BGS INFORMATICS

User Guide: BGS Geology 50k V9

Open report OR/24/041

BRITISH GEOLOGICAL SURVEY

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British Geological Survey (BGS)

Keywords

Geology, Great Britain.

Map

1:50 000 scale, BGS Geology 50k (V8)

Front cover

Salisbury Crags, Edinburgh. Source: BGS Geoscenic. P545612.

Bibliographical reference

BRITISH GEOLOGICAL SURVEY 2025.
User Guide: BGS Geology 50k V9. *British Geological Survey Open Report*, OR/24/041. 38pp.

Keyworth, Nottingham British Geological Survey 2025

BRITISH GEOLOGICAL SURVEY

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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 UK Research and Innovation.

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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

This report is the published product of a study by the British Geological Survey (BGS) to produce a digital dataset depicting the geology of Great Britain. The report was compiled and re-written by R. Lawley, and edited by D.Daley, K. Linley and K. Lee.

The author would like to thank the many individuals (past and present) in BGS including geologists; cartographers and Geographic Information System (GIS) experts who have helped create, maintain and update the BGS Geology 50k dataset.

Contents

FIGURES

TABLES

Summary

BGS Geology 50k (formerly known as DiGMapGB-50) is a detailed, national geological dataset produced by BGS and is provided at 1:50 000 scale. It is based on the BGS's highest-resolution survey mapping.

BGS Geology 50k version 9 has an almost complete coverage (approximately 99% of bedrock and approximately 95% superficial-deposits coverage of Great Britain). The geological areas within the dataset are attributed with a name to identify their geological age (stratigraphy) or mode of emplacement (igneous characterisation), and their composition (rock type or lithology). This information is arranged in five themes (as available): bedrock geology; superficial deposits; mass movement deposits, artificial ground and linear features.

The British Geological Survey (BGS) Geology datasets are digital geological maps of Great Britain based on the different series of published BGS paper maps and updated with information from field surveys conducted by BGS, as well as previously unpublished maps and additional interpretation. Geological maps are the foundation for many other types of earth science related maps and are of potential use to a wide range of customers.

The information provided in this User Guide is intended to give an overview to using and understanding this BGS Geology 50k data product.

1 Introduction

The British Geological Survey provides digital geological maps as part of its ‘BGS Geology’ product line. The dataset has been developed over several years and is the result of a series of high-resolution mapping activities at BGS, including:

- Original survey
- Compilation & generalisation
- Digital capture & re-publication

Since its launch in 1998, BGS Geology 50k (formerly known as DiGMapGB) has produced several versions of the 1:50 000 scale data and this guide relates to Version 9.25 released in 2025. Each version has included new and replacement content that reflects the ongoing work of the Survey to extend and improve its geological map coverage.

1.1 WHAT THE DATA SHOW

The BGS Geology 50k data provide a digital representation of the geology of Great Britain previously shown on the map face of the published 1:50 000 scale paper maps. The data are the highest resolution, national coverage mapping available from BGS (with 99% of bedrock mapped). The geographical coverage of the dataset is given in Figure 2.

The data are arranged into four geological themes:

1. **Bedrock geology**: the main mass of rocks forming the earth, and which are present everywhere, whether exposed at the surface in rocky outcrops or concealed beneath superficial deposits, artificial ground, soil or water.
2. **Superficial deposits**: the youngest geological deposits formed during the most recent period of geological time, the Quaternary. They date from about 2.58 million years ago to the present.
3. **Mass movement deposits**: primarily superficial deposits or weathered bedrock that have moved downslope under gravity to form landslips.
4. **Artificial ground**: where the ground surface has been significantly modified by human activity including quarrying, landscaping, land-raise, cuttings and embankments.

And one additional component:

> **Linear features**: an intrinsic part of the bedrock and superficial themes defining relationships between geological units or landscape features. Linear features are useful additional data that can help you understand the structure and origin of the geological map.

Each theme is provided as an individual layer of data for viewing within a GIS (see Figure 1 below). The bedrock, superficial, mass movement and artificial layers represent geological units as a series of polygons with full attribution. The linear features layer is a series of polylines with attribution; it represents features that are either non-polygonal (such as fault planes or geological lineaments and landforms) or features that are too small to be defined as polygons in the other layers (such as thin coal seams and fossil horizons).

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 such as the age of a geological unit, its lithology (see Appendix 1), links to further resources (such as hyperlinks to BGS webpages) and metadata about the dataset (e.g., the scale, version, or release date of the data). Information about the types of geological attribution available in BGS Geology 50k is provided in section 4.3 attribute descriptions.

Users are advised to familiarise themselves with the data structure and the underpinning geological concepts as outlined in Table 1, Table 2 and Appendix 1.

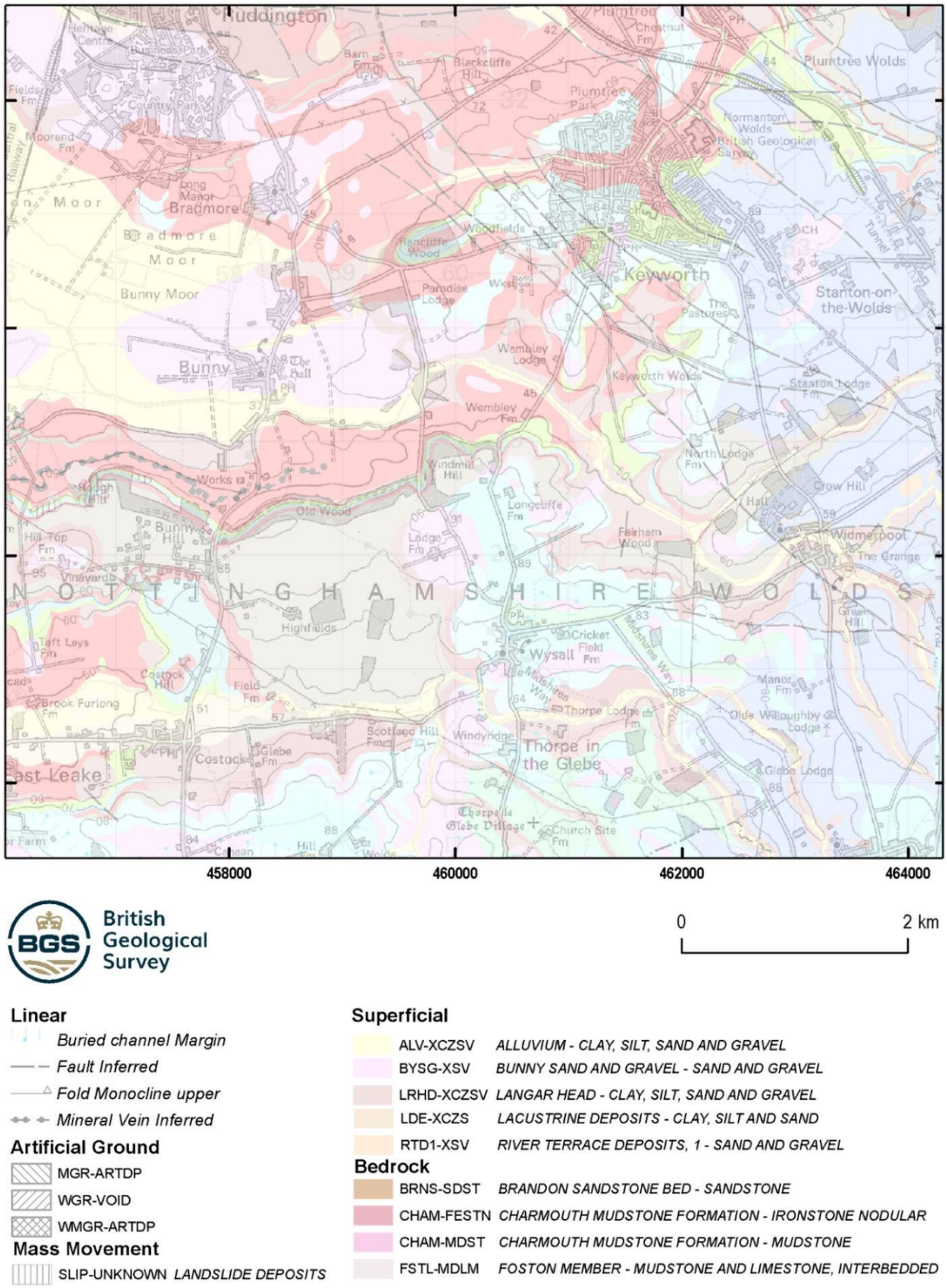


Figure 1 Example of BGS Geology 50k. Topographic backdrop: Contains OS data © Crown copyright and database rights 2024. OS AC0000824781 EUL

1.2 WHO MIGHT REQUIRE THIS DATA

Geological maps are the foundation for many types of environmental work. Potential uses differ according to map scale, ranging from detailed site-level study (typically 1:10 000 scale), through local and regional generalisations (1:50 000 to 1:250 000 scale), to national overviews (1:625 000).

They are of use to a wide range of customers with economic interests in planning and development, oil and gas reserves, water and mineral resources, waste disposal sites, utilities, transport, geohazards and property insurance; as well as more academic aspects such as the Earth's geological history and landscape development.

The BGS Geology 50k dataset offers users information at a 'neighbourhood' or 'borough' scale.

This dataset is of particular relevance to any user who needs a high degree of detail concerning the geology across a local area of 10's of Km^2. The dataset is typically consulted by experts who are about to embark on a development for construction (such as linear infrastructure) or assessment of local reserves for mineral extraction purposes.

The data are commonly used to provide information for Environmental Impact Assessments, outline planning applications, desktop studies and wider (generally county-wide) reviews of natural capital, land-use, natural hazards and redevelopment.

2 Case study

The BGS Geology 50k dataset underpins geoscience research in Great Britain. It forms a significant component of datasets that detail properties of, and processes modifying, ground conditions. It is widely used by many stakeholders to provide baseline information about areas of interest relating to their surface, or subsurface, assets.

BGS Geology 50k has been used in conjunction with BGS Civils, BGS GeoSure, and G-Base (geochemical data) to analyse asset condition and current/future perils for national network assets for electricity, water pipelines, gas pipelines, transport (road & rail) and communications. With analysis of those assets ranging in scope from large assets, such as reservoirs, towers, roads, buildings and bridges, down to small assets, including substations, cables, pipes and junction boxes.

2.1 THE PROBLEM

A national infrastructure network for utilities (e.g., power, water) needs to review its surface and buried asset register to establish their resilience to changing climate and land use.

Engineers have identified that some assets may be subject to ground stability, corrosion, or inundation risk (now, or in a future climate setting, within the lifespan of the asset). They need to assess reasons why some assets may not be performing to specification, and whether there are environmental factors in-common with the failures. They suspect that ground conditions relating to geology may be a causal factor for the failures they observe. Further, they need to develop a forecast model to identify future 'at risk' assets.

2.2 THE CHALLENGE

The challenge is identifying ground conditions and processes that may influence asset longevity or function for every asset in the company register. There may be complex networks of interlinked and interdependent assets, with many tens of thousands of individual assets, of varying size, distributed across the landscape (national or regional in scope).

The first task is to populate the asset register with expected ground characteristics for each asset. The BGS Geology 50k product has a suitable combination of resolution (+/- 50m), with national coverage. It can be used to identify basic geological facts for each asset, as well as identifying specific perils such as faulting, or landslides.

For other types of peril, the geology information can be further enhanced with additional products from BGS (e.g., corrosivity data, or geochemical parameters).

2.3 THE SOLUTION

Once the asset register is populated with geology data, engineers can quickly analyse the data to see if failing assets have commonalities in their ground conditions (e.g., a particular type of geological unit at foundation level).

If commonalities **are** found, it is then possible to quickly identify other assets in similar settings that may require further attention, or investigation. If necessary, a forecasting model for weather, or climate change can also be applied to establish if conditions are likely to change (improve, or decline), depending upon the susceptibility of the foundation conditions.

BGS Geology 50k has been used in this way, in conjunction with BGS GeoSure (compressible ground, collapsible ground, landslides, soluble rocks (dissolution), running sand, shrink swell); BGS G-base (geochemistry baseline survey of the environment analysis of stream sediment, stream water and soil samples); BGS Civils (engineering properties: bulking volume, corrosivity ferrous, discontinuities, engineered fill, excavatability, foundation conditions, strength, sulfate/sulphide), to improve understanding of surface and buried assets for a wide range of stakeholders.

3 Methodology

The BGS Geology 50k dataset is a digital representation of the most recently published geological maps at 1:50 000 scale (or 1:63 360 scale for areas surveyed and published prior to 1970) and any additional map updates made by BGS since paper maps ceased (c.2011). It comprises 494 geological map tiles that are based on the OS 1 inch to 1-mile new series sheet layout.

3.1 ORIGINAL SURVEY

Geology mapping is an interpretation of what was observed and inferred at the time of survey. For many parts of Great Britain, geological units are obscured by infrastructure, vegetation, soil or water. Unlike other types of survey where features are often readily visible and measurable to a surveyor; it is not always possible to directly observe geology everywhere across the landscape.

BGS surveyors use a range of techniques to interpret geological characteristics from rock exposures, and other indirect sources, such as boreholes, geochemistry, and geophysics to then extrapolate the likely geometries of the geological units across areas with no exposure.

Field surveys were traditionally captured on ‘field- slips’ (annotated topographic maps) and notebooks; BGS has been surveying at 1:10,000 scale since 1970 (following the introduction of the standardised 1:10,000 base map from Ordnance Survey). Previously, BGS surveyors utilised 1:10,560 base mapping (‘county’ series mapping).

Modern geological surveys utilise a range of digital systems to record ‘traditional’ human-surveyed information as well as autonomous and sensor-surveyed data streams. Survey techniques are adapted to suit the terrain being surveyed.

A survey of Quaternary deposits will require different types and quantities of evidence, compared with that required for an area of Carboniferous strata. Similarly, legacy surveys will have been designed to resolve specific challenges at that time. For example, a survey from 1920, will have had a focus on resource mapping, whilst a modern survey in 2020 is more likely to focus on environmental factors and processes.

BGS maintains an extensive paper and digital archive of all its previous survey data. The published 1:10 000 and 1:10 560 maps derived from these surveys, form the basis of all the 1:50 000 scale (and prior to 1970, 1:63 360 scale) map outputs by BGS.

3.2 COMPILATION & ORIGINAL PUBLICATION

Batches of 1:10 000 (or 1:10 560) scale maps are generalised and re-compiled into 1:50 000 scale geological sheets (or 1:63 360 scale sheets, if prior to 1970). The 1:50 000 sheets are based on the OS, *Old series* one-inch-to-one-mile sheet layout.

Prior to the use of digital systems, the generalisation relied upon various forms of photo-reduction and mechanical rescaling methods, whereby the large-scale mapping was reduced to the smaller scale and then manually recaptured by a cartographic team.

The process of recapture allowed for an iterative 'generalisation process', overseen by a geologist, to try and ensure that the 'conceptual' and spatial understanding of the geology was not lost in the scale reduction. The primary factors for generalisation were driven by the limitations of the printing processes available at the time, and visual limitations of creating paper outputs (e.g., physically representing multiple layers of overlapping data on a 2d print layout).

The standard 1:50 000 and 1:63 360 geological sheets generally portrayed bedrock and superficial deposits, with linear features typically including faults, mineral veins, and fold axes. Over time, the later generations of paper maps included artificial materials and mass movement deposits.

Marginalia for the sheets included summary generalised vertical sections and cross sections, or special insert maps (from the larger scale mapping) where required.

Production of paper maps (for 1:50 000 scale), ceased in 2011.

3.3 DIGITAL CAPTURE & RE-PUBLICATION

As part of wider digital capture programme, the geological standards (circa 1:10 000), and geological sheets (circa 1:50 000), held in paper and plastic map archives have been digitised into a set of five thematic GIS layers described in section 1.1. These data have been incorporated into the main BGS Geology 50k database which holds all the recent survey work captured in the 'all digital' environment.

In addition to capturing the map information as spatial objects, each object is attributed with a range of feature-specific textual information (e.g., age, lithology) as well as basic metadata about each geological sheet and unique object identifiers.

4 Technical information

4.1 SCALE

The BGS Geology 50k dataset is intended for use at 1:50 000 scale and largely created from data cartographically captured at that scale, as such the underlying geological linework is considered accurate to +/- 50m.

4.2 COVERAGE

BGS Geology 50k has almost complete coverage of Great Britain and the Isle of Man (see Figure 2). The dataset comprises 494 map tiles and covers approximately 236 000 km^2 (approximately 99%) of the land surface.

BGS continues to update the mapping at this scale; where there is no current cover for a theme at 1:50 000 scale, the smaller scale 1:625 000 data is available, and for some areas larger scale data (1:10 000 or 1:25 000) may be substituted where revised 50k mapping is still in preparation.

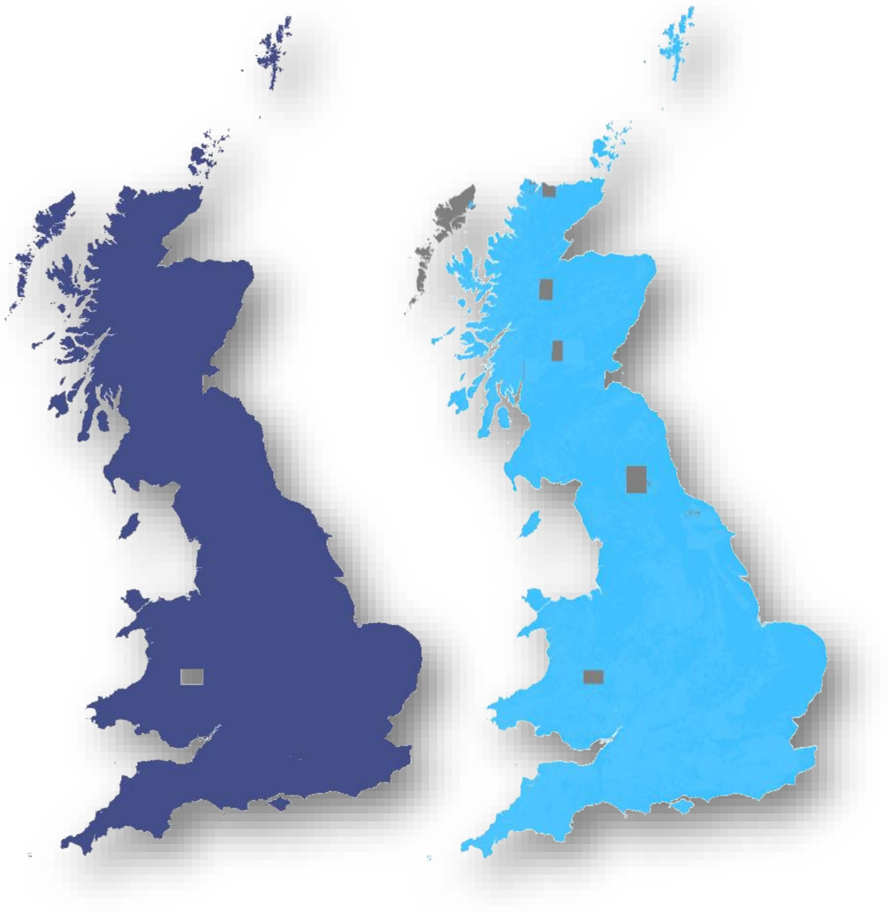


Figure 2 Coverage of bedrock (dark blue) and superficial materials (light blue). Unmapped areas (no primary survey at 10/50k) are shown in grey. Coastline: Contains OS data © Crown copyright and database right 2024

4.3 ATTRIBUTE DESCRIPTION

Each geological theme (map layer) in BGS Geology 50k contains a series of attribute fields. Attribution is specific to the theme, for example, bedrock objects are attributed with lithostratigraphy, chronostratigraphy or lithodemic class (see Appendix 1), whereas the linear theme with features such as geological faults are not. Table 1 and Table 2 describe the attributes in each theme/layer.

BGS aims to provide a balance between built-in content and web-delivered content, alongside potential for 'add-on' information/dictionaries from other sources.

4.3.1 Attribution fields for the Bedrock, Superficial, Artificial and Mass-movement themes

The Bedrock, Superficial, Artificial and Mass-movement themes depict domains of geological materials and are typically attributed with descriptions for their name, age (expressed in multiple ways) and their lithology.

The nomenclature for age and lithology are held in the BGS Lexicon of Named Rock Units (http://www.bgs.ac.uk/Lexicon/), and the BGS Rock Classification Scheme guides (http://www.bgs.ac.uk/bgsrcs/details.html).The information fields attached to polygons in these two themes are explained in Table 1 below.

Table 1 Attribution of Bedrock, Superficial, Artificial and Mass-movement themes

DATA FIELD	EXPLANATION OF DATA FIELD	NOTE
LEX_WEB	Direct hyperlink to the definition of the particular geological unit in the BGS Lexicon of Named Rock Units (BGS website): e.g. https://webapps.bgs.ac.uk/lexicon/lexicon.cfm?pub=GOG	*Note 1*
LEX	A single Lexicon (or LEX) computer code used to identify the rock unit(s) or deposit(s) as listed in the BGS Lexicon of Named Rock Units: e.g., GOG	*Note 2*
LEX_D	A description of the LEX code above, giving the full name of the unit(s): e.g., GREAT OOLITE GROUP is the full name of the unit coded as GOG	
LEX_RCS	The primary two-part, LEX & RCS, code used to label the geological units in BGS Geology data: e.g., GOG-LMST	*Note 3*
RCS	A rock-classification code of up to 6 characters (mostly letters) forming the second part of the primary LEX_RCS attribute. E.g., MDCO. The code can represent a single lithology or multiple lithologies (see RCS_X)	*Note 4*
RCS_X	A variant of the RCS code (above) which individually lists the components of heterolithic units: e.g., MDST + [CONG] (shown as RCS = MDCO). Subordinate units are denoted in [] brackets	*Note 5*
RCS_D	Description of the RCS code(s) above giving the lithology of the unit: e.g., MUDSTONE AND [SUBEQUAL/SUBORDINATE] CONGLOMERATE is the description of the rock coded as MDST + [CONG]	
RCS_ORIGIN	An attribute of the RCS code(s) above, classifying the mode of origin of the lithology of the rock/deposit: e.g., Sedimentary, Igneous, and Metamorphic	*Note 6*
RANK	Rank of the unit in the lithostratigraphical or lithodemic hierarchy: e.g., BED or SUITE	*Note 7*
BED_EQ_D	Description of the Bed or equivalent lexicon code for the unit where applicable	
MB_EQ_D	Description of the Member or equivalent lexicon code for the unit where applicable	
FM_EQ_D	Description of the Formation or equivalent lexicon code for the unit where applicable	
SUBGP_EQ_D	Description of the Sub-Group or equivalent lexicon code for the unit where applicable	
GP_EQ_D	Description of the Group or equivalent lexicon code for the unit where applicable	
SUPGP_EQ_D	Description of the Super-Group or equivalent lexicon code for the unit where applicable	
MAX_TIME_Y	Maximum age (in years), of the oldest time division in which the geological unit was formed: e.g., 170300000	*Note 8*
MIN_TIME_Y	Minimum age (in years), of the youngest time division in which the geological unit was formed: e.g., 163500000	
MAX_AGE	Maximum age defined for the unit e.g., ASBIAN	*Note 9*
MAX_EPOCH	Maximum epoch defined for the unit: e.g., VISEAN	
MAX_SUBPER	Maximum sub-period defined for the unit: e.g., MISSISSIPPIAN	
MAX_ PERIOD	Maximum period defined for the unit e.g., CARBONIFEROUS	
MAX_ERA	Maximum era defined for the unit e.g., PALAEOZOIC	
MAX_EON	Maximum eon defined for the unit e.g., PROTEROZOIC	
BGSTYPE	The BGS Geology theme: e.g., BEDROCK, SUPERFICIAL	
LEX_RCS_I	A computer code that can be used to sort *units into approximately the correct stratigraphical order (by Period). NB it does not completely resolve UK stratigraphy and must NOT be used as a substitute for determining full stratigraphical relationships between units.*	
LEX_RCS_D	A full description of the LEX_RCS above: e.g., GREAT OOLITE GROUP - LIMESTONE	
BGSREF	A BGS code used to define the colour for the polygon based on the LEX_RCS code pair.	
BGSRED	The RGB colour value for Red (expressed as a value between 0 and 255), for the LEX_RCS attribute (as seen in the provided style sheets)	
BGSGREEN	The RGB colour value for Green (expressed as a value between 0 and	

	255), for the LEX_RCS attribute (as seen in the provided style sheets)	
BGSBLUE	The RGB colour value for Blue (expressed as a value between 0 and 255), for the LEX_RCS attribute (as seen in the provided style sheets)	
MAP_SRC	Name of the digital geological tile (number and name based on published map sheet) in which the polygon appears e.g., EW075_PRESTON, SC084E_NAIRN where prefix 'EW' is for England & Wales and 'SC' for Scotland	*Note 10*
MAP_WEB	The MAP_WEB link provides a direct hyperlink to the appropriate, original, paper maps held in the BGS Map Portal http://www.bgs.ac.uk/data/maps/home.html	*Note 11*
VERSION	Version number and attribute level of the digital data: e.g., 9.25 is version 9, with attribute level 25	
RELEASED	Date the BGS Geology data files were created by BGS: e.g., 30-06-2024	
NOM_SCALE	Nominal scale is the advisory scale of use for the published digital information. Information used to prepare the digital data is derived from a range of scales as available and appropriate (see limitations section below)	
NOM_BGS_YR	The year date of publication of the most up-to-date map sheet, or the date of publication in BGS Geology 50k (if no map previously exists). Where not known or inappropriate, field is left null	
UUID	Universally Unique Identification that can be used to identify individual features: e.g. bgsn:DM50_V8_digmap1004081046355357	
GUID	Globally Unique Identification that will be used to identify individual features in future BGS services: e.g., 4e526e5d-58c3-420b-84ba-31d9fd4163c5	

EXPLANATORY NOTES	
Note 1	*The LEX_WEB link provides a hyperlink to the online Lexicon resource. The online version of the lexicon is updated regularly.*
Note 2	*The Lex attribute is the computer code linking to the BGS Lexicon (database of named rock units) http://www.bgs.ac.uk/lexicon/home.cfm..The Lexicon code may refer to a single identifiable unit or a package of units where the individual components cannot be differentiated.*
Note 3	*The BGS Geology dataset uses the LEX_RCS codes as a primary key, which can be used to JOIN (append) 'add-on' datasets*
Note 4	*The RCS attribute is the computer code linking to the BGS Rock Classification Scheme (RCS) http://www.bgs.ac.uk/bgsrcs/home.html. The field may include abbreviated codes for multiple lithologies.*
Note 5	*The RCS_X field provides a list of individual RCS lithology codes that make up the overall lithological description of the unit. The suffix _X was added to distinguish this listing of the components from the abbreviated code now shown in the RCS field.*
Note 6	*The origin of each rock/deposit type has been introduced in version; this is in part to assist users who want to know some fundamental properties of the geological materials.*
Note 7	*The parentage of each rock/ deposit is provided in these fields, and these are all derived from the BGS LEXICON. The 'RANK' of a unit identifies the unit's position within a hierarchy e.g., a 'bed' may be part of a named member, which is itself part of a formation; several formations may make up a group and several groups may form a supergroup. The BED, MEMBER, FORMATION, SUBGRP GROUP and SUPGRP codes/names describe the ascending parentage for each unit (other non-stratigraphic schema are also shown in this way). A formation is the fundamental lithostratigraphic unit and is the prime mapping-unit for BGS and need not be divided up into named members or beds; nor does a formation have to belong to a group or supergroup. 'NotAp' is the abbreviation for 'Not Applicable' and is used to indicate that it is not appropriate to list child units of lower rank; 'NoPar' is the abbreviation for 'No Parent' and is used to indicate that no parental unit of higher rank has been identified. Users are recommended to refer to the LEX_WEB link to find the latest information concerning the lithostratigraphy of a unit. All codes and names used in V8 are correct at time of publication.*
Note 8	*These figures give an indication of the maximum age range (in years before present) of the lithostratigraphical units as given in the BGS Geological Timechart available at: https://www.bgs.ac.uk/discovering-geology/fossils-and-geological-time/geological-timechart/ (where they are expressed as 'million years'). Some of these values are interpolations; the +/- error ranges are not provided here. The age range given is that for the time period*

	ascribed to each geological unit in the BGS Lexicon. They do not give absolute age measurements made on the individual geological units (see future revisions section below).
Note 9	*The maximum geochronological age (expressed as age/stage/chron, epoch, sub-period, period, era or eon) for each rock/ deposit is provided in these fields. These are all derived from the BGS Lexicon and Geological Timechart. 'NOT DEFINED' is used to indicate that no age classification has been identified (or is needed). Users are recommended to refer to the LEX_WEB link to find the latest information concerning the lithostratigraphy of a unit. Some geological units straddle more than one geological age. All codes and names used in V9 are correct at time of publication.*
Note 10	*This attribute was previously called SHEET. It was changed in Version 8 to MAP_SRC, to reflect that BGS Geology is no longer just compiled from published map sheets, but from a range of sources.*
Note 11	*The MAP_WEB link provides a hyperlink to any online resource that acts as reference material for BGS Geology content. Currently, the weblink will take users to the appropriate, original, paper maps held in the BGS Map Portal http://www.bgs.ac.uk/data/maps/home.html (future versions will hyperlink to other resources).*

4.3.2 Attribution fields for the linear theme

BGS Geology 50k includes a linear layer to portray geological features and concepts that are normally depicted on maps in linear form. This layer includes:

- FAULTS (Lines representing planes of structural movement such as: normal faulting or thrusts. Relevant to the Bedrock theme (see Appendix 1)).
- MINERAL_VEINS (Lines representing the surface expression of mineralised fractures/veins. Relevant to the Bedrock theme).
- FOLD_AXES (Lines representing planes of structural change/symmetry such as: anticline or syncline. Relevant to the Bedrock theme).
- ALTERATION_AREAS (Lines that represent the spatial limit of alteration e.g. Metamorphic aureoles or vein swarms. Relevant to the Bedrock theme).
- ROCK (Lines representing thin beds of notable geological materials e.g., Coal, gypsum, ironstone. Relevant to the Bedrock theme).
- FOSSIL_HORIZON (Lines representing surfaces/beds of fossil zonation e.g., marine bands or fish beds. Relevant to the Bedrock theme).
- LANDFORMS (Lines that represent landform features e.g., dune crest-line or channel margins Relevant to all themes and topography).

The Linear layer is attributed in a similar manner to the bedrock and superficial themes, as described in Table 1 Attribution of Bedrock, Superficial, Artificial and Mass-movement themes Table 1, but includes additional fields for linear-specific details described in Table 2.

Table 2 Additional attribution fields of the linear theme

DATA FIELD	EXPLANATION OF DATA FIELD
CATEGORY	Geological unit category e.g., ROCK, FOSSIL_HORIZON
FEATURE	The type of line feature/geological feature, in coded and abbreviated form, e.g., Coal_seam_Obs; Ironstone_bed_Inf
FEATURE_D	Full description of the type of line feature e.g., Coal seam, observed; Ironstone bed, inferred
FLTNAME_D	Description of the FLTNAME code above giving the name of the fault: e.g., Highland Boundary Fault
MINERAL_D	Description of the first Mineral found or associated with the linear feature: e.g., Galena (Pb)
GEO_HWALL	Indicates the side of the fault that is the "Hanging wall". The side is depicted as an octant on a compass rose: (North, North-east, East, South-east, South, South-west, West, North-west) e.g. East indicates the hanging wall is on the eastern side of the fault trace; Faults yet to be characterised are shown as ND ('Not Defined'). The hanging wall is derived by geologist assessment and partly based on fault geometry. It can be difficult to establish a true hanging wall side for faults that have

	multiple phases of deformation (due to possibility of reversed sense of throw). Users are advised to seek expert advice if they need further information about an individual fault, its orientation, and its sense of movement.
LEFT_HND	This indicates if the linear feature is 'handed' and can be symbolised on one side. For example, this can be used to indicate the hanging wall side of the fault. The left-hand indicator identifies if the left-hand side of the fault (when viewed along the line from its start point to its end point) can be represented with a handed symbol (such as a hachure/ triangle). E.g., Y (Yes – left handed), N (No – right handed), ND (Not Defined).

4.4 DATA FORMAT

The BGS Geology 50k data are created in vector format. They are routinely released in ESRI® shapefile format and as an open-format GeoPackage. Other vector formats are available on request. More specialised formats may be available but may incur additional processing costs. Please email BGS Digitaldata team (digitaldata@bgs.ac.uk) to request further information.

4.5 DATA HISTORY

This is Version 9.25 of the data. It incorporates all edits since V8.24 (released in 2017); including new and revised tiles of geology data, OS OpenData coastline and miscellaneous updates and corrections to geological features across the country. Version 9 includes new mapping from the following geological sheets:

Edits incorporated into V9.25 2024	Coverage
EW34_GUISBOROUGH	Partial Sheet (mass movement only)
EW35_WHITBY	Partial Sheet (mass movement only)
EW43_EGTON	Partial Sheet (mass movement only)
EW44_SCALBY	Partial Sheet (mass movement only)
EW63_YORK	Whole 50k Sheet but as 10k tiles
EW93_ANGLESEY	Whole Sheet
EW94_LLANDUDNO	Partial Sheet
EW105_ANGLESEY_AND CAERNARFON	Partial Sheet
EW220_LEIGHTON_BUZZARD	Partial Sheet
EW221_HITCHIN	Partial Sheet
EW255_BEACONSFIELD	Partial Sheet
EW256_NORTH_LONDON	Partial Sheet
EW257_ROMFORD	Partial Sheet
EW258_SOUTHEND	Partial Sheet
EW271_DARTFORD	Partial Sheet
EW273_FAVERSHAM	Partial Sheet
EW280_WELLS	Partial Sheet
EW281_FROME	Partial Sheet
EW283_ANDOVER	Partial Sheet
EW284_BASINGSTOKE	Partial Sheet
EW285_GUILDFORD	Partial Sheet
EW286_REIGATE	Partial Sheet
EW287_SEVENOAKS	Partial Sheet
EW288_MAIDSTONE	Partial Sheet
EW289_CANTERBURY	Partial Sheet
EW295_TAUNTON	Partial Sheet
EW296_GLASTONBURY	Whole 50k Sheet but as 10k tiles
EW297_WINCANTON	Partial Sheet
EW305_FOLKESTONE	Partial Sheet
EW238_AYLESBURY	Partial Sheet
EW239_HERTFORD	Partial Sheet
SC107E_LOCH_GLENCOUL	Partial Sheet
SC73E_FOYERS	Partial Sheet

SC047_CRIEFF	Partial Sheet
SC38W_BEN_LOMOND	Partial Sheet
Edits incorporated into version 8 (pre 2017)	
EW049 KIRKBY LONSDALE	SC046E KILLIN BEDROCK EDITION
EW084 WIGAN	SC046W CRIANLARICH BEDROCK EDITION
EW118 NEFYN	SC051E_052W NORTH MULL AND ARDNAMURCHAN
EW125 DERBY	SC054E LOCH RANNOCH BEDROCK EDITION
EW147 AYLSHAM	SC074E AVIEMORE SUPERFICIAL EDITION
EW266 MARLBOROUGH	SC084E NAIRN SUPERFICIAL EDITION
EW330, 331, 344, 345 ISLE OF WIGHT	SC108W BEN HEE
	SC102W OYKEL BRIDGE SUPERFICIAL EDITION

The map-face changes for Version 9.25 are shown in Appendix 2. The underlying databases include 195 updates or additions to the BGS Lexicon (in terms of British stratigraphy and age/epoch/period time scales), a total of 105 lithostratigraphic terms were deprecated. Overall, 553 LEX-RCS code combinations changed between versions 8 and 9.

4.5.1 Attribute fields:

Version 9.25 of BGS Geology 50k has slightly modified attribute content compared with DiGMapGB Version 8.24 (and prior).

The dataset has broadly the same attribution as Version 8.24, except for the following:

- All layers of data now include a persistent GUID field for future compatibility and object tracking with other BGS products (see table 1).
- All layers of data now include 3 fields (BGSRED, BGSGREEN, BGSBLUE) to assist users implementing RGB colour profiles
- The Linear features layer includes one new field (LEFT_HND) to assist in identifying fault-trace handedness (see table 2).
- The Linear features layer has renamed the field HWALL_ROSE to GEO_HWALL to assist in identifying the hanging wall orientation of the faults.

Users can delete or rename the additional fields if they wish to maintain compatibility with V8.24 attribution.

Users should note that due to nomenclature changes, some text attribute fields now have longer field lengths to accommodate their new content (notably new lithostratigraphical and lithological classification).

4.5.2 Comparison with the BGS Geology 50k data shown on BGS websites and apps

Simplified versions of the BGS Geology 50k Bedrock, Linear and Superficial themes are also available to view (for free) via the BGS OpenGeoscience pages at: http://www.bgs.ac.uk/opengeoscience/home.html where there are links to an online digital map viewer. This variant of the data can also be acquired as a Web Map Service (https://www.bgs.ac.uk/technologies/web-map-services-wms/web-map-services-geology-50k/).

Note that these variants of the map contain simplified content and also use alternative map data for the small areas of Great Britain that do not yet have 1:50 000 scale data.

Similar data can also be viewed using the 'BGS Geology Viewer' app for all mobile devices, tables and personal computers utilising a web browser, available via https://www.bgs.ac.uk/map-viewers/bgs-geology-viewer/.

4.6 DISPLAYING THE DATA

It is recommended that the five layers of data within BGS Geology 50k are displayed in the following order within GIS (to allow best visualisation and clarity of the map objects):

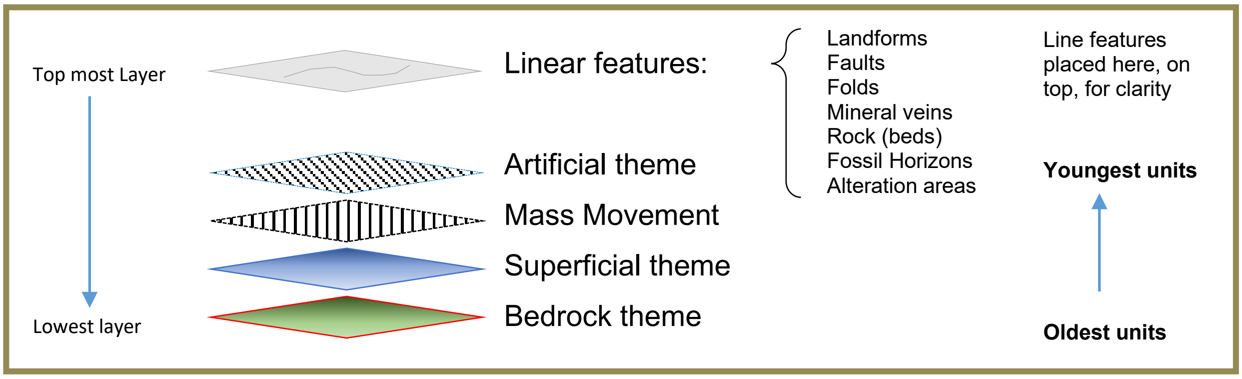


Figure 3 Recommended layer ordering

Users should be aware that some themes are intrinsically related to each other, for example, the 'Fault' features from the linear theme are directly relevant to the bedrock theme; and the mass-movement theme should always be assessed in conjunction with the superficial and bedrock themes, an example is shown in Figure 3 above.

4.6.1 Map colours

BGS Geology 50k (v9) replicates the printed colours used on paper maps as far as possible. The dataset is supplied with an Excel spreadsheet detailing the RGB and hexadecimal colour coding used.

In addition to style sheets, there are optional colour codes that are be embedded within the data for each map object as indicated in Table 3. These allow users to thematically re-style the map content.

Table 3 Colour coding fields

COLOUR	EXPLANATION
BGSREF	Colour for use when symbolising according to the name and lithology of the unit (LEX_RCS). This is the BGS reference colour that replicates the printing colour as far as possible, though in some cases new default colours have been established for the purpose of rationalisation countrywide
BGSRED	The RGB colour value for Red (expressed as a value between 0 and 255), for the LEX_RCS attribute (as seen in the provided style sheets)
BGSGREEN	The RGB colour value for Green (expressed as a value between 0 and 255), for the LEX_RCS attribute (as seen in the provided style sheets)
BGSBLUE	The RGB colour value for Blue (expressed as a value between 0 and 255), for the LEX_RCS attribute (as seen in the provided style sheets)

The colour code takes the form of a numerical value. The BGSRED, BGSGREEN and BGSBLUE fields can be used directly in any GIS platforms that use RGB (or RGB triplets) to emulate the print colour of the map objects.

For the fields identified as 'BGSREF', this is a legacy coding system and typically is a three-digit number which is used to represent the percentage of Yellow, Cyan and Magenta present in the colour. The code can be interpreted using Table 4:

Table 4 Colour ratios

Digit	0	1	2	3	4	5	6	7	8	9
%	0	7	14	21	31	42	54	67	80	100

For example the code 912 represents
Yellow (9) = 100% + Cyan (1) = 7% + Magenta (2) = 14%.

These YCM colours can also be converted to RGB (red, green and blue) colours using the following formulae:

Red	=	255 – (cyan% x 2.55)
Green	=	255 – (magenta% x 2.55)
Blue	=	255 – (yellow% x 2.55)

Thus 912 (YCM) = red - 237, green - 219, blue – 0

5 Licencing the data

5.1 BGS LICENCE TERMS

The British Geological Survey does not sell its digital mapping data to external parties. Instead, BGS grants external parties a licence to use this data, subject to certain standard terms and conditions. In general, a licence fee will be payable based on the type of data, the number of users, and the duration (years) of a licence.
All recipients of a licence (potential licensees) are required to return a signed digital data licence document before authorisation for release of BGS digital data is given.

In general terms, a BGS digital data licensee **will** be permitted to:

- make internal use of the dataset(s)
- allow a specified number of internal users to access/use the data (the number of users will be agreed with the licensee and specified in the licence document) for the purposes of their day-to-day internal activities.
- reproduce extracts from the data up to A3 for use in external analogue (paper/hard copy) or non-query able electronic (e.g., secured .pdf) format: to meet a public task duty; fulfil a statutory requirement; and/or as part of academic or other non-commercial research.

But **will not** be permitted to:

- provide a bureau service for others or incorporate the data in the generation of products or services for commercial purposes.
- sell, assign, sublicense, rent, lend or otherwise transfer (any part of) the dataset(s) or the licence.
- place (any part of) the dataset(s) on the Internet

The BGS is committed to ensuring that all the digital data it holds which is released to external parties under licence has been through a robust internal approval process, to ensure that geoscientific standards and corporate quality assurance standards are maintained. This approval process is intended to ensure that all data released: (i) is quality assured; (ii) meets agreed BGS data management standards; (iii) is not in breach of any 3rd party intellectual property rights, or other contractual issues (such as confidentiality issues), that would mean that release of the data is not appropriate.
When the BGS digital datasets are revised any upgrades will be automatically supplied to the licensee, at no additional cost. Geological map datasets are revised on a periodic rather than on an annual basis, licensees will therefore not automatically receive a new dataset each year unless changes have been made to the data.

These are general comments for guidance only. A licensee of BGS's digital data is provided with full details of the basis on which individual BGS datasets licensed to them are supplied.
If you have any doubts about whether your proposed use of the BGS data will be covered by a BGS digital licence, the BGS Intellectual Property Rights (IPR) section will be happy to discuss this with you and can be contacted through the following email address: iprdigital@bgs.ac.uk
BGS IPR will usually be able to provide reassurance that the licence will cover individual user requirements and/or to include additional 'special conditions' in the licence documentation, addressing specific requirements within BGS's permitted usage.

5.2 DATA ACKNOWLEDGMENTS

Please use the following acknowledgements when using BGS Geology 50k v9.

DATASET NAME licenced data: ‘Derived from BGS Digital Data under Licence (cite your licence number) British Geological Survey © UKRI. All rights reserved.’

DATASET NAME data: ‘Contains British Geological Survey materials © UKRI [year]’

5.3 CONTACT INFORMATION

For all data and licensing enquiries please contact:

BGS Data Services
British Geological Survey
Environmental Science Centre
Keyworth
Nottingham
NG12 5GG
Direct Tel: +44(0)115 936 3143
Email: digitaldata@bgs.ac.uk

6 Limitations

6.1 DATA CONTENT

BGS Geology 50k is a compilation of digital tiles derived from previously published and unpublished maps and archive information. The mapping, description and classification of rocks are based upon the interpretations and evidence available at the time of survey, or time of re-evaluation for modifications/correction.

The BGS Geology 50k dataset therefore represents data of different vintages and origins. This means that it may not always agree with more recently gathered observations (such as boreholes) and that adjacent geological sheets/tiles (of different survey vintages) may not seamlessly fit together spatially, or in terms of lithological description (resulting in some map-sheet 'edges' that exhibit contrasting colours/attribution).

The original geological map interpretations were fitted to Ordnance Survey topographical bases available at the time of survey. The digital geological data do not necessarily fit other topographical bases including more modern Ordnance Survey datasets.

Whilst every effort is made to ensure all digital data are processed to the same standard; the differing map sources, modes of derivation, and compilation methods (arising from the analogue to digital, and all-digital streams) can cause subtle differences between map tiles in the database. The differences are related to issues of:

- Source scales: e.g., 1: 10 000 and 1:10 560 scale of paper originals, as well as recent multi-scale digital data such as satellite or terrain.
- Source diversity: e.g., modern maps will utilise a much wider range of spatial information, not just survey observation.
- Source age: e.g., terrain complexity and representation vary with age of survey (geology is extrapolated across terrain information available at the time of survey, modern surveys utilise higher resolution and more precise terrain data).
- Source age: e.g., geological complexity and representation vary with age of survey (complexity and detail is subject to evidence available at the time of survey, older surveys benefit from exposures now obscured by urban growth, whilst recent surveys will be based on the latest concepts of geology and will have far more information derived from sampling and remote sensing techniques).
- Source type: e.g. digitisation of paper and plastic originals can introduce errors of capture relating to issues such as geo-rectification and warping of paper originals, human error (capture, interpretation and classification) and for all-digital surveys – issues concerning accuracy and precision of location (e.g., GPS methods and types).

6.2 SCALE

BGS Geology mapping should be used at an appropriate scale, normally at the same scale as the original paper compilation or generalised variant. The recommended nominal scale of use is embedded in the BGS Geology data as an attribute (NOM_SCALE). Users should note that

Version 9.25 now includes some small areas of data captured at scales 1:10 000, 1:25 000, 1:35 000 that are presented without generalisation. These represent areas where new mapping exists, but for which no generalised 1:50 000 data is currently available. Additionally, very small areas of 1:625 000 scale mapping are included in the Superficial theme for areas where no larger scale data is available. Users should note that Sheet 180 (Knighton) is not yet available, enquiries about this sheet can be sent to digitaldata@bgs.ac.uk.

The BGS Geology 50k data is designed to provide local –neighbourhood representation of geology only, and to assist (not replace) any required site-specific geological investigation. The data, information and related records supplied by the BGS should not be taken as a substitute for specialist interpretations, professional advice and/or detailed site investigations.

Detail clearly defined and accurately depicted on large-scale maps of small areas may be removed or exaggerated when small-scale maps of large areas are derived from them by generalisation. You must seek professional advice before making technical interpretations on the basis of the materials provided.

6.3 ACCURACY/UNCERTAINTY

The cartographic accuracy associated with the BGS Geology 50k dataset is nominally stated as +/-1 mm which equates to +/-50 m on the ground, at true scale. The small areas of larger scale mapping have similar cartographic accuracy, equating to +/- 10m, 25 or 35m as appropriate. This is only a measure of how faithfully the lines have been captured from the original paper mapping, it is not a measure of the accuracy of the original geological survey.

Users should apply an appropriate buffer to their spatial searches of the dataset if their location is uncertain or imprecise. When assessing locations that may be in close proximity to a geological boundary, users may need to consider adding an additional search buffer to their site to establish if the proximity of the geological boundary has an impact on their project site assessment.

All geological and soil materials vary naturally in their composition and characteristics and their interpretation and classification is based on of evidence for which no explicit uncertainty is provided. The depiction of a boundary on a geological map does not necessarily represent a fixed line of transition from one rock/soil type to another. The nature of geological boundaries can be complex and diffuse, therefore the depiction of a boundary by a line on a geology map may represent a zone of transition rather than a specific 'linear boundary' of change. This is particularly the case where the boundary is known to be inferred, or conjectural (because it is hidden from sight and not exposed at surface) or postulated only from subsurface data such as boreholes. This is an inherent form of spatial uncertainty with geological mapping and is unavoidable.

6.3.1 Factors that can affect accuracy and uncertainty differ slightly for the five data layers:

6.3.1.1 Bedrock and Superficial deposits

Accuracy and uncertainty for bedrock and superficial features depends heavily on the nature of the rock, or deposits, and the relationship between the different features being mapped. For example, a sharp, planar boundary separating two contrasting lithologies, is likely to be more accurately mapped, with greater certainty that a diffuse or gradational boundary between two similar lithologies. The complexities of the boundaries and heterogeneity of the lithologies is further complicated by the evidence available at the time of survey to enable a surveyor to resolve the map features.

There is an inherent uncertainty for some geological features (such as metamorphic zone characterisation, lateral facies variation, or stratigraphic identification that is heavily dependent upon sampling strategies).

In general, accuracy and uncertainty with depth, varies independently from lateral accuracy/uncertainty, with deeper (generally non-visible) features having much greater uncertainty associated with them, and lower accuracy of spatial representation.

6.3.1.2 Artificial ground

Anthropogenic materials are mobilised continuously, and their distribution and form can change significantly over short periods of time.

In areas of significant urban development, artificial deposits of variable thickness and composition, are present everywhere.

Users should be aware that BGS mapping of artificial materials represents a snapshot of what was observed/inferred at the time of survey and may not reflect what has changed since that survey, nor what is currently present.

Users should also be aware that at the 1:50 000 scale only the artificial deposits will have been retained (following generalisation from the survey scale).

Additionally, not all geological survey campaigns included capture of artificial features. Capture of made and worked ground, was traditionally associated with only the larger quarrying and mining operations scattered across Great Britain. It is only since the 1990's that a more systematic approach has been taken to capturing such features (and including features such as road embankments and cuttings). There is therefore an inherent uncertainty in the mapped artificial theme associated with the scale, age and remit of the survey.

6.3.1.3 Mass movement

BGS Geology 50k Mass movement deposits represent the mobilised 'slip' materials only and not necessarily the entire area of the landslip feature.

Users should also be aware that at the 1:50 000 scale only the larger land slip deposits will have been retained (following generalisation from the survey scale).

Later surveys (post 1970's) made greater use of air photography and photogrammetry to identify and map these features more consistently. Modern surveys, utilising LiDAR data can also now detect features obscured by vegetation of urban development. There is therefore an inherent uncertainty in the mass-movement theme associated with the scale, and age of the survey.

6.3.1.4 Faulted features

A fault is typically portrayed in BGS Geology 50k as a single line. Users should be aware that this linear representation does not imply any specific dimensions or characteristics to the fault/fault zone. The line merely represents the apparent location of a faulted feature (faults are planes of failure and commonly exist as zones of disrupted materials). It is therefore difficult to provide simple descriptions for accuracy and uncertainty for such features.

The representation of faulting (in terms of geometry, distribution, sense of movement and heterogeneity) are highly dependent upon the evidence available at the time of survey. For example, surveys that have been able to utilise seismic data, may provide a more complete model of fault history and distribution than surveys without. Faults, as bedrock-related features, are characteristically obscured by superficial deposits, soil and vegetation. As such there are inherent uncertainties associated with them.

For a more detailed discussion of cartographic generalisation and other issues concerning the BGS Geology portfolio of datasets see Smith, 2009.

6.4 ARTEFACTS

Geological maps were originally fitted to a particular topographical base (mostly Ordnance Survey). An indication of the age of each base is given by a 'nominal topographic year' value (NOM_OS_YR), which provides the date of the latest revision made to the base.

Care must be taken with interpretations linked to topography, particularly when the geological data are displayed on to a topographic base of different age to that specified by the year embedded in the data. The geology may not fit a more recent topography for reasons of landscape evolution or survey technique. For example, the alluvium along a river may have been modified by fluvial scour processes since the original survey. Or a geological survey mapped to the terrain shown on a 20th century contour map, will not necessarily align well with a modern airborne-LiDAR derived map.

The BGS Geology 50k dataset also represents data from different episodes of survey. This can result in disparities between interpretations and observations made at the time of those surveys, across different parts of the dataset. Consequently, adjacent geological sheets/tiles (of different survey dates) may not seamlessly fit together spatially, or in terms of lithological description. This can result in some map-sheet 'edges' that exhibit contrasting colours and dissimilar attribution. BGS is working to reduce the occurrence of these as part of its ongoing continuous revision programmes.

If users are uncertain about the use of data, they should seek professional advice. They may consult the BGS on technical matters, licensing arrangements, or geological aspects including the appropriateness and limitations of the data.

6.5 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 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 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.

BGS strives to maintain its information products to the highest standards. Information products released are quality checked for both their scientific and technical completeness and merit. Any feedback from users should be notified to BGS via digitaldata@bgs.ac.uk. All feedback will be logged, assessed and prioritised, feeding into the product development process for action as appropriate.

7 Frequently asked questions

The questions and answers below have been provided to address ant potential issues relating to how the product can be used or how it can be interpreted. If you have any additional questions, please contact digitaldata@bgs.ac.uk

Q: What does this dataset show?

A: A digital representation of geology via five 'layers' of data suitable for use within mapping software (such as GIS).

Q: What scale are these data provided at?

A: The data are provided for use at approximately 1:50 000 scale, small areas of data captured at smaller and larger scale are present where no 1:50 000 scale data is available.

Q: How accurate is this dataset?

A: The data has been mostly captured from paper mapping at 1:50 000 scale. The quality of capture is estimated to provide +/- 1mm of cartographic accuracy (which represents +/- 50m of accuracy at true scale). Some components of the mapping are partly derived from larger scales of 1:10 000, 1:25 000 and 1:35 000 scale (which represents +/- 10 - 35m of cartographic accuracy at true scale).

Users should be aware that geological maps are a compilation of observed and inferred features. It is not possible to provide a consistent level of accuracy for all objects in a geological map. For example: a sharp geological boundary, observed at surface, at a given location using differential GPS, will be captured with greater accuracy (and precision), than a conceptual, gradational boundary, that is postulated to occur beneath a thick layer of superficial materials. Further details about geology map accuracy are provided in the 'Limitations' section of this report.

Q: How do the digital maps compare with paper maps?

A: It is common for BGS Geology 50k content to differ from the information shown on many of the original paper maps. During compilation, the digital data is modified to improve nomenclature (to current usage/terminologies), identified errors on printed maps will be periodically corrected and, in some cases, additional or revised geological interpretations (derived from information gathered since the last survey) may have been created. The BGS Geology 50k dataset should be regarded as a dynamic document, subject to continuous update and correction.

Unlike the traditional paper maps, BGS Geology 50k is supplied without a topographic backdrop, cartographic symbology, cartographic legends, generalised vertical sections or other marginalia. It is designed to provide a simple geological backdrop for users to review within digital mapping software. Users are advised to exercise caution if comparing analogue and digital sources of mapping data and to seek further guidance from BGS if they require further clarification.

Q: How often will this dataset be updated?

A: The dataset is subject to ongoing continuous revision, whereby parts of the map are updated as and when further information becomes available to require a map alteration. There is not a specific timetable for all parts of the map. Users can contact digitaldata@bgs.ac.uk if they wish to confirm if any new information is available for specific locations since publication date of the digital dataset.

Q: In what formats can these data be provided?

A: The data are provided in a range of vector formats suitable for geographic information systems. Typically, BGS provides this data in ESRI 'shp' and MapInfo 'tab' formats, with additional supporting files to enable use in QGIS and other GIS platforms. Additionally, original paper maps are available separately as raster scanned images within the BGS Maps portal (https://www.bgs.ac.uk/information-hub/bgs-maps-portal/) .

Q: What is the difference between this data and BGS Geology 10k/25 dataset?

A: This data is largely generalised from the BGS Geology 10k dataset but it is managed via an independent editorial workflow. As a result, the two different datasets are unlikely to exactly 'match'. Overall, users should be able to determine the 'familial relationship' between this dataset and the larger scale 10k/25k mapping. However, there may be small parts of either dataset that have been more recently been updated than the other, and so there may be spatial content, or text attribution that differs between the two at site-scope. Users should pay attention to the metadata provided in both datasets with respect to survey and publication dates. They should seek expert advice, or further information from BGS, if they are unsure about differences in the datasets at specific locations. Users should be aware that some parts of the 50k dataset now include more recent mapping at 10k/25k/35k/625k scale with only minimal cartographic simplification (because 50k maps are no longer produced, and the 50k generalised digital mapping may not yet be available). The 50k dataset also has a more complete coverage of the UK (99%).

Q: Should I use this dataset instead of the 10/25k dataset?

A: Choosing which dataset to use depends upon your needs and location. The 50k dataset is available for 99% of Great Britain, whereas the 10k/25k is limited to c. 50%. There may also be analogue paper maps at the larger scale available on the BGS Maps portal (https://www.bgs.ac.uk/information-hub/bgs-maps-portal/). For site investigation purposes BGS typically recommends using the highest resolution (10k-25k) mapping available. Where more than one scale is available both datasets can be used together. However, users should be aware that as separate datasets of differing scales and vintages, they will not always perfectly match. In a small number of areas, there will be differences due to age of mapping and pending updates. In such cases further information from BGS, or a qualified geoscientist can be sought.

Q: What is the difference between this data and that shown in the BGS Geoindex and BGS Geology Viewer app?

A: The BGS Geoindex and BGS Geology Viewer platforms show a variant of the BGS Geology 50k dataset, there are fewer attributes provided with the online services. However, where no 1:50 000 scale data exist, alternative data has been provided for the online services.

Q: What do I do if I think I have spotted an error in the data?

A: Please contact enquires@bgs.ac.uk to let us know.

Q: Can I use this dataset 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.

Appendix 1

LITHOLOGY

Rocks may be described in several different ways. Their lithology, for example, may be defined in terms of their general characteristics of appearance: colour, texture, and composition. Some lithologies may require microscope or chemical analysis for the latter to be fully determined.

The BGS Rock Classification Scheme (RCS), which is available in four volumes for download at: http://www.bgs.ac.uk/bgsrcs/home.html, provides hierarchies that can be used to describe rocks.

The igneous rocks are described in Volume 1, the metamorphic rocks are described in Volume 2 and the sedimentary rocks (and sediment) are described in Volume 3. These three volumes form the basis for the RCS codes used in the Bedrock theme in BGS Geology 50k.

Volume 4 of the rock classification scheme, classifies artificial and natural superficial deposits according to their genesis (mode of origin) and overall form (shape) or gross composition. This volume forms the basis for identification in the Artificial, Mass Movement and Superficial themes. Note that the use of genesis and form as an identifier means that the descriptions are NOT wholly lithological.

For the purpose of making digital maps each rock unit is labelled with a lithological code based upon the Rock Classification Scheme. For example, MDST is the code for 'MUDSTONE'. Many rock units comprise more than one lithology; for example, a formation of interbedded mudstone and limestone may be attributed with the composite code MDLM. Individual components in the mixed lithology are listed separately in the RCS_X field.

For the superficial deposits, the unlithified deposits are encoded to reflect the presence of six key components (clay, **C**; silt, **Z**; sand, **S**; gravel, **V**; cobbles, **L**; boulders, **B**) and peat, **P**. The codes are extended by the use of an ‘X’ prefix in order to include “composite” lithologies. For example, the code “VSL” describes an admixed lithology of ‘cobbly, sandy gravel’; whilst the code “XVSL” describes an interbedded sequence of Gravel, Sand and Cobbles (of unknown proportions).

LITHOSTRATIGRAPHY

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 rocks are used to establish the changing geological conditions or geological history of the area through time. The description, definition, and naming of these layered or stratified rock sequences is termed lithostratigraphy (rock stratigraphy). The strata can also be described in other ways depending on the types of information available: for example, in biostratigraphy (life stratigraphy) fossils are used.

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 in a formal hierarchy. The main lithostratigraphic ranks in this hierarchy are: Bed (lowest), Member, Formation, Subgroup, Group and Supergroup (highest). The units are usually named after a geographical locality, typically the place where exposures were first described.

Table 5 Lithostratigraphical hierarchies

<table>
<tr><th></th><th>Rank 6</th><th>Rank 5</th><th>Rank 4</th><th>Rank 3</th><th>Rank 2</th><th>Rank 1</th></tr>
<tr><td rowspan="13">Litho-stratigraphic units</td><td></td><td></td><td>Formation J</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>Formation K</td><td></td><td rowspan="6">Group C</td><td rowspan="10">Supergroup B</td></tr>
<tr><td></td><td></td><td>Formation L</td><td rowspan="2">Subgroup F</td></tr>
<tr><td></td><td></td><td>Formation M</td></tr>
<tr><td>Bed W</td><td rowspan="2">Member U</td><td rowspan="3">Formation N</td><td></td></tr>
<tr><td>Bed X</td><td></td></tr>
<tr><td></td><td>Member V</td><td></td></tr>
<tr><td></td><td></td><td>Formation O</td><td rowspan="2">Subgroup G</td><td rowspan="4">Group D</td></tr>
<tr><td></td><td></td><td>Formation P</td></tr>
<tr><td></td><td></td><td>Formation R</td><td rowspan="2">Subgroup H</td></tr>
<tr><td></td><td></td><td>Formation S</td></tr>
<tr><td>Bed Z</td><td></td><td rowspan="2">Formation T</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>BGS Geology Fields</td><td>BED_EQ</td><td>MB_EQ</td><td>FM_EQ</td><td>SUBGP_EQ</td><td>GP_EQ</td><td>SUPGP_EQ</td></tr>
</table>

These formal ranks are often appended to names in the BGS Lexicon of Named Rock Units. Formations are a fundamental rock unit for mapping purposes at 1:10 000 scale and can be stand-alone; they do not have to belong to a group and need not be split into smaller units. A Group is an assemblage of related and adjacent Formations and may be subdivided into Subgroups. A Super-Group is an assemblage of Groups. A Member is a sub-division of a Formation, and a Bed is the smallest formal unit. Some possible lithostratigraphic relationships are shown schematically in Table 5.

In this hierarchical scheme, each unit may have parent and child relationships with other units of greater and lesser rank respectively. For example, Formation J does not belong to a group, nor is it subdivided. Part of Group C is recognised as Subgroup F comprising two formations (L and M). Formation N is divided into Members U and V; with Member U comprising beds (W and X). Bed Z forms part of Formation T.

The names of the relevant BGS Geology fields at each of these ranks are also shown.

Lithodemic terminology

Where rocks are not laid down in stratified sequences, they are given names using a lithodemic scheme, as shown in Table 6. In the lithodemic hierarchy applied to intrusive igneous rocks, developed for BGS (Gillespie, Stephenson and Millward, 2008; Gillespie, Campbell and Stephenson, 2011) units are placed into one of six ranks (the same number as in the lithostratigraphic scheme, although there is not necessarily any direct correlation in the rank).

In this hierarchical scheme each lithodemic unit may be part of a ‘parent’ unit of greater rank or may be composed of ‘child’ units of lesser rank. Thus, within the intrusive units a pluton may be part of a suite or subsuite and may itself comprise several intrusions (see Table 6). These can be applied to igneous intrusive, highly deformed and/or highly metamorphosed and genetically mixed assemblages of rocks.

Table 6 Lithodemic hierarchies

	Rank 6	Rank 5	Rank 4	Rank 3	Rank 2	Rank 1
Intrusive units	Intrusion	Pluton	Centre Cluster	Subsuite	Suite	Supersuite
		ring-intrusion				
		lopolith				
		intrusion-swarm				
	laccolith	laccolith-swarm				
	plug	plug-swarm				
	vent	vent-swarm				
	pipe	pipe-swarm				
	neck	neck-swarm				
	diatreme	diatreme-swarm				
	sheet	sheet-swarm				
	dyke	dyke-swarm				
	sill	sill-swarm				
	ring-dyke	ring-swarm				
	cone-sheet	cone-sheet-swarm				
	vein	vein-swarm				
Tectono-meta-morphic units	lens, block	train, swarm	set	sub-assemblage	assemblage	super-assemblage
	layer, mass	unit	package	sub-succession	succession	super-succession
Mixed class units			sheet-complex sill-complex vein-complex ring-complex	subcomplex ophiolite-complex central complex volcano-complex	complex	super complex
BGS Geology fields	**BED_EQ_D**	**MB_EQ_D**	**FM_EQ_D**	**SUBGP_EQ_D**	**GP_EQ_D**	**SUPGP_EQ_D**

A similar scheme has been developed for the metamorphic and tectono-metamorphic units (Leslie, Krabbendam and Gillespie, 2012). Here an assemblage may comprise several sets (if dispersed) or packages (if contiguous) and within these there may be lenses and blocks, for example. In addition to these, where there are mixtures of rocks such as igneous intrusive and sedimentary or igneous intrusive and metamorphic, then a hierarchy based on the 'complex' has been developed.

Rock units are described using their gross compositional or lithological characteristics and named according to their perceived rank in a formal hierarchy. These formal ranks are often appended to names in the BGS Lexicon of Named Rock Units. The name of the relevant BGS Geology field at each rank is also shown.

For expediency the lithodemic hierarchy uses the same field names as the lithostratigraphic hierarchy; the 'EQ' suffix (for 'Equivalent'), does not imply exact geological equivalence of rank between lithostratigraphic and lithodemic units, it is a convenience facilitating the supply of data.

TIME AND CHRONOSTRATIGRAPHY

There are a number of ways of describing geological time. Most are 'relative' in which the Earth's geology is subdivided into named units based on their stratigraphical relationships or relative ages, with younger strata typically overlying older strata (in undeformed sedimentary sequences). Some methods are 'absolute' and typically measure time units in millions of years (before present). Chronostratigraphy, deals with 'time & rock' units and refers to the *sequence of rocks* deposited in a particular time span. There is an established formal hierarchy of chronostratigraphical terms, shown in Table 7, in which the principal ranks range from stage (small subdivisions) to eonothem (large subdivisions).

Table 7 Chronostratigraphical and geochronological hierarchies

Chronostratigraphical (time-rock) Divisions	Stage	Series	System	Erathem	Eonothem
Geochronological (time) Divisions	**Age**	**Epoch**	**Period**	**Era**	**Eon**
Example	*Gorstian*	*Wenlock*	*Silurian*	*Palaeozoic*	*Phanerozoic*

Geochronology, as used in BGS Geology 50k, deals with 'time' units and refers directly to the time spans. The corresponding principal formal geochronological terms range from Age to Eon. The same name can be used in both schemes; thus, rocks of the Jurassic "*System*" were deposited during the Jurassic "*Period*" of time.

The BGS time chart (https://www.bgs.ac.uk/discovering-geology/fossils-and-geological-time/) and the latest version of the ICS time chart (https://stratigraphy.org/chart) can be used to discover further information about chronostratigraphy and geochronology.

STRUCTURE

Faults

Geological faults are the most common feature in the Linear theme of the BGS Geology data, but uncertainties often affect their mapped position at the surface (or at rockhead). A fault is a fracture or zone of fractures along which the materials on opposing sides of the fracture have been displaced relative to one another, by movements along the surface of the fault.

A fault may split ('splay') and the separate surfaces effectively become a fault "zone" rather than a single fault; fault zones may be tens to hundreds of metres wide. Movements along faults may crush the rocks adjacent to the fault plane(s), creating a 'fault breccia'.

A fault is typically portrayed in BGS Geology 50k as a single line. Therefore, users should be aware that this linear representation does not imply any specific dimensions or characteristics to the fault/fault zone, the line merely represents the apparent location of a faulted feature.

Faulting in BGS Geology 50k has been extracted from previously published paper maps or 3d modelling work. Evidence for the existence of faulting can be based upon ***observed*** exposures (above and below ground) or by inference linear depressions, the truncation or displacement of topographical features, or the sudden change in geology proved by boreholes (i.e., the fault is ***inferred***). If there are superficial deposits at surface then the position, nature and maybe even the existence of a fault recorded within the underlying bedrock will be ***conjectural***.

Faulting is a response to structural evolution of the landscape, and faulting can be more common in some areas than others. However, because faults are easier to identify and map in areas with large amounts of supporting evidence, some parts of Great Britain appear to be more faulted than others. Users should be aware that BGS Geology 50k faults are a representation of survey evidence and inference and may not represent the complete distribution of faults in an area.

Traditionally, on paper maps, where one side of a normal fault is downthrown relative to the other, the downthrown side is indicated by a small 'tick' (*hachure*) on the fault line (representing the 'hanging wall' side). Similarly, for thrust faults the up-thrown side is marked with a triangle (again this is the hanging wall of the fault).

It has not been possible to provide a consistent digital representation of faults and their hanging wall orientation due to processing and conversion to other formats. However, BGS is currently trialling a revised fault database to provide more robust orientation attribution in this, and future, versions. **Information on fault throw (hanging wall) remains incomplete and subject to change in BGS Geology 50k**. Users are advised to use the GEO_HWALL (hanging wall) and LEFT_HND (left handed) attribution fields with caution and seek further advice from BGS where necessary.

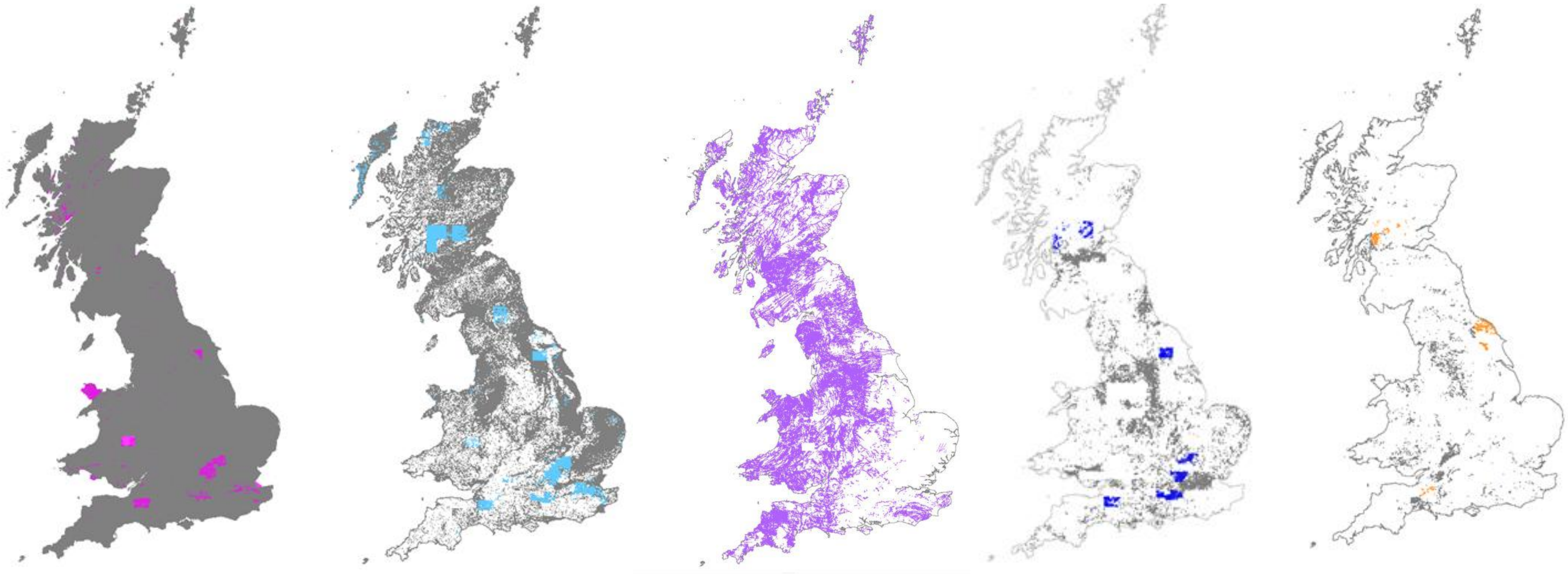
Folds

Many of the rocks forming the Earth's crust have been deformed by structural evolution and the resulting strata tilted or inclined to form folds. They are best seen in layered sedimentary rocks where the bedding was originally planar. In the simplest examples these folds may have a rounded hinge zone with planar limbs to either side of the hinge; dipping outwards (in an upward arched anticline) or inwards (in a downwards or concave syncline). Simple folds have an "axial plane" about which the folding appears to have taken place. The trace of this axial plane on the Earth's surface may be shown in BGS Geology 50k depending upon on the scale of the fold feature (e.g., micro folds may not be shown at the 1:50 000 scale).

As for fault-related features, evidence for fold axes is based on observation or inference. Some uncertainty therefore attaches to their mapped position; their linear representation in the data should be regarded as zones of folding.

Appendix 2

Changes in Spatial Data in Version 8: Locations of new or modified content in Version 9 (by comparison with V8)



Bedrock Superficial Linear Artificial Mass movement

Figure 4 Bedrock changes (pink), Superficial changes (light blue), Linear changes (purple), Artificial changes (dark blue), Mass-movement changes (brown). Coastline Contains OS data © Crown copyright and database right 2024

Glossary

Term	Explanation
Artificial	Ground surface has been significantly modified by human activity. Examples include recent anthropogenic or artificially modified ground where the ground surface has been significantly modified by human activity including quarrying, landscaping, land-raise, cuttings and embankments.
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.
Chronostratigraphic	The classification (within a defined hierarchy) of rock successions based on relative age and time relationships. Chronostratigraphical ages (e.g. Jurassic) are defined but the International Commission on Stratigraphy (https://stratigraphy.org/)
Compilation	The process or output of bringing together combinations of data to create a map output.
Conjectural	A conjectural geological feature is one where there is no direct evidence of it existing, but indirect evidence is sufficient for a geologist to propose its existence to satisfy the overall conceptual model being shown by the map. For example, a non-observed fault, can be conjectured to exist beneath superficial cover to explain the juxtaposition of two bedrock types inferred from other observations.
Desktop-modelling	A virtual model or concept developed from compiled evidence, rather than solely field-based activities.
Fault	Plane or zone of displacement. An area where bodies of rock have been displaced relative to each other by geological forces. Faults are commonly represented on maps as lines but may represent zones and volumes of failed materials.
Field survey	A strategic campaign to capture observations and measurements of geological features in situ.
Geographical Information System	Geographic Information Systems (GIS) provides accurate information, assistance, support, and maintains and creates information to aid in the development of maps and data analysis.
Geohazard	Geological and environmental conditions, involving long and short-term processes which may lead to widespread damage. There are many different types of geohazard with different natural and artificial processes causing them to occur. All have the potential to create problems for development of the human environment and threats to the safety and well-being of people. Geohazards can develop quickly (seconds or minutes) in response to the processes that drive them, or take tens, hundreds, or thousands of years to develop to a point where they pose a danger. They are found in most parts of the world, including marine and fluvial environments.
Geology	The study or science of the Earth, its history, and its life as recorded in the rocks; includes the study of geologic features of an area, such as the geometry of rock formations, weathering and erosion, and sedimentation.
Georectification	To correct positional displacement with respect to the surface of the Earth. This process is commonly applied to maps that require minor adjustments to their portrayed shape, and to enable identification of map coordinates, relative to real-world coordinates.

Inferred	An inferred geological feature is one where there is no direct evidence of it existing, but indirect evidence is sufficient for a geologist to propose its existence. For example, a landform, vegetation-change or soil-change can be used to 'infer' that the underlying geology has changed.
Light Detection And Ranging (LiDAR)	System consisting of 1) a photon source (frequently, but not necessarily, a laser), 2) a photon detection system, 3) a timing circuit, and 4) optics for both the source and the receiver that uses emitted laser light to measure ranges to and/or properties of solid objects, gases, or particulates in the atmosphere.
Lithodemic	Bodies of rock which do not conform to the Law of Superposition (i.e. in any undisturbed sequence of rocks deposited in layers, the youngest layer is on top and the oldest on bottom) are described as lithodemic. They are generally composed of intrusive, highly deformed or metamorphic rocks, determined and delimited based on rock characteristics. Their boundaries may be sedimentary, intrusive, extrusive, tectonic or metamorphic. Their classification is by lithology (rock type) and form or mode of origin e.g. a LITHO-MORPHO-GENETIC grouping.
Lithology	Rocks may be defined in terms of their general characteristics of appearance: colour, texture and composition. Some lithologies may require a microscope or chemical analysis for the latter to be fully determined.
Lithostratigraphic	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 rocks are used to establish the changing geological conditions or geological history of the area through 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 lithostratigraphic 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.
Mass movement	Primarily superficial deposits or weathered bedrock that have moved downslope under gravity to form landslips.
Observed	An observed geological feature is one that has provided some form of direct measurement (physically seen or sampled).
Raster	Raster data can be thought of as being similar to a digital photograph. The entire area of the map is subdivided into a grid of tiny cells, or pixels. A value is stored in each of these cells to represent the nature of whatever is present at the corresponding location on the ground.
Resource	Any geological material that has some form of economic value.
Scale	The relation between the dimensions of features on a map and the geographic objects they represent on the Earth's surface, 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.
Stratigraphy	The study of, or classification of rocks by their relative or absolute ages. Stratigraphy places rocks into groups of similar 'ages' and identifies the oldest and youngest events and sequences that led to their occurrence.
Superficial	The youngest geological deposits formed during the most recent period of geological time, the Quaternary. They date 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.

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

Armstrong, R. A., Daley, D. L., Lawley, R., Myers, A. H, Smith, A. 2016. User Guide for the BGS Geology: 50k dataset (V8). British Geological Survey Open Report, OR/16/46. 25pp.

British Geological Survey. 2016. Digital Geological Map of Great Britain 1:50 000 scale (BGS Geology 50k) data. Version 8.24. Keyworth, Nottingham: British Geological Survey. Release date 16-01-2017.

DOI: 10.5285/455f9151-61ae-479f-9916-f01d612ab66a
https://www2.bgs.ac.uk/services/ngdc/citedData/catalogue/455f9151-61ae-479f-9916-f01d612ab66a.htm

Gillespie, M.R., Stephenson, D., Millward, D. 2008 *BGS classification of lithodemic units: proposals for classifying units of intrusive rock.* Nottingham, UK, British Geological Survey, 25pp. (RR/08/005)

Gillespie, M.R., Campbell, S.D.G., Stephenson, D. 2012 *BGS classification of lithodemic units: a classification of onshore Phanerozoic intrusions in the UK.* Nottingham, UK, British Geological Survey, 67pp. (RR/12/001)

Leslie, A.G., Krabbendam, M., Gillespie, M.R. 2012 *BGS classification of lithodemic units: proposals for classifying tectonometamorphic units and mixed-class units.* Nottingham, UK, British Geological Survey, 28pp. (RR/12/002)

Smith, A. 2009. Accuracy of BGS legacy digital geological map data. *British Geological Survey. (OR/09/064)*. http://nora.nerc.ac.uk/id/eprint/8755/1/OR09064.pdf