



**British
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

User Guide DiGMapPlus+ Engineering Properties: Use for Engineered Fill dataset (version 1)

Information Products Programme

Open Report OR/12/091

BRITISH GEOLOGICAL SURVEY
INFORMATION PRODUCTS PROGRAMME
OPEN REPORT OR/12/091

User Guide DiGMapPlus+ Engineering
Properties: Use for Engineered Fill dataset
(version 1)

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No. 100021290.

Keywords

Engineering properties, use
as engineered fill, National
dataset, User guide.

Front cover

National use as engineered
fill map

Bibliographical reference

ENTWISLE, D C, LAWLEY,
R S and LEE K A. 2012.
User Guide DiGMapPlus+
Engineering Properties:
Use for Engineered Fill
dataset (version 1). *British
Geological Survey Open
Report*, OR/12/091. 18pp.

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BRITISH GEOLOGICAL SURVEY

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

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1 Introduction

This document provides information for users on the ‘Engineering Properties: Use as engineering Fill’ dataset.

The ‘use as engineering fill’ of rocks and soils is an important consideration in civil engineering and extractive industry. The rapidly increasing cost of removal of material offsite, and especially disposal of unused material, means that a great deal of effort is now taken to identify how extracted materials are to be used on site. Engineered fill is used in earthworks, which includes infill, raising or levelling ground, embankments, foundation pads, road bases and landscaping. The earlier in the process this can be done then the greater the likelihood that it can be done efficiently.

1.1 BACKGROUND

‘Suitability as engineering fill’ was one of the characteristics included in many of the series of BGS Technical Reports on ‘A geological background for planning and development’ funded by the Department of the Environment during the 1980’s and 1990’s (reviewed in Smith and Ellison, 1999). It is also included in a number of British Geological Survey 1:50 000 geological sheet brief explanations and at 1:1 000 000 scale in the engineering geology maps of the United Kingdom (Dearman et al., 2011, Dobbs et al., 2012).

Some materials are extracted as resources and have increased value over and above use as engineering fill. These include materials that may be used as a part of the project such as aggregate used in concrete aggregate and construction sand. Others that may be relevant include specialist aggregate for roadstone and railway ballast. Other materials are used in industry such as gypsum, calcium carbonate, kaolinite, and ‘fuller’s earth’ and foundry sand. Uses for construction materials include clay for bricks, roofing slate and building stone. Where deposits are known to have uses other than for engineering fill (defined by their identification in the BGS BRITPITS database) they are identified within the dataset.

In 2010 the British Geological Survey initiated a development programme to produce thematic datasets that identified and assessed a variety of engineering and soil properties in Great Britain. These include datasets for strength, excavatability, fill and parent materials. Additional data for Bulking volume, foundation conditions, and discontinuities, Sulphate content and engineering rockhead are in development

Along with the engineering properties datasets, the Information Programme has also generated:

- Superficial Thickness Model
- GeoSure ground stability data
- Scans of onshore borehole logs for Great Britain
- Scans of geology and historic topography maps
- Ground permeability data
- Susceptibility to Groundwater Flooding
- Geological Indicators of Flooding
- Environmental sensitivity data
- Radon potential
- Non-coal mining hazards
- Potentially Harmful Elements

2 Who would benefit from the dataset?

It is envisaged that ‘use as engineering fill’ is of interest to a wide range of organisations concerned with development, including utility companies, local authorities and developers. Engineering geologists and ground engineers have long required information on fill materials. Although this information (at a 1:50 000 scale) provides only a generic assessment and wouldn’t be suitable for specific site-design purposes, it would however help to inform engineers at the ‘desk study stage’ of investigation thereby allowing for more efficient planning and execution of proceeding ground investigations.

3 What the dataset shows

3.1 CLASSIFICATION

The ‘use as engineering fill’ dataset forms part of a suite of GIS layers for different engineering parameters. The purpose of this dataset is to provide general guidance on the use of geological units, as defined on DigMAPGB-50 by their lithostratigraphic description. The GIS model will display the spatial distribution of deposits for suitability as engineered fill.

The primary sources of engineering content are the BGS archives of geotechnical properties. The archive data related to excavatability of geological materials is subdivided into three hierarchical ‘use as fill’ classes (Type, Use and Detail) so that the information can be utilised by a broad range of users and with a range of detail and description.

The data provides national coverage for England, Scotland and Wales at a scale of 1:50 000.

The ‘use as engineered fill’ classification is based on:

- Competency of geological material (e.g. rock or engineering soil)
- Type of geological materials (e.g. Chalk)
- Maximum particle size (e.g. Coarse granular)
- Presence of sulphate or readily oxidised sulphides
- Presence of unsuitable materials (e.g. peat)

Much of the classification used to create this dataset is based on the ‘Specification for Highway Works’ Series 600 Earthworks (Highways Agency, 1991a, 1991b). More detailed specification tests will be required when deciding on specific site use. In some cases, it is likely that the classification of the materials of some geological formations (identified using the BGS LEX_RCS code system) may be ‘upgraded’ from a ‘general’ use to more specific higher value use if required and practical. Equally, local site geology or ground conditions may require the materials to be downgraded or rejected for use, if testing indicates that they are outside the required specification for use as fill, for example, if the liquid limit or plasticity index is too high, the material is too wet (in its typical natural state) or previously undetected materials are present, such as peat or sulphides/sulphate.

Additionally, there are some limitations in the use of some lithostratigraphic descriptors to define ‘use as engineered fill’. In previous reports, commissioned by the Department of the Environment during the 1980’s and 1990’s, (reviewed by Smith and Ellison (1999), the term ‘Rock fill’ is used to imply that these materials have the durability and strength of ‘Rock’ as described in Highways Agency (1991b). These rocks are *likely* to require crushing to the required size if they are to be used in fill operations.

A similar approach to defining use for engineering fill’ is used in the compilation of the national 1:1 000 000 scale engineering geology map (Dearman et al., 2011 a, b, c and Dobbs et al., 2012).

The dataset includes additional information for alternative uses of some of the geological material. The current or previous industrial use of these materials is based on information derived from BRITPITS, the British Geological Survey Database for quarries and mines (Cameron, 2011). This information is intended to provide guidance as to potentially higher value, uses other than ‘fill’ of materials.

3.2 FIELD DESCRIPTORS

The data fields included in this dataset are described below. Field descriptions as they appear in the dataset are shown in Appendix 1.

General lithology (GEN_PMLITH)

This is a simplified geological description of the parent material and is derived from the original DiGMapGB-50 LEX-RCS coding compared with the hierarchical classification of UK rocks from the BGS RCS system. In general the aim is to provide the user with as simplified a lithological description as possible.

Lexicon Rock Classification Scheme (LEX_RCS)

This field is the standard DiGMapGB-50 code that describes the lithostratigraphy of the geological units found in Great Britain. It provides the starting point for the parent material characterisation. It comprises a ‘stratigraphic’ code (LEX) and ‘Lithology’ code (RCS).

Use as engineering fill (FILL_CODE)

This is the code used by BGS to identify a type of ‘use as engineering fill’. It is provided to enable identification of properties of a geological unit and for data management purposes (this code is a unique identifier of the Fill ‘Details’ field, see tables below).

Use as engineering fill (FILL_TYPE)

This is a description of the broad type of ‘engineering fill’ associated with the geological materials. The following values are used:

Table 1. Explanation of the 'fill type' descriptor

Fill Code(s)	Fill type	Meaning
0,0A	Mixed 'soil' fill	Mixed coarse and fine engineering 'soils'
1,1A,1B,1C,1D	Coarse 'granular' soil fill	Coarse-grained engineering soils
2A,2B,2C,2D,2E,2F,2G	Fine 'cohesive' fill	Fine-grained engineering soils
3,3A,3B,3C	Chalk fill	Chalk materials
6,6A,6B,6C,6D	Rock fill	Generic 'rock' materials
7A,7B,7C	Mixed rock and 'soil' fill	Mixed 'rock' and engineering 'soil' materials
8	Unsuitable for fill	Unsuitable for fill (contains unsuitable materials, i.e. Peat)
9	Unknown	Rock/Soil type is unknown, suitability is not yet known, or site is located in a body of water

Use as engineering fill (FILL_USES)

This is a description of the typical USE of the ‘engineering fill’ associated with the geological materials. It is a slightly more informative version of the FILL_TYPE field as it identifies key ‘fill’ characteristics that are important to test for, or ascertain, at an early stage of site investigation. For example it identifies fill types that may be ‘partly’ unsuitable. See the DETAIL section below for further description).

Use as engineering fill (DETAIL)

This is a verbose description of the 'engineering fill' associated with the geological materials. It is a more descriptive and informative version of the FILL_USE and FILL_TYPE fields as it identifies key 'fill' characteristics that are important to test for, or ascertain, at an early stage of site investigation. It outlines the full range of subdivisions of fill-use in this dataset. The following values are used.

Table 2. Description of the engineering fill materials

FILL_USES	DETAIL
Mixed 'soil' fill	Both fine and coarse beds, generally soil, 'cohesive' and 'coarse' fill
Mixed 'soil' fill (partly unsuitable)	Both fine and coarse beds, 'cohesive' and 'coarse' fill, may be partly unsuitable for engineered fill
Coarse 'granular' soil fill	Coarse 'granular' fill (sand, gravel, possible cobbles)
	Well-graded sand and gravel 'granular' fill
	Uniform-graded sand or gravel 'granular' fill
	Well-graded coarse soil, 'granular' fill containing cobbles
Coarse 'granular' soil fill (partly unsuitable)	Generally coarse, may be partly unsuitable material
Fine 'cohesive' fill	Generally suitable for 'cohesive' engineering fill
Fine 'cohesive', dry fill	Generally 'dry cohesive' fill
Gravel clay	Mostly gravelly clay 'stony cohesive' fill, may contain sand and gravel beds or silt and clay beds
Fine soil (silty)	Silty 'cohesive' fill
Fine soil (sulphide/sulphate)	Fine 'cohesive' fill that may contain sulphide or sulphate
Fine soil (specialist clay)	Contains specialist clays commonly of very high or extremely high plasticity clay
Fine soil ('wet')	'Cohesive' material that may be 'too wet' (in its typical natural state) for engineered fill.
Chalk fill	Chalk
	Chalk with flint
	Northern Province Chalk
	Chalk and calcareous mudstone
Rock fill	Rock fill but may have higher grade fill uses
	Rock fill that has been used for crushed rock aggregate
	Rock fill that has been used for higher value uses than rock fill or aggregate
	Rock fill with mixed lithology, which may have different uses
Rock fill (sulphide or sulphate)	Rock fill sometimes with mixed lithologies that may contain sulphide or sulphate
Mixed rock and soil	Mixed materials uses: Rock fill and/or coarse 'granular' fill (coarse rock sandstone, breccias, conglomerate or sand, gravel)
	Mixed rock fill and 'cohesive' or coarse 'granular' fill
Mixed rock and soil (sulphide/sulphate)	Mixed rock fill and 'cohesive' fill sometimes coarse 'granular' fill, 'cohesive' fill may contain sulphide or sulphate
Unsuitable for fill	Generally unsuitable may have special uses identified during the project or require special processing
Unknown	Unknown material or suitability

Use of the unit as identified from BRITPITS (OTHER_USE)

The possible alternative or recorded use of the geological materials as found in BRITPITS. There are multiple entries where the units are used for different purposes. This may be for the same lithology or for different lithologies found at the quarry/pit (at different depths). Note that this does not mean that the entire unit is used for that purpose, in many cases, only part of the unit may have alternative uses. The following descriptive terms are used:

- Used as general aggregate (but may have high value uses)

- Rocks that require crushing prior to use,
- Aggregate with high value uses (railway ballast, road aggregate, armour rock),
- Building sand, concrete sand, asphaltting sand
- Silica sand, glass sand, foundry and moulding sand, cleaning sand,
- Building stone, slate, decorative stone,
- Bricks, tiles, pipes
- Ceramic clay, Pottery (whiteware),
- Paper making, fillers, fullers earth
- Coal
- Gypsum, calcium carbonate (limestone, chalk), fluorspar, flux, cement
- Peat products
- Quarried (unspecified use in Britpits)

Nominal Scale (NOM_SCALE)

This field describes the notional x-y spatial scale of the data. Most geological map data in the dataset is captured and presented at a scale of 1:50 000. The field identifies a combination of scales used to create the map from the bedrock and superficial map sources. The available scales are show as follows:

Table 3. Explanation of the nominal scales of geological map data

Field Value	Meaning
50	No superficial data is present for this sheet and bedrock data is available at 1:50 000 scale
250	No superficial data is present for this sheet and bedrock data is available at 1:250 000 scale
625_50	Superficial data is present for this sheet at a scale of 1:625 000 and Bedrock data is available at a scale of 1:50 000
50_50	Superficial data is present for this sheet at a scale of 1:50 000 and Bedrock data is available at a scale of 1:50000
35_50	Superficial data is present for this sheet at a scale of 1:35 000 and Bedrock data is available at a scale of 1:50 000
35_250	Superficial data is present for this sheet at a scale of 1:35 000 and Bedrock data is available at a scale of 1:250 000

4 How the dataset was created

Data was collated and interpreted from a number of different sources currently held by BGS. The primary datasets used for the ‘use as engineering fill’ GIS are:

- Parent Material Map V6 dataset.
- DiGMap+ ‘strength’ dataset (Lee et al., 2012a, 2012b).
- BGS National Geotechnical Properties Database
- BRITPITS (an abbreviation of British Pits)

The DiGMap+ datasets follow a standard workflow to create each dataset:

- Step1: Identify characteristic, measurements and observations from archive records.
- Step2: Categorise the observations into classes/groups of similar behaviours. Where possible using published standards of classification such as BS 5930, Eurocode 7 or similar.
- Step3: Assess the range of lithostratigraphic variation of geological materials across Great Britain, in terms of the categories and classes identified in step 2 to create a ‘lookup’ dataset of expected attributes (material characteristics and behaviours) per lithostratigraphic unit.
- Step4: Compile the spatial (map) components of the DiGMap+ datasets with the ‘lookup’ dataset using standard GIS and data techniques to create a new ‘map’ of fill characteristics.

Typical values and characteristics for engineering fill or potential-use have been assessed and compiled using information held in the BGS National Geotechnical Properties Database, the BGS BritPits database, BGS technical reports and site investigation reports held in BGS archives.

Categorisation of the data, and assignment of fill classes/use and details have been made by expert judgement in order to create ‘look up tables’ of lithostratigraphic rock type and associated engineering properties. Assignments of characteristics have been made at the ‘formation’ level of lithostratigraphic classification of rock/deposit type.

Spatial data-creation and fill-attribution has been completed using ESRI ARCGIS software.

5 Technical information

5.1 SCALE

The *Engineering Properties: Use for Fill* dataset is produced for use at 1:50000 scale providing 50 m ground resolution.

The data are released in ESRI shapefile formats. Other formats such as MapInfo TAB are available on request. The standard data supplied to customers has polygons or areas in a single layer or theme.

5.2 COVERAGE

Data is provided to indicate the Use for Fill of rocks and soils across Great Britain. The scales of map data available to create this dataset are shown in Appendix 3.

5.3 DATA HISTORY

Version 1 (released 2013): Derived from DiGMapGB-50 version 6.

5.4 LIMITATIONS

- The Engineering Properties datasets have been developed at 1:50 000 scale and must not be used at larger scales. All spatial searches against the data should be done with a minimum 50 m buffer
- The spatial distribution of the data is limited by the distribution of the site investigation exploratory holes from which the geotechnical data have been extracted and the distribution of available information from pits and quarries (shown in Appendix 2) and digital geological map data (DiGMapGB-50) (Appendix 3). Although the National Geotechnical Properties Database is the 'first port of call' for data it has limited coverage so other descriptive data from exploratory hole logs or from Site Investigation Reports has been used.
- Local conditions may vary and this dataset should **not** replace detailed site investigations. Further detail of the geology may be available on more detailed 1:10,000 scale geological maps.
- The spatial distribution of the data is limited by the spatial accuracy and resolution of the digital geological map data (DiGMapGB-50) (Appendix 3). Spatial mismatches of fill-use related to mismatches in lithology type (ie variation in LEX_RCS across map-sheet boundaries) are unavoidable,, and require resolution by reference to higher resolution map information. Further detail of the geology may be available on more detailed 1:10,000 scale geological maps.
- Use as engineering fill data are created as vector polygons and are 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.
- Use as engineering fill dataset is concerned with the properties and potential use of NATURAL geological deposits and conditions only. It does NOT cover any man-made constructions or materials.
- Use as engineering fill is based on, and limited to, an interpretation of the records in the possession of The British Geological Survey at the time the dataset was created.
- An indication of the typical natural suitability of a rock or soil for use as fill does not necessarily mean that the rock properties are consistent throughout the

outcrop. Such an assessment can only be made by inspection of the area by a qualified professional.

- An indication of the typical natural suitability of a rock or soil for use as fill does not necessarily imply what the properties of any mixed fill may be (i.e. where large scale projects have combined fill-resources from differing sources/localities). Such an assessment can only be made by inspection of the fill materials by a qualified professional.

6 Contact information

For all data and licensing enquiries please contact:

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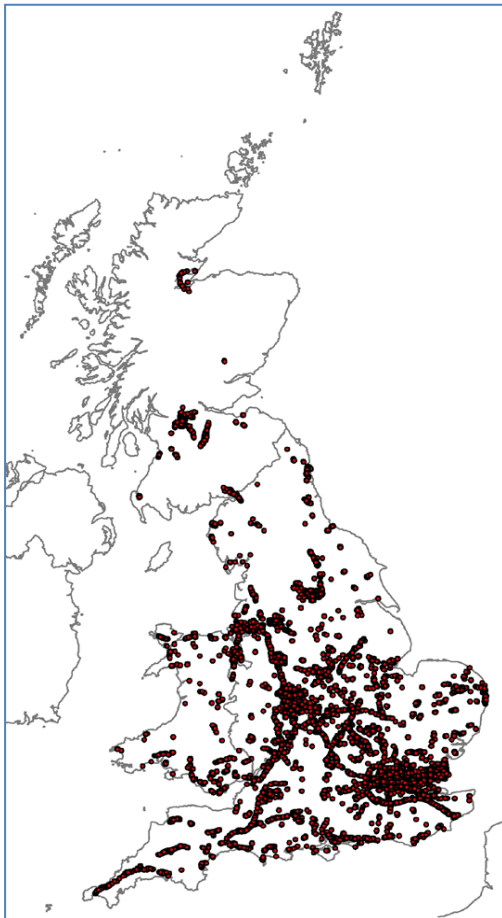
Email: enquiries@bgs.ac.uk

Appendix 1 Engineering Properties: Field Properties

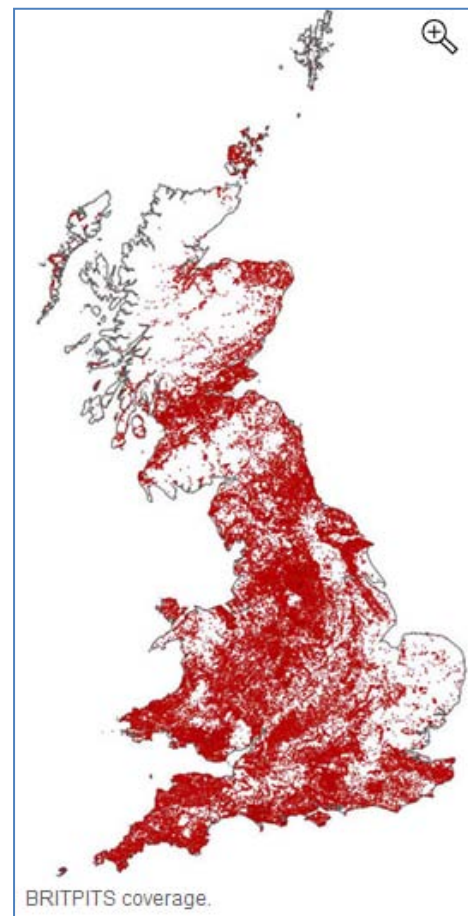
Field name	Field description	Description
GEN_PMLITH TEXT	Generalised lithology description	This is a simplified geological description of the parent material and is derived from the original DiGMapGB-50 LEX-RCS coding compared with the hierarchical classification of UK rocks from the BGS RCS system. In general the aim is to provide the user with as simplified a lithological description as possible.
LEX_RCS TEXT	BGS Lexicon-rock classification scheme	This field is the standard DiGMapGB-50 code that describes the geological units found in Great Britain. It provides the starting point for the parent material characterisation. It comprises a 'stratigraphic' code (LEX) and 'Lithology' code RCS).
FILL_CODE TEXT	Code to identify Fill type according to BGS classification criteria	This is the code used by BGS to identify a type of 'use as engineering fill'. It is provided to enable identification of properties a geological unit and for data management purposes
FILL_TYPE TEXT	Typical engineering fill 'type'	This is a description of the broad type of 'engineering fill' associated with the geological materials
FILL_USES TEXT	Typical engineering fill 'Use'	This is a description of the typical USE of the 'engineering fill' associated with the geological materials, with additional information on limitations of use.
DETAIL TEXT	Description of the fill use	This is a verbose description of the 'engineering fill' associated with the geological materials, with additional information on limitations of use or quality/further use of the fill.
OTHER_USE TEXT	A description of known alternative uses of the materials	A list of alternative uses identified for the geological materials, as defined in the BritPits database. (List is not exclusive)
NOM_SCALE TEXT	Nominal Scale	This field describes the notional x-y spatial scale of the data. Most geological map data in the dataset is captured and presented at a scale of 1:50,000. The field identifies a combination of scales used to create the map from the bedrock and superficial map sources.
UID	Unique identifier	Map metadata (identifies each spatial object uniquely)
VERSION	Version of the dataset	Map metadata (identifies dataset uniquely)

Appendix 2. Distribution of data held in the National Geotechnical Properties Database (a) and the BritPits database (b).

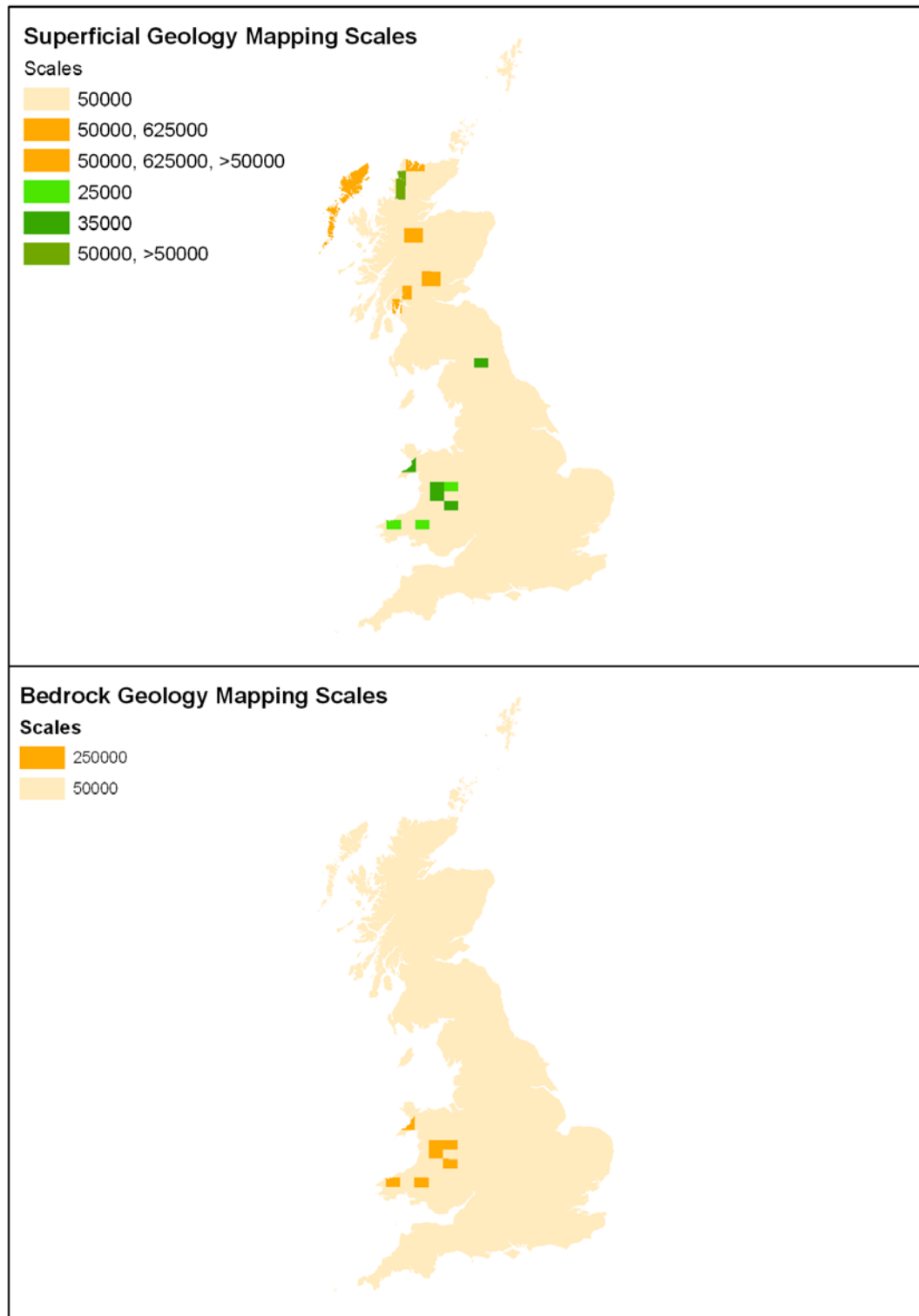
(a)



(b)



Appendix 3 Mapping Scales



References

British Geological Survey holds most of the references listed below, and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at: <http://geolib.bgs.ac.uk>.

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