British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

User Guide Mining Hazard (not including coal) version 7

Open Report OR/15/039

BRITISH GEOLOGICAL SURVEY

OPEN REPORT OR/15/039

User Guide Mining Hazard (not including coal) v7

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BRITISH GEOLOGICAL SURVEY

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This report describes the national scale Mining Hazard not including coal version 7 data. The methods used to create the dataset have been evaluated and deemed fit for purpose by specialists in BGS.

This User Guide describes the data outlines why it was created; its potential uses and provides advice on using the dataset.

1 Introduction

Founded in 1835, the British Geological Survey (BGS) is the world's oldest national geological survey and the United Kingdom's premier centre for earth science information and expertise. The BGS provides expert services and impartial advice in all areas of geoscience. Our client base is drawn from the public and private sectors both in the UK and internationally.

Our innovative digital data products aim to help describe the ground surface and sub-surface across Great Britain. These digital products are based on the outputs of the BGS survey and research programmes and our substantial national data holdings. This data coupled with our in-house geoscientific knowledge are combined to provide products relevant to a wide range of users in central and local government, insurance and housing industry, engineering and environmental business, and the British public.

Further information on all the digital data provided by the BGS can be found on our website at http://www.bgs.ac.uk/products/geohazards/ or by contacting:

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2 About the Mining Hazard (not including coal)

Underground extraction of minerals and rocks has taken place in Britain for more than 5000 years. A variety of raw materials have been extracted, ranging from precious metals such as gold and silver, building materials including limestone, sandstone, slate, industrial minerals e.g. gypsum, salt and potash and many more. Mining has been both surface and underground and the voids resulting from past underground mining activity could pose a possible hazard.

The Mining Hazard (not including coal) data draws together a diverse range of information derived from a variety of sources. The geology (bedrock and superficial) forms the primary constraint on distribution; this data is drawn from DiGMap-GB50 version 7 (the digital geology of Great Britain). Additional information has been sourced by literature searches identifying historic locations of former workings and from in-house experts. The information from these various sources has been assembled, interpreted and compiled to produce a single digital dataset indicating the geographic location and spatial extent of former mine workings.

Mining of coal is specifically excluded from this dataset and associated enquiries on past coal mining should be directed to the Coal Authority. This includes other commodities, such as iron ores, ganister and clays, produced from the working of some coal mines.

The data is stored in an ESRI shapefile format with information relating to individual polygons stored in an attribute table. The structure and content of this table is described in section 2.4.

2.1 BACKGROUND

Public understanding of the effect of ground conditions to the safety of their property and the implications for the value of their property is growing. Local councils are under increasing pressure from central government to provide environmental information. Information about geological and anthropogenic hazards is needed, in particular, the identification of areas with a potential for ground movement.

In response to this, The BGS initiated a development programme to produce datasets that identified and assessed potential geohazards that threaten the human environment in Great Britain. The mining hazard (not including coal) maps the distribution of our historical mining legacy and forms part of a comprehensive suite of geohazard datasets. Other datasets generated by the BGS development programme are:

- Six ground stability hazard datasets (GeoSure)
  - collapsible deposits, compressible ground, soluble rocks, running sand, landslides, shrink-swell;
- Superficial deposit thickness models;
- Scans of onshore borehole logs for Great Britain;
- Scans of geology and historic topography maps;
- Ground permeability data;
- Susceptibility to groundwater flooding;
- Geological indicators of past flooding
- Radon potential;
- Soil chemistry;
- Soil parent material.

2.2 WHO MIGHT REQUIRE THIS DATA?

The Mining Hazard (not including coal) data provides essential information for planners and developers working in areas where former underground mine workings may have occurred.

Our mining legacy may lead to financial loss for anyone involved in the ownership or management of property, including developers, householders and local government. These costs could include increased insurance premiums, depressed house prices and, in some cases, engineering works to stabilise land or property.

Equipped with knowledge about potential occurrences, preventative measures can be put in place to alleviate the impact on people and property. The cost of such prevention may be very low, and is often many times lower than the repair bill following ground movement.

2.3 WHAT THE DATASET SHOWS?

The dataset provides information on the areas where past underground (non coal) mining has occurred. The presence of former underground workings, particularly where shallow, may collapse and cause surface settlement. These areas represent areas where underground voids may have been left as a consequence of past underground mining activity, and provide an assessment of the likelihood of the existence of such mining.

The data is divided into six classes which are used to indicate different degrees of likelihood of the existence of past underground non-coal mining so that an informed judgement can be made of the vulnerability to ground movement.

The defined mining areas are based on a combination of geological factors relating to the known distribution of mineral veins, building stones and other commodities known to have been mined. This data is supplemented by information on known and suspected locations of workings.

It should be noted that this is not an assessment of mining instability but it does identify the likelihood of past non-coal mining at any particular location.

The data does not attempt to classify the risk of instability; and, even where undermined, the workings may be stable and therefore either present no risk of subsidence, or be at such a depth that even if collapse has occurred, the surface will not be affected. The user is advised to seek further advice on the existence of known workings and, if present, their potential impact on surface stability.

Stabilisation by remedial treatment is not taken into account in this dataset. The impacts of mining methods, such as roof collapse behind longwall workings, where surface impacts occur within a few years of the mining activities following which surface effects are minimal, have also not been considered. Because of these factors, some previously extensively mined areas have been rated E but may not have any surface stability issues as a result of mining.

2.4 CLASS DESCRIPTORS

Underground mining is not present.

There is no known past underground mining because the rock types present are such that no commodities or metal ores have been worked by underground mining methods. It should be noted, however, that there is always the possibility of the existence of other sub-surface excavations, such as wells, cess pits, follies, air raid shelters/bunkers and other military structures etc. that could affect surface ground stability but which are outside the scope of this dataset. Coal mining is not covered by this data, and a Coal Authority mining search maybe required.

(A) Sporadic underground mining of restricted extent may have occurred. Potential for difficult ground conditions are unlikely and localised and are at a level where they need not be considered.

Presence of past underground mining is not known to have occurred. Areas are categorized on the basis that the rock types present are known to have been worked in other areas. Areas therefore have the potential for underground mining but there is little or no evidence of mining activity.

Class A examples include:

a) Areas where minor mineral veins may be present on which it is possible that there have been attempts to work these by underground methods
b) Areas of chalk where no evidence of working has been recorded

It should be noted, that there is always the possibility of the existence of other sub-surface excavations, such as wells, cess pits, follies, air raid shelters/bunkers and other military structures etc. that could affect surface ground stability but which are outside the scope of this dataset. Coal mining is not covered by this data, and a Coal Authority mining search maybe required.

(B) Localised small scale underground mining may have occurred. Potential for difficult ground conditions are unlikely or localised and are at a level where they need not be considered.

Presence of past underground mine workings may occur but workings of small limited extent. Rock types present could support small scale underground mining. All such occurrences are likely to be of minor localised extent and infrequent.

Class B examples include:

a) Areas where small mineral veins may be present on which it is possible that small scale mining has been undertaken.

b) Sandstone (for building stone) areas where bedrock geological formation e.g. Elland Flags are present but no evidence of working is found at the location.
c) Salt (brine) workings which have been recently abandoned. Areas of known working using controlled extraction methods.

It should be noted, that there is always the possibility of the existence of other sub-surface excavations, such as wells, cess pits, follies, air raid shelters/bunkers and other military structures etc. that could affect surface ground stability but which are outside the scope of this dataset. Coal mining is not covered by this data, and a Coal Authority mining search maybe required.

(C) Small scale underground mining may have occurred; mine adits, shafts and tunnels may be present. Potential for localised difficult ground conditions are at a level where they should be considered.

Presence of past underground mine workings may be present. Underground mining is likely to have been of limited extent.

Class C examples include:

a) Chalk areas where the approximate location of workings rather than an exact location are known.
b) Slate workings e.g. Woodhouse Eaves (Leicestershire) where working is known to have occurred but exact location is not known.
c) Vein mineral areas of North Pennine orefield which surround worked mineral veins but which contain no mapped veins and no actual evidence of underground working.

It should be noted, that there is always the possibility of the existence of other sub-surface excavations, such as wells, cess pits, follies, air raid shelters/bunkers and other military structures etc. that could affect surface ground stability but which are outside the scope of this dataset. Coal mining is not covered by this data, and a Coal Authority mining search maybe required.

(D) Underground mining is known or considered likely to have occurred within or close to the area. Potential for difficult ground conditions are at a level where they should be considered.

Presence of past underground mine workings are probable. These are areas known or suspected to contain underground mining for minerals and/or other materials.

Class D examples include:

a) Mineral veins these are areas within 500m of mapped mineral veins within which it is likely that mining activities may have occurred and subsidiary veins explored and exploited.
b) Bedded ironstone workings where ironstone is extracted in association with coal but is not the primary mineral.

It should be noted, that there is always the possibility of the existence of other sub-surface excavations, such as wells, cess pits, follies, air raid shelters/bunkers and other military structures etc. that could affect surface ground stability but which are outside the scope of this dataset. Coal mining is not covered by this data, and a Coal Authority mining search maybe required.

(E) Underground mining is known to have occurred within or very close to the area. Potential for difficult ground conditions should be investigated. Potential for localised subsidence is at a level where it should be considered.

Presence of past underground mine workings are known or suspected to contain underground workings for minerals and/or other materials, extent of workings are likely to be extensive. No consideration has been given to the effects of remediation and it may be necessary to check if any remediation has been carried out.

Class E examples:

a) Mineral veins areas within 200m of mapped mineral veins within which it is likely or known that mining activities may have occurred.
b) Areas where hydraulic limestone is known to have been worked at Barrow-on-Soar (Leicestershire)
c) Gypsum working at West Leake (Nottinghamshire) where the extent of workings has been mapped from published documents.

It should be noted, that there is always the possibility of the existence of other sub-surface excavations, such as wells, cess pits, follies, air raid shelters/bunkers and other military structures etc. that could affect surface ground stability but which are outside the scope of this dataset. Coal mining is not covered by this data, and a Coal Authority mining search maybe required.

3 Technical Information

3.1 SOURCE OF INFORMATION

The data is drawn from a broad range of sources. The underlying geology (as polygon areas) is derived from BGS 1:50,000 scale DiGMapGB (the digital geological map of Great Britain) version 7. Details of additional locations and criteria used to refine areas of working have been sourced through BGS experts and extensive literature research. A condensed list of the references used is provided.

3.2 SCALE

The Mining Hazard (not including coal) data has been developed at 1: 50 000 scale. The data is not suitable for use at larger scales. It should be recognised that using the data at a scale of greater than 1:50 000 is beyond the accuracy of the underlying geological map data from which the mining hazard data is partially derived. In carrying out spatial searches against the data it is recommended that this should be done with a minimum 50m buffer.

3.3 CREATION OF THE DATASET

Great Britain has a long and varied history of underground mining. Over the last five thousand years a range of over fifty different minerals have been extracted leaving underground spaces or voids. Table 1 lists the commodities included in the dataset and worked as part of this long and varied mining legacy.

Because of the broad range of commodities, their different modes of occurrence and extraction, the commodities were grouped into seven categories with shared characteristics:

1. Vein Minerals includes copper, lead, zinc, tin.
2. Chalk
3. Oil shale
4. Building stone including limestone, sand, sandstone, slate.
5. Bedded ores including iron ores (haematite), manganese, sulphides.
6. Evaporites including gypsum, anhydrite, potash, salt.
7. Other commodities – small locally worked materials including ball clay, black marble, jet, graphite, chert.

A methodology was devised for each separate group. The categorisation was based on local geological factors, expert knowledge and detailed research from literature. Whilst the

methodologies were broadly similar, with the distribution of commodities being constrained by geological distribution, local or market factors play a significant part in where materials were worked. Examples include:

a) Chalk – because of its widespread distribution and low value, material would not have been worked in areas below the water table.
b) Building stone production - constrained by economic factors such as distance to end use and accessibility to transport infrastructure. These form constraining factors on where material was worked.

Table 1 Commodities included in the Mining Hazard data

Commodity	Commodity	Commodity
Anhydrite	Hearthstone	Potash and salt
Anhydrite and gypsum	Hornstone	Raddle
Ball clay	Iron - Ochre	Ragstone (Kentish)
Barite (Bedded)	Iron Ore (Bedded)	Salt - brine
Bauxite	Iron Ore (Non Vein)	Salt - Rock salt
Bedded Ore (Manganese)	Jet	Salt - salt and brine
Black Marble	Lead	Sand
Chalk	Lignite	Sand - Glass making
Chert	Limestone	Sand & Gravel
Chromite	Limestone - Ardwick	Sand Rock
Clay	Limestone - Bath Stone	Sandstone
Copper	Limestone - Beer Stone	Sandstone - Chilmark Stone
Fireclay	Limestone - Black Country	Sandstone - Elland Flags
Firestone	Limestone - Burford Stone	Sandstone - Flagstones
Flagstone	Limestone - High Purity	Silica
Flint	Limestone - Ketton Stone	Slate
Fullers Earth	Limestone - Lincolnshire	Slate - Colleyweston
Ganister	Limestone - Portland	Sulphide (Bedded)
Graphite	Limestone - Purbeck	Talc
Gritstone	Limestone (hydraulic)	Vein Mineral
Gypsum	Manganese (Bedded)	Whetstone
Gypsum and anhydrite	Oil shale	Whinstone

Where mitigating criteria are known to influence location and extent of mining they have been used to constrain the mining areas shown in the data. Where no supplementary information is available the full geological coverage has been retained.

Initial processing resulted in seven separate data layers. The contents of each layer are classified against a single A-E classification scheme. This standardisation ensures for example that a C rating for vein minerals is equitable with a C rating for chalk.

Having created the seven separate data layers (vein minerals, chalk, oil shale, building stones, bedded ores, evaporites, other commodities) they are brought together into a single comprehensive mining hazard layer. A simplified version of the iterative integration process is given in Figure 1 Iterative process for combining data layers

All data processing and spatial data checking has been carried out using ESRI ArcGIS software.

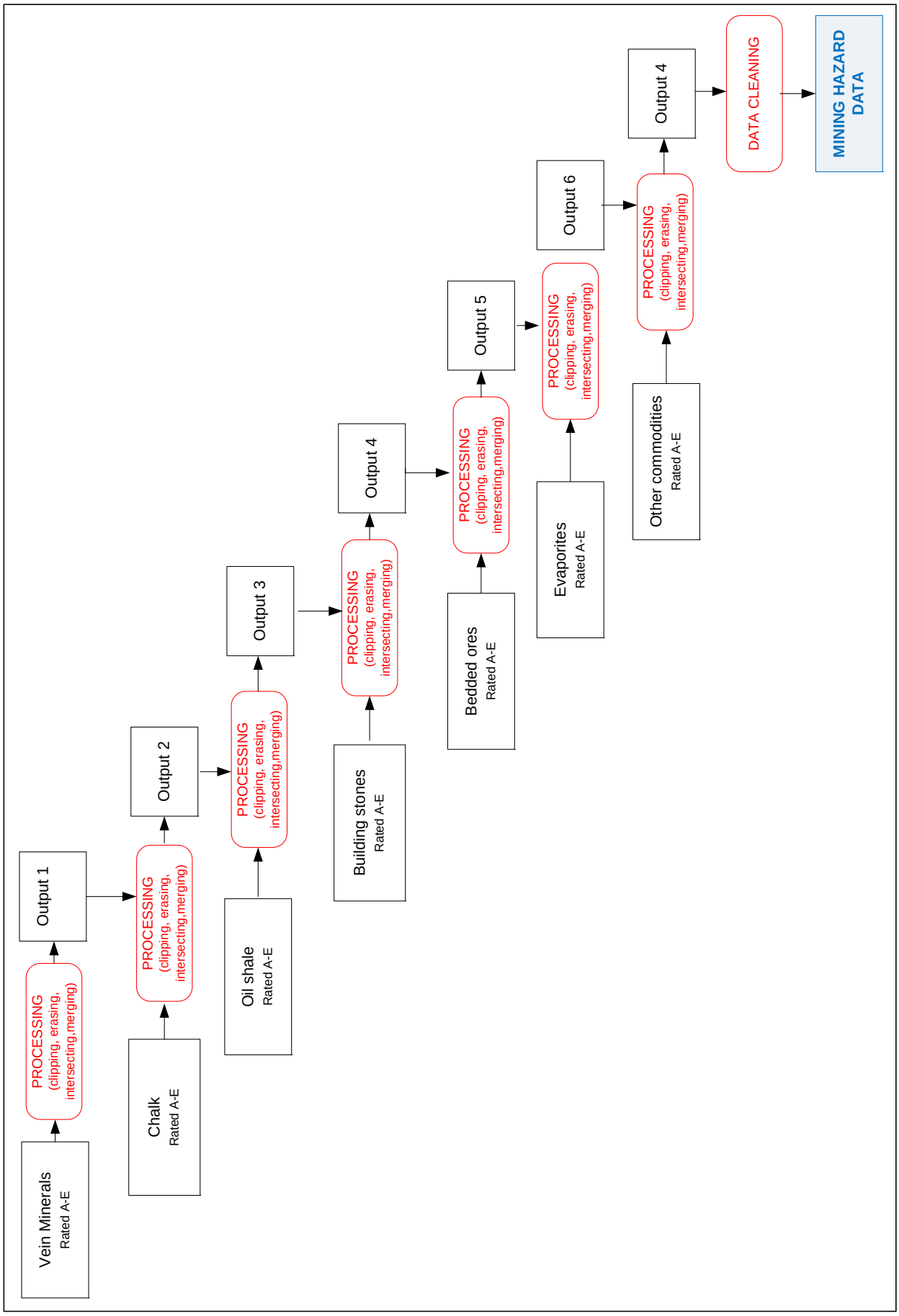

Figure 1 Iterative process for combining data layers.

3.4 TABLE FIELD DESCRIPTIONS

Table 2 describes the attribute table fields.

Table 2 Attribute table field descriptions

Field name	Field description
SHAPE	Necessary for the ESRI shapefile format indicating polygon data
CLASS	Polygons are classified using an A-E scale (see section 2.4 Class Descriptors) Where mining of more than one commodity has occurred at a location the highest class is applied to a polygon for example a polygon with a building stone rating of B and a vein mineral rating of E is given a class E rating. See Note 2
LEGEND	Brief description of classes, for more detailed explanation see section 2.4.
COMMODITY	Commodity describes the material worked for example chalk, sandstone. Where these can be subdivided for example Limestone- Black Country, Limestone-Bath Stone, Limestone – Burford Stone, Where information is available on the commodity worked it is recorded here e.g. Bath Stone, limestone, brine. Note 1 and Note 3
COMMENTS	Within the chalk the location of some known workings is only available within a 1km grid square. These grid cells have been flagged with a comment to show that mining is known in this area but the exact location is unknown.
NAME	This is the site name where available. For some data types for example building stones the sites specific names e.g. Bethel, Draycott-in-the-Moor, and Ewe Crag this is shown. For other commodities and the majority of localities the data represents unnamed occurrences. In these cases the field is populated with 'Not available'. Where a site has been given more than one name (often when more than one commodity has been worked) e.g. Dalry/Glenarnoch both site names are given. See Note 1
VERSION	Mining Hazard not Including Coal for Great Britain v7
Note 1 Where more than one commodity occurs at a location both are shown e.g. Vein minerals/Building stone. The order also applies to the Name field i.e. Name = Dalry/Glenarnoch Group = Vein Minerals/Building stone Dalry is a vein minerals location whilst Glenarnoch is the building stone location name.	
Note 2 If a site lies within a rated polygon, it does not necessarily indicate the presence of mining, rather the likelihood of past mining to have occurred. In these cases it is recommended that further enquiries are made regarding the potential for past mining activity.	
Note 3 Where no information is available a description of 'Not available' it indicates that no value has been found.	

3.5 DATASET HISTORY

The original version of the Mining Hazard (not including coal) GB V1 was released in February 2009.

Since then work has continued to develop with an updated version of Mining Hazard (not including coal) GB V5 release in July 2010. The version 5 release included:

- Inclusion of more building stone locations.
- Re-working of the chalk methodology to provide improved coverage
- Re-design of the vein minerals methodology to produce a more focused and representative extent for this set of commodities.

Early in 2014 a number of mining related 'sink hole' events occurred. As a consequence a small number of revisions have been made to the Mining Hazard (not including coal) dataset. These revisions resulted in the release of an interim Version 5.1.

The version 5.1 update concentrated on generalisation of some of the known chalk localities in the South East of England. To reflect the change in the geometry of the data, a comments field has been included in the attribute table to record chalk localities where only an approximate grid reference is available but no further detail. These grid references are accurate to within 1000m grid square in these cases the whole grid square was tagged with a comment to indicate that chalk workings are known at that locale but that no more specific information is available.

In 2015, version 7 of the dataset was released. Updates focussed on redevelopment of the chalk methodology. This work was carried out as a consequence of the sink holes which occurred in early 2014. Whilst many of the sink holes were of natural origin i.e. dissolution events linked to climate i.e. dry summer followed by wet winter conditions; several of the collapses included an anthropogenic influence through association with former mining locations.

Additional work has been carried out to identify new and refine existing locations from literature and these have been integrated into the existing data.

Note: In 2008 BGS introduced its new versioning system whereby the version number of the dataset relates to the version of DiGMapGB-50 base data, the original version of Mining Hazard (not including coal) was released as version 1 but to comply with the new naming practice it has jumped from Mining Hazard (not including coal) version 1 to version 5 and subsequent versions relate to the version of DiGMapGB 50k the base data was drawn from.

3.6 COVERAGE

Data coverage includes England, Scotland and Wales. For data distribution see Figure 2.

3.7 DATA FORMAT

The Mining Hazard (not including coal) data has been created as vector polygons and are available in a range of GIS formats, including ArcGIS (.shp), ArcInfo Coverages and MapInfo (.tab). More specialised formats may be available but may incur additional processing costs.

3.8 LIMITATIONS

- Most geological maps were originally fitted to a particular edition of the topographic base and care must be taken in interpretation, for example when the geological data are draped over a more recent topography. All spatial searches against the data should be done with a minimum 50 m buffer.
- The observations made in the production of this data are according to the prevailing understanding of the subject at the time. The quality of such observations may be affected by

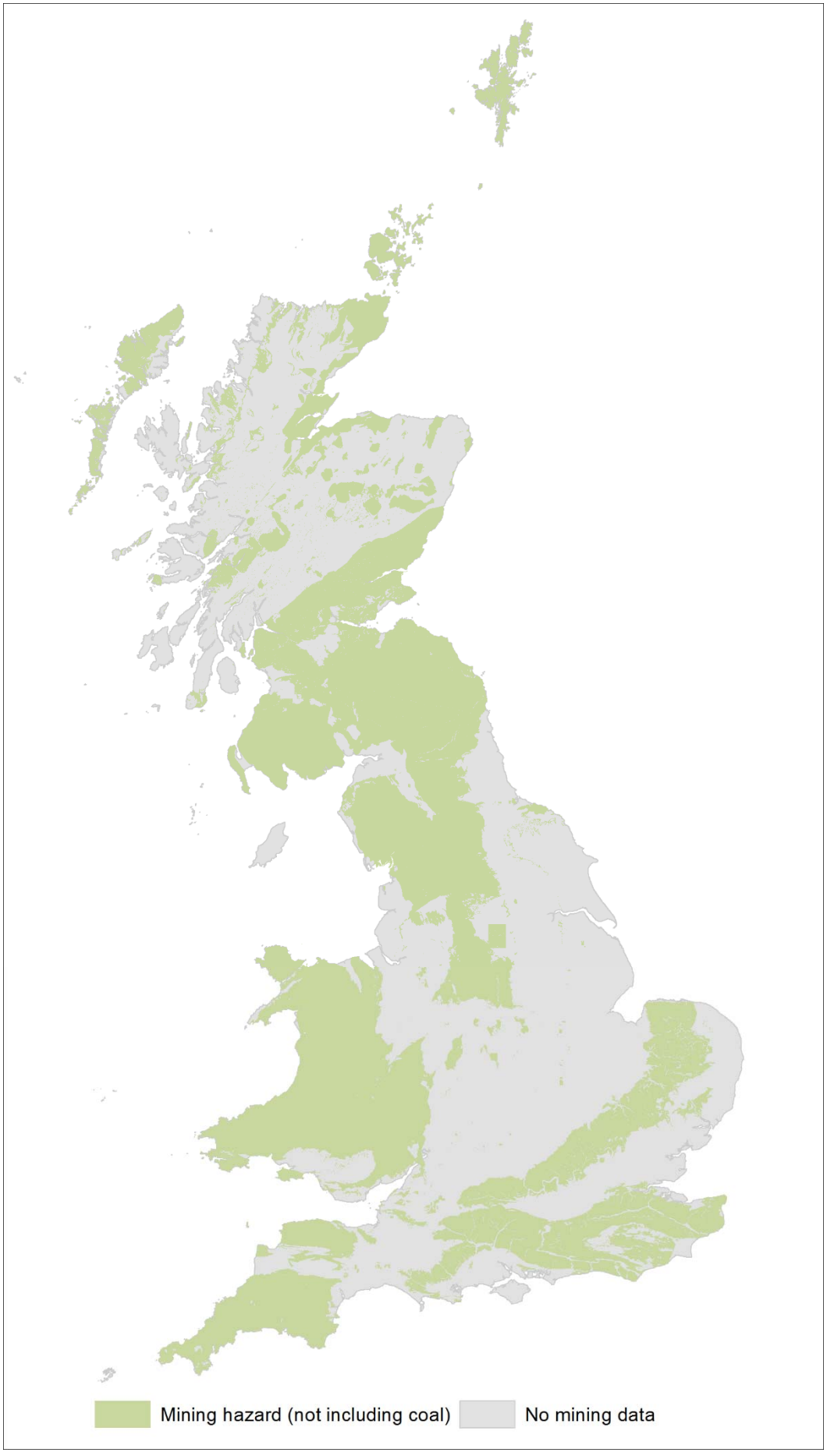

Figure 2 Coverage of the Mining Hazard (not including coal)

- Subsequent advances in knowledge, improved methods of interpretation, and access to new sources of information.
- Raw data may have been transcribed from analogue to digital format, or may have been acquired by means of automated techniques. Although such processes are subjected to quality control to ensure reliability where possible, some raw data may have been processed without human intervention and may in consequence contain undetected errors.
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- If customers are uncertain about the use of particular data they should seek professional advice. They may consult the BGS contacts listed at the end of this document on technical matters, licensing arrangements, or geological aspects including the appropriateness and limitations of the data.
- Although there are a number of sites affected by underground mining where remediation has occurred including parts of the Northwich salt field, Barrow-on Soar, Coalbrookdale, Dudley and Bury St Edmunds, the impact of this remediation work is not considered in this assessment and all ratings are given as if localities are unremediated.

4 Licensing Information

The British Geological Survey does not sell its digital mapping data to external parties. Instead, BGS grants external parties a licence to use this data, subject to certain standard terms and conditions. In general, a licence fee will be payable based on the type of data, the number of users, and the duration (years) of a licence.

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