

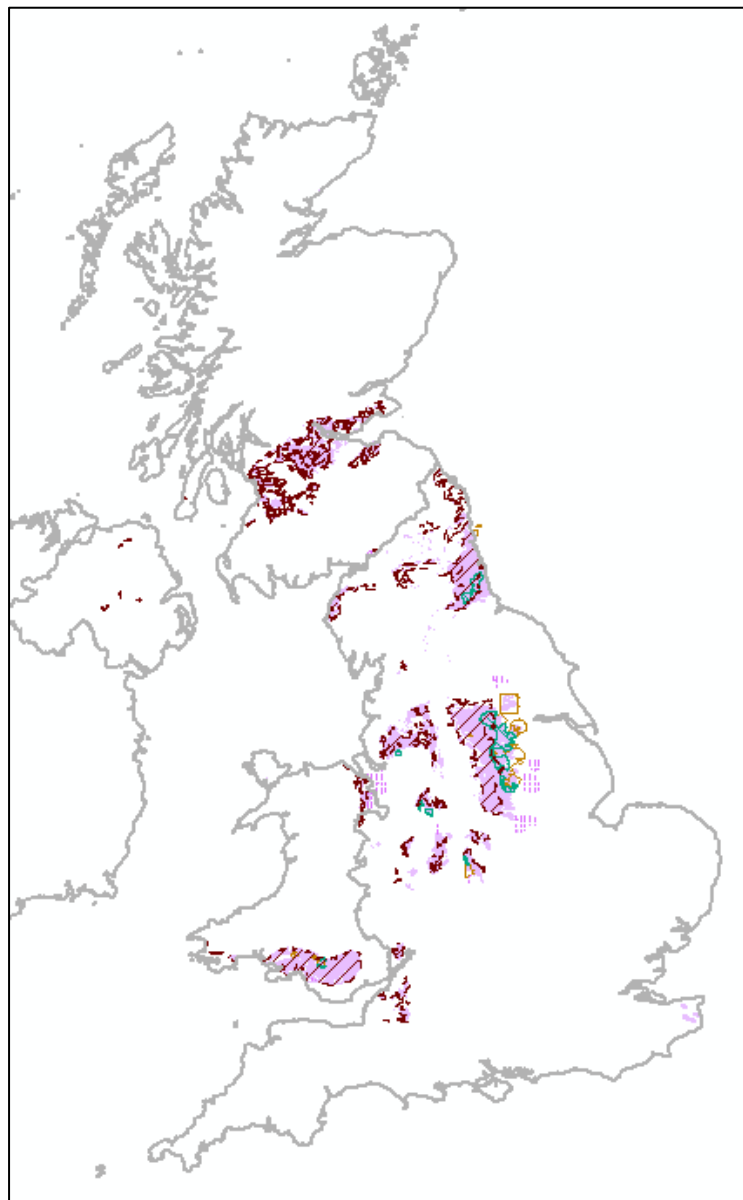


**British
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

User Guide for the BGS UK Coal Resource for New Exploitation Technologies (Version 1) Dataset

Open Report OR/15/055



BRITISH GEOLOGICAL SURVEY

OPEN REPORT OR/15/055

User Guide for the BGS UK Coal Resource for New Exploitation Technologies (Version 1) Dataset

Gow, H.V, Myers, A.H & Smith, N.J.P

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Keywords

Coal resources, coal exploitation, abandoned mine methane, coalbed methane, opencast coal mining, underground coal mining, coal mine methane, underground coal gasification, carbon dioxide sequestration .

Front cover

UK Coal Resource for New Exploitation Technologies Dataset

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British Geological Survey offices

BGS Central Enquiries Desk

Tel 0115 936 3143 Fax 0115 936 3276
Email enquiries@bgs.ac.uk

Environmental Science Centre, Keyworth, Nottingham NG12 5GG

Tel 0115 936 3100 Fax 0115 936 3200
Email sales@bgs.ac.uk

The Lyell Centre, Research Avenue South, Edinburgh, EH14 4AP

Tel 0131 667 1000
Email scotsales@bgs.ac.uk

Natural History Museum, Cromwell Road, London, SW7 5BD

Tel 020 7589 4090 Fax 020 7584 8270
Tel 020 7942 5344/45 email bgs london@bgs.ac.uk

Columbus House, Greenmeadow Springs, Tongwynlais, Cardiff, CF15 7NE

Tel 029 2052 1962 Fax 029 2052 1963

Maclean Building, Crowmarsh Gifford, Wallingford, OX10 8BB

Tel 01491 838800 Fax 01491 692345

Geological Survey of Northern Ireland, Department of Enterprise, Trade & Investment, Dundonald House, Upper Newtownards Road, Ballymiscaw, Belfast, BT4 3SB

Tel 028 9038 8462 Fax 028 9038 8461
Email gsni@detini.gov.uk
www.bgs.ac.uk/gsni/

Parent Body

Natural Environment Research Council, Polaris House, North Star Avenue, Swindon SN2 1EU

Tel 01793 411500 Fax 01793 411501
www.nerc.ac.uk

Website www.bgs.ac.uk

Shop online at www.geologyshop.com

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Summary

This report describes the Coal for New Technologies GIS dataset, which is a suite of data layers derived from a study conducted in 2004 by the British Geological Survey (BGS), with the assistance of Wardell Armstrong and Imperial College, London.

The principle aim of the original study was to develop a methodology to assess the potential of the UK onshore coal resources for both exploitation by conventional (mining) and new technologies. Digital data was created using a Geographic Information System (GIS) to reproduce the delivered output of the original project, a series of paper maps that would identify prospective areas.

The Coal for New Technologies digital data has been derived from the paper maps produced for the original 2004 study. **This reflected our understanding of the subject matter at the time and no updates on resource potential have been carried out since.** The data set has been published in its original format under Open Government Licence as a set of data layers covering mining technologies:

Mining Technologies:

- Area with technical potential for opencast workings (source Coal Resource Map of Great Britain BGS/Coal Authority 1999)
- Underground mining exploration prospects
- Good prospects for abandoned mine methane (AMM) (Mine workings not recovered)
- Resource area for coal mine methane (CMM) (source Coal Authority Underground Licences, May 2002)
- Extent of underground workings with 500m buffer zone (based on Coal Authority data, May 2002)

New Technologies:

- Area greater than 1200m from surface with potential for CO₂ sequestration
- Area with good coalbed methane (CBM) potential
- Underground coal gasification (UCG) potential
- Coalbed methane (CBM) resource area
- Coal-bearing strata

The original methodology is described in the project report, which outlines the assessment, development and uncertainties of the methodology, which is available as a free download on the BGS website here: <http://www.bgs.ac.uk/downloads/start.cfm?id=1712>.

Report Reference:

Jones N S, Holloway S, Creedy D P, Garner K, Smith N J P, Browne, M.A.E. & Durucan S. 2004. UK Coal Resource for New Exploitation Technologies. Final Report. *British Geological Survey Commissioned Report CR/04/015N*

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A number of individuals in the Data Services, Geoanalytics and Modelling, Energy and Marine Geoscience Programmes have contributed to the project and helped compile this report. We would like to particularly acknowledge the original report authors, Neil Jones and Sam Holloway.

Assistance and additional data were provided by the Coal Authority, Wardell Armstrong and Imperial College, which is gratefully acknowledged.

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 what is beneath across the whole of Great Britain. These digital products are based on the outputs of the BGS's 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> or by contacting:

Central Enquiries
British Geological Survey
Environmental Science Centre
Keyworth
Nottingham
NG12 5GG
Direct tel. +44(0)115 936 3143
Email enquiries@bgs.ac.uk

2 About the UK Coal Resource for New Exploitation Technologies Dataset

2.1 BACKGROUND

The principal aim of the original 2004 project was to assess the potential of the UK onshore coal resources for both exploitation by conventional (mining) and new technologies and to represent this on a series of maps that would identify prospective areas. This dataset was built using GIS software by BGS to create the original cartographic paper maps and digital CD publication. **The Coal for New Technologies digital data is a facsimile of the paper map created in 2004, no update to the original work on resource potential has been carried out and this data reflects the findings of the original study.**

Coal-bearing strata dataset includes:

1. Coal-bearing strata at surface
2. Concealed coal-bearing strata <1200m from surface datum
3. Concealed coal-bearing strata >1200m from surface datum

The mining technologies dataset includes:

1. Underground and opencast mining
2. Coal mine methane (CMM)

3. Abandoned mine methane (AMM)

The new technologies dataset includes:

1. Underground coal gasification (UCG)
2. Virgin coalbed methane (VCBM)
3. Coal seam-related carbon dioxide (CO₂) sequestration

The UK contains extensive resources of coal, both at surface and in the subsurface. It is estimated that onshore these surface and subsurface deposits cover an area of approximately 40,000 km². The potential for mining was mainly considered because it has a bearing on the scope for the new exploitation technologies rather than to identify resources or potential mine development areas (Jones *et al*, 2004).

2.2 WHO MIGHT REQUIRE THESE DATASETS?

The coal data will be of use for companies involved in:

- Identifying coal-mining prospects
- Exploration for coalbed methane
- Exploration for underground coal gasification (although all the current licences are offshore)
- Vent gas exploration
- Potential future CO₂ sequestration projects
- Assessing infrastructure needed for coalbed methane and other gas sources

Additional data on the boreholes and depths are likely to be useful for other types of subsurface work including conventional hydrocarbon exploration and academic research. Together with the CO₂ and methane hazards reports they may also be of use to planning authorities.

2.3 WHAT THE DATASETS SHOW?

The data are supplied as nine layers of spatial information in a GIS format:

2.3.1 Coal-Bearing Strata

This dataset was derived from the 1999 BGS/Coal Authority Coal Resources Map of Britain (published in paper format), including both the 'at surface' and 'concealed' areas of lignite and coal-bearing strata.

1. *Coal-Bearing Strata at Surface*. This represents the area where coal-bearing strata could be expected to be present at the surface. In most instances, the coal-bearing strata will be buried below a thin covering of more recent superficial deposits such as drift or alluvium. There is no differentiation between the different ages of the coal-bearing strata on these maps.
2. *Concealed Coal-Bearing Strata <1200m from Surface Datum*. This represents the area where coal-bearing strata, buried below younger strata, are present in the subsurface at depths less than 1200m. The down-dip limit is the 1200m line, drawn on the top of the coal-bearing unit. This area has potential for further underground mines, as long as suitable geology is present. In most instances, the cover rocks immediately overlying the coal-bearing strata are Permo-Triassic in age, although in Kent the Permo-Triassic is absent and the Coal Measures are overlain by younger Mesozoic strata. In some areas, e.g. South Wales, the Coal Measures are not concealed below younger strata, so the presence of coal-bearing strata is represented by the 'Coal-bearing strata at surface' pattern. It should be

borne in mind that coal-bearing strata in this coalfield do continue to depths in excess of 1200m, but they are not concealed.

3. *Concealed Coal-Bearing Strata >1200m from Surface Datum.* This represents the area where coal-bearing strata, buried below younger strata, are present in the subsurface at depths in excess of 1200m. The updip limit is the 1200m line, drawn on the top of the coal-bearing unit. The downdip limit is the known extent of coal-bearing strata.
4. *Lignite at Surface.* This represents the extent of outcrop of the main lignite-bearing geological units.

2.3.2 Area with Technical Potential for Opencast Working

Areas with technical potential for opencast working is defined as an area of coal- or lignite-bearing strata containing seams with <50m non-coal-bearing overburden. It extends to depths of 200m below the ground surface, the normal limit of opencast workings in the UK. It excludes a small area of non-coal bearing strata at the base of the Coal Measures.

2.3.3 Extent of Underground Workings with 500m Buffer Zone

Areas with the technical potential for underground coal mining are defined here as unmined areas where coal seams >1.5m thick are present between depths of 200 and 1200m. A 500m arbitrary buffer was applied to encapsulate potential variability in our understanding of the coal-bed geometry at depth. However, in reality, areas with potential for underground mining must satisfy a very wide-ranging set of geological and engineering constraints that are not described in this dataset or discussed within the scope of the associated report (Jones et al, 2004).

2.3.4 Resource Area for Coal Mine Methane (CMM)

Methane trapped in coal and surrounding strata can be released as a result of mining; this gas is known as Coal Mine Methane (CMM)

A CMM resource area is defined as the mining licence around a working mine with methane drainage. CMM resources have not been calculated as part of this study, but resource areas have been defined and mapped. CMM sites are identified by a shaft location for the working mine and the potential area of CMM extraction is represented by the mine licence.

2.3.5 Good Prospects for Abandoned Mine Methane (AMM)

Abandoned Mine Methane (AMM) consists of the fuel gas (mainly methane) fraction of the free gas trapped within abandoned coal mines, plus any methane that can be desorbed from the coal seams in the strata surrounding the mined seam by applying suction to the mine workings (Creedy et al 2001a).

In AMM areas, methane values are known to be >1m³/tonne and the mine waters in these workings are thought to have not recovered.

2.3.6 Coalbed Methane (CBM) Resource Areas

Coalbed methane is the methane-rich gas found naturally within coal seams. Typically, it consists of 80-95% methane, 0-8% ethane, 0-4% propane and higher hydrocarbons, 2-8% nitrogen and 0.2-

6% carbon dioxide, together with traces of argon, helium and hydrogen (Creedy 1991). In mines it can be explosive when mixed with air. It is known as firedamp in the mining industry.

The criteria used to define and map the location of Coalbed methane (CBM):

- Coal seams greater than 0.4m in thickness at depths >200m
- Maximum depth of 1200m
- Seam gas content >1m³/tonne
- 500 metres or more horizontal separation from underground coal workings
- Vertical separation of 150m above and 40m below a previously worked seam
- Vertical separation of >100m from major aquifers, and
- Vertical separation of >100m from major unconformities
- Areas with a CMM resource (current underground coal mining licences) were excluded.

2.3.7 Areas with Good Coalbed Methane (CBM) Potential

Following application of the criteria as established above, regions with potential for CBM were derived. In order to refine these CBM regions and produce a more accurate resource calculation these regions were divided into smaller areas across which the methane values are believed to be fairly consistent. These areas were defined using methane point and contoured data, available in Creedy (1986, 1988, and 1991) and Wardell Armstrong (2002).

2.3.8 Underground Coal Gasification (UCG) Potential

Underground Coal Gasification describes the process whereby combinations of air, oxygen, hydrogen and steam are injected into one or more in-situ coal seams to initiate partial combustion of the coal and liberation of further combustible gases.

Areas of Underground Coal Gasification (UCG) are subdivided into three categories:

1. *Area with good UCG potential.* This represents an area that meets all the criteria for UCG below:
 - Seams of 2m thickness or greater
 - Seams at depths between 600 and 1200m from the surface
 - 500m or more horizontal and vertical separation from underground coal workings and current coal mining licences
 - Greater than 100m vertical separation from major aquifers
 - Greater than 100m vertical separation from major overlying unconformities
2. *Area with poor UCG potential.* This represents an area that does not meet all the criteria for UCG, specifically seams are present at suitable depths, but do not meet the required thickness of >2m.
3. *Area with unverifiable UCG potential.* This represents an area in which coal is believed to be present at suitable depths, but borehole information is lacking. Hence the potential cannot be verified. Unverifiable areas require further investigation to determine their resource potential.

2.3.9 Area greater than 1200m from surface with potential for CO₂ sequestration

These are defined as areas of unminable coal seams where the seams are at depths greater than 1200m below surface and more than 500m from known mine workings (as known in 2004). These are primary areas for potential CO₂ sequestration. Because carbon dioxide sequestration requires

that CO₂ remains in place for very long time periods, areas of coal seams deemed suitable for potential mining or underground gasification are NOT suitable for CO₂ sequestration.

3 Technical Information

3.1 SCALE

The Coal Technologies dataset is produced for use at 1:1 000 000 scale.

3.2 ATTRIBUTE TABLE FIELD DESCRIPTIONS

Table 1 - Area with technical potential for opencast workings field descriptions

| FIELD NAME | DESCRIPTION |
|------------|--|
| FEATURE | Description of the geological feature represented e.g. Technical potential for opencast workings |
| SHEET | Digital geological or paper map that the polygon appears on e.g. UK Coal Resource for New Exploitation Technologies |
| VERSION | Version number of the digital data. The version number is changed when a new dataset is released following major changes. This data is not expected to be updated. |
| RELEASED | Date the data files were created by BGS: e.g. 18/07/2016 |
| NOM_SCALE | Nominal scale of the published (or compiled) information used to prepare the digital data: e.g. 1 000 000. Provides an indication of scale-dependant accuracy |
| NOM_BGS_YR | The latest year date of the principal BGS geological information contained in the digital data. This is the year of publication e.g. 2004 |

Table 2 – Extent of underground workings with 500m buffer zone attribute table field descriptions

| FIELD NAME | DESCRIPTION |
|------------|--|
| FEATURE | Description of the geological feature represented e.g. Extent of underground workings with 500m buffer |
| SHEET | Digital geological or paper map that the polygon appears on e.g. UK Coal Resource for New Exploitation Technologies |
| VERSION | Version number of the digital data. The version number is changed when a new dataset is released following major changes. This data is not expected to be updated. |
| RELEASED | Date the data files were created by BGS: e.g. 18/07/2016 |
| NOM_SCALE | Nominal scale of the published (or compiled) information used to prepare the digital data: e.g. 1 000 000. Provides an indication of scale-dependant accuracy |
| NOM_BGS_YR | The latest year date of the principal BGS geological information contained in the digital data. This is the year of publication e.g. 2004 |

Table 3 - Underground mining exploration prospects attribute table field descriptions

| FIELD NAME | DESCRIPTION |
|------------|---|
| FEATURE | Description of the geological feature represented e.g. Underground mining exploration prospects |
| SHEET | Digital geological or paper map that the polygon appears on e.g. UK Coal Resource for New Exploitation Technologies |

| | |
|------------|--|
| PROSPECT | Name of Prospect e.g. Witham |
| VERSION | Version number of the digital data. The version number is changed when a new dataset is released following major changes. This data is not expected to be updated. |
| RELEASED | Date the data files were created by BGS: e.g. 18/07/2016 |
| NOM_SCALE | Nominal scale of the published (or compiled) information used to prepare the digital data: e.g. 1 000 000. Provides an indication of scale-dependant accuracy |
| NOM_BGS_YR | The latest year date of the principal BGS geological information contained in the digital data. This is the year of publication e.g. 2004 |

Table 4 – Resource area for coal mine methane (CMM) attribute table field descriptions

| FIELD NAME | DESCRIPTION |
|------------|--|
| FEATURE | Description of the geological feature represented e.g. Resource area for CMM |
| SHEET | Digital geological or paper map that the polygon appears on e.g. UK Coal Resource for New Exploitation Technologies |
| LIC_NAME | Name of Licence e.g. Betws Colliery |
| VERSION | Version number of the digital data. The version number is changed when a new dataset is released following major changes. This data is not expected to be updated. |
| RELEASED | Date the data files were created by BGS: e.g. 18/07/2016 |
| NOM_SCALE | Nominal scale of the published (or compiled) information used to prepare the digital data: e.g. 1 000 000. Also gives an indication of scale-dependant accuracy |
| NOM_BGS_YR | The latest year date of the principal BGS geological information contained in the digital data. This is the year of publication e.g. 2004 |

Table 5 - Good prospects for abandoned mine methane (AMM) attribute table field descriptions

| FIELD NAME | DESCRIPTION |
|------------|--|
| FEATURE | Description of the geological feature represented e.g. Good prospects for abandoned mine methane (AMM) |
| SHEET | Digital geological or paper map that the polygon appears on e.g. UK Coal Resource for New Exploitation Technologies |
| VERSION | Version number of the digital data. The version number is changed when a new dataset is released following major changes. This data is not expected to be updated. |
| RELEASED | Date the data files were created by BGS: e.g. 18/07/2016 |
| NOM_SCALE | Nominal scale of the published (or compiled) information used to prepare the digital data: e.g. 1 000 000. Provides an indication of scale-dependant accuracy |
| NOM_BGS_YR | The latest year date of the principal BGS geological information contained in the digital data. This is the year of publication e.g. 2004 |

Table 6 - Coalbed methane (CBM) resource area attribute table field descriptions

| FIELD NAME | DESCRIPTION |
|------------|---|
| FEATURE | Description of the geological feature represented e.g. CBM area |
| SHEET | Digital geological or paper map that the polygon appears on e.g. UK Coal Resource for New Exploitation Technologies |
| SOURCETHM | Source comment e.g. East Scotland 3 |

| | |
|------------|--|
| METHANE_RA | Coal Bed Methane range comment e.g. 1 to 4 |
| METHANE_VA | Average Coal Bed Methane value (m ³ /t) e.g. 2 |
| CBM_RESOUR | Coal Bed Methane resource 10 ⁶ m ³ e.g. 28290 |
| CBM_RES_DE | Coal Bed Methane resource density 10 ⁶ m ³ ha ⁻¹ e.g. 43 |
| CBM_RANKIN | Ranking defined by the criteria set for a potential CBM area in section 2.3.8 e.g. Good |
| VERSION | Version number of the digital data. The version number is changed when a new dataset is released following major changes. This data is not expected to be updated. |
| RELEASED | Date the data files were created by BGS: e.g. 18/07/2016 |
| NOM_SCALE | Nominal scale of the published (or compiled) information used to prepare the digital data: e.g. 1 000 000. Provides an indication of scale-dependant accuracy |
| NOM_BGS_YR | The latest year date of the principal BGS geological information contained in the digital data. This is the year of publication e.g. 2004 |

Table 7 - Area with good coalbed methane (CBM) potential attribute table field descriptions

| FIELD NAME | DESCRIPTION |
|------------|--|
| FEATURE | Description of the geological feature represented e.g. Area with good CBM potential |
| SHEET | Digital geological or paper map that the polygon appears on e.g. UK Coal Resource for New Exploitation Technologies |
| VERSION | Version number of the digital data. The version number is changed when a new dataset is released following major changes. This data is not expected to be updated. |
| RELEASED | Date the data files were created by BGS: e.g. 18/07/2016 |
| NOM_SCALE | Nominal scale of the published (or compiled) information used to prepare the digital data: e.g. 1 000 000. Provides an indication of scale-dependant accuracy |
| NOM_BGS_YR | The latest year date of the principal BGS geological information contained in the digital data. This is the year of publication e.g. 2004 |

Table 8 - Underground coal gasification (UCG) potential attribute table field descriptions

| FIELD NAME | DESCRIPTION |
|------------|--|
| FEATURE | Description of the geological feature represented e.g. Area with good UCG potential |
| SHEET | Digital geological or paper map that the polygon appears on e.g. UK Coal Resource for New Exploitation Technologies |
| VERSION | Version number of the digital data. The version number is changed when a new dataset is released following major changes. This data is not expected to be updated. |
| RESOURCES | Ranking of UCG resources based on the criteria outlined in section 2.3.8 |
| RELEASED | Date the data files were created by BGS: e.g. 18/07/2016 |
| NOM_SCALE | Nominal scale of the published (or compiled) information used to prepare the digital data: e.g. 1 000 000. Provides an indication of scale-dependant accuracy |
| NOM_BGS_YR | The latest year date of the principal BGS geological information contained in the digital data. This is the year of publication e.g. 2004 |

Table 9 - Areas greater than 1200m from surface with potential for CO₂ sequestration attribute table field descriptions

| FIELD NAME | DESCRIPTION |
|-------------------|--|
| FEATURE | Description of the geological feature represented e.g. Area with potential for CO ₂ sequestration |
| SHEET | Digital geological or paper map that the polygon appears on e.g. UK Coal Resource for New Exploitation Technologies |
| VERSION | Version number of the digital data. The version number is changed when a new dataset is released following major changes. This data is not expected to be updated. |
| RELEASED | Date the data files were created by BGS: e.g. 18/07/2016 |
| NOM_SCALE | Nominal scale of the published (or compiled) information used to prepare the digital data: e.g. 1 000 000. Provides an indication of scale-dependant accuracy |
| NOM_BGS_YR | The latest year date of the principal BGS geological information contained in the digital data. This is the year of publication e.g. 2004 |

Table 10 - Coal-bearing strata attribute table field descriptions

| FIELD NAME | DESCRIPTION |
|-------------------|--|
| FEATURE | Description of the geological feature represented e.g. Concealed coal bearing strata < 1200m from surface datum |
| SHEET | Digital geological or paper map that the polygon appears on e.g. Coal Resources Map of Britain 1999 |
| VERSION | Version number of the digital data. The version number is changed when a new dataset is released following major changes. This data is not expected to be updated. |
| RELEASED | Date the data files were created by BGS: e.g. 18/07/2016 |
| NOM_SCALE | Nominal scale of the published (or compiled) information used to prepare the digital data: e.g. 1 000 000. Provides an indication of scale-dependant accuracy |
| NOM_BGS_YR | The latest year date of the principal BGS geological information contained in the digital data. This is the year of publication e.g. 1999 |

3.3 CREATION OF THE DATASET

The data was originally created in 2004 as part of a project carried out by the British Geological Survey, with the assistance of Wardell Armstrong and Imperial College, London. It represents a summary of the results of the Study of the UK Coal Resource for New Exploitation Technologies Project, carried out for the DTI Cleaner Coal Technology Programme under the management of Future Energy Solutions. For more information please see the project report (Jones et al, 2004), available at <http://www.bgs.ac.uk/downloads/start.cfm?id=1712>.

The 2004 study drew on both existing and new digital data to produce a summary paper map with a nominal scale of 1: 1,750,000. The paper publication included regional coal fields at 1: 600,000 scale.

Other datasets that were used in the 2004 study include:

- BGS 1:50,000 digital geological map data (DiGMapGB-50 version 1.05 and 1.10)
- BGS/Coal Authority 1:1,500,000 Coal Resource Map of Britain 1999
- Digital dataset of onshore petroleum exploration (PEDL and EXL) licences, supplied by the DTI Oil and Gas Directorate
- Seam gas content data originally obtained by British Coal and provided by Wardell Armstrong
- Locations of shafts or abandoned mine and working mine locations compiled as part of this project

3.4 DATASET HISTORY

This is the first digitally released version of this dataset although the data has been made available previously to interested parties under letters of undertaking. The digital version was originally produced in 2004 for the production and release of the paper maps and the content has not been updated since.

3.5 COVERAGE

Data is provided to identify areas for each of the potential coal resources for new exploitation technologies in the UK. Figures 1 (Coal Bearing Strata), 2 (Mining Technologies) and 3 (New Technologies) show the distribution of data.

The data has been divided into Great Britain and Northern Ireland. Great Britain is projected using the British National Grid whilst the Northern Ireland data is projected using the Irish National Grid.

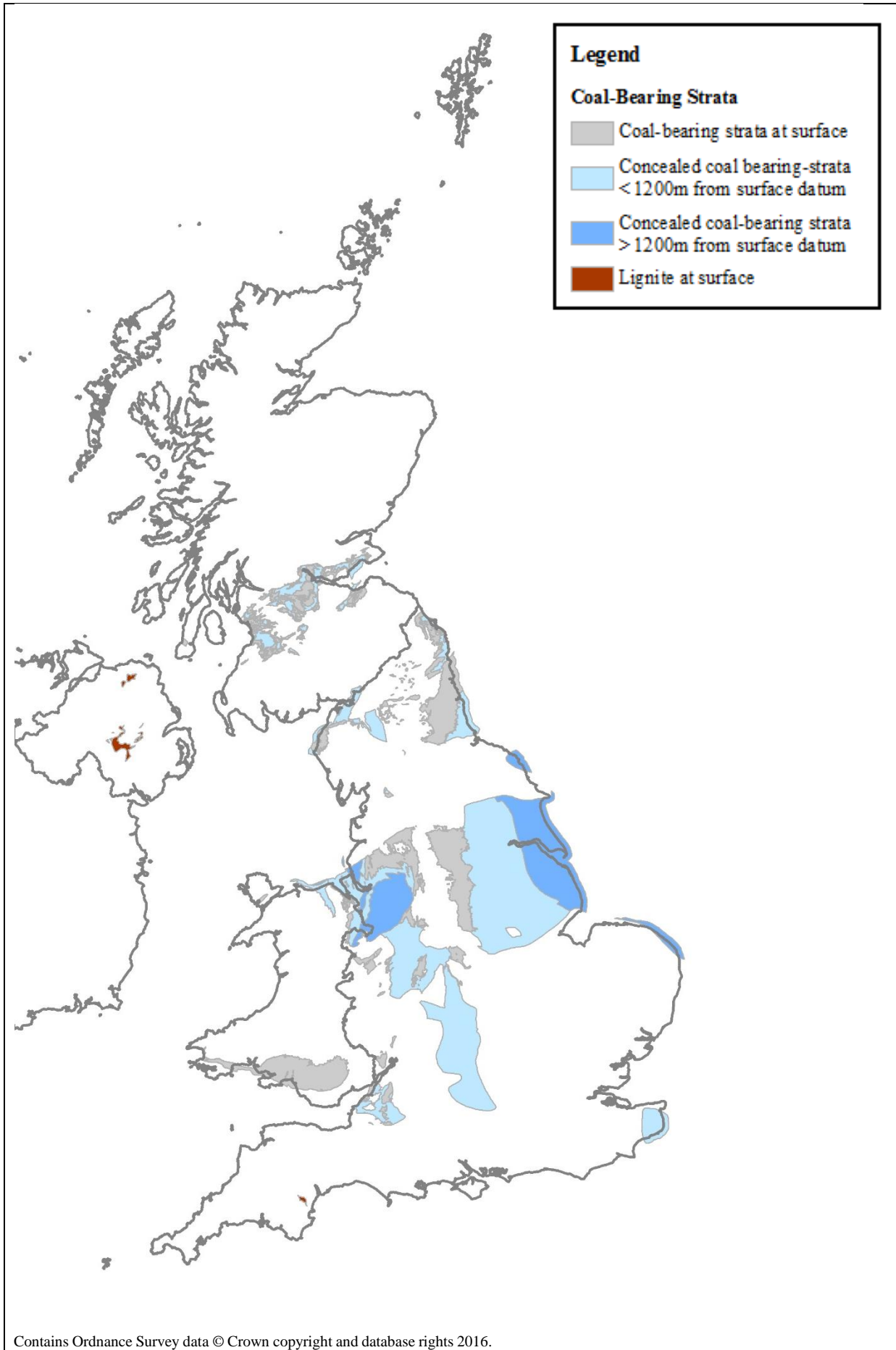


Figure 1 - Data Coverage for Coal Bearing Strata.

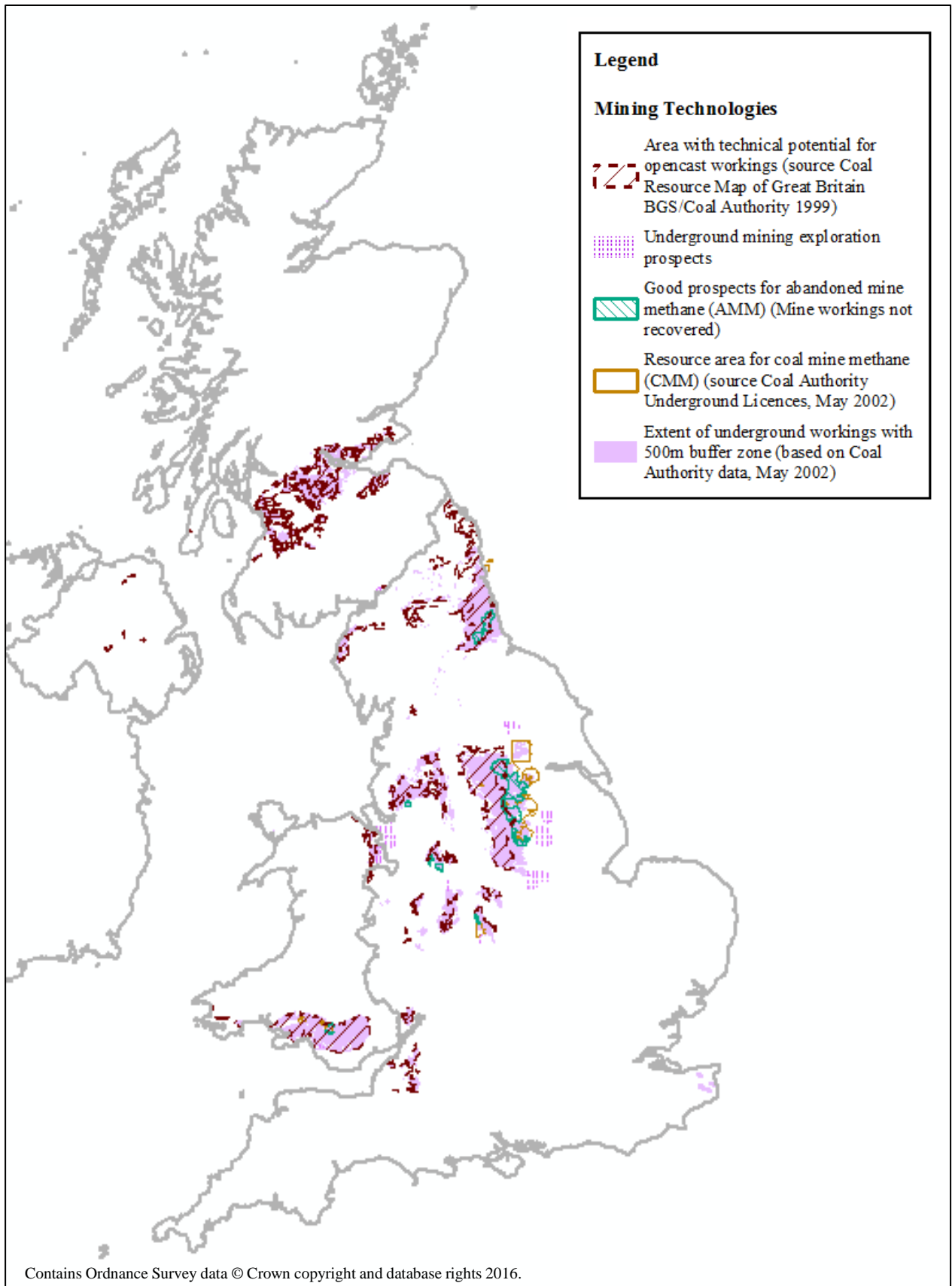


Figure 2 - Data Coverage for Mining Technologies..

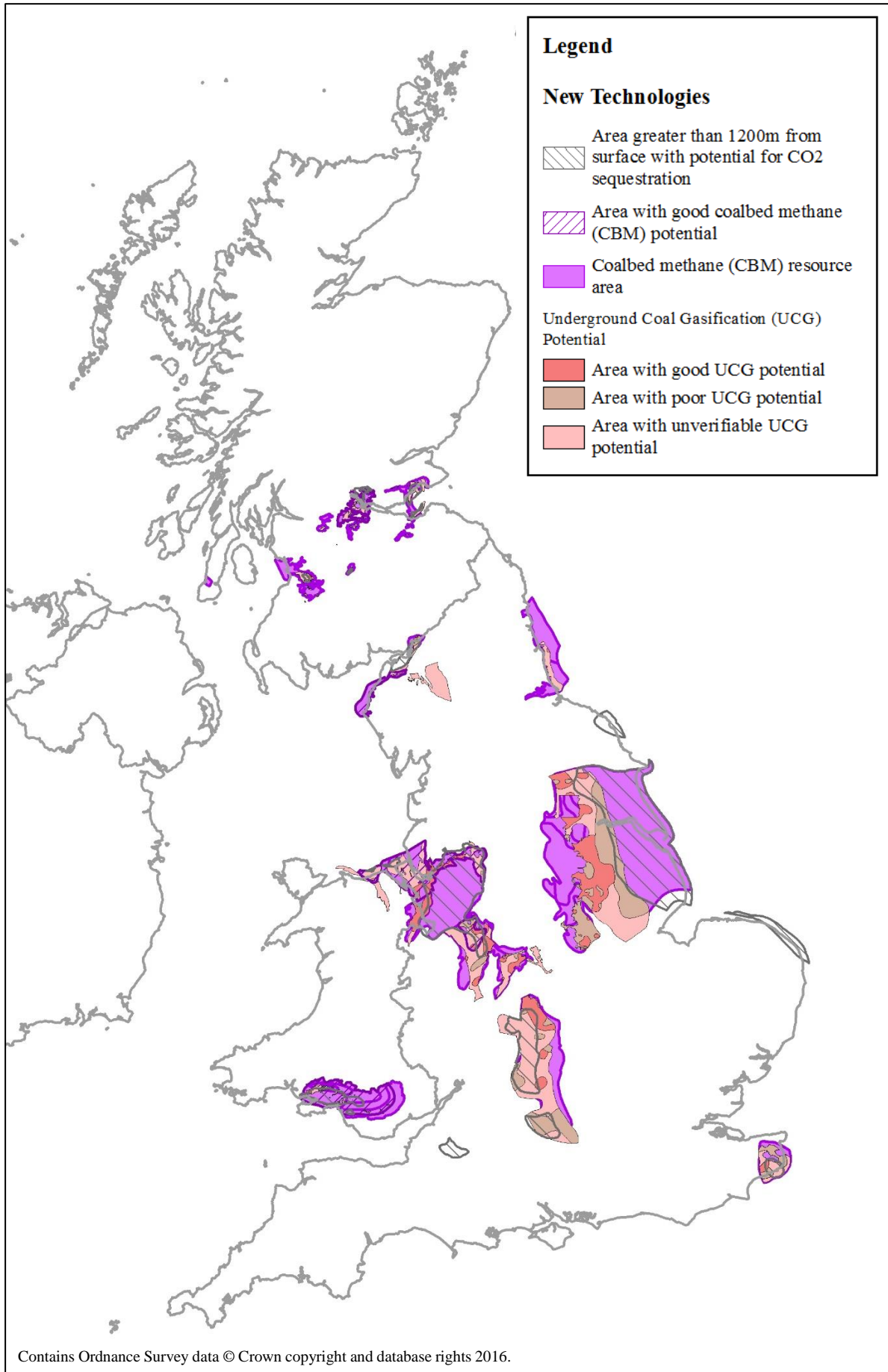


Figure 3 - Data Coverage for New Technologies.

3.6 DATA FORMAT

The Coal Resources for New Exploitation Technologies dataset was created as vector polygons and is available in ESRI shape (.shp) format. Alternative spatial data formats can be prepared but may incur additional processing costs.

3.7 LIMITATIONS

- Coal Resources for New Exploitation Technologies was originally published as a printed cartographic map at 1:600,000, 1: 750,000 and 1: 100,000 scale the data must not therefore be used at larger scales.
- GIS users should note that the original data contained spatial exaggeration and offsetting to enable clarity of printed-paper outputs, these exaggerations and offsets are visible within the GIS converted data.
- Coal Resources for New Exploitation Technologies is based on, and limited to, an interpretation of the records in the possession of The British Geological Survey at the time the maps were created in 2004.
- The original 2004 published maps also included spatial reference to the location of petroleum licences (source DTI 2002), underground mining licences (source Coal Authority 2002) and mineshafts. This data is not a part of the digital release of Coal Resource for New Exploitation Technologies. This information, if required can be sourced from www.gov.co.uk.
- There are areas of uncertainty relating to the resource delineation and the mapping process. Main sources of uncertainty are associated with data availability, data reliability, the presence of faulting and hydrogeology.

4 Licensing Information

To encourage the use and re-use of this data we have made it available under the Open Government Licence (www.nationalarchives.gov.uk/doc/open-government-licence/version/3/), subject to the following acknowledgement accompanying the reproduced BGS materials: "Contains British Geological Survey materials ©NERC [year]".

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