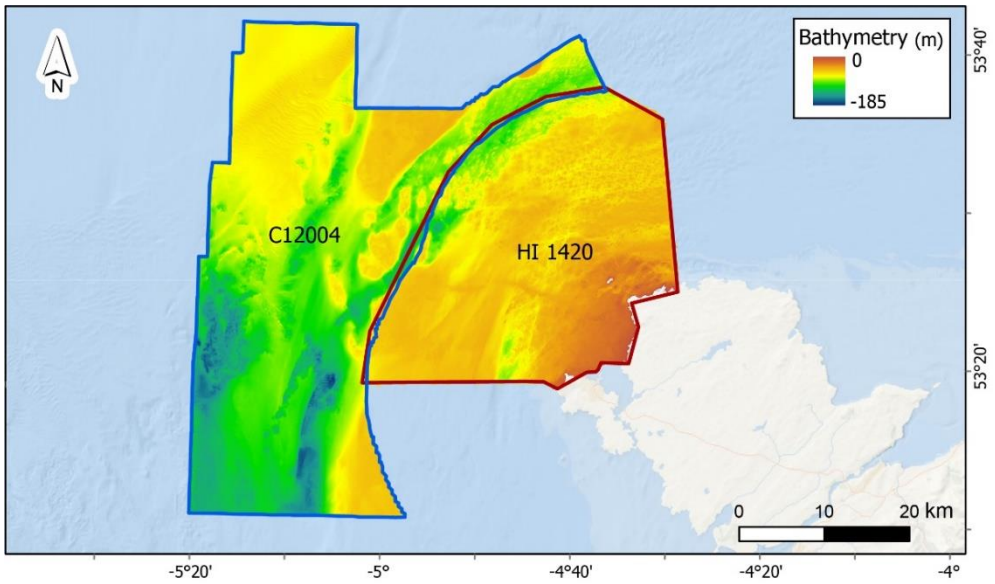


Figure 2 – Location map of the two multibeam datasets used for the BGS Seabed Geology 10k: Anglesey map.

This image contains data acquired by the MCA and by Defra © Crown Copyright 2022, released under OGL. Basemap image from World Ocean Base dataset compiled by Esri, Garmin, GEBCO, NOAA NGDC, and other contributors. Basemap created using ArcGIS. Copyright © Esri. All rights reserved. www.esri.com.

MBES backscatter, physical samples (e.g., grabs, cores, and boreholes) and previous geological mapping were also used to further inform the geological interpretation. In addition, OS topographic maps, BGS geological maps at 1:50 000 scale and hill shaded Digital Terrain Models (DTMs) for the adjacent onshore areas were also used to ensure that the onshore geological mapping corresponds to that mapped onshore, to facilitate the future development of a “seamless” onshore-offshore geological map for the Anglesey region.

2.2 GEOLOGICAL INTERPRETATION

The geological interpretation of multibeam bathymetry is akin to onshore methods of terrain analysis (specifically that which utilises LiDAR), where the surveyor is seeking to find domains (areas) of similar geology, and lineaments (lines) that either bound the domains, or crosscut, or displace them. From the depth digital terrain model (DTM) provided by the multibeam bathymetry, several derived surfaces were created (such as hillshade and slope; Figure 3). These can be used, for example, to identify changes in the general ‘texture’ of the seabed (finer-grained deposits have smoother seafloor expressions than rough, rocky or cobbly surfaces) or recognise the geometry of certain seabed features.

Using multibeam echosounder, multibeam backscatter data are collected at the same time as the bathymetry data. While bathymetry measures depth, backscatter measures the intensity of the return acoustic signal (Figure 3) of the seabed providing information on the ‘hardness’ of the seafloor. It is used to differentiate between different types of seafloor, such as hard rock or soft sediment, and can be used as a proxy to understand the characteristics of the seabed.

The combination of seabed shape, orientation and texture, acoustic signature coupled with the other data resources (such as grab samples) allows geologists to identify areas exhibiting similar rock and deposit characteristics, as well as seabed forms that can imply geological ‘processes’, such as overriding by glacier ice.

The high-resolution of the multibeam data and the use of derived, visualisation layers (such as hillshade and slope) reveal in detail the seabed morphology and allow the identification of numerous seabed features in a GIS.

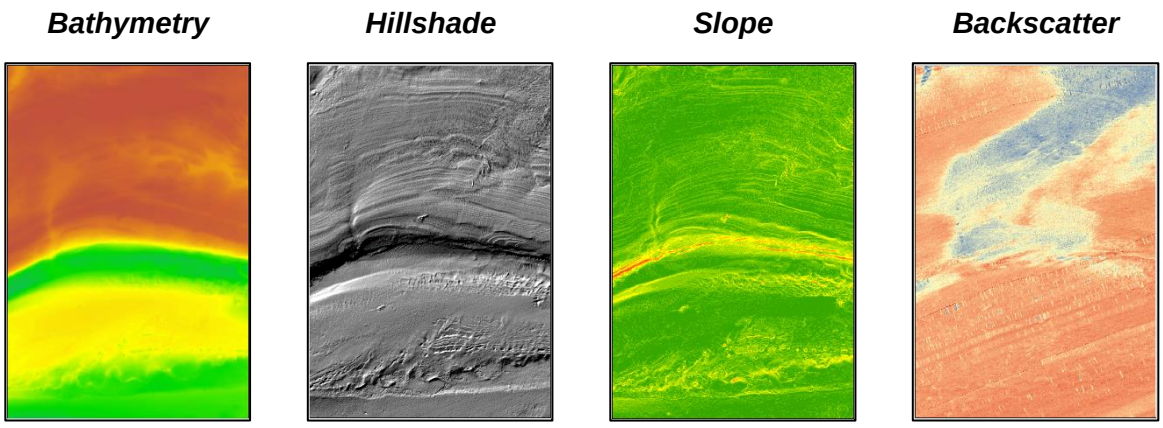


Figure 3 – Extracts of the bathymetry, hillshade, slope and backscatter multibeam data used during the geological interpretation.
Image contains data acquired by the MCA © Crown Copyright (2022), released under OGL.

2.3 DIGITAL CAPTURE

The geological linework for the BGS Seabed Geology 10k: Anglesey map was captured at a scale of 1:5 000 to 1:7 000, for use at an intended working scale of 1:10 000. The interpretation was undertaken and the resulting map is provided using the projected coordinate system EPSG:32630 (WGS 84 / UTM Zone 30N).

The geological interpretation and digital capture were completed in an ArcGIS™ environment supported by the use of the BGS·SIGMA Desktop application.

The distribution of bedrock and superficial deposits were mapped as independent layers comprising polygons with geological attribution to describe their stratigraphical age (based on the BGS Lexicon of Named Rock Units), and their lithological composition (as defined in the BGS Rock Classification Scheme).

The distribution of lineaments was mapped as polylines using set structural, morphological or geomorphological classification. Morphology features are characterised only by the feature's form (i.e. size, shape, configuration, texture); whereas the geomorphology features are defined by both their form and the environmental and interpreted geomorphological process(es) that created that morphology. Pockmarks, due to their dimensions, were mapped as points.

The morphological and geomorphological lineaments were captured across the entire map area; while structural lineaments were only captured where bedrock was interpreted to be at or near the seabed surface (*i.e.*, where bedrock structures were visible in the MBES imagery).

The attribute fields provided with the digital map are described further in section 3.

2.4 DATASET PROCESSING

During the geological mapping, interpretations were captured in several independent layers within a BGS·SIGMA database. To create the final compilation, the linework of some of

BGS·SIGMA layers were merged into a single layer. This compilation of linear and polygon features is shown in Figure 4 and example map output can be seen in Figure 1.

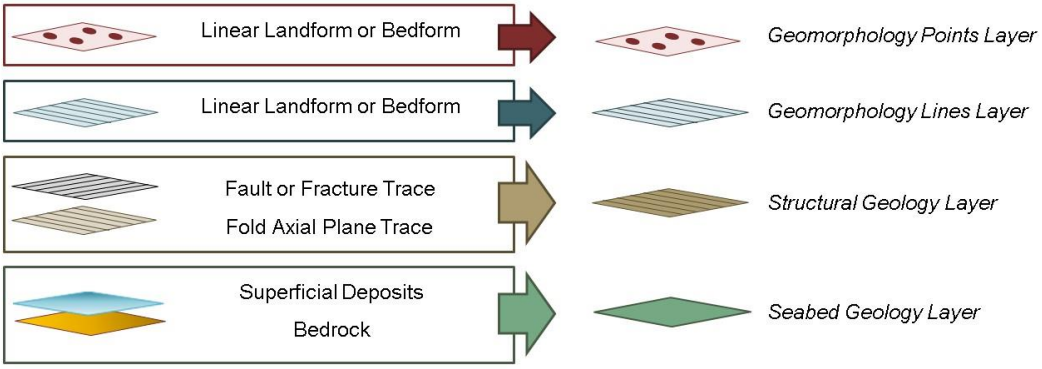


Figure 4 – Schematic representation of the transition from the layers used during the geological mapping and the final layer that comprises BGS Seabed Geology 10k: Anglesey.

3 Technical Information

3.1 SCALE

This dataset is produced for use at 1:10 000 scale. The multibeam data was used with spatial resolution of 4 m, but due to the nominal scale of the dataset the minimum feature size is 10 m.

3.2 COVERAGE

The BGS Seabed Geology 10k: Anglesey map covers an area of approximately 2240 km^2 to the north-west of the island of Anglesey, off the north-west coast of Wales (Figure 5).

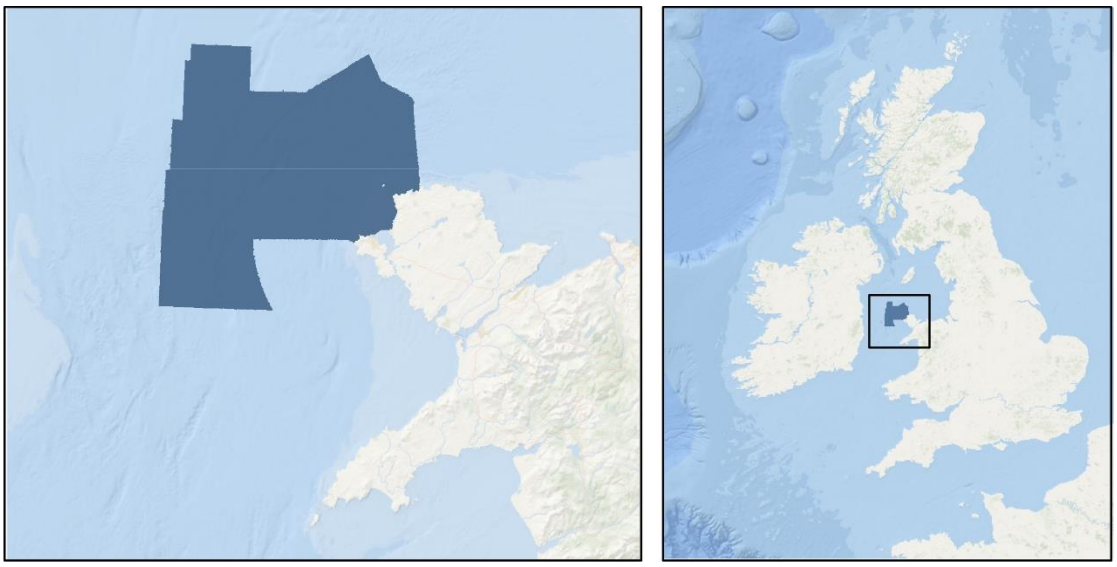


Figure 5 - Coverage of BGS Seabed Geology 10k: Anglesey shown in dark blue.

Background image from World Ocean Base dataset compiled by Esri, Garmin, GEBCO, NOAA NGDC, and other contributors. *Basemap created using ArcGIS. Copyright © Esri. All rights reserved*. *www.esri.com*.

3.3 ATTRIBUTE DESCRIPTION

Each geological theme (map layer) in BGS Seabed Geology 10k: Anglesey contains a series of attribute fields. Attribution is specific to the layers, for example, bedrock objects are attributed with lithostratigraphy, chronostratigraphy or lithodemic class, whereas the *Structural Geology* layer with features such as fractures is not. Table 1, Table 2 and Table 3 describe the attribute fields in each layer. Note the following abbreviations are used as attribute values: N/A - Not applicable and N/D - Not defined.

Table 1 - Names and their descriptions of the attribute table fields of the polygonal features on *Substrate Geology* layer of the BGS Seabed Geology 10k: Anglesey.

Field name	Description
BGS_ID	Unique ID for each polygon
BGSTYPE	The BGS Geology theme: e.g. BEDROCK, SUPERFICIAL
LEX_RCS	The two-part code, LEX & RCS, used to label the geological units in BGS Geology data: e.g. PNG-MDST
LEX_RCS_D	Description of the two-part code above giving the name and the lithology of the unit: e.g. Penarth Group-Mudstone
LEX	Lexicon (or LEX) code. First part of the LEX_RCS label. Up to 5 characters (mostly letters). An abbreviation of the rock unit or deposit as listed in the BGS Lexicon of Named Rock Units: e.g. LI
LEX_D	Description of the Lexicon code above giving the name of the unit: e.g. LIAS GROUP is the full name of the unit coded as LI
RCS	The RCS code (or an abbreviation for the string of RCS codes given in full in RCS_X)
RCS_X	RCS codes. An alternative code abbreviation (or a string of such codes joined by + signs with square brackets used for subordinate types), each up to 6 characters, for the type of rock or lithology as based on the hierarchical BGS Rock Classification Scheme (RCS): e.g. MDST + LMST
RCS_D	Description of the RCS code(s) above giving the lithology of the unit: e.g. MUDSTONE and LIMESTONE
RANK	Rank of the unit in the lithostratigraphical or lithodemic hierarchy: e.g. GROUP
PARENT_DESC	Name of the 'parent' unit of greater rank, where applicable: e.g. Blue Lias Formation
MB_EQ_D	Name at member level, where applicable.
FM_EQ_D	Name at formation level, where applicable
SUBGP_EQ_D	Name at subgroup level, where applicable
GP_EQ_D	Name at group level, where applicable
SUPGP_EQ_D	Name at supergroup level, where applicable
MAX_TIME_D	Maximum or oldest age of the unit, to the most accurate time (or geochronological) division possible: e.g. ALBIAN
MIN_TIME_D	Minimum or youngest age of unit, to the most accurate time (or geochronological) division possible: e.g. APTIAN
MAX_AGE	Maximum age. Name of the age of maximum geochronological time applicable: e.g. RYAZANIAN

MAX_EPOCH	Maximum epoch. Name of the epoch of maximum geochronological time applicable: e.g. CARADOC
MAX_PERIOD	Maximum period. Name of the period of maximum geochronological time applicable: e.g. CARBONIFEROUS
MAX_ERA	Maximum era. Name of the era of maximum geochronological time applicable: e.g. PALAEOZOIC
MAX_EON	Maximum eon. Name of the eon of maximum geochronological time applicable: e.g. PROTEROZOIC
MIN_AGE	Minimum age. Name of the age of minimum geochronological time applicable: e.g. BARREMIAN
MIN_EPOCH	Minimum epoch. Name of the epoch of minimum geochronological time applicable: e.g. ASHGILL
MIN_PERIOD	Minimum period. Name of the period of minimum geochronological time applicable: e.g. PERMIAN
MIN_ERA	Minimum era. Name of the era of minimum geochronological time applicable: e.g. MESOZOIC
MIN_EON	Minimum eon. Name of the eon of minimum geochronological time applicable: e.g. PHANEROZOIC
LEX_WEB	The LEX_WEB link provides a direct hyperlink to the definition of the particular geological unit in the BGS Lexicon of Named Rock Units: e.g. http://www.bgs.ac.uk/Lexicon/lexicon.cfm?pub=PNG
RCS_WEB	The RCS_WEB link provides a direct hyperlink to the definition of the particular type of rock or lithology as based on the BGS Rock Classification Scheme (RCS): e.g. https://webapps.bgs.ac.uk/bgsrcs/rcs_details.cfm?code=MDST
BGSREF	BGS reference colour for the polygon based on the LEX_ROCK code pair. The default printing colour defined as a 3-digit number:
RED	The equivalent red channel colour of the intended colour
GREEN	The equivalent green channel colour of the intended colour
BLUE	The equivalent blue channel colour of the intended colour
HEX	The equivalent HEXadecimal value of the intended colour
NOM_SCALE	Nominal scale used to prepare the digital data: e.g. 10000. Also gives an indication of scale-dependant accuracy
DATASET	Official name of the dataset
VERSION	Version of the digital data. The version number is changed when a new dataset is released following major changes
RELEASED	Date released

Table 2 - Names and their descriptions of the attribute table fields of the linear features on *Structural Geology* layer of the BGS Seabed Geology 10k: Anglesey.

Field name	Description
BGS_ID	Unique ID for each polyline
BGSTYPE	The BGS Geology theme, it can be FAULT or FOLD AXIS
FEATURE_D	Description of the geological feature e.g. Axial plane trace of an anticline

NOM_SCALE	Nominal scale used to prepare the digital data: e.g. 10000. Also gives an indication of scale-dependant accuracy
DATASET	Official name of the dataset
VERSION	Version of the digital data. The version number is changed when a new dataset is released following major changes
RELEASED	Date of dataset release

Table 3 - Names and their descriptions of the attribute table fields of both linear and point features in the *Geomorphology* layers of the BGS Seabed Geology 10k: Anglesey.

Field name	Description
BGS_ID	Unique ID for each polyline
BGSTYPE	Geological theme, it can be MORPHOLOGICAL or GEOMORPHOLOGICAL
FEATURE_D	Description of seabed feature type: e.g. Bedform (Crestline)
MORPH_FEAT	Description of the feature according to its morphologic type, regardless of the geological process: e.g., Crestline of a ridge
MORPH_TYP	Type of morphology: e.g., Lineament
ASSOC_REL	Type of relief of associated to the delineated feature: e.g., Bathymetric high
ORIG_ENV	The original environment represents the geological setting contemporaneous of the development of the seabed feature e.g. Marine
FEATURE_C	Type of class of geomorphological features according to the geological process that formed the feature, when known e.g. Current-induced bedform
NOM_SCALE	Nominal scale used to prepare the digital data: e.g. 10000. Also gives an indication of scale-dependant accuracy
DATASET	Official name of the dataset
VERSION	Version of the digital data. The version number is changed when a new dataset is released following major changes
RELEASED	Date of dataset release

3.4 DATA FORMAT

The BGS Seabed Geology 10k: Anglesey data are in vector format and comprise of four geospatial data layers: *Substrate Geology* layer (comprised of polygons), *Geomorphology (lines)* layer (comprised of polylines), *Geomorphology (points)* layer (comprised of points) and *Structural Geology* layer (comprised of polylines).

They are routinely released in ESRI® shapefile format. Other vector formats are available on request. More specialised formats may be available but may incur additional processing costs. Please email BGS Enquiries (enquiries@bgs.ac.uk) to request further information.

3.5 DATASET HISTORY

The BGS Seabed Geology 10k: Anglesey digital map was created in 2022. This is the first release of the dataset.

3.6 DISPLAYING THE DATA

It is recommended that the *Substrate Geology* layer should be displayed based on the "LEX_RCS" field in the attribute table (Table 4), whereas, the *Structural Geology* layer and *Geomorphology* layer should be displayed based on "FEATURE_D" (Table 5 and 6). The "LEX_RCS" field provides an abbreviation of the rock or deposit unit as listed in the BGS Lexicon of Named Rock Units and the type of rock (lithology) or sediment according to the hierarchical BGS Rock Classification Scheme. The "FEATURE_D" field provides a description of the geological feature delineated. The *Structural Geology* and the *Geomorphology* layers should display above the *Seabed Substrate* layer, to allow the best visualisation and clarity of the map objects.

Table 4 – Colour symbology intended for the Substrate Geology layer based on field "lex_rcs".

LEX-RCS	RED	GREEN	BLUE	HEX	LOOKS LIKE
MDU-XSM	148	224	0	#94E000	
MDU-S	255	255	0	#FFFF00	
MDU-XSV	255	201	0	#FFC900	
MDU-V	176	117	0	#B07500	
MDU-XVSM	224	201	176	#E0C9B0	
GFIC-V	0	0	21	#FFC9FF	
ICD-V	21	31	0	#B0FFC9	
MORD-XVSM	12	12	0	#E0FFE0	
TILL-DMTN	0	12	0	#E0FFFF	
CL-LSSA	148	255	237	#94FFED	
LPRU-MVRSS	237	224	255	#EDE0FF	
N-MMSD	255	176	117	#FFB075	

Table 5 - Symbology intended for the *Structural Geology* layer based on field "FEATURE_D".

FEATURE_D	Symbol
Fault or fracture at rockhead	

Table 6 - Symbology intended for the *Geomorphology (lines)* layer based on field "FEATURE_D".

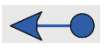
FEATURE_D	Symbol
Bedform (crestline)	
Drumlin (crestline)	
Drumlin (baseline)	
Crag and tail (crestline)	
Moraine (crestline)	
Esker (crestline)	
Iceberg ploughmark	
Meltwater channel (centreline)	
Concave break of slope	
Convex break of slope	
Negative lineament	
Positive lineament	

Table 7 - Symbology intended for the *Geomorphology (points)* layer based on field "FEATURE_D".

FEATURE_D	Symbol
Pockmark	

4 Limitations

4.1 DATA CONTENT

The BGS Seabed Geology 10k: Anglesey portrays the distribution of the different types of bedrock and unconsolidated superficial deposits and also includes the distribution of the main seabed morphological features and structural features observed at rockhead. Some features, such as bedforms crests will be identified by only a subset of selective, representative digitisation. The mapping, description and classification of the seabed geology are based upon the interpretations and evidence available at the time.

4.2 SCALE

This digital map at 1:10 000 scale is generalised and the geological interpretation should be used only as a guide to the geology at a local level, not as a site-specific geological plan based on detailed site investigations. Do not over-enlarge the data; for example, do not use 1:10 000 nominal scale data at 1:5 000 working scale.

4.3 ACCURACY/UNCERTAINTY

Linework provided within this digital map has been interpreted from multibeam data, with a grid cell size of 4 m, and a working scale of 1:10 000. It is not possible to provide a consistent level of accuracy for all objects in a geological map. For example, a sharp geological boundary will be captured with greater accuracy (and precision), than a conceptual, gradational boundary.

This is even more marked on geological maps of the seabed, based on the remote geophysical data and limited ground-truthing data. Marine in situ measurement techniques (e.g. grabs, cores and underwater video footage) reveal detailed information of the seabed substrate and provide, in general, an accurate representation of the local seabed. However, the seabed sampling that underpins this dataset was principally collected at a reconnaissance level and, therefore, the data could be several kilometres apart and may not always be sufficient to represent the sediment heterogeneity. Backscatter and texture analyse of the bathymetric data also indicate the boundaries between sediment types. However, it will depend heavily on the relationship between the different seabed substrates being mapped. For example, a sharp boundary separating two contrasting sediments types is likely to be more accurately mapped, with greater certainty than a diffuse or gradational boundary between two similar seabed substrates (e.g. sand and sand and gravel).

In addition, the user of this digital map should also be aware that it should be considered a “snapshot in time” of a transitory reality due to the high mobility of certain sedimentary deposits. Within the most dynamic areas, the spatial distribution of these deposits may change dramatically over time due to the local hydrodynamic regime, plus the seafloor may have been subjected to a range of anthropogenic disturbances (e.g. dredging of sediments).

4.4 DISCLAIMER

The use of any information provided by the British Geological Survey (‘BGS’) is at your own risk. Neither BGS nor the Natural Environment Research Council (NERC) or UK Research and Innovation (UKRI) gives any warranty, condition or representation as to the quality, accuracy or completeness of the information or its suitability for any use or purpose. All implied conditions relating to the quality or suitability of the information, and all liabilities arising from the supply of the information (including any liability arising in negligence) are excluded to the fullest extent permitted by law. No advice or information given by BGS, NERC, UKRI or their respective employees or authorised agents shall create a warranty, condition or representation as to the quality, accuracy or completeness of the information or its suitability for any use or purpose.

5 Frequently asked questions

Q: What does this map show?

A: The distribution of the different bedrock units and superficial sediments that have been interpreted to represent on the dominant geology within the top 1-2 metres of the seabed at a scale of 1:10 000. It also includes the distribution of the main seabed morphological and geomorphological features and the principal structural features observed at rockhead.

Q: What are the different colours on the map for?

A: The different colours are to show the different rock units and types of seabed substrate, as listed in the BGS Lexicon of Named Rock Units.

Q: How accurate is this map?

A: The geological interpretation that was undertaken to create this map was done to be viewed at a scale of 1:10 000 scale. Users should be aware that geological maps are a compilation of inferred features. It is not possible to provide a consistent level of accuracy for all objects in a geological map. Further details about the accuracy of this dataset are provided in the 'Limitations' section of this report.

Q: How often will this map be updated?

A: As more multibeam datasets became available in the area, future versions of this dataset are likely to expand its geographic coverage. However, dates for new version releases are, as yet, undetermined. BGS will contact licence holders with information on future releases of this dataset once they become available.

Q: Where can I get digital data?

A: This digital map is licenced from BGS, subject to certain standard terms and conditions. However, an increasing number are available for view or download. Many products also offer sample data downloads and user guides to help you decide if the data is suitable for you.

Q: In what formats can these data be provided?

A: This is available in a range of GIS formats, including ArcGIS (.shp), ArcInfo Coverages and MapInfo (.tab). More specialised formats may be available but may incur additional processing costs. Please email BGS Enquiries (enquiries@bgs.ac.uk) to request further information.

Q: I don't have a GIS. Can I still view the data?

A: Yes! Our Offshore Map Viewer is a good place to start. It is an online data and GIS service that covers a very wide range of marine geoscience research.

Q: Can I use this map as part of a commercial application?

A: Please refer to the licencing terms supplied alongside the dataset. For further queries regarding the licencing terms of our products, please contact digitaldata@bgs.ac.uk.

Q: I think the geology map might be wrong. What can I do?

A: We make every effort to ensure that our mapping reflects our best understanding of the geology of Anglesey. Sometimes our interpretations need to be revised as new evidence (such as new multibeam data) are obtained and simple errors sometimes get through our quality assurance procedures. We are currently working on a web service to improve notifications of errors that have been found and corrected; we hope to make this available soon. If you think you have spotted a problem with our datasets please let us know.

Glossary

Jargon	Explanation
ArcGIS	Geographic Information System (GIS) software for working with maps and geographic information maintained by the Environmental Systems Research Institute (ESRI).
Attribute	Named property of an entity. Descriptive information about features or elements of a database. For a database feature like census tract, attributes might include many demographic facts including total population, average income, and age. In statistical parlance, an attribute is a variable, whereas the database feature represents an observation of the variable.
Backscatter data	Data that was acquired with a sonar system capable of measuring the intensity of the return acoustic signal (echo) backscattered by the seafloor. The intensity of the return signal results from a complex combination of acoustic and geophysical processes, accounting for both transmitting and recording electronics of the sonar and intricate physical phenomenon occurring both in the water column and at the seafloor. New methods of analysing backscatter data have increased its potential for seabed characterisation.
Bathymetry	The measurement of the water depth in oceans, seas, or lakes over an area of seabed. In other words, bathymetry is the underwater equivalent to topography.
Bedrock	The main mass of rocks forming the earth, laid down prior to 2.588 million years ago. Present everywhere, whether exposed at the surface in rocky outcrops or concealed beneath superficial deposits, artificial ground or water. Formerly called solid.
Epoch	Geological unit of time during which a rock series is deposited. It is a subdivision of a geological period.
ESRI	Environmental Systems Research Institute (ESRI) is an international supplier of Geographic Information System (GIS) software, web GIS and geodatabase management applications.
Geophysical data	Data that has been acquired by recording and analysing measurements of the Earth’s physical properties, such as electrical, gravity, magnetic, radioactivity and seismic properties.
Geospatial data	Data that has a geographical component to it. This means that the records in a dataset have locational information directly linked to them, such as geographic data in the form of coordinates, address, city, or postcode.
Lexicon	Vocabulary defining rock names, the BGS Lexicon of Named Rock Units database provides BGS definitions of terms that

	appear on our maps and in our publications. https://www.bgs.ac.uk/lexicon/home.html
Lithological units	A rock identifiable by its general characteristics of appearance colour, texture and composition defined by the distinctive and dominant, easily mapped and recognizable petrographical or lithological features that characterize it.
Lithology	Rocks maybe defined in terms of their general characteristics of appearance: colour, texture and composition. Some lithologies may require a microscopical or chemical analysis for the latter to be fully determined.
Lithostratigraphy	Age and lithology. Many rocks are deposited in layers or strata and the sequence of these strata can be correlated from place to place. These sequences of different rock types are used to establish the changing geological conditions or the geological history of the area over time. The description, definition and naming of these layered or stratified rock sequences is termed lithostratigraphy (rock stratigraphy). Lithostratigraphy is fundamental to most geological studies. Rock units are described using their gross compositional or lithological characteristics and named according to their perceived rank (order) in a formal hierarchy. The main lithostratigraphical ranks in this hierarchy are Bed (lowest)>Member,>Formation>Subgroup>Group>Supergroup (highest). The units are usually named after a geographical locality, typically the place where exposures were first described.
Multibeam data	Data that was acquired with a multibeam echosounder. This type of sonar system emits sound waves in a fan shape. Multibeam systems acquire both bathymetry (depth) and backscatter (intensity) data. The amount of time taken for the sound waves to bounce off the seabed and return to a receiver is used to determine water depth. Whereas, the return intensity (i.e. how much of a transmitted acoustic signal is bounced back) reflects the nature of the seabed and can be used to determine the type of material or sediment on the seafloor.
Polygon	Polygons are a representation of areas. A polygon is defined as a closed line or perimeter completely enclosing a contiguous space and is made up of one or more links.
Scale	The relation between the dimensions of features on a map and the geographic objects they represent on the Earth, commonly expressed as a fraction or a ratio. A map scale of 1/100,000 or 1:100,000 means that one unit of measure on the map equals 100,000 on the earth.
Sedimentary	Rocks that originated from the broken up, or dissolved and re-precipitated, particles of other rocks. Examples include claystone, mudstone, siltstone, shale, sandstone, limestone

	and conglomerate. Sedimentary rocks cover more than two-thirds of the Earth's surface. They are formed from the weathering and erosion products of rock material, which have been transported (usually by water or wind), redeposited and later lithified.
Sediments	Mud, sand, gravel, boulders, bioclastic material (shells, plants), and other matter carried and deposited by water, wind, or ice.
Shapefile	The shapefile format is a geospatial vector data format for geographic information system software. It is developed and regulated by ESRI as a mostly open specification for data interoperability among ESRI and other GIS software products.
Superficial	The youngest geological deposits formed during the most recent period of geological time, the Quaternary. They range in age from about 2.6 million years ago to the present.
Vector	A representation of the spatial extent of geographic features using geometric elements (such as point, curve, and surface) in a coordinate space.