BGS DIGITAL

User Guide: BGS Mineral Resources

Open report OR/20/51

British Geological Survey

BRITISH GEOLOGICAL SURVEY

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OPEN REPORT OR/20/051

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Keywords

Mineral resources, digital linework, aggregates.

Cover picture details, Silica sand processing at Leziate quarry, Kings Lynn © BGS UKRI

Bibliographical reference

BRITISH GEOLOGICAL SURVEY 2021.
User guide: BGS Mineral Resources. *British Geological Survey Open Report*, OR/20/051. 57pp.

DOI (England): 10.5285/f265629c-5e03-4927-b482-0668da720aca

DOI (Wales): 10.5285/f6fa87e7-4010-4782-8a3a-7c322faa939d

DOI (Central belt of Scotland): 10.5285/f6fa87e7-4010-4782-8a3a-7c322faa939d

Maps and diagrams in this book use topography based on Ordnance Survey mapping.

Keyworth, Nottingham British Geological Survey 2021

BRITISH GEOLOGICAL SURVEY

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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

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.

Acknowledgments

This user guide was written by Tom Bide and Teresa Brown with editorial input from Joseph Mankelow. A large number of individuals within BGS have contributed to the dataset. This assistance has been received at all stages of the study.

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Summary

Minerals are the raw materials that underpin most sectors of the UK economy and their use contributes to the UK's high standard of living. Certain minerals are also exported and thus generate income for the country.

The UK's land mass contains a wide range of indigenous minerals including construction minerals (e.g. aggregates; gypsum), industrial minerals (e.g. china clay; salt) and metals (e.g. tin; tungsten). Many of these minerals cannot be imported because of the large quantities required or the high cost that would be incurred.

The BGS Mineral Resource Dataset shows the spatial extent of known mineral resources in England, Wales and the central belt of Scotland.

- England: DOI:10.5285/f265629c-5e03-4927-b482-0668da720aca
- Wales: DOI:10.5285/f6fa87e7-4010-4782-8a3a-7c322faa939d
- Central belt of Scotland: DOI:10.5285/f6fa87e7-4010-4782-8a3a-7c322faa939d

In general, a 'mineral resource' contains minerals that are of current or potential economic interest. However, this dataset is based on the geology of Great Britain and only a limited assessment of economic potential has been made during its compilation.

The dataset delineates areas within which potentially workable minerals may occur. These areas are not of uniform potential and take no account of planning constraints that may limit their working. Therefore, the dataset should only be used to show a broad distribution of mineral resources. The data should not be used to determine individual planning applications or in taking decisions on the acquisition or use of a particular piece of land, although they may give useful background information that sets a specific proposal in context.

This dataset was designed to produce baseline data in a consistent format, which can be updated, revised and customised to suit planning needs as well as to be of use to the extractive industry and anyone interested in the potential locations of mineral resources. It aims to facilitate consideration of mineral resources alongside other types of land use and safeguard resources for future generations.

This user guide provides the information required to enable the reader to understand and use this BGS data product.

1 Introduction

This dataset provides spatial information on the location of mineral resources in England, Wales and the central belt of Scotland at a scale of 1:50 000. An example of the data can be seen in Figure 1. The dataset allows users to visualise the extent and distribution of mineral resources and to relate them to other forms of land use (such as urban areas or designated environmentally sensitive areas) or to other factors (such as transport infrastructure and conservation information).

The term 'mineral resources' has a definition under international standards, which includes both an economic and a geological dimension. These maps are based primarily on mapped geology with limited assessment of economics. Therefore, the term 'mineral resources' is used here in a broad sense. For more information on definitions please refer to Section 1.2 and Appendix 2.

The UK is endowed with a wide range of minerals and their use makes a vital contribution to the economy. It is important that a steady supply is maintained. However, these resources are finite and they can only be worked where they occur. As a result, the extraction of minerals inevitably competes with other land uses and can be contentious. It is therefore important that the relevant bodies (e.g. local government Mineral Planning Authorities (MPA) in England and devolved governments in Wales and Scotland) have access to accurate spatial mineral resources information. Such organisations have the responsibility to ensure that adequate supplies are available to meet society's need for minerals and to balance both the negative and positive effects on society and the environment.

1.1 BACKGROUND TO THE DATASET

The dataset is derived from a set of commissioned projects that were used to prepare a series of mineral resource maps based on counties or amalgamations of counties. Maps for England were commissioned by the central Government department with responsibility for mineral planning at the time; including:

- Department of the Environment (DoE)
- Department of the Environment, Transport and the Regions (DETR)
- Department for Transport, Local Government and the Regions (DTLR
- Office of the Deputy Prime Minister (ODPM)
- Department for Communities and Local Government (DCLG)

Those for Scotland and Wales were commissioned by the Scottish and Welsh governments respectively.

Each map produced (with an accompanying report describing the mineral resources depicted on the map) is available to download as a PDF file from the BGS-hosted MineralsUK website (www.MineralsUK.com). The references for these maps are cited in Appendix 1.

This work began in 1994 and was completed in 2010. It should be recognised that, for many counties, the mineral resource data depicted on the original PDF maps will have changed as BGS has since revised the underpinning geological data. Such changes are reflected in the digital mineral resource dataset, which this user guide accompanies.

1.2 MINERAL RESOURCES

Mineral resources are natural concentrations of minerals that might now, or in the foreseeable future, be of economic value. The definition of mineral resources is complex and dependant on many factors: for a more detailed explanation see Appendix 2.

The identification and delineation of mineral resources is imprecise because it is limited by the quantity and quality of data currently available and involves predicting what might or might not become economic to work in the future. The assessment of mineral resources is therefore a dynamic process that must take into account a range of factors. These include:

- geological reinterpretation as additional data become available
- the continually evolving demand for minerals
- specific qualities of minerals
- changing economic, technical and environmental factors

Consequently, the economic potential of mineral resources is not static, but changes with time.

The BGS Mineral Resource Dataset presents areas with potential for 'resources' only and does not delineate mineral reserves. In the UK, mineral reserves can only be defined if planning permission for the extraction of an economic mineral resource has been received (see text box). There is no presumption that any areas delineated within the dataset will ultimately be acceptable for mineral extraction.

What is a mineral resource?

> ***Mineral resources*** *are natural accumulations of minerals, or bodies of rock, that are (or may become) of potential economic interest as a basis for the extraction of a commodity.*

What is a mineral reserve?

> *A* ***mineral reserve*** *is that part of a mineral resource that is economic to work and has been fully evaluated on a systematic basis by drilling and sampling and is free from any legal or other obstruction that might inhibit extraction.*

When does a mineral resource become a mineral reserve?

> *More detailed evaluations of a mineral resource (such as trenching and drilling) may result in the identification of an area where the volume and quality of mineral are such that they could be economically extracted. Once planning permission for extraction has been received it can be called a mineral reserve.*

1.3 WHAT MINERAL RESOURCES ARE INCLUDED IN THE DATASET?

The mineral resources contained in the dataset are varied, reflecting the geology in Great Britain. Although all minerals are covered, focus is given to construction and industrial minerals due to the importance of indigenous supply to the UK economy.

The dataset is split into the following resource types:

- ball clay
- brick clay
- chalk
- coal (deep)
- coal (shallow)
- fireclay
- fuller’s earth
- gypsum/anhydrite
- igneous rock
- kaolin
- limestone (including dolomite)
- oil shale
- peat
- polyhalite
- potash
- salt
- sand and gravel (from bedrock)
- sand and gravel (superficial)
- sandstone
- silica sand
- slate
- vein minerals

These resources are described in more detail in Appendix 3. They are also described in the reports (Appendix 1) accompanying the original mineral resource maps.

1.4 CURRENT VERSION OF THE DATA

Due to the different histories of the data (see Section 4.5) England, Wales and Scotland all have different version numbers. The current version for England is 3, Wales is 2 and Scotland is 2. Any reference to the dataset should be quoted as:

- England: BRITISH GEOLOGICAL SURVEY (BGS). 2020. Mineral resource polygons England Version 3. Electronic dataset. (British Geological Survey.) DOI:10.5285/f265629c-5e03-4927-b482-0668da720aca
- Scotland: BRITISH GEOLOGICAL SURVEY (BGS). 2020. Mineral resource polygons central belt of Scotland Version 2. Electronic dataset. (British Geological Survey.) DOI:10.5285/f6fa87e7-4010-4782-8a3a-7c322faa939d
- Wales: BRITISH GEOLOGICAL SURVEY (BGS). 2020. Mineral resource polygons Wales Version 2. Electronic dataset. (British Geological Survey.) DOI:10.5285/83c4e31f-237d-4fa7-a345-7648315f4d22

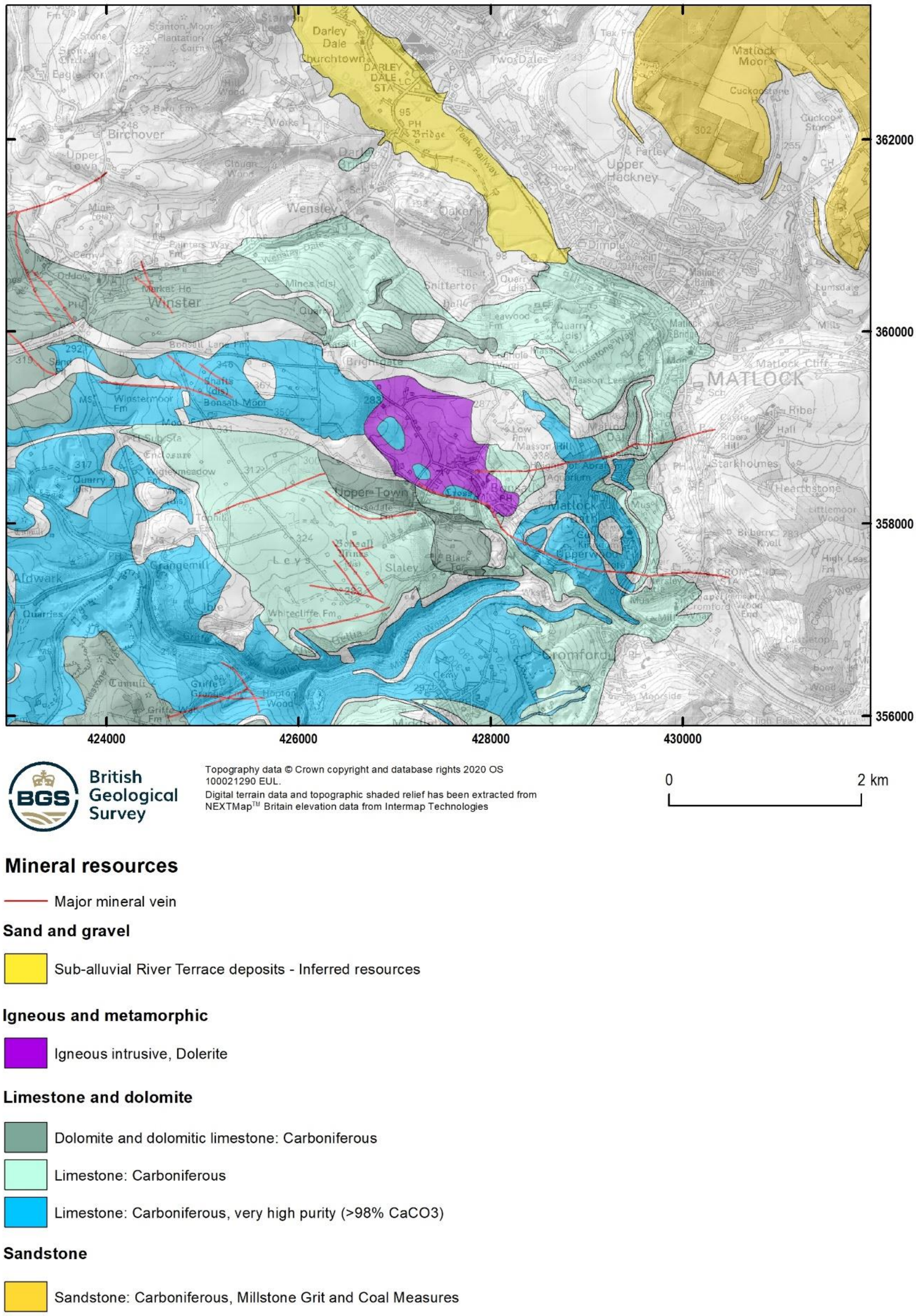

Figure 1 Example of data at 1:50 000.

2 Case study: mineral resource data for planning documents

2.1 THE CHALLENGE

Land use planning is a 'plan-led' system in England, Wales and Scotland. Although the town and country planning system is devolved and consequently there is some variation between the different parts of the UK, all areas are required to have local 'development plans' that document local planning polices, providing a framework for addressing economic, social and environmental priorities.

As part of national policy (Scottish Government, 2014; UK Government, 2019; Welsh Government, 2019) planning authorities are required to ensure adequate provision of mineral resources or to facilitate their responsible use, as well as to safeguard mineral resources against sterilisation by other forms of development. This requires planners to have access to up-to-date, accurate spatial data for mineral resources together with an understanding of what these resources represent.

2.2 THE SOLUTION

The BGS Mineral Resources Dataset forms the base data that can be used by local planning authorities to inform development of local planning documents, for industry consultation and to formulate mineral safeguarding maps. In some cases, more detailed maps are required for long-term resource management. For these, additional information from boreholes, or information on mineral properties from physical and chemical testing, can be interpreted alongside the mineral resources dataset to create enhanced maps with a higher level of confidence and that include aspects such as the depth and volumes of mineral resources.

Subsequent to the release of the mineral resource dataset, BGS was commissioned by several local mineral planning authorities to produce enhanced maps of, for example, sand and gravel resources, as well as mineral safeguarding maps.

2.3 THE OUTCOME

Almost all mineral safeguarding areas contained within local plans in England and Wales are based on BGS's mineral resource data, as shown by the example in Figure 2. This has enabled planners to meet their statutory obligations in a timely manner via the use of a robust, evidence-based dataset, alongside expert knowledge from BGS. This has also enabled the industry to access new supplies of essential resources.

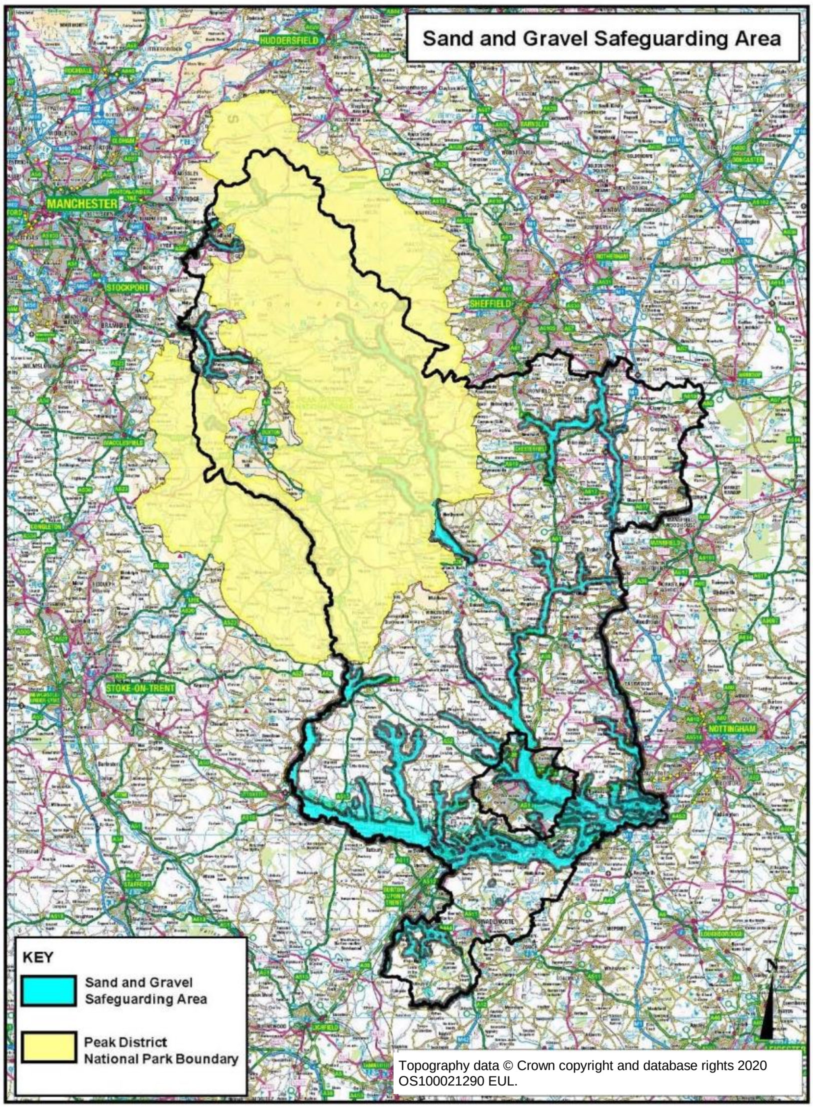

Figure 2 A typical example of a mineral safeguarding map using BGS mineral resource data, in this case sand and gravel resources in Derbyshire. Source: Chapter 10.1 Derbyshire and Derby Emerging Minerals Local Plan. Courtesy of Derbyshire County Council (2017).

3 Methodology

The BGS Mineral Resource Dataset was constructed in three separate parts during different years.

- England (1995–2006) to underpin production of the county mineral resource maps and then merged into regional and then national data from 2008–2012.
- The central belt of Scotland (2008). Other parts of Scotland are not covered by the dataset.
- Wales (2010).

The dataset is largely derived from the BGS national 1:50 000-scale digital geological map (DiGMapGB-50 version 5, or version 4 for Scotland), which is now known as BGS Geology 50K.

BGS Geology 50k is based on surveys carried out at six-inch or 1:10 000 scales and acquired at different times. During the development of the dataset, some rationalisation was necessary to accommodate different eras of mapping. Whilst every effort was made to ensure consistency of approach, the level of detail reflects in part the age of the original mapping.

The mineral resource dataset was constructed by identifying geological units that can be considered as a mineral resource due to their physical and chemical properties and, in some cases, their economic importance. In order to do this, as many sources of information as possible were consulted, ranging from historic publications to consultation with geologists with specialist knowledge of the local area. The majority of decisions were based on existing BGS publications such as:

- memoirs for geological map sheet areas
- previous BGS mineral resource assessments (in particular those for sand and gravel and limestone and dolomite undertaken by the then Industrial Minerals Assessment Unit (IMAU)
- the BGS-hosted 'BritPits' mines and quarries database
- expert knowledge

Stakeholder consultation was also an important input to the process. The views of representatives from the minerals industry, planners, non-governmental organisations and local and national governments were all considered. Coal data was sourced from the Coal Resource Map of Great Britain (1999), with data for shallow coal being subsequently updated using the coal appraisal maps produced by Jones (2006).

Where available, more detailed mapping has been incorporated into the mineral resource dataset. Examples include:

- the digitised 1:25 000-scale IMAU maps for sand and gravel and limestone resources
- maps for areas that have been re-assessed as part of separate commercial projects by BGS
- industry data
- data from peer-reviewed publications and reports for resources not well represented by geological mapping (e.g. salt; gypsum; potash; polyhalite)

Anthropogenic sterilisation (e.g. by urban areas) and relationships to environmental designations were not taken into account when deciding what constitutes a mineral resource, even though these factors influence planning considerations that may limit their working.

After the relevant sources of information had been consulted, the geological units identified in the DiGMapGB-50 dataset were assigned to the relevant mineral resource classification, e.g. river terrace sediments were assigned to sand and gravel resources. Once they had been attributed with resource information, certain geological lines, such as faults, were removed and the final mineral resource dataset created.

For areas of extensive low-value resources, the extract from DiGMapGB-50 was edited using the BGS National Superficial Deposits Thickness Model (Version 5) (Lawley and Garcia-Bajo, 2009) because large areas are covered by a significant thickness of overburden, which limits the volume economically available for extraction. For brick clay in the East of England and South Wales, and chalk in the East Midlands and Yorkshire and the Humber, only parts of the geological units, with less than 5 m of overburden, are considered to be a mineral resource. This depth is based on what is acceptable at active and historic quarries.

4 Technical Information

4.1 SCALE

The mineral resource dataset has been developed at 1:50 000 scale and is not suitable for use at larger (i.e. more detailed) scales, for example 1:50 000 scale data should not normally be enlarged and used at 1:10 000 scale. All spatial searches of the maps should be undertaken using a minimum 50 m buffer. This is because the smallest detectable feature at this scale is 50 m.

4.2 COVERAGE

The dataset covers onshore areas for England, Wales and the central belt of Scotland. The central belt of Scotland includes:

- City of Edinburgh
- City of Glasgow
- Clackmannanshire
- East Ayrshire
- East Dunbartonshire
- East Lothian
- East Renfrewshire
- Falkirk
- Fife
- Inverclyde
- Midlothian
- North Ayrshire (excluding islands)
- North Lanarkshire
- Renfrewshire
- South Ayrshire
- South Lanarkshire
- West Dunbartonshire
- West Lothian

4.3 ATTRIBUTE DESCRIPTION

Table 1 shows the attributes of the BGS Mineral Resource Dataset.

Table 1 Attributes of the mineral resource dataset.

Field name	Field description	
MIN_RES	The specific type of mineral resource. This may be a general rock type, or may contain information relating to the properties (or geological description that relates to properties), age or the location of the mineral e.g. • Glaciofluvial deposits, • Higher purity chalk (93-98% $CaCO_3$): Cretaceous • Ball clay: Palaeogene, Bovey Formation (Bovey and Petrockstowe Basins) A full list of MIN RES categories can be found in Appendix 4.	
MIN_ABBR	A generic mineral resource description, this will include one or many different MIN RES categories e.g. sand and gravel or igneous and metamorphic rock. This is designed to make resources simpler to categorise. A full list of MIN ABBR categories can be found in Appendix 4.	
SOURCE	The source of the data	DiGMapGB-50, this is the case for the majority of the data.

		IMAU (from the original project maps and reports).
		IMAU Re-assessed (to modern standards by county specific reports).
		DiGMapGB-50 Re-assessed (by county specific reports).
VERSION	This states the version of the data.	

Additional fields used only for shallow coal resources (taken from original data contained within Jones (2006):

Field name	Field description
RESOURCE	A classification of the resources relating to its depth and thickness of overburden. Categories comprise: Primary, Secondary, Tertiary and Fourth.
ZONE	A numerical description of the classification defined by the RESOURCE field from 1-4.
SURFACE	This states whether the coal occurs at surface or buried near-surface.
DESCRIP	This gives a brief geological and economic description related to the classification of the RESOURCE and ZONE fields.

Additional fields used only for sand and gravel resources in England:

Field name	Field description
LOCATION	If the resource has been re-assessed by area specific work this is the location where additional work has been undertaken.
REPORT	If the resource has been re-assessed by area specific work this is the report detailing the criteria used.

Additional fields used only for mineral veins in England:

Field name	Field description
NAME	If a vein is known by a specific name that has been recorded during the original compilation of paper-based resource maps it is recorded here.

Additional field used for the central belt of Scotland data:

Field name	Field description
BGSNAME	For some commodities this field gives a more detailed geological description and further breakdown, based on lithological properties, than is given by the MIN_RES field.

Additional fields used only for shallow coal resources (taken from original data contained within Jones (2006).

Field name	Field description

RESOURCE	A classification of the resource relating to its depth and thickness of overburden. Categories comprise: Primary, Secondary, Tertiary and Fourth.
ZONE	A numerical description of the classification defined by the RESOURCE field, from 1–4.
SURFACE	This states whether the coal occurs at surface or buried near-surface.
DESCRIP	This gives a brief geological and economic description related to the classification of the RESOURCE and ZONE fields.

Additional fields used only for sand and gravel resources in England.

Field name	Field description
LOCATION	If the resource has been re-assessed by area-specific work, this is the location where additional work has been undertaken.
REPORT	If the resource has been re-assessed by area-specific work, this is the report detailing the criteria used.

Additional fields used only for mineral veins in England.

Field name	Field description
NAME	If a vein is known by a specific name that has been recorded during the original compilation of paper-based resource maps it is recorded here.

Additional field used for the central belt of Scotland data.

Field name	Field description
BGSNAME	For some commodities, this field gives a more detailed geological description and further breakdown, based on lithological properties, than is given by the MIN_RES field.

4.4 DATA FORMAT

The BGS Mineral Resource Dataset is available as a vector GIS dataset with attribute values relating to mineral resource. The dataset comprises both polygon and polyline data.

The dataset is split into three separate areas: England, Wales and the central belt of Scotland. Within these areas, the data are further split by resource type. Therefore, a separate GIS data layer is available for each mineral resource occurring in each area.

4.5 DATA HISTORY

Data for England, Scotland and Wales have different histories.

4.5.1 England

Mineral resources data for England were originally complied on a county-by-county basis (version 1, completed in 2006). Version 2 (completed in 2012) merged these individual counties into a seamless, England-wide dataset, addressed border mismatches across county and regional boundaries, corrected any mistakes that had occurred during the original digitisation process and updated all linework to DiGMapGB-50 version 5. Version 3 has been created to address some minor corrections and incorporate additional BGS work on mineral resources undertaken subsequently for local authorities.

4.5.2 Scotland and Wales

Welsh and Scottish data was created on a national/regional level in 2010 and 2008 respectively. Both datasets are version 2, due to minor corrections and changes to ensure consistency across the datasets.

4.6 DISPLAYING THE DATA

The MIN_RES attribute field is used to classify the data; the associated legend files and colour pallet refer to this attribute. Tables detailing the RGB and hexadecimal values of the separate MIN_RES categories, separated by England, Scotland and Wales, can be found in Appendix 4.

4.7 HOW MINERAL RESOURCES ARE REPRESENTED

Mineral resources defined in the data delineate areas within which potentially workable minerals may occur. These areas are not of uniform potential. The extent of mineral resources shown in the data are generally the surface expression (outcrop) (or near-surface expression, in the case of resources buried under superficial deposits) of geological units inferred from mapping (from the DiGMapGB-50 dataset).. However, users should note that workable minerals may extend beneath overburden that is adjacent to the outcrop area shown. This is illustrated in Figure 3.

The potential depth at which overburden can be removed in order to extract the mineral resource is dependent on economic and technical factors and will differ between resources and locations. Some resource types are shown at depth beneath overburden, where appropriate. These include:

- assessed areas of sand and gravel
- limestone in the south-east of England
- salt, anhydrite, gypsum, potash and polyhalite resources
- some areas of igneous rocks occurring at depth in the East Midlands, where they are known to occur at depth and are likely to be worked due to their location relative to markets

In the last example, resources are represented by a dashed line showing the known extent at depth due to the uncertainties of subsurface extents.

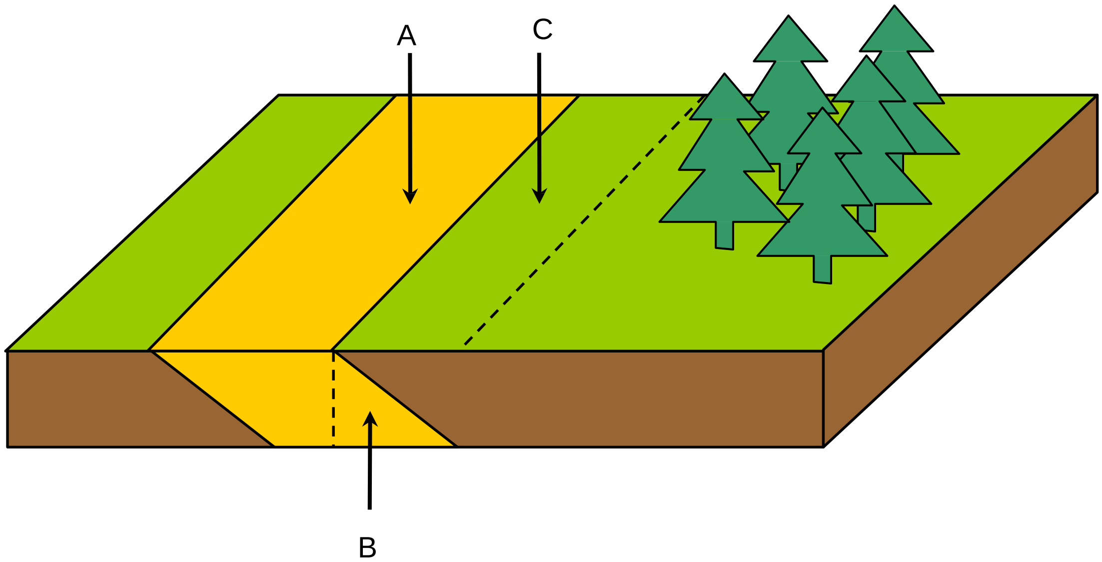

Figure 3 Surface expression, subsurface extent and overburden. The difference between (A) surface expression, i.e. outcrop, and (B) possible subsurface extent of a geological formation. (C) shows where overburden is adjacent to the outcrop area and may conceal the full extent of the formation when viewed in 2D plan.

Mineral resources can be subdivided into three main classes (inferred, indicated and measured) based on increasing levels of certainty as a result of geological investigation. These categories are explained in more detail in Appendix 3. The BGS Mineral Resources Dataset generally shows the surface extent of inferred resources. In areas where more detailed assessments have been carried out, sufficient information may be available to define mineral resources at the indicated resource level. These may include areas assessed for superficial sand and gravel by the IMAU in the 1970s and 1980s, or areas re-assessed by BGS more recently using borehole data. In these areas, the possible extent of sand and gravel concealed beneath other deposits is also shown. As a consequence, apparent mismatches between mineral resource linework may occur at the interface between areas surveyed at different levels of detail (between indicated and inferred resources) (Figure 4).

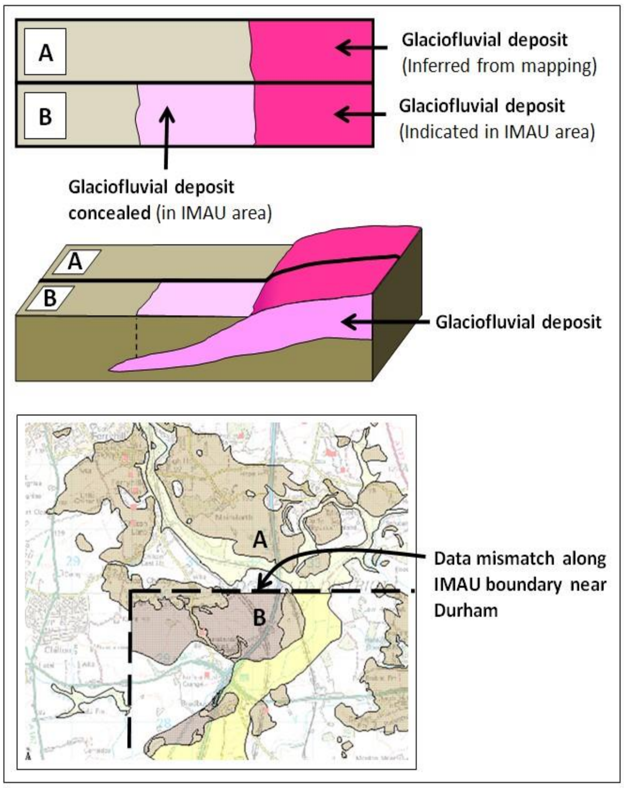

Figure 4 The potential mismatches caused by differing levels of information available. Diagrammatic map view (top), a 3D block model view (middle) and in a real example south of Durham (bottom). (A) shows the standard resource map derived mainly from geological mapping. (B) shows the increased level of detail mapped in an Industrial Mineral Assessment Unit area (IMAU) that includes indicated glaciofluvial resources partially concealed beneath overburden.

5 Limitations

5.1 DATA CONTENT

This dataset has been produced by the collation and interpretation of geological data relevant to mineral resources held by BGS. The mineral resource data presented is based on the best available information, but the quality of source data is not always consistent and quality is variable. The inferred boundaries shown are therefore approximate. Mineral resources defined in the dataset delineate areas within which potentially workable minerals may occur.

Data coverage for Scotland only extends to the central belt (see Section 4). Data for Scotland, England and Wales are split into three separate subdatasets. Within these, resource data are split by commodity for ease of use and to avoid overlapping polygons.

5.2 ACCURACY AND UNCERTAINTY

The areas delineated are not of uniform potential and also take no account of planning considerations that may limit their working. The BGS Mineral Resource Dataset does not determine mineral reserves.

The pattern of demand for minerals is continually evolving due to changing economic, technical and environmental factors. This dataset should only be used to show a broad distribution of areas that may contain mineral resources of current or potential economic interest. Criteria used to define resources, for example in terms of mineral-to-waste ratios or maximum overburden thickness, also change with location and/or time. Thus, a mineral deposit with a high proportion of waste may be viable if located in close proximity to a major market, but uneconomic if located further away. These criteria vary depending on the quality of the information available.

The data should not be used to determine individual planning applications, nor to take decisions regarding the acquisition or use of a particular piece of land, although they may give useful background information that sets a specific proposal in context. The economic potential of specific sites can only be proved by a detailed evaluation programme, including geological assessment and market investigation. Such an investigation is an essential precursor to submitting a planning application for mineral working. The individual merits of the site must then be considered against other land-use planning issues.

The extents of mineral resources shown in the data are generally the inferred surface expression of the resource. However, users should note that workable minerals may extend beneath overburden that is adjacent to the outcrop area shown.

Extensive areas are shown as having no mineral resource potential, but some isolated mineral workings may occur in these areas. The presence of these operations generally reflects very local or specific situations.

5.3 ARTEFACTS

The data were compiled on a regional basis. What is considered to be a mineral resource in one region may not be considered economic within another region. This may be due to economic or technological factors or because resource quality within a geological formation differs.

The data were compiled using DigmapGB-50 V5 for England (2012) and Wales (2010) and V4 for the central belt of Scotland (2008). As a result, there will be discrepancies between the latest version (BGS Geology 50k) and this dataset. Similarly, it should be noted that, in some areas, data other than DigmapGB-50 have been used, namely IMAU mapping, more detailed mineral resource assessments carried out by BGS and resources types not well represented by surface mapping.

5.4 DISCLAIMER

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

6 Frequently asked questions

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

Q: What does the BGS Mineral Resources Dataset show?
A: This dataset shows the spatial extent of areas that may potentially contain mineral resources. In general, a 'mineral resource' contains minerals that are of current or potential economic interest.

Q: How can the BGS Mineral Resources Dataset help in the planning process?
A: The dataset is designed to assist with the planning process, including for use in the preparation of local plan documents and mineral safeguarding plans.

Q: What areas does the BGS Mineral Resources Dataset cover?
A: This dataset covers England, Wales and the central belt of Scotland, as separate layers.

Q: In what data formats can the BGS Mineral Resources Dataset be provided?
A: The dataset is provided as vector data in ArcGIS format (shapefiles). More specialised formats may be available but may incur additional processing costs. Please email digitaldata@bgs.ac.uk to request further information.

Q: What is the source of the data?
A: The BGS Mineral Resources Dataset is derived from a series of projects commissioned by the central Government department with responsibility for mineral planning at the time to prepare a series of mineral resource maps:

- Department of the Environment (DoE)
- Department of the Environment, Transport and the Regions (DETR)
- Department for Transport, Local Government and the Regions (DTLR)
- Office of the Deputy Prime Minister (ODPM)
- Department for Communities and Local Government (DCLG))
- Scottish Government
- Welsh Government

It was co-funded by the BGS Sustainable Mineral Solutions project. Each map is also available to download as PDF files from the BGS-hosted website MineralsUK. It must be noted that the underlying digital mineral resource data presented in the PDF files have since been updated.

Q: What are mineral resources?
A: Mineral resources are natural concentrations of minerals that might now, or in the foreseeable future, be of economic value. The identification and delineation of areas that might

contain mineral resources in this dataset is imprecise, as it is limited by the quantity and quality of data currently available and involves predicting what might or might not become economic to work in the future. The identification of what is or may become a mineral resource is a dynamic process that must take into account a range of factors. These include:

- geological reinterpretation as additional data become available
- the continually evolving demand for minerals
- specific qualities of minerals
- changing economic, technical and environmental factors

Consequently, the economic potential of mineral resources is not static, but changes with time. This dataset is based on the geology of Great Britain and only limited assessment of economic potential and technical feasibility was made during its compilation. More detailed assessments are required before any extraction is considered.

Q: Why do we need to extract minerals in the UK?
A: Minerals are the raw materials that underpin most sectors of the UK economy and their use contributes to the UK's high standard of living. Certain minerals are also exported and thus generate income for the country. The UK's land mass contains a wide range of indigenous minerals including construction minerals (e.g. aggregates; gypsum), industrial minerals (e.g. china clay; salt) and metals (e.g. tin; tungsten). Many of these minerals cannot be imported because of the large quantities required or the high cost that would be incurred.

Q: At what map scale is the BGS Mineral Resource Dataset provided?
A: The dataset is provided at 1:50 000 scale and is intended for use at this scale. All spatial searches of the maps should be undertaken using a minimum 50 m buffer. This is because the smallest detectable feature at this scale is 50 m. Consequently, digital data should therefore be used at about the same scale as the original compilation; for example, 1:50 000-scale data should not normally be blown up and used at 1:10 000 scale.

Most geological maps were originally fitted to a particular topographic base and care must be taken in interpretation, for example when the geological data is draped over a more recent topography.

Q: How accurate is the BGS Mineral Resource Dataset ?
A: In general, a 'mineral resource' contains minerals that are of current or potential economic interest. However, the BGS Mineral Resource Dataset is based on the geology of Great Britain and only limited assessment of economic potential was made during its compilation. The delineated areas are not of uniform potential and also take no account of planning considerations that may limit their working.

The dataset does not determine mineral reserves. Extensive areas are shown as having no mineral resource potential, but some isolated mineral workings may occur in these areas. The presence of these operations generally reflects very local or specific situations.

The extents of mineral resources shown in this dataset are generally the inferred surface expression of the resource. However, users should note that workable minerals may extend beneath overburden that is adjacent to the outcrop area shown. This dataset incorporates all the relevant data available to BGS at the time of its compilation, however, BGS cannot guarantee all potential minerals resources have been represented. More detailed geological investigations may reveal future areas of mineral resources not defined here.

Q: How often will the BGS Mineral Resource Dataset be updated?
A: This dataset is not routinely updated. The dataset is revised on an ad hoc basis, as and when there are significant changes in its source data, and/ or it is prioritised for update. Work is currently planned to ensure this dataset is aligned with the latest version of BGS Geology 50k. A new version of the dataset will be released once this upgrade has been completed.

Q: Can I use the BGS Mineral Resource 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 List of map sheets incorporated into spatial data

6.1 ENGLAND

County	Products	Date published	Ref. No.
Bedfordshire	Report and map	1995	WF/95/2
Berkshire (comprising West Berkshire, Reading, Wokingham, Windsor and Maidenhead, Bracknell Forest and Slough)	Report and map	2004	CR/03/074N
Buckinghamshire and Milton Keynes	Report and map	2004	CR/03/77N
Cambridgeshire (comprising Cambridgeshire and the City of Peterborough)	Report and map	2003	CR/02/131N
Cheshire (comprising Cheshire, Boroughs of Halton and Warrington)	Report and map	2006	CR/05/090N
Cornwall	Report and map	1997	WF/97/11
Cumbria and Lake District	Report and 3 maps, Sand and gravel, North and south, Other resources	2001	WF/01/02
Derbyshire	Report and map	1995	WF/95/3
Devon (comprising Devon, Plymouth, Torbay, Dartmoor National Park and part of Exmoor National Park)	Report and 2 maps	2006	CR/05/096N
Dorset, Bournemouth and Poole	Report and map	2001	WF/01/01
Durham and Tees Valley	Report and map	2000	WF/00/6
East Sussex (comprising Brighton & Hove and East Sussex)	Report and map	2002	CR/02/126N
Essex (comprising Essex, Southend–on–Sea, Thurrock, London Boroughs of Barking and Dagenham, Havering, Redbridge and Waltham Forest)	Report and map	2002	CR/02/127N
Gloucestershire (comprising Gloucestershire and South Gloucestershire)	Report and map	2006	CR/05/105N
Greater Manchester (comprising Cities of Manchester and Salford and metropolitan boroughs of Bolton, Bury, Oldham, Rochdale, Stockport, Tameside, Trafford and Wigan)	Report and map	2006	CR/05/182N

Hampshire (comprising Hampshire, City of Portsmouth and City of Southampton)	Report and map	2003	CR/02/129N
Herefordshire and Worcestershire	Report and map	1999	WF/99/4
Hertfordshire and north-west London boroughs	Report and map	2003	CR/03/075/N
Humberside (comprising East Riding of Yorkshire, North Lincolnshire, North East Lincolnshire and City of Kingston upon Hull).	Report and map	2005	CR/04/227N
Isle of Wight	Report and map	2002	CR/02/130N
Kent (comprising Kent, Medway and London boroughs of Bexley and Bromley)	Report and map	2003	CR/02/125N
Lancashire (comprising Lancashire and boroughs of Blackpool and Blackburn with Darwen)	Report and map	2006	CR/05/144N
Leicestershire, City of Leicester and Rutland	Report and map	2002	CR/02/24/N
Lincolnshire	Report and two maps: north and south	2003	CR/02/128N
Merseyside (comprising City of Liverpool and boroughs of Knowsley, Sefton, St Helens and Wirral	Report and map	2005	CR/05/129N
Norfolk	Report and map	2004	CR/03/174N
North Yorkshire (comprising North Yorkshire, Yorkshire Dales and North York Moors national parks and City of York)	Report and two maps: east and west	2006	CR/04/228N
Northamptonshire	Report and map	2000	WF/00/4
Northumberland and Tyne & Wear	Report and two maps: north and south	2000	WF/00/5
Nottinghamshire and City of Nottingham	Report and map	2002	CR/02/23/N
Oxfordshire	Report and map	2004	CR/04/62N
Peak District National Park	Report and map	1995	WF/95/4
Shropshire	Report and two maps: sand and gravel, other minerals	1998	WF/98/6

Somerset (comprising Somerset, North Somerset, Bath and North-east Somerset, City of Bristol and part of Exmoor National Park)	Report and map	2005	CR/04/214N
South Wales	Report and two maps: coal, other minerals	1997	WF/97/10
South Yorkshire (comprising metropolitan boroughs of Barnsley, Doncaster and Rotherham and City of Sheffield)	Report and map	2006	CR/04/173N
Staffordshire	Report and two maps: sand and gravel, other minerals	1995	WF/95/5
Suffolk	Report and map	2003	CR/03/076N
Surrey (comprising Surrey and the London boroughs of Croydon, Hounslow, Kingston upon Thames, Richmond upon Thames and Sutton)	Report and map	2003	CR/03/073N
Warwickshire	Report and map	1999	WF/99/2
West Midlands	Report and map	1999	WF/99/3
West Sussex	Report and map	1998	WF/98/5
West Yorkshire (comprising metropolitan boroughs of Bradford, Calderdale, Kirklees and Wakefield and City of Leeds)	Report and map	2006	CR/04/172N
Wiltshire (comprising Wiltshire and the Borough of Swindon)	Report and map	2004	CR/04/049N

SCOTLAND

Area	Products	Date published	Ref. No.
Mineral resource map for Clackmannanshire, Fife and Falkirk	Map	2008	OR/08/12

Mineral resource map for East Lothian, Midlothian, West Lothian and City of Edinburgh	Map	2008	OR/08/13
Mineral resource map for North Ayrshire, East Ayrshire and South Ayrshire	Map	2008	OR/08/14
Mineral resource map for Inverclyde, West Dunbartonshire, East Dunbartonshire, Renfrewshire, East Renfrewshire, North Lanarkshire, South Lanarkshire and City of Glasgow	Map	2008	OR/08/15

WALES

Area	Products	Date published	Ref. No.
Mineral resource map for south-east Wales	Map	2010	OR/10/26
Mineral resource map for south-west Wales	Map	2010	OR/10/25
Mineral resource map for north-east Wales	Map	2010	OR/10/22
Mineral resource map for north-west Wales	Map	2010	OR/10/21
Mineral resource map for mid-Wales (south)	Map	2010	OR/10/24
Mineral resource map for mid-Wales (north)	Map	2010	OR/10/23

Appendix 2 Definitions of resources and reserves[1]

MINERAL RESOURCES

A 'mineral resource' is a concentration or occurrence of material of economic interest in or on the Earth's crust in such form, quality and quantity that there are reasonable prospects for eventual economic extraction. The location, quantity, grade, continuity and other geological characteristics of a mineral resource are known, estimated or interpreted from specific geological evidence and knowledge.

Mineral resources are subdivided, in order of increasing geological confidence, into inferred, indicated and measured categories.

Inferred mineral resources

An 'inferred mineral resource' is that part of a mineral resource for which tonnage, grade and mineral content can be estimated with a low level of confidence. It is inferred from geological evidence and assumed, but not verified, geological and/or grade continuity. It is based on information, which is limited or of uncertain quality and reliability, gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes.

Indicated mineral resources

An 'indicated mineral resource' is that part of a mineral resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a reasonable level of confidence. It is based on exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are too widely or inappropriately spaced to confirm geological and/or grade continuity but are spaced closely enough for continuity to be assumed.

Measured mineral reserves

A 'measured mineral resource' is that part of a mineral resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a high level of confidence. It is based on detailed and reliable exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are spaced closely enough to confirm geological and grade continuity.

MINERAL RESERVES

A 'mineral reserve' is the economically mineable part of a measured and/or indicated mineral resource. It includes diluting materials and allowances for losses that may occur when the material is mined. Appropriate assessments, which may include feasibility studies, have been carried out and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate that, at the time of reporting, extraction could reasonably be justified.

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[1] Extracts from the Pan-European code for reporting of exploration results, mineral resources and reserves ('The PERC reporting code'), 2017.

Mineral reserves are subdivided in order of increasing confidence into probable mineral reserves and proved mineral reserves.

Probable mineral reserves

A 'probable mineral reserve' is the economically mineable part of an indicated, or in some circumstances a measured, mineral resource. It includes diluting materials and allowances for losses that may occur when the material is mined. Studies to at least pre-feasibility level will have been carried out, including consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. The results of the studies demonstrate at the time of reporting that extraction could reasonably be justified.

Proved mineral reserves

A 'proved mineral reserve' is the economically mineable part of a measured mineral resource. It includes diluting materials and allowances for losses that may occur when the material is mined. Studies to at least pre-feasibility level will have been carried out, including consideration of, and modification by, realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These studies demonstrate at the time of reporting that extraction is justified.

RELATIONSHIP BETWEEN RESOURCES AND RESERVES

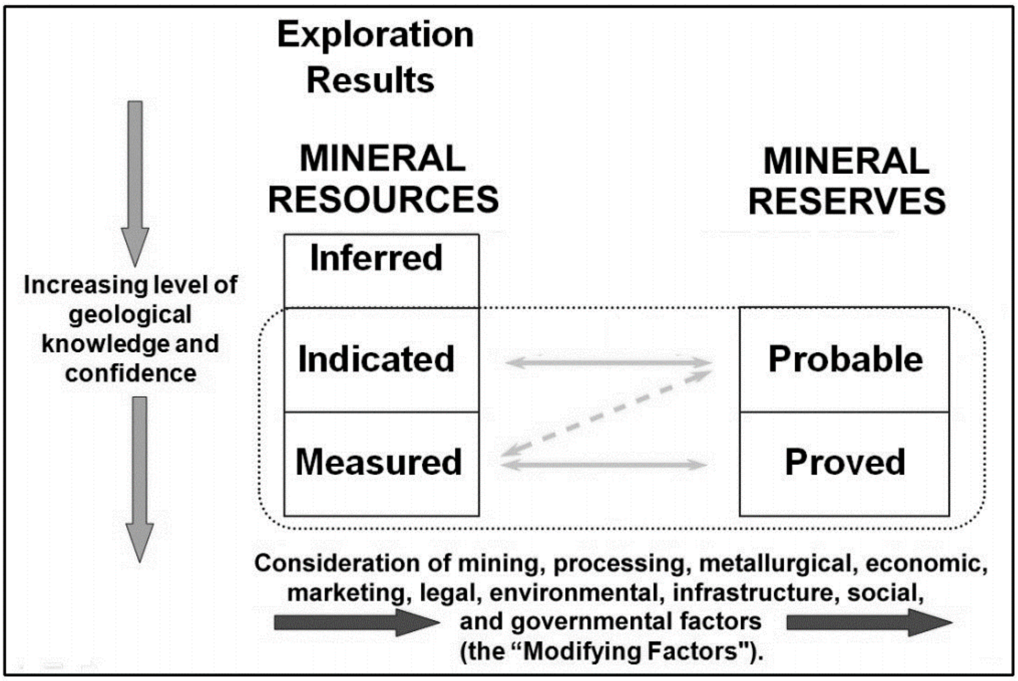

Figure 5 The relationship between mineral resources and mineral reserves.

Note: In the context of UK land-use planning, the term 'mineral reserve' should strictly be further limited to those minerals for which a valid planning permission for extraction exists (i.e. permitted reserves). Without a valid planning consent, no mineral working can take place and consequently the inherent economic value of the mineral resource cannot be released and resulting wealth created. The ultimate fate of a mineral reserve is to be either physically worked out or to be made non-viable by changing economic circumstances.

Appendix 3 BGS Mineral Resource Dataset resource descriptions

This appendix gives a broad overview of all the various mineral resource types covered in the BGS Mineral Resource Dataset. For more detail on specific occurrences please refer to the original map and/or accompanying report (listed in Appendix 1 and available on MineralsUK), which will contain further information as to the extent and properties of resources.

SAND AND GRAVEL MINERAL RESOURCE DESCRIPTION

Sand and gravel are defined on the basis of particle size rather than composition. In current commercial practice, following the introduction of new European standards from 1 January 2004, the term ‘gravel’ (or more correctly ‘coarse aggregate’) is used for general and concrete applications to define particles between 4 and 80 mm and the term ‘sand’ (or ‘fine aggregate’) for material that is finer than 4 mm but coarser than 0.063 mm. For use in asphalt, 2 mm is now the break point between coarse and fine aggregate.

Sand and gravel deposits are accumulations of the more durable rock fragments and mineral grains that have been derived from the weathering and erosion of hard rock by glacial and river action. The properties of gravel, and to a lesser extent sand, largely depend on the properties of the rocks from which it was derived. Most sand and gravel are composed of particles that are durable and rich in silica (quartz, quartzite and flint). Other rock types may occur locally, including limestone and deleterious impurities such as mudstone and coal.

The principal aggregate uses of sand are as fine aggregate in concrete, mortar and asphalt. The main use of gravel is as coarse aggregate in concrete. Substantial quantities of sand and gravel may also be used for constructional fill. Nationally, typically over 70 per cent of sand and gravel output is used as concreting aggregate.

The variability of sand and gravel deposits, together with their possible concealment within or beneath till (boulder clay) and other deposits, means that it can be difficult to infer the location and likely extent of potentially workable resources from geological maps.

The properties that influence the economic potential of a sand and gravel deposit include:

- sand to gravel ratio
- proportion of fines (<0.063 mm) and oversize material
- presence of deleterious rock types (such as coal or mudstone)
- thickness of deposit, overburden ratio and its proximity to surface
- position of the water table
- possible presence of unwanted interbedded material
- the ease with which material can be processed to produce a saleable product (clay fines are more difficult to remove than silt)
- location relative to demand

Sand and gravel layer subdivisions

The sand and gravel resources in England occur in several different geological environments, each with different characteristics. They can be grouped into two main categories: bedrock and superficial.

Bedrock (or ‘solid geology’) is actually unconsolidated or loosely consolidated in this category and refers to sand and gravel that is generally soft enough to be dug, for example the Cretaceous-age Folkestone Formation found in the south-east of England. These deposits can vary in grain size and composition across their extent. For example, the Lambeth Group varies considerably in its sand and clay content, therefore in some counties it is considered a brick clay resource rather than a sand and gravel resource.

Superficial (or 'drift') deposits comprise sediments laid down in the last 2.6 million years. They are subdivided according to how they were deposited and those that form a sand and gravel resource are listed as follows:

Suballuvial river terrace deposits

Suballuvial river terrace deposits are an inferred continuation of river terrace deposits, that is, beneath the alluvium of modern fluvial systems (alluvium itself comprises largely silt and clay). Industry identifies them separately from river terrace deposits as they can often be wet-worked if exploited.

River terrace deposits

River terrace deposits represent successive levels of river deposition through time. They comprise sequences of sand and gravel with sheet-like geometry and subhorizontal upper surfaces. The older terraces are higher than the present course of the river and are generally dry in their upper parts. Younger terraces can be saturated and require wet-working. Thicknesses typically vary from <1 m to maximum values of around 10 m. Deposit quality generally depends on the geology of the catchment area as this dictates the type of material that is incorporated. Sand to gravel ratios are also variable but river terrace deposits are typically relatively clean with lower fines (silt and clay) content than glaciofluvial deposits.

Glaciofluvial deposits

Glaciofluvial deposits originated during ice ages where glacial meltwaters flowing on, within, beneath and around ice sheets and glaciers deposited sand and gravel. These deposits are often discontinuous sand and gravel lenses and sheets within, above and below other glacial deposits such as till. They may be completely concealed and their extent is therefore likely to be greater than included in the data. They vary in thickness and consist of poorly sorted sand and gravel with generally a higher proportion of clay than the cleaner river terrace deposits.

Head gravel deposits

Head gravel deposits are formed by solifluction (complex periglacial mass-movement) during cold climate periods or gravity slope movements downhill. The gravel composition reflects the geology of the area it has moved over. Most head gravel deposits contain a significant clay content and so processing for concreting aggregate requires washing, although it is sometimes used ‘as dug’ in southern England where it is referred to as ‘hoggin’ (used for surfacing rough tracks or bulk fill). Extensive head gravel deposits occur in West Sussex, where the gravel is the result of mass movement off the chalk downs and the gravel contains a high proportion of flint.

Fan gravel deposits

Fan gravel deposits are the result of fluvial deposition at the mouths of tributary valleys onto a plain or a wide valley. The spread of material often forms a relatively flat or gently sloping fan-shape. Examples include the Chichester fan gravel in West Sussex and the Wallingford fan gravels in Oxfordshire. Generally, sand and gravel deposited in this way is better sorted than head gravel deposits and has lower clay content.

Blown sand deposits

Blown sand is mainly found in coastal areas where sand is picked up from beaches by the wind and re-deposited in dunes, although other sources of sand can also contribute to inland deposits, for example the Lincolnshire cover sands, which tend to accumulate along the lower slopes of west-facing escarpments. The sand is usually fine grained, well sorted and with well-rounded grains. Deposit thicknesses range from <1 m to around 6 m. It is often too fine grained with too narrow a grain-size range for use as concreting aggregate or mortar sand, however it can be mixed for other construction application and its purity can allow it to be used as silica sand (e.g. Messingham, North Lincolnshire).

BEACH DEPOSITS

Beach deposits can be found subparallel to the modern coast and up to several kilometres inland, reflecting the former positions of parts of the coastline. Deposits vary widely in grain size and composition and are generally a few metres to up to 20 m thick. They are often more ‘gravelly’ inland and grade seawards into sand or silt. Beach deposits include 'shoreface beach deposits', 'storm beach deposits' and ‘raised beach deposits’. Examples include the raised beach deposits at Boxgrove in West Sussex.

CLAY-WITH-FLINTS

Clay-with-flints is specific to the chalk downs of south-east England (e.g. St Boniface Down on the Isle of Wight) where the maximum vertical thickness of the deposit is unknown. It is structureless and contains bleached, unworn flint fragments within clay. It is also of unknown age and found on summits and upper parts of slopes.

SILICA SAND MINERAL RESOURCE DESCRIPTION

Silica (industrial) sands contain a high proportion of silica (SiO_2) in the form of quartz and are used for purposes other than as construction aggregates. They are essential raw materials for the glass and foundry-castings industries, but also have a wide range of other industrial and horticultural applications, including ceramics and chemical manufacture, and water filtration. They are produced from both loosely consolidated sand deposits and by crushing weakly cemented sandstones.

Unlike construction sands, which are used for their physical properties alone, silica sands are valued for a combination of their chemical and physical properties. These include a high silica content in the form of quartz and, more importantly, an absence of impurities, particularly clay, iron oxides and refractory minerals such as chromite. Silica sands typically have a narrow grain-size distribution, generally in the range 0.5–0.1 mm, although coarser grades are required for some applications. For most applications, silica sands have to conform to very closely defined specifications and consistency in quality is of critical importance. Particular uses often require different combinations of properties.

Consequently, different qualities of silica sand are usually not interchangeable in use. Silica sands command a higher price than construction sands. This allows them to serve a wider geographical market, including exports.

Silica sand processing is of varying degrees of complexity and depends on the end use of the sand. It typically requires a high capital investment in-plant. Processing is aimed at improving both the physical and chemical properties of the sand to meet user specifications. The ease with which contaminants, such as iron-bearing impurities and clay, can be removed, together with the level of losses incurred in removing oversize and undersize fractions from a sand, has a major bearing on its potential use. Deposits of silica sand occur in only limited areas and the special characteristics of silica sand extraction and, in particular, the cost of processing mean that the industry has a restricted distribution.

Silica sand layer subdivisions

The silica sand resources in England occur in a number of different geological environments, each with different characteristics. They can be grouped into two main categories.

Bedrock (or ‘solid geology’) includes loosely consolidated sand deposits and weakly cemented sandstones. These deposits can change laterally in grain size and composition across their extent. Only certain parts of a formation may have the required physical and chemical properties to be considered a silica sand resource.

Superficial (or 'drift’) deposits comprise sediments laid down in the last 2.6 million years. They are subdivided according to how they were deposited and those that form a sand and gravel resource are listed in the sand and gravel section. Some of these deposits may have the required physical and chemical properties to be considered a silica sand resource, for example, some blown sand deposits.

SHALLOW COAL MINERAL RESOURCE DESCRIPTION

Coal is a combustible sedimentary rock made of lithified plant remains. It is formed by the progressive biological and thermal degradation of vegetation, which is consolidated between other sedimentary rocks, notably seatearth, mudstone, siltstone and sandstone, to form coal seams (layers). These vary in thickness from a few centimetres up to (rarely) 3.5 m, although exceptionally thicker seams may also occur. Almost all onshore coal resources in Britain occur in rocks of Carboniferous age (300–330 million years old) and the main strata containing coal seams at fairly regular intervals are referred to as the Coal Measures. As a result of subsequent faulting and folding of these rocks, coal seams occur at varying depths from the surface. The depth at which coal is found defines the resource category into which it is placed. The ownership of all coal resources resides with the Coal Authority.

The property of coal that makes it of economic interest is that it is combustible. It oxidises and releases heat went burnt, which in turn can be used for power generation, its most important use, and for industrial processes, such as iron smelting, as well as domestic heating. The amount of heat contained in a coal is measured by its calorific value (CV) and is one of the main quality criteria used by coal consumers.

The dry, ash-free CV is specific to a particular seam in a particular coalfield, however the net CV as sold to a customer depends on a number of factors and is controllable by coal preparation. All deep mines have coal preparation facilities. In surface coal-mining operations, the coal can be worked more cleanly to bed thicknesses as little as 0.1 m, thus recovering a large proportion of the coal in place. Surface-mined coal normally does not require further processing.

Shallow coal layer subdivisions

These are the areas that are technically amenable to surface mining of coal, sometimes with associated fireclay. They are mainly areas where coal-bearing strata occur at the surface in the exposed coalfields but also include such strata beneath less than 50 m of overburden (defined as barren rocks overlying the coal-bearing strata).

Coal resources are split into primary, secondary, tertiary and buried resources, which indicate the ‘prospectivity’ of an area for open-cast coal resources and are related to the thickness of coal present, the depth it occurs and the amount of impurities present. More information regarding this classification scheme can be found in Jones, (2006).

DEEP COAL MINERAL RESOURCE DESCRIPTION

For the geological description of deep coal, see the Shallow coal mineral resource description.

Deep coal layer subdivisions

In these areas, coal-bearing strata do not occur at the land surface but are concealed and may occur anywhere from 50 m below the surface to depths in excess of 1200 m. Conventional underground coal mining in Britain has been carried out to approximately 1200 m from surface. This resource category also includes coal-bearing rocks below 1200 m that could be a source of coalbed methane.

BALL CLAY MINERAL RESOURCE DESCRIPTION

Ball clays are fine-grained, highly plastic sedimentary clays, which fire to a light or near white colour. They are used mainly in the manufacture of ceramic whiteware and are valued for their key properties of plasticity, which makes them easy to mould, unfired strength and the fact that, when fired, they have a light colour (normally, sedimentary clays fire to a reddish colour). Some ball clays are also valued for their ability to readily disperse in water to produce ‘fluid slips’ (high-solids, aqueous suspensions).

Ball clays exhibit highly variable compositions and consist not of a single mineral but a mixture of predominantly three minerals: kaolinite, mica and quartz, with each mineral contributing different properties. The clay mineral kaolinite is the key component. The crystallinity of the kaolinite, in terms of being well-ordered (less plastic and coarser) or disordered (highly plastic and fine grained) also has a marked influence on ceramic performance. Fire colour is a function of iron and titanium content, whilst unfired strength is largely related to fineness of particle size, as well as crystallographic ordering of the kaolinite.

The wide variation in the mineral composition and particle size of ball clays, together with the crystallinity of the kaolinite, all result in differing ceramic and rheological (fluid) properties. This natural variability occurs both between and within seams and from basin to basin. It is related to the origin of the clays and is caused mainly by differences in source rocks, the degree of weathering and the environment in which the clays were deposited.

Modern ceramic manufacturing, with its trend towards increasing automation and fast firing to improve energy efficiency, is placing increasingly stringent demands on ball clay quality. Raw materials with consistent and predictable ceramic properties are required.

Ball clay layer subdivisions

Bovey Basin

The Bovey Basin in south Devon is a fault-bounded trough containing over 1100 m of sediments of Palaeogene age. These sediments comprise clays, silts, sands, gravels and lignite and are divided into the lower, middle and upper parts of the Bovey Formation; these are further divided into members. Most of the commercially valuable ball clays are obtained from the top of the middle Bovey Formation, but the lower part of the upper Bovey Formation is becoming of increasing importance. Production is from the Abbrook Clay And Sand to Goosehams members. The thick lower Bovey Formation does not crop out at the surface and any ball clays that may be present are too deep to be of commercial interest.

The sediments were deposited in a fluvio-lacustrine environment and exhibit considerable lateral variation in character. The ball clays were deposited in back swamps, which explains their fine particle size and the presence of colloidal carbonaceous matter. Sands were laid down by stronger currents, which often eroded or covered pre-existing ball clay deposits.

Ball clays in the Bovey Basin contain both well-ordered and disordered kaolinite, which accounts for the diversity of their properties. They include the whitest firing and most fluid UK ball clays, important for sanitaryware and tableware manufacture. They were probably derived from weathering profiles developed on the Dartmoor Granite and some resemble kaolin in character. The clays in the Abbrook Clay And Sand Member are fine-grained and contain highly disordered kaolinite and were more likely to have been derived from mudstones and slates. The clays in the stratigraphically higher, Southacre Clay And Lignite, Stover and Goosehams members contain higher proportions of coarser and better-ordered kaolinite.

The Bovey Basin has the largest permitted reserves and unpermitted resources of all the three ball clay basins, together with the greatest diversity of clays. Permitted reserves have been estimated at 63 million tonnes and the basin will continue to be the major source of ball clay in the future. However, this gross figure includes a range of ball clay qualities and over 120 production clays are extracted from individual seams or parts of seams. Reserves of individual clay qualities that are essential for specific blends and applications may be more limited. Of particular importance will be the clays that form the basis of sanitaryware blends.

Petrockstow Basin

The smaller Petrockstow Basin in north Devon occupies an area of about 10 km^2. It is bounded by two north-westerly trending faults of the Sticklepath fault zone. The basin is filled with Palaeogene-age Bovey Formation sediments. These comprise clays, silts, sands, gravels and lignites. The clays vary from relatively homogeneous sandy to very sandy clays with some bands of slightly sandy to ‘smooth’ clays. The clays are generally grey to greyish-brown to black and lignitic. Some of the clays are varved and consist of very silty clays interlaminated with clayey silts.

Mineralogical composition of the Petrockstow ball clays is variable and generally consists of illite, kaolinite, quartz and carbonaceous material (lignite), with smaller amounts of iron oxide, marcasite and siderite. Lignite is less common than in the Bovey Basin and typically occurs as scattered fragments or finely disseminated in lignitic clay.

The clays are mainly used in tile manufacture but also in sanitaryware blends. Ball clay has been worked in the Petrockstow Basin at two locations: Sibelco UK operate at Peters Marland at the north-western end of the basin (Westbeare and Courtmoor quarries) and, at the south-east end, operations by IMERYS were close to Meeth (Glebe, Stockleigh Moor and Woolladon quarries). However, IMERYS ceased production at the end of 2004, because of the high cost of extraction.

WAREHAM BASIN

Ball clays occur in four host clays in the Poole Formation in this basin in Dorset. In ascending sequence, the host clays are the Creekmoor, Oakdale, Broadstone and Parkstone Clay members of the Poole Formation; their extent is included in the data. The average thickness of the host clays is 6–16 m, but thickness can vary over short distances.

The host clays exhibit vertical and lateral variations in properties, which markedly affect their potential as ball clays. Each host clay contains beds of ball clay together with inferior-quality clays. The proportion of ball clay to host clay varies but may be up to 25 per cent. Clay quality can vary quite rapidly over short distances. The presence of a host clay is not a guarantee that it will contain workable ball clay.

- The Creekmoor Clay Member is the most important host clay, providing the highest-quality ball clays and accounting for the largest proportion of output.
- The Oakdale Clay Member is extracted on the Arne Peninsula.
- The Broadstone Clay Member is no longer worked.
- The Parkstone Clay Member has a limited outcrop but is worked both in the north and south of the basin.

North of the River Frome, the Oakdale Clay is the most extensive host clay but it is generally of lower quality. The quality of the host clays decreases north-eastwards (north-east of Wareham). The highest-quality clays are restricted to the area south of the River Frome.

BRICK CLAY MINERAL RESOURCE DESCRIPTION

Brick clay is the term used to describe ‘clay and shale’ used in the manufacture of structural clay products, such as facing and engineering bricks, pavers, clay tiles for roofing and cladding, and vitrified clay pipes. Clay and shale may also be used in cement making, as a source of constructional fill, for lining and sealing landfill sites and, rarely, for the manufacture of lightweight aggregate.

Brick clays are sedimentary mudstones of different geological ages and compositions. They consist essentially of clay minerals and quartz in varying proportions, although many other minerals may occur in accessory amounts and considerably affect their suitability for brick manufacture. In a brick clay, there must be sufficient clay minerals present to make it plastic enough to mould and to retain its shape prior to firing. Sufficient fluxing materials must also be present for the clay to vitrify (partially fuse to form a glass to give the brick strength) at temperatures between 950 and 1100°C. An adequate proportion of non-plastic constituents, usually quartz, is also required to prevent excessive shrinkage and deformation during drying and firing.

The chemical properties of mudstones, which are related to their mineralogical composition, and physical properties, such as grain size, are critical to determining their suitability for the manufacture of structural clay products. These properties affect the forming behaviour of the clay (the process prior to firing in which the ware is shaped) and also its behaviour during drying and firing. They also determine the technical properties of the fired product, such as strength, water absorption (porosity) and frost resistance, and thus its durability and performance in service.

Importantly, they also affect aesthetic appearance, such as colour and texture, providing greater choice and style for architects and developers.

Clay bricks (and tiles) are versatile and durable construction materials and one of the most visible components of the built environment. In addition to their functional use, they make an important contribution to local architectural styles in our cities, towns and villages. The variety of clay used gives rise to the distinctive regional variations in the appearance of the built environment.

Most facing bricks, engineering bricks and related clay-based building products, such as pipes, are manufactured in large automated factories. These represent a high capital investment in-plant and are therefore increasingly dependent on raw materials with predictable and consistent firing characteristics in order to achieve high yields of saleable products. Blending different clays to achieve improved durability and to provide a range of fired colours and textures is an increasingly common feature of the brick industry. Whilst in the past, brick clay was usually consumed in brickworks adjacent to the quarry, today substantial tonnages are transported to remote brickworks for blending purposes or to serve plants with no associated clay reserves. Continuity of supply of consistent raw materials is of paramount importance to the brick industry.

Brick clay layer subdivisions

Due to the numerous complex divisions that occur over national scale, the subdivisions for this category have been tabulated.

Table 2 Brick clay layer subdivisions

Subdivision	Location
Brick clay: Jurassic, Oxford Clay Fmn, Peterborough Mbr (no overlying superficial deposits)	Bedfordshire and Cambridgeshire
Brick clay: Jurassic, Oxford Clay Fmn, Peterborough Mbr (overlying thin or resource superficial)	Bedfordshire and Cambridgeshire
Brick clay: Alveley Mbr (extent shown in areas where the unit has been worked)	West Midlands
Brick clay: Carboniferous, Coal Measures mudstones (coincident with shallow coal)	Bath and North-east Somerset, Bristol City, Cheshire, County Durham, Cumbria, Darlington, Derbyshire, Flintshire, Gloucestershire, Greater Manchester, Hereford and Worcester, Lancashire, Leicestershire, Merseyside, North Somerset, North Yorkshire, Northumberland, Nottinghamshire, Shropshire, Somerset, South Gloucestershire, South Yorkshire, Staffordshire, Stoke-on-Trent City, Tyne and Wear, Warwickshire, West Midlands, West Yorkshire and Wrexham
Brick clay: Carboniferous, Crackington Fmn (Exeter area only), Devonian slate (Plymouth area only)	Devon
Brick clay: Carboniferous, Etruria Fmn (principal brick clay resource)	Merseyside, Greater Manchester, Staffordshire, Shropshire and Warwickshire
Brick clay: Cretaceous, Weald Clay Fmn	Surrey, Kent, West Sussex, East Sussex and Isle of Wight

Brick clay: Cretaceous, Wadhurst Clay Fmn	Surrey, Kent, West Sussex and East Sussex
Brick clay: Palaeogene, Reading Fmn (Hants only)	Hampshire
Brick clay: Quaternary, Brickearth (Faversham/Sittingbourne area, Kent and Southend areas only)	Essex and Kent
Brick clay: Quaternary, Norwich Crag Fmn, Chillesford Clay Mbr	Suffolk
Brick clay: Quaternary, Reading Fmn/Clay-with-flints (Chesham area, Bucks and Hemel Hempstead areas only)	Hertfordshire and Buckinghamshire
Brick clay: Quaternary, glaciolacustrine deposits (clay and silt)	North Yorkshire and York City
Brick clay: Quaternary, interglacial lake clay (Colchester area only)	Essex
Brick clay: Ruabon (Etruria) Fmn (Extent shown only where unit is not concealed by overburden)	Shropshire
Brick clay: Recent, alluvium/tidal flat deposits (in areas of workings only)	North Lincolnshire and East Riding of Yorkshire
Brick clay: Triassic, Mercia Mudstone Gp (principal brick clay resource Notts, Leics and Isle of Axholme, North Lincs, only)	Nottinghamshire, Leicestershire, Leicester City, North Yorkshire and East Riding of Yorkshire
Brick clay: lake deposits	Central belt of Scotland
Brick clay: common shale for brick	Central belt of Scotland
Brick clay: common shale for brick coincident with shallow coal	Central belt of Scotland
Brick clay with overburden less than 5 m	Wales

CHALK MINERAL RESOURCE DESCRIPTION

Chalk is a relatively soft, fine-grained, white limestone consisting mostly of the debris of planktonic algae. The Chalk Group is a remarkably uniform and pure form of limestone, except in its lower part, where clay is more abundant. One characteristic of parts of the Chalk Group is the presence of abundant flint nodules.

The Chalk Group is of Upper Cretaceous age and occurs extensively in eastern and southern England, where it forms an important resource of 'limestone raw materials'. Chalk and limestone are interchangeable in use where they are valued for their chemical properties such as in the manufacture of cement, as a source of agricultural lime and for many industrial applications, for example lime production. However, chalk has a lower physical strength than limestone and is used as only a minor source of crushed-rock aggregate. Certain horizons in the Chalk Group are very white and are valued as sources of ‘chalk whiting’ for a range of filler applications in paper, paints and plastics.

Chalk layer subdivisions

The northern Chalk Group is divided into five distinct formations. In ascending order these are:

- Ferriby Chalk Formation, with a red-coloured chalk at the base, which is
  - Hunstanton Formation, previously 'Red Chalk'
- Welton Chalk Formation
- Burnham Chalk Formation
- Flamborough Chalk Formation

The most obvious differences between the formations are in the occurrence of flint. The Ferriby and Flamborough Chalk formations are flint-free, while the Welton and Burnham Chalk formations are characterised by flint nodules and bands. Most of the formations contain numerous partings of calcareous mudstone (marl), which are most common in the Ferriby and Flamborough Chalk formations. Thin and widely spaced mudstone bands are a feature of the Welton and Burnham Chalk formations. The numerous mudstone partings in the Ferriby and Flamborough Chalk formations lead to higher alumina, iron and silica contents and this part of the sequence is thought to be mainly of medium purity (>93 per cent $CaCO_3$). The middle part of the sequence (the Welton and Burnham Chalk formations) is generally of higher purity (>97 per cent $CaCO_3$), although the silica content is variable depending on the flint content. The Burnham and Flamborough Chalk formations are concealed beneath superficial deposits, which thicken towards the coast. These areas are not shown as a resource. The distribution of high and low purity chalk and chalk beneath relatively thin superficial deposits are included in the mineral resources dataset.

In southern England, chalk crops out over very extensive areas and all counties have large resources. It forms the prominent features of the North and South Downs and the Chiltern Hills. Chalk mineral resource data has been divided into two categories: low purity and high purity. Low purity chalk (generally less than 93 per cent $CaCO_3$) is found in the formations of the Grey Chalk Subgroup (formerly known as the Lower Chalk). These formations tend to have a high clay content, particularly towards the base. The Grey Chalk Subgroup is up to about 75 m thick and has only a relatively narrow outcrop. High purity chalk (93–98 per cent $CaCO_3$, excluding flints) includes formations of the White Chalk Subgroup (formerly known as the Middle and Upper Chalk). Flint, occurring as nodular bands and tabular beds, is common, particularly towards the top of the subgroup. The White Chalk Subgroup is up to 450 m thick and forms a very large limestone resource.

FIRECLAY MINERAL RESOURCE DESCRIPTION

Fireclays are non-marine, sedimentary mudstones that occur as seatearths and underlie almost all coal seams. They represent the fossil soils on which coal-forming vegetation once grew and their occurrence is, therefore, mainly confined to coal-bearing strata. Fireclays are named after the overlying coal seam. The term 'fireclay' is used to describe seatearths that are of economic interest.

Fireclays were originally valued as refractory raw materials due to their high alumina and low alkali contents. However, demand for refractory use has declined markedly and little fireclay is used for this purpose today. Fireclays have relatively low iron contents compared with other brick clays. Consequently, they are now primarily valued for the production of buff-coloured facing bricks and pavers. They are often blended with red-firing brick clays to give a range of colours.

Seatearths include all grades of sediment from mudstone (seatclay) to sandstone (ganister) and are distinguished from associated sediment by the presence of rootlets and the absence or extreme interruption of bedding and the presence of highly polished (listric) surfaces.

Ganisters, or high-silica sandstones, are comparatively rare, although they were formerly worked locally for refractory use. Clay-rich seatearths (seatclays) are much more common. However, not all seatearths can be considered as commercial fireclays. Seatearths are typically thin (normally

<1 m) and there appears to be no correlation between the thickness of a coal seam and the thickness and properties of its associated seatearth.

As fireclays are closely associated with coal resources, they are mainly confined to Coal Measures strata. A characteristic feature of Coal Measures strata is the pronounced cyclicity of the sedimentation, with coal seams and seatearths appearing at irregular intervals. The occurrence of fireclays as relatively thin, widely spaced beds in close association with coal seams means that surface coal-mining operations provide one of the few viable sources of the mineral. Fireclay resources in Britain are therefore, with few exceptions, largely coincident with shallow coal resources and the supply is crucially dependent on the future of the surface coal-mining industry by making available clays that would not otherwise be economically recoverable.

Planning guidance urges the examination of the potential for fireclay recovery at proposed sites. However, only a small proportion (about 20 per cent) of surface coal mining sites normally produce fireclay. This may be due to the unsuitable quality of the fireclays or may be the result of operational or planning restrictions. The size and speed of surface mining invariably creates a mismatch between potential supply and immediate market demand. Unless marketable fireclays can be stockpiled, either on or off site, they are usually backfilled with overburden and thus irrecoverably lost.

Although fireclays occur in similar geological environments, they exhibit a wide range of mineralogical compositions and properties. They consist essentially of the clay minerals kaolinite and hydrous mica, together with fine-grained quartz in varying proportions. Typically, these three minerals make up some 90 per cent of the rock. Seatearths may exhibit rapid vertical and lateral variations in composition and thus properties. All are contaminated to a greater or lesser extent by impurities, which can render part or the whole of a seam unusable.

Siderite (iron carbonate) and carbonaceous matter present as coaly matter and fossil debris are common constituents. They may represent serious impurities in commercial fireclays and restrict use. Pyrite, which is often associated with carbonaceous material, is also an impurity.

In addition to carbon and sulphur, which should normally be less than 1.5 per cent and 0.1 per cent respectively, fired colour is the main criterion on which the suitability of a fireclay is judged for facing--brick manufacture. Iron oxide contents should normally be less than 2.5–3.0 per cent Fe_2O_3 and on firing the fireclay should give a uniform buff/cream colour. Blending does allow lower quality clay to be used but is dependent of the availability of a range of clays.

Fireclay layer subdivisions

The subdivisions for this category have been tabulated.

Table 3 Fireclay layer subdivisions

Subdivision	Location
Fireclay: Carboniferous, Coal Measures (coincident with shallow coal)	This unit is extensive, occurring coincident with brick clay and shallow coal
Fireclay: Carboniferous, Pottery Clays Mbr (principal resource)	Derbyshire and Leicestershire
Fireclay and siliceous clay: Jurassic, Rutland Fmn	Lincolnshire, Rutland, Northamptonshire and Cambridge
Ayrshire Bauxitic Clay: Carboniferous, Passage Fmn	Central belt of Scotland
Coincident with silica sand	Central belt of Scotland

FULLER'S EARTH MINERAL RESOURCE DESCRIPTION

Fuller’s earth is a rare sedimentary clay that contains a high proportion of clay minerals of the smectite group. One of the key properties of smectite is a high cation-exchange capacity, in which exchangeable cations, usually calcium (Ca) and sodium (Na), are loosely held within the clay. Depending on the dominant cation present, the clay has markedly different properties and industrial applications. Ca-smectite is the principal constituent of British fuller’s earths and those that have been worked in recent years contain 80–85 per cent Ca-smectite. A common impurity is quartz. Ca-smectite can be easily converted into Na-smectite (bentonite) by a simple sodium exchange process and most fuller’s earth is used in this form.

Fuller’s earth deposits formed as a result of the alteration of volcanic ash deposited in seawater. The accumulation and preservation of volcanic ash into sufficiently thick beds (2–3 m) to be commercially workable involves a complex set of geological processes and consequently, fuller’s earth deposits of potential economic interest have a very restricted distribution in Britain.

Fuller’s earth has had a wide range of applications in the past as a fibre and filler retention aid in papermaking systems, mainly for the export market, and as a bonding agent for foundry sand. Fuller’s earth had been produced in England since Roman times. Peak output was 216 000 dry tonnes in 1985 but declined rapidly as reserves with planning permission were depleted and not replaced. Production ceased as of 2005.

Fuller’s earth layer subdivisions

Due to the numerous complex divisions that occur over national scale the subdivisions for this category have been tabulated.

Table 4 Fuller’s earth layer subdivisions.

Subdivision	Location
Fuller's earth: Cretaceous, Lower Greensand Gp, Sandgate Fmn (Redhill area only)	Oxfordshire
Fuller's earth: Cretaceous, Lower Greensand Gp, Woburn Sands Fmn	Bedfordshire
Fuller's earth: Cretaceous, Lower Greensand Gp (Baulking/Fernham area only)	Surrey
Fuller's earth: Jurassic, Fuller's Earth Fmn (inferred extent of Fuller's Earth Rock Mbr)	Bath and North-east Somerset, Somerset and Wiltshire

GYPSUM AND ANHYDRITE MINERAL RESOURCE DESCRIPTION

Gypsum ($CaSO_4.2H_2O$) and anhydrite ($CaSO_4$) are, respectively, the hydrated and anhydrous forms of calcium sulphate. In nature, they occur as beds or nodular masses up to a few metres thick and were originally deposited from the evaporation of sea water. Gypsum is formed by the hydration of anhydrite at or near surface but passes into anhydrite generally at depths greater than 40–50 m, although this depends on local conditions. Anhydrite is therefore very much more extensive than gypsum. Gypsum is economically the most important and is extracted mainly in shallow underground mines and, locally, open pits.

Calcium sulphate is also derived as a synthetic by-product of certain industrial processes. The most important is flue gas desulphurisation (FGD), a process that removes sulphur dioxide (SO_2) from the flue gases at coal-fired power stations. The product, known as desulphogypsum, is now an important supplement to the supply of natural gypsum but cannot replace it for all uses. This synthetic gypsum has a higher purity (gypsum content of 96 per cent) than most natural gypsum (80 per cent) in England. However, some very high purity, natural gypsum does occur in Nottinghamshire. The amount of natural gypsum extracted in Britain has declined appreciably in recent years due to the availability of substantial amounts of desulphogypsum derived from FGD plants.

When gypsum is ground to a powder and heated at 150–165° C, three-quarters of its combined water content is removed to produce hemi-hydrate plaster ($CaSO_4.1/2H_2O$), commonly known as 'Plaster of Paris.' When this powder is mixed with water, the resulting paste will set hard as a result of the water recombining to produce gypsum again. The most important applications of gypsum are, therefore, in the production of plaster and plasterboard and the mineral forms the basis of a large industry producing a range of building products. In contrast, anhydrite has more limited uses but large quantities of a gypsum/anhydrite mixture are used as a retarder in the manufacture of cement.

Gypsum is used principally in the manufacture of plaster and plasterboard. A mixture of gypsum/anhydrite is also used in the production of cement; an addition of about 5% being made to retard the setting time of the cement.

High-purity gypsum is used to produce special plasters, for example for use as plaster moulds in the pottery industry and for surgical and dental work. Small quantities of high-purity gypsum are also used in confectionery food, the brewing industry, pharmaceuticals, in sugar-beet refining, as cat litter and as an oil absorbent.

Anhydrite layer subdivisions

Anhydrite is present at depth under much of north-east England, throughout the area to the east of the Permian crop, and occurs at several horizons. In ascending order these are:

- Hartlepool Anhydrite Formation
- Billingham Anhydrite Formation
- Sherburn (Anhydrite) Formation

The Hartlepool Anhydrite Formation, which is up to 150 m thick, occurs near the surface in the Hartlepool area and its conjectured western limit and subsurface extent is defined. The Billingham Anhydrite and the Sherburn (Anhydrite) formations are much thinner but more uniform in thickness and extent.

The Billingham Anhydrite Formation has been of considerable economic importance in the past as a source of sulphur for the manufacture of sulphuric acid and ammonium sulphur for fertiliser; its conjectured western limit and subsurface extent is defined. It was formerly extensively mined on Teesside and between 1923 and 1955 virtually all UK production of anhydrite was derived from the area. Anhydrite is no longer of economic importance as a source of sulphur.

Gypsum layer subdivisions

Due to the numerous complex divisions that occur over national scale the subdivisions for this category have been tabulated.

Table 5 Gypsum and anhydrite layer subdivisions.

Subdivision	Location
Gypsum-bearing host rock: Jurassic, Purbeck Gp	East Sussex
Gypsum: Permian, Eden Shale Fmn/St Bees Shale Fmn A Bed outcrop	Cumbria
Gypsum: Permian, Eden Shale Fmn/St Bees Shale Fmn B Bed outcrop	Cumbria
Gypsum: Permian, Eden Shale Fmn/St Bees Shale Fmn C Bed outcrop	Cumbria
Gypsum: Permian, Eden Shale Fmn/St Bees Shale Fmn D Bed outcrop	Cumbria
Gypsum: Permian, extent of Eden Shale Fmn/St Bees Shale Fmn	Cumbria
Gypsum: Triassic, Mercia Mudstone Gp, Cropwell Bishop Formation (inferred extent of Tutbury Gypsum and Newark Gypsum)	Nottinghamshire, Leicestershire and City of Leicester
Gypsum: Triassic, Tutbury Gypsum	Staffordshire

IGNEOUS ROCK MINERAL RESOURCE DESCRIPTION

Igneous rocks were formed by solidification of molten rock or magma either at or below the Earth's surface. They may be classified as either intrusive, formed from molten rock solidified below the Earth's surface, or extrusive (volcanic), formed from lava or volcanic ash (tuff) erupted at the Earth's surface. Igneous rocks are used almost entirely as sources of construction aggregate and, to a much lesser extent, as building stone. Location relative to markets is an important factor with respect to resource potential. In some parts of Britain, notably Scotland, igneous rocks are abundant but remote from markets. These resources have little economic potential unless at coastal locations with seaborne access.

Igneous rocks are important sources of crushed-rock aggregates. They are valuable for roadstone, including skid-resistant road surfacing aggregate in all but the most demanding sites, and for railway track ballast. Igneous rocks are also used for concrete aggregate, particularly where alternatives such as gravel and limestone are absent. Their suitability for aggregate use depends mainly on fabric and texture (mineral grain size), together with the degree of alteration or weathering they have undergone. In general, intrusive igneous rocks tend to be more consistent in quality for aggregate production. Smaller intrusive bodies, which are typically composed of finer-grained rocks, are usually the preferred source and more widely worked. Some igneous rocks have been metamorphosed, which improves their strength.

Igneous rock layer subdivisions

Due to the numerous complex divisions that occur over national scale the subdivisions for this category have been tabulated.

Table 6 Igneous rock layer subdivisions.

Subdivision	Location
Charnian (minor intrusives and volcanics)	Warwickshire
Diorites hosted by Stockingford Shale Gp	Warwickshire
Dolerite (Whin Sill)	Cumbria and Northumberland
Extrusive (lavas, tuff and volcanic ash)	Somerset, Shropshire and Hereford and Worcester
Felsite dykes	Northumberland, Devon and Cornwall
Granite	Devon and Cornwall
Granite-diorite, Malvern Complex	Gloucestershire and Hereford and Worcester
Igneous intrusive, dolerite	Shropshire, West Midlands, Hereford and Worcester and Derbyshire
Intrusive and volcanic rocks, Precambrian/Cambrian	Leicestershire
Intrusive rocks: acid and intermediate rocks, mainly granitic and diorites	Cumbria
Intrusive rocks: basic rocks, mainly gabbro and dolerite	Cumbria
Mafic igneous rock (intrusive and extrusive)	Devon and Cornwall
Minor intrusives, Ercall Granophyre	Shropshire
Minor intrusives, porphyritic felsite	Shropshire
Stockingford Shale Gp (host for diorite in Warwickshire)	Warwickshire
Thermally altered (hornfels) rocks	Cumbria
Ultramafic rock	Cornwall
Volcanic (extrusive) rocks: Borrowdale Volcanic Gp, mainly andesite, tuff and volcanic sandstone	Cumbria
Volcanic (extrusive) rocks: Eycott Volcanic Gp, mainly andesite	Cumbria
Quartz-dolerite sills and dykes (Midland Valley Sill Complex)	Central belt of Scotland
Alkali dolerite	Central belt of Scotland
Olivine-dolerite sills and felsic intrusions	Central belt of Scotland
Other igneous rocks, including basalts, trachytes, andesites, dolerites and associated intrusions	Central belt of Scotland
Dolerite intrusions with potential for high-specification aggregate	Wales
Other igneous rocks including basalts, felsites, gabbros, tuffs and granites	Wales

KAOLIN MINERAL RESOURCE DESCRIPTION

China clay or kaolin is a commercial clay composed principally of the hydrated aluminosilicate clay mineral kaolinite. The commercial value of kaolin is based on the mineral's whiteness and its fine but controllable particle size, which may be optimised during processing. Particle size affects fluidity, strength, plasticity, colour, abrasiveness and ease of dispersion. Other important properties include its flat particle shape, which increases opacity or hiding power, its soft and non-abrasive texture, due to the absence of coarser impurities, and its chemical inertness. These key properties distinguish kaolin from the other kaolinitic clays produced in Britain, such as ball clay and fireclay. The kaolinite content of processed kaolin varies, but is generally in the range 75–94 per cent.

Kaolin resources in Britain are confined to the granites of south-west England. The deposits are world famous for their size and quality and have yielded some 164 million tonnes of marketable product since production began in the mid-18th century. The industry is of regional and national importance.

All the main granite intrusions have been worked to a limited extent in the past, but production has historically principally been based on the St Austell Granite and the south-western margin of the Dartmoor Granite. The St Austell Granite is by far the most important source, accounting for nearly 90 per cent of total sales, which were around one million (dry) tonnes in 2009. Of total sales, around 90 per cent are exported. Minor production from the Land's End Granite ceased in 1991 and from the Bodmin Granite in 2001.

The kaolin deposits were formed by the in situ alteration of the feldspar component of the granites. The kaolinisation process involves the decomposition of feldspar by hydrothermal fluids and surface weathering to form kaolinite and mica. Most other minerals are largely unchanged by this process. Extraction and processing consist essentially of separating the fine-grained kaolinite from the coarser, unaltered material, a process that results in large quantities of mineral waste. Some of this material is being sold for aggregate use.

Kaolin has a range of uses but by far the most important, accounting for about 70 per cent of total sales, is in papermaking. The kaolin performs two quite separate functions, as a paper filler and as a coating pigment. The ceramics industry is the second most important market. Kaolin is also used as a filler in paint, rubber and plastics.

The St Austell Granite covers an area of about 93 km^2 and is extensively kaolinsed in the central and western parts over an area of about 63 km^2. The western part of the St Austell Granite has traditionally supplied ceramic clays, the central part paper-coating clay and the eastern part filler clays. Blending and improved processing technology now make this statement an oversimplification.

In Devon, kaolin resources are confined to the extreme south-western margin of the Dartmoor Granite and on the adjacent but separate Cornhill Down Granite. Kaolinisation has been intense and there is a higher proportion of sand and less rock than in the St Austell Granite. The kaolin has a lower iron and higher potash content than in Cornwall and a large proportion of sales are used in ceramics, paints, plastics and rubber than in Cornwall. There is also a significant output of calcined kaolin, for which the clays are well suited. Recently, dry mining has been introduced in the Devon operations, which allows for more selective extraction and improved yields than traditional hydraulic mining.

Planning permissions for kaolin extraction are more extensive as they also include land allocated for tipping. In Devon, the projected life of the permitted reserves exceeds those in Cornwall. However, a critical factor is the availability of tipping space for the large quantities of sand and rock produced. Reserves will be constrained unless current sales of these wastes as aggregates increases very substantially.

The kaolinisation is adjacent to and extends into the Dartmoor National Park. In 2001, IMERYS Minerals and WBB Minerals announced that they were to relinquish their permissions in the park because of the impact that would have on a sensitive area. This has been carried out.

Kaolin layer subdivisions

Two classes of kaolin resources have been distinguished in the data. The principal resource areas are those where economic deposits are known to occur and where detailed exploration and evaluation have been undertaken by the industry. They are generally coincident with current production areas and where future working will occur. Inferred resources are those areas where the industry believes that deposits may occur. They include areas that have been worked in the past, but the industry has no current plans to undertake further extraction in these areas. Small areas of kaolinisation, for example on the Dartmoor Granite, are not shown.

LIMESTONE MINERAL RESOURCE DESCRIPTION

Limestones are sedimentary rocks consisting principally of calcite ($CaCO_3$). With an increase in magnesium carbonate content ($MgCO_3$) they grade into dolomite ($CaMg(CO_3)_2$). Chalk is a particular type of soft, white, fine-grained limestone that, in Britain, is of Cretaceous age.

England and Wales are well endowed with limestone resources of different geological ages, their relative economic importance being based mainly on their thickness, extent, strength and consistency, and the location of outcrops with respect to major centres of demand. Some limestones are also highly valued for their chemical purity (>97 per cent $CaCO_3$). Dolomite has a more restricted distribution but is also valued for its magnesia (MgO) content.

Limestones, notably limestones of Carboniferous age, are the principal source of crushed-rock aggregate in Britain. Limestone is generally easy to quarry and, being relatively soft, does not consume as much energy to crush or cause the same degree of abrasion on plant as other rock types. It is therefore the material of choice for most general-purpose aggregate applications, such as concrete aggregate and roadstone. However, because of its poor resistance to polishing, it is unsuitable for use as a road surfacing aggregate on all but minor roads. Limestones, again mainly limestones of Carboniferous age, are also the principal source of lime (CaO) used in cement manufacture and a wide range of industrial applications.

Limestone layer subdivisions

Due to the numerous complex divisions that occur over national scale the subdivisions for this category have been tabulated.

Table 7 Limestone rock layer subdivisions.

Subdivision	Location
Concealed limestone: early Carboniferous (East Kent)	Kent
Dolomite and dolomitic limestone: Carboniferous	Bristol City, Derbyshire, Gloucestershire, Hereford and Worcester, Leicestershire, Monmouthshire, North Somerset, Nottinghamshire, Somerset, South Gloucestershire, South Yorkshire and Staffordshire
Dolomite and dolomitic limestone: Permian, Cadeby and Brotherton formations (‘Magnesian Limestone’)	County Durham, Darlington, Derbyshire, North Yorkshire, Nottinghamshire, South Yorkshire and West Yorkshire
Dolomite and dolomitic limestone: Permian, lower ‘Magnesian Limestone’	County Durham, Darlington, Derbyshire, North Yorkshire, Nottinghamshire, South Yorkshire and West Yorkshire
Dolomite and dolomitic limestone: Permian, middle ‘Magnesian Limestone’	County Durham, Darlington, Derbyshire, Hartlepool, North Yorkshire, Stockton-on-Tees and Tyne and Wear

Dolomite and dolomitic limestone: Permian, upper 'Magnesian Limestone'	County Durham, Darlington, Derbyshire, Hartlepool, North Yorkshire, Stockton-on-Tees and Tyne and Wear
Ironstone: Jurassic, Marlstone Rock Fmn	Oxfordshire and Warwickshire
Limestone with interbedded mudstone: Silurian (and some Carboniferous)	Gloucestershire, Herford and Worcester, Shropshire, Staffordshire and West Midlands
Limestone: Carboniferous	Bath and North-east Somerset, Bristol City, County Durham, Cumbria, Derbyshire, Devon, Gloucestershire, Hereford and Worcester, Lancashire, Monmouthshire, North Somerset, North Yorkshire, Northumberland, Somerset, South Gloucestershire and Staffordshire, Wales
Limestone: Carboniferous, concealed (inferred extent)	Cambridgeshire
Limestone: Carboniferous, high purity (>97% $CaCO_3$)	Bath and North-east Somerset, Bristol City, County Durham, Cumbria, Gloucestershire, Lancashire, Monmouthshire, North Somerset, North Yorkshire, Somerset, South Gloucestershire, Staffordshire and Wales
Limestone: Carboniferous, very high purity (>98% $CaCO_3$)	Derbyshire and Staffordshire
Limestone: Cretaceous, Hythe Formation ('Kentish Rag')	Kent
Limestone: Devonian	Devon
Limestone: Jurassic	Bath and North-east Somerset, Bedfordshire, Bristol City, Buckinghamshire, Cambridgeshire, Dorset, Gloucestershire, Hereford and Worcester, Lincolnshire, Milton Keynes, North Somerset, Northamptonshire, Oxfordshire, Somerset, South Gloucestershire, Swindon, Warwickshire and Wiltshire
Limestone: Jurassic, Blue Lias Fmn (eastern extent inferred)	Bath and North-east Somerset and Somerset
Limestone: Jurassic, Lincolnshire Limestone Fmn/Malton Oolite Mbr (in N Yorks)	Lincolnshire, North Lincolnshire, East Riding of Yorkshire and North Yorkshire
Limestone: Jurassic, Portland Stone Fmn and Todber Freestone Mbr	Dorset
Limestone: Jurassic, Purbeck Gp	Dorset
Limestone: Oligocene, Bembridge Limestone Fmn	Isle of Wight
Limestone: Carboniferous, Lower and Upper Limestone fmns	Central belt of Scotland
Other limestone	Wales

OIL SHALE MINERAL RESOURCE DESCRIPTION

Oil shale is a term to define a fine-grained sedimentary rock with a high enough organic content to make it possible to extract hydrocarbons. This extraction is energy intensive, so any deposits have to be sizeable. Oil shale was worked exclusively in parts of the central belt of Scotland until the early 1960s. Since then no working has occurred, however the waste tips left behind have been explored for secondary minerals.

PEAT MINERAL RESOURCE DESCRIPTION

Peat is an unconsolidated deposit of compressed plant remains in a water-saturated environment. There are two fundamental types of peatland in Britain: fens and bogs. Fens occur in waterlogged situations where the plants receive nutrients in water from the surrounding catchments as well as rainfall. Bogs occur in areas that are largely dependent on rainfall for the supply of water. Bog vegetation is characterised by acid-tolerant plant communities in which the genus *Sphagnum* is the dominant component.

The two main types of bog are:

- raised: characteristic of flat topography and found on low plains or broad valley floors
- blanket: occur mainly in upland areas where conditions are suitably cool and wet

Commercial peat extraction, almost all of which is used as a growing medium, is from raised bogs. Many lowland raised bogs have been designated as sites of international and national nature-conservation importance.

POLYHALITE MINERAL RESOURCE DESCRIPTION

Polyhalite is a hydrated potassium/magnesium sulphate. It is related to potash in terms of the geological setting it is found in and its applications (see Potash mineral resource description).

Polyhalite is found at depth onshore and offshore north-east England in the same sequence as the Boulby Potash Member and in thick deposits from the Fordon Evaporite Formation, which underlies the Boulby Halite, occurring in a broad swathe across Yorkshire from the Tees to the Humber estuary. Polyhalite is currently extracted from the Boulby Mine in the North York Moors National Park. Sirius Minerals' York Potash project within NYMNP proposes extraction of principally polyhalite.

POTASH MINERAL RESOURCE DESCRIPTION

'Potash' is a generic term for a variety of potassium-bearing minerals and refined products. There are many potassium-bearing minerals but only those that are water-soluble are of significant commercial interest. Sylvine (potassium chloride, KCl) is by far the most important worldwide, because of its solubility and high potassium content, and has accounted for all the potash produced in the UK to date.

Potassium minerals rarely occur in the pure form and the mined material is invariably a physical mixture of salts. Sylvinite is a mixture of sylvine and halite (rock-salt, NaCl) in varying proportions and this is the material mined in the UK. Potash does not crop out at the surface because of dissolution by groundwater and, in the UK, deposits only occur at depths in excess of 800 m.

Potassium (K) is one of the three primary nutrients essential for plant growth (the others being nitrogen and phosphorus). Most UK potash production is consumed in the manufacture of fertilisers. Smaller quantities are also used by the chemical and pharmaceutical industries. Potassium oxide (K_2O), a compound not found in nature, is the basis for comparing all potassium compounds. Marketable potassium chloride contains about 60 per cent K_2O.

In the last 25 years, Britain has emerged as a significant world producer of potash with the development of the Boulby Mine at Loftus. The Boulby mineshaft and associated facilities, although situated within Redcar and Cleveland region, sits within the North York Moors National Park, which is also the local Mineral Planning Authority. Much of the southern mining area is also located within the national park and falls in the Yorkshire and the Humber region. However, the northern mining area extends into Redcar and Cleveland and the eastern mining district extends out beneath the sea. Potash mining began in 1973 but has now ceased with the focus on polyhalite extraction. Rock-salt is also produced as a by-product.

Potash of current economic interest occurs as the Boulby Potash Member, which occurs at the top of the Permian Boulby Halite. The subsurface extent of the Boulby Potash Member and its conjectured western limit is defined. The bed dips at a shallow angle from north-west to south-east and occurs at depths of over 1200 m in southern onshore areas and 800 m offshore. It averages 7.5 m in thickness, ranging from zero to over 20 m. The bed consists of sylvinite with minor clay minerals and anhydrite, and traces of other minerals. The potash bed is of high grade by international standards, with a mean KCl content of 34 per cent (21 per cent K_2O). However, grade varies both vertically and laterally.

SALT MINERAL RESOURCE DESCRIPTION

Salt (sodium chloride, NaCl), occurs in nature in solid form as rock-salt (halite) or in solution as brine. Rock-salt occurs in beds, commonly associated with mudstone, ranging from a few centimetres up to several hundred meters in thickness. The purity of individual salt beds depends on the extent of mudstone interbedding. Salt-bearing strata may underlie extensive areas, but does not crop out at the surface because of dissolution by groundwater, which produces natural brine. Brine may also be produced artificially by injecting water into salt beds and pumping out the resultant brine. The boundary at which salt dissolution takes place is called the ‘wet-rockhead.’ Where salt-bearing strata are too deep to be affected by groundwater, the normal contact between the salt and overlying rock is known as ‘dry-rockhead’.

Rock-salt is extracted by underground mining, for use principally in de-icing roads, and by controlled brine pumping, for use as a chemical feedstock and in the manufacture of white salt. Natural brine pumping has, in the past, resulted in extensive subsidence at the surface. Modern methods of brine extraction do not cause subsidence.

SANDSTONE MINERAL RESOURCE DESCRIPTION

Sandstones are sedimentary rocks consisting of sand-sized particles composed predominantly of quartz, with variable amounts of feldspar and rock fragments, set in a fine-grained matrix or cement. Sandstones of various geological ages occur extensively throughout Britain but differ widely in their thickness and physical properties, such as strength, durability and porosity, and thus resource potential. Sandstones have traditionally been valued as sources of building stone but in some parts of the country they are also important sources of crushed-rock aggregate.

The suitability of a sandstone for aggregate use depends mainly on its strength and durability. Variations in the aggregate properties (and thus aggregate potential) of sandstones are related to differences in composition, grain size, texture, burial history and tectonic setting, metamorphism and weathering. Individual sandstone units also vary in thickness and lateral extent. Strength depends on post-depositional and/or metamorphic history, as well as degree of weathering. In general, geologically older, more indurated sandstones exhibit higher strengths. Many types of sandstone are too porous and weak to be used other than as sources of constructional fill.

Compositional differences, both of the sand grains and the matrix, give rise to a range of rock names under the general heading ‘sandstone.’ Hard sandstones containing mineral and rock fragments cemented in a clay matrix are known as greywackes. These are particularly valued as sources of high-quality, skid-resistant aggregates for road surfacing and are the premium products of the crushed-rock aggregate industry. This is because the variation in hardness between the constituent grains, and between grains and the matrix, results in a high degree of surface roughness.

Sandstone layer subdivisions

Due to the numerous complex divisions that occur over national scale the subdivisions for this category have been tabulated.

Table 8 Sandstone rock layer subdivisions.

Subdivision	Location
Sandstone with potential for high specification aggregate: Ordovician and Silurian, Kirkby Moor Fmn, Coniston Gp and Wray Castle Fmn	Cumbria
Sandstone: Cambrian, Ordovician quartzites	Hereford and Worcester, Shropshire, Warwickshire and West Midlands
Sandstone: Carboniferous, Cromhall Sandstone Fmn and Grovesend Fmn	Gloucestershire
Sandstone: Carboniferous, Millstone Grit Gp and Coal Measures	Cheshire, Derbyshire, Greater Manchester, Lancashire, Leicestershire, Merseyside, North Yorkshire, South Yorkshire, Staffordshire, Shropshire and West Yorkshire
Sandstone: Devonian and Carboniferous sandstone-bearing strata	Devon, Cornwall and Somerset
Sandstone: Lower Cretaceous, Carstone Fmn	Norfolk
Sandstone: Precambrian, Ordovician, Silurian greywacke	Shropshire
Sandstone: Triassic, Sherwood Sandstone Gp (building stone)	Shropshire
Building stone: sandstone	Central belt of Scotland
Quartz conglomerate (Douglas Muir Quartz-conglomerate Mbr)	Central belt of Scotland
Greywacke sandstone	Central belt of Scotland
Sandstone with potential for high specification aggregate	Wales
Sandstone and conglomerate beneath overburden less than ten metres	Wales
Interbedded sandstones and mudstones (only on GIS)	Wales

SLATE MINERAL RESOURCE DESCRIPTION

The term ‘slate’ is applied to rocks that can be readily split, or cleaved, into thin sheets or slabs suitable for roofing or other architectural purposes. Slate is most commonly developed from fine-grained sedimentary rocks, such as mudstones, which have developed a well-marked slaty cleavage due to the crystallisation and realignment of platy minerals within the rock mass. It is along this cleavage that the rock can be split, thus giving it its economic importance. Bodies of slate generally have a restricted occurrence within more extensive masses of less-perfectly cleaved rock, which accounts for the large tips of waste commonly associated with the slate industry.

Slate layer subdivisions

Due to the numerous complex divisions that occur over national scale the subdivisions for this category have been tabulated.

Table 9 Slate layer subdivisions.

Subdivision	Location
Roofing slate resource areas (Cornwall only)	Cornwall
Slate: Lakeland blue-grey slate (Windermere Sgp)	Cumbria
Slate: Lakeland green slate (Borrowdale Volcanic Gp)	Cumbria
Potential slate resource with recorded workings (only on GIS)	Wales
Slate	Wales
Slate waste	Wales

VEIN MINERALS RESOURCE DESCRIPTION

The term 'vein minerals' refers to mineralisation by hydrothermal fluids depositing a range of metallic and industrial minerals during metamorphic processes. The extent of vein minerals shown by this dataset is limited to lead ore (galena), fluorspar (fluorite) and barium ore (barytes) in locations where they occur at surface and have been extensively mined, namely the Southern Pennine Orefield in Derbyshire and the Northern Pennine Orefield around Teesdale, County Durham.

Vein minerals are defined by major mapped veins for geological mapping purposes. In the Southern Pennine Orefield, veins are not differentiated, however in the Northern Pennine Orefield veins have been subcategorised into those that are fluorspar-dominated and those which are barytes-dominated.

Appendix 4 Mineral resources colour sheet

See separate excel file.

Glossary

Term	Explanation
Aggregates	A range of generally hard, granular, mineral substances, which are suitable for use either on their own or with the addition of cement, lime or a bituminous binder in construction. Examples include sand, gravel, crushed rock, stone or artificial substances such as slag.
Alluvial deposits	Deposits of sediment, such as sand and gravel, transported and deposited by a river.
ArcGIS	Geographic information system (GIS) software for working with maps and geographic information, maintained by the Environmental Systems Research Institute (ESRI).
Beneficiation	The process of concentration of the valuable components of an ore or other mineral commodity. It may include multiple stages such as crushing, grinding, washing, screening, flotation, roasting, etc.
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 geology’.
Britpits	An abbreviation of British Pits, and the word 'pits' is used here to include both surface and underground mineral workings. The BGS Britpits database holds information for mines, quarries, oil wells, gas wells, ash and desulphogypsum plants. Details include names; geographic location; address; operator; mineral planning authority; geology; mineral commodities produced, and end uses, where known.
Building stone	Naturally occurring rocks of igneous, sedimentary or metamorphic origin that are sufficiently consolidated to enable them to be cut or shaped into blocks or slabs for use as walling, paving or roofing materials in the construction of buildings and other structures. The principal building stones include igneous rocks (such as granite) and massive-bedded sandstones, limestones and metamorphic rocks (such as marble and slate). Also known as dimension stone.
Ball clay	A clay, comprising mainly kaolinite, which is valued for its white-firing properties and plasticity in the manufacture of ceramics.
Chalk	A sedimentary rock formed from the accumulation of the shells of marine microorganisms composed of calcium carbonate.
Coal	A combustible sedimentary rock made of lithified plant remains.
Central belt of Scotland	Defined in this dataset as: City of Edinburgh, City of Glasgow Clackmannanshire, East Ayrshire, East Dunbartonshire, East Lothian, East Renfrewshire, Falkirk, Fife, Inverclyde, Midlothian, North Ayrshire (excluding islands), North Lanarkshire, Renfrewshire, South Ayrshire, South Lanarkshire, West Dunbartonshire and West Lothian.
Development plan documents	In England, the development plan for an area is made up of development plan documents (DPDs). They are spatial planning documents that are subject to independent examination. Collectively

	they are known as the 'Local Plan'. Local authorities use the policies in DPDs to guide development decisions.
Digital mapping	A method of preparing maps in which the data is stored in a computer for ease of access and updating.
Digitisation	The process of converting information into the digital codes stored and processed by computers. In geographic applications, digitising usually means tracing map features into a computer using a digitising tablet, graphics tablet, mouse or keyboard cursor.
Dimension stone	See Building stone.
Environmental designations	Areas that have been defined by their environmental importance in the planning process, such as National Parks, Areas of Outstanding Natural Beauty, Sites of Special Scientific Interest, etc.
Evaporite	A sedimentary rock composed mainly of minerals produced by evaporation, normally from an enclosed body of sea water or a salt lake. Minerals formed in this way include gypsum, rock-salt and various nitrates and borates.
Fluvial	Sedimentary deposits consisting of material transported by, suspended in, and laid down by a river or stream.
Fluorspar	The commercial name for the mineral fluorite, a common mineral comprising, when pure, 51.1 per cent calcium and 48.9 per cent fluorine.
Glaciofluvial	Sediments laid down primarily by waters issuing from ice sheets and glaciers. The source of the water also includes rainfall and run-off from ice-free slopes as well as melting ice. Deposits consist mainly of sand and gravel, but include silt, clay and diamicton (unsorted to poorly sorted material containing particles ranging in size from clay to boulders, suspended in a matrix of mud or sand).
Igneous	One of the three main groups of rocks on Earth. They have a crystalline texture and appear to have consolidated from a silicate melt (magma or lava).
Indicated resource	Economic mineral occurrences that have been sampled to a point where an estimate has been made, at a reasonable level of confidence, of their contained metal, grade, tonnage, shape, densities and physical characteristics.
Industrial Mineral Assessment Unit	This research programme at BGS that mapped sand and gravel resources for selected areas between 1968 and 1990, categorising areas based on borehole analysis, particle-size assessment and mapping.
Inferred resource	The part of a mineral resource for which tonnage, grade and mineral content can be estimated with a low level of confidence. It is inferred from geological evidence and assumed, but not verified, geological and/or grade continuity.
Kaolin	Group of pale-coloured clay minerals. In the UK, kaolin is an industrial mineral extracted from kaolinised granites in south-west England. It is used as a paper filler and coater and for high-grade ceramics and pottery (china clay).
Limestone	Any sedimentary rock consisting mostly of carbonates (calcite and/or dolomite).

Lithological units	A rock identifiable by its general characteristics of appearance (colour, texture and composition) defined by the distinctive and dominant, easily mapped and recognisable petrographical or lithological features that characterise it.
Local Plan	In England, the development plan for an area is made up of development plan documents known collectively as the 'Local Plan'. It is a plan for the future development of the local area drawn up by the Local Planning Authority in consultation with the community. Each document may contain strategic or non-strategic policies, or a combination of the two. Broad locations for development are shown on key diagrams and a policies map shows land-use designations and allocations reproduced from or based on an Ordnance Survey map. Local authorities use the policies in a Local Plan to guide development decisions on planning applications.
Local Development Plan	A term used in both Wales and Scotland, Local Development Plans (LDPs) contain locally specific policies to explain or develop national/regional policy further and to take forward local priorities for action. Local authorities use the policies in an LDP to guide development decisions on planning applications.
Measured resource	Indicated resources that have undergone enough further sampling that a 'competent person' (defined by the norms of the relevant mining code; usually a geologist) has declared them to be an acceptable estimate, at a high degree of confidence, of the grade (or quality), quantity, shape, densities and physical characteristics of the mineral occurrence.
Mineral deposit	A natural concentration of minerals or bodies of rock that are, or may become, of potential economic interest for extraction of a commodity. They have chemical and/or physical properties that make them suitable for specific uses and are present in sufficient quantitates to be of economic interest.
Mineral Planning Authorities (MPA)	The planning authority responsible for planning control of minerals development. This may typically be county councils or unitary authorities.
Mineral safeguarding	A mechanism by which mineral resources can be 'protected' (in a similar way to the protection afforded to environmental and cultural assets or prime agricultural land) to ensure supplies for the future. Mineral resources are finite and can only be worked where they occur. Increased land-use pressure in the UK can result in mineral resources becoming sterilised (through restricted access) by other forms of development. When included in the planning process, mineral safeguarding can help avoid unnecessary sterilisation by providing a mechanism that allows for the consideration of mineral resources in the decision-making balance.
Mineral to waste ratio	The ratio of mineral extracted compared to waste produced, a key factor in determining whether some types of mineral deposits are economic.
Mudstone	Fine-grained sedimentary rocks that are similar to shales in their non-plasticity, cohesion and low water content, but lack fissility.
Non-renewable resources	A natural substance that is not replenished with the speed at which it is consumed. It is a finite resource.

Overburden	Rock or soil overlying a mineral deposit, which must be removed to access the deposit.
Permitted reserves	Mineral deposits with the benefit of planning permission for extraction that are also economic to extract.
Planning application	The process of applying for planning permission for development.
Planning permission	Formal approval sought from a council, often granted with conditions, allowing a proposed development to proceed. Permission may be sought in principle through outline plans, or be sought in detail through full plans.
Quarrying (surface mining)	The extraction of rock from an open pit site.
Sandstone	A clastic sedimentary rock made of detrital rock grains.
Scale	Describes the relationship between distance on the ground and distance on a map. At 1:50 000 scale, 500 m on the ground equals 1 cm on the map.
Sediments	Silt, sand, rocks, fossils and other matter carried and deposited by water, wind or ice.
Topography	The physical features of the Earth. A topographical map’s principal purpose is to portray and identify the features of the Earth. These features might include the cultural landscape, but normally refer to the terrain and its relief.
Workings	The current or past underground or surface openings and tunnels of a mine. More specifically, the area where the ore has been extracted.

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The 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.

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