

Review of Availability of Data on Deep Geology in the UK Onshore Area

Environmental Protection Programme Commissioned Report CR/05/017



BRITISH GEOLOGICAL SURVEY

ENVIRONMENTAL PROTECTION PROGRAMME COMMISSIONED REPORT CR/05/017

Review of Availability of Data on Deep Geology in the UK Onshore Area

R.P. Shaw

The National Grid and other Ordnance Survey data are used with the permission of the Controller of Her Majesty's Stationery Office. Ordnance Survey licence number Licence No:100017897/2004.

Keywords

Report; keywords.

Front cover

FMS (left) and BHTV (right) Images with scanned core photograph of fractured Borrowdale Volcanic Group rocks, Sellafield Borehole PRZ1.

Bibliographical reference

R.P. SHAW. 2005. British Geological Survey Commissioned Report, CR/05/017. 25pp.

Copyright in materials derived from the British Geological Survey's work is owned by the Natural Environment Research Council (NERC) and/or the authority that commissioned the work. You may not copy or adapt this publication without first obtaining permission Contact the BGS Intellectual Property Rights Section, British Geological Survey, Keyworth, e-mail ipr@bgs.ac.uk You may quote extracts of a reasonable length without prior permission, provided a full acknowledgement is given of the source of the extract.

© NERC 2005. All rights reserved

Keyworth, Nottingham British Geological Survey 2005

BRITISH GEOLOGICAL SURVEY

The full range of Survey publications is available from the BGS Sales Desks at Nottingham, Edinburgh and London; see contact details below or shop online at www.geologyshop.com

The London Information Office also maintains a reference collection of BGS publications including maps for consultation.

The Survey publishes an annual catalogue of its maps and other publications; this catalogue is available from any of the BGS Sales Desks.

The British Geological Survey carries out the geological survey of Great Britain and Northern Ireland (the latter as an agency service for the government of Northern Ireland), and of the surrounding continental shelf, as well as its basic research projects. It also undertakes programmes of British technical aid in geology in developing countries as arranged by the Department for International Development and other agencies.

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

British Geological Survey offices

Keyworth, Nottingham NG12 5GG

© 0115-936 3241
 Fax 0115-936 3488
 e-mail: sales@bgs.ac.uk
 www.bgs.ac.uk
 Shop online at: www.geologyshop.com

Murchison House, West Mains Road, Edinburgh EH9 3LA

 The matrix
 <thTe matrix</th>
 The matrix
 The matri

London Information Office at the Natural History Museum (Earth Galleries), Exhibition Road, South Kensington, London SW7 2DE

Ŧ	020-7589 4090	Fax 020-7584 8270
Ŧ	020-7942 5344/45	email: bgslondon@bgs.ac.uk

Forde House, Park Five Business Centre, Harrier Way, Sowton, Exeter, Devon EX2 7HU

a 01392-445271 Fax 01392-445371

Geological Survey of Northern Ireland, Colby House, Stranmillis Court, Belfast, BT9 5BF ☎ 028-9038 8462 Fax 028-9038 8461

Maclean Building, Crowmarsh Gifford, Wallingford, Oxfordshire OX10 8BB

a 01491-838800 Fax 01491-692345

Sophia House, 28 Cathedral Road, Cardiff, CF11 9LJ 2 029–2066 0147 Fax 029–2066 0159

Parent Body

Natural Environment Research Council, Polaris House,
North Star Avenue, Swindon, Wiltshire SN2 1EU☎ 01793-411500Fax 01793-411501www.nerc.ac.uk

Executive Summary

This report has been prepared for UK Nirex Limited. It reviews the availability of information on the deep geology of on-shore UK and on recent (post 1980) deep (>1,000m) boreholes.

At regional scales geological and geophysical coverage is comprehensive though uncertainty increases with increasing depth, for example the rock type, and even age, of the pre-Carboniferous basement in eastern England is often unknown. At more detailed scales coverage is patchy or very limited. Recent BGS projects undertaken as part of its DGSM Project have modelled selected areas of the UK at a variety of resolutions and in these areas understanding and visualisation of sub-surface geology is greatly improved. It is intended that this process will continue in future with the eventual objective that the whole of the UK will be modelled to defined standards at a variety of resolutions.

Over the last 30 years the BGS has undertaken a systematic geochemical baseline survey of the UK landmass. To date approximately 75% of the area has been completed, starting in northern Scotland, with eastern and southern England remaining to be surveyed.

The majority of the deep boreholes drilled since 1980 have been drilled for coal or hydrocarbon exploration/development purposes. Relatively few boreholes have been drilled post 1990. All BGS boreholes and the geothermal energy programme boreholes pre-date 1980. The majority of the boreholes for which the records were examined and for which information was recorded were drilled using drilling mud for pressure control (use of blow out protection is not recorded for any of the boreholes examined though this may be because of a lack of recording rather than a lack of installation) with large diameters and multiple casing strings.

Contents

Ex	ecutive Summary	i
Co	ntents	ii
1	Introduction	1
2	Objectives	2
3 3.1	Review of existing BGS Geological, Geophysical and Geochemical Information Geological Data	2
3.2	Geophysical Data	7
3.3	Geochemical Data	12
3.4	Groundwater	13
3.5	3-D Modelling	15
4	Review of Existing Deep Borehole Records	19
5	References	33

1 Introduction

UK Nirex Ltd. (Nirex) is undertaking a Geosphere Characterisation Project which is designed to demonstrate, on the basis of designs and documents, that a programme of geosphere characterisation could be implemented by Nirex, if requested to do so, and that it is practicable to characterise a site for the development and implementation of a phased geological repository facility in UK. The Geosphere Characterisation Project is being conducted to support CoRWM in assessing the viability of the Nirex Phased Geological Repository Concept. Variants to the geosphere characterisation programme designs and documents will also be provided to indicate how the characterisation would vary in the event that, on the basis of a decision by Government of the recommendations of CoRWM, it was decided to develop a near-surface or deep interim storage facility for radioactive wastes rather than proceeding directly towards the development of a phased geological repository facility.

Generic studies previously undertaken by Nirex have indicated that in order to achieve a satisfactory degree of safety and security a geological repository facility would need to be constructed with the waste disposal vaults at a depth of between 300 m and 1000 m below ground level. Some alternative disposal concepts could involve construction of waste disposal vaults at up to 1600 m below ground level. Preliminary assessments, based on precedent practice in Sweden, suggest that geosphere characterisation may be needed to extend to a depth of approximately 1.5 times the planned depth of the disposal vaults. Thus, characterisation may be required to extend to depths of up to around 2.4 km below ground surface.

Nirex envisages that geosphere characterisation at any prospective site will commence with the collection of existing data on the geological succession, hydrochemistry and structure of the area around the site. From these data a descriptive, 3-dimensional geological model will be constructed. Preliminary generic studies suggests that this model will need to cover a rock volume of approximately 20 km by 20 km (centred at the potential site for the disposal facility) and extending to a depth of approximately 2.4 km below ground surface.

This initial geological model, constructed using existing data, will be progressively refined and updated as new data become available during the characterisation programme, for example from geophysical surveys and drilling. The model will also be used to assist in selecting the locations for future boreholes and geophysical surveys.

Initial studies by Nirex, confirmed by preliminary discussions with British Geological Survey, indicates that the extent of the available existing data on the deep geology in the onshore UK is highly variable and that, in areas remote from areas of coal mining and hydrocarbon exploration where potential sites for a phased geological repository facility are likely to be located, there is likely to be limited existing data on the deep geology. As a result, considerable uncertainties are likely to be attached to the definition of the geological succession and structure in these areas prior to any new geophysical surveys or drilling being carried out.

The scope of the task set out in this specification is designed to provide authoritative information on the extent of existing subsurface geological data within the onshore areas of the UK and to provide information on aspects of the ways in which these existing data have been acquired.

2 Objectives

The objectives of this report are to:

- present an overview of the extent and reliability of the existing subsurface information on the geological succession and geological structures within the onshore areas of UK within a depth range of 1.0 to 2.4 km below ground surface; and
- provide information from existing recent (post 1980), deep (> 1000 m depth) boreholes drilled in onshore areas of the UK to permit Nirex to review this information in relation to practical aspects of drilling further deep boreholes.

3 Review of existing BGS Geological, Geophysical and Geochemical Information

This section reviews the extent of the existing geological, geophysical, geochemical and hydrogeological data in the BGS archives and provides an assessment of the level of detail and reliability of these data in providing indications of geological succession, hydrochemistry and structure at a depth of between 1 km and 2.4 km in different parts of onshore UK. The work undertaken by Nirex in the Sellafield and Dounreay areas as their geological evaluations of these two sites is not included in this report.

Information on deep geology in the UK is patchy and is largely associated with the exploration for or the exploitation of energy resources. At regional scales coverage is fairly complete but at more detailed scales information is only available in selected areas. Similarly, with increasing depth certainty decreases. For example, pre-Carboniferous basement rock types, and even age, are largely unknown in much of eastern England though their structure is better understood (Pharaoh et al; 1995) and, while the extent of known or possible Devonian rocks below East Anglia has been determined by geophysical investigation and limited borehole information (Allsop; 1985) and the basement structure in this area as a whole are defined geophysically (Cornwell et al; 1996), the distribution of pre-Permian rocks is largely unknown. In coalfields and areas that have been explored for hydrocarbon resources better information is available than elsewhere. Outside these areas deeper geological understanding is based on limited information from boreholes, from patchy records from old, mainly metalliferous, mining activity, more recent or active iron ore and potash mining, occasional seismic surveys and the interpretation of regional geophysical survey data. This section of the report provides information on the extent of existing subsurface geological data within the onshore areas of the UK and provides information on aspects of the ways in which these existing data have been acquired.

An overview of the principal sources of existing subsurface information relating to the geological succession and geological structures within the onshore areas of UK within a depth range of 1.0 to 2.4 km below ground surface are provided in the following sub-sections of this report. In addition to these sources, about 1500 boreholes with depths greater than 1000 metres have been drilled in onshore areas of the UK, mainly in England, over the last 150 years. Many these boreholes provide point information on subsurface geology and some of which have geophysical logs that are held by the BGS. Further information on some of these deep boreholes is provided in section 4 below.

3.1 GEOLOGICAL DATA

Understanding of surface and near surface geology is good. Figure 1 shows the age of bedrock at rockhead (below drift cover) for the whole of the UK. Most BGS geological mapping is

undertaken at a scale of 1:10,000 (formerly 1:10,560) and UK coverage is shown in Figure 2. Large amounts of information are frequently available from shallow borehole, excavations and quarries etc to enhance the information obtained by mapping. In general, reasonably high confidence in geological 'models' is achieved to depths of 200 to 500 metres depending on the nature of the area. In areas of particularly complex structure, for example large parts of Scotland and Mid and North Wales, to somewhat less than this depth. In mined coalfields and hydrocarbon fields this level of understanding may extend to depths in excess of 1000m (in coalfields) and 2000m (in some hydrocarbon fields).



Figure 1: Age of bedrock at rockhead (from Jackson; 2004)



Figure 2: Coverage of BGS 1:10,000 and 1:10,560 mapping. Note that most of this data is not available digitally except in a few, mainly urban, areas including London within M25. (Source; GDI)

BGS mapping has not been completed in a few map sheets in Mid Wales (currently in progress) and parts of the Scottish Highlands has been mapped at a primary scale of about 1:50,000 rather

than 1:10,000. Figure 3 shows the availability of 1:50,000 geological data. This data is available in seamless digital form as well as printed paper maps, the boundary grid is shown in the figure. The map sheets indicated as not complete (pink) in Scotland have solid geology completed but not superficial (drift) maps.



Figure 3: Coverage of BGS 1:50,000 scale mapping (pink sheets in Wales have not been mapped at this scale; the three pink sheets in N. England and Scotland are available with solid geology but not superficial (drift) geology). (Source; GDI)

3.2 GEOPHYSICAL DATA

Extensive on-shore seismic reflection surveys, mainly in England, have been conducted during the last 30 years, though particularly in the 1980's and early 1990's, for hydrocarbon exploration (Figure 4) and coal exploration (Figure 5). The areas of interest for hydrocarbon resources include most of the areas of interest for coal resources. It is important to note that large coalfield areas that were already well known before the widespread introduction of seismic surveying, for example most of the South Wales, Lancashire and Northumberland coalfields, do not have coverage. Figure 6 shows the extent of UK coalfields, including Tertiary lignite deposits, and shows areas that are considered to have potential for the exploitation of energy resources by extraction of coal bed methane or in situ gasification. To date there has not been widespread development of the former, though some methane is produced by methane drainage in advance of coal extraction, and pilot trials of the later technology are currently being considered.



Figure 4: Coverage of seismic reflection surveys undertaken for hydrocarbon exploration purposes (Source; GDI)

Figure 5: Coverage of seismic reflection surveys undertaken for coal exploration purposes (Source; GDI)



Figure 6: UK Coalfields including lignite resources and areas considered suitable for in situ exploitation of energy resources. (from Jackson; 2004)

Seismic refraction surveys have provided information on moderately deep structure in some areas, for example in the Midland Valley of Scotland as well as in a number of other basins with important coal or potential hydrocarbon resources. Seismic refraction studies, utilising natural seismic events, have been helpful in determining very deep geological structure, such as the Moho and major crustal discontinuities.

The whole of the UK has basic coverage of geophysical data. Airborne radiometric and magnetic (Figure 7) field surveys have country-wide coverage at flight line spacing of 5 to 15 km. The latter data provides broad information on deep geology such as deep intrusions. The former is a surface, or very near surface, mapping of the distribution of radioactivity that can help in understanding surface geology.

Gravity information (Figure 8) has been collected with a measurement station density of 1 to 2 stations per km^2 . The data provide broad information on buried high and low density rocks, such as granitic intrusions.

The BGS has flown two high-resolution airborne surveys in the past few years. The first of these, HiRES-1 (**Hi**gh resolution airborne **R**esource and **E**nvironmental **S**urvey, phase **1**) covered an area of 14,000km² (50,000 line kilometres) of the English midlands and was completed in 1998. Figure 9 shows the comparison between the recent aeromagnetic data in the Derbyshire Dome area and the results of an earlier, nation-wide survey carried out in the 1950s and 1960s. This area includes shallow volcanic rocks and the increased resolution and fine detail revealed by the HiRES-1 data is remarkable. Clearly such surveys offer a rapid and cost efficient means of preliminary structural mapping in areas with favourable geological conditions in which are significant magnetic signatures to the various rock types present. Figure 10 shows the current coverage of high resolution airborne geophysical surveys. BGS is co-owner of a survey aircraft equipped for this type of survey and further surveys are planned to greatly extend the coverage.

BGS holds other potentially useful geophysical information about deep geology, such as heat flow (derived from borehole measurements - Figure 11).



Figure 7: UK Magnetic Anomaly Map (from Jackson; 2004)



Figure 8: UK Gravity Anomaly Map (from Jackson; 2004)



Figure 9: The comparison between conventional (left) and high resolution (right) aeromagnetics, shows much increased detail in an area of shallow volcanics (Source; HiRES)



Figure 10: Coverage of high resolution geophysical surveys. (Source; GDI)



Figure 11: Heat flow can be used to predict rock temperatures at depth (from Jackson; 2004).

3.3 GEOCHEMICAL DATA

BGS has an ongoing programme (G-BASE) to characterise the geochemical baseline of the UK. About 75% of the country has now been surveyed, commencing in Northern Scotland in the early 1970s. Figure 12 shows the extent of completed work using one element (uranium in stream waters) as an example. Current sampling and analytical programmes are in the East Midlands/East Anglia areas. A comprehensive suite of elements and other determinands, such as pH, is acquired for stream waters and stream sediments and, mainly in England and Wales, soils. With time analytical methods have improved, in particular with better detection limits than were achieved early in the programme. Rigorous sampling, analytical and data handling procedures ensure that all the data are comparable. Sample density is approximately 1 sample per 1.5 km^2 in rural areas and 2 samples per 1 km² in urban areas.

While the stream sediment and soil data only reflect surface/very near surface geology the stream water data will provide some information on groundwater chemistry.

BGS has a limited amount of borehole derived hydrogeochemical data of varying quality and vintage.



Figure 12: Uranium in stream water showing current extent of BGS geochemical survey (from Jackson, 2004).

3.4 GROUNDWATER

BGS maintains a database of water wells and springs (Wellmaster) and data derived from this includes maps of piezometric surfaces, including water table elevations (using information from over 2000 boreholes) (Figure 13).



Figure 13: Groundwater levels, England and Wales (from Jackson, 2004)

3.5 3-D MODELLING

For the past 5 years the BGS has had a project (Digital Geoscience Spatial Model – DGSM) to develop software and procedures for the 3D modelling of UK geology. The DGSM links together geological models visualised in 3-dimensions, with the data that was used to create them, the thinking behind the building of the model and the conclusions that can be drawn from the modelling.

Models may be constructed from mapped geological lines, borehole interpretations, isopach/isochor contours, cross-sections derived from seismic and other geophysical interpretations, as well as including the geoscientific intuition (controlled by 'interpretative' or 'phantom' points. They are not necessarily 'solid' or volumetric models, but might show borehole traces, cross-sections and surfaces – but visualised in 3D, these can have real impact on 3-D understanding. They might represent lithostratigraphic units (the extension of the geological map into 3-dimensions), mineralised bodies and mine-workings, physical properties and fluid-flow models. Parts of the model might be attributed to include geological boundary type, fault style and sense of movement. Volumes might be attributed to include lithological, chrono- and lithostratigraphical, physical, geotechnical and hydrogeological properties. In addition, information on data quality, methodology, context and provenance is included.

The primary aim of the DGSM project has been to develop software, systems and methodology for building 3-dimensional models. As part of the project, primarily as a means of testing methodology and systems, various pilot projects have been completed. These projects have used a variety of 3-D modelling software packages including earthVision, Vulcan, GoCAD, and GSI3D. They are listed in Table 1 below, together with broad information on resolution and depth modelled, and their extent shown in Figure 14. To illustrate the results of these pilot studies perspective views of two models are given in Figures 15 (the Wessex Basin) and 16 (UK Model). These models were constructed at different resolutions, the Wessex basin at 1:250,000 and the UK at 1;1,000,000. The pilot projects have produced models at a range of resolutions including 1:10,000, 1:50,000, 1:250,000, and 1:1,000,000. The areas modelled were selected to be representative of the main British geological environments and of the different levels of data availability and the modelling has not been done systematically for the whole UK but given enough resources much of the UK could be modelled. The BGS is starting a new five year programme in April 2005 and a key aspect of this programme is the systematic production of 3-D models and the management of the models and related data to standards defined by the DGSM Project. It is, however, likely to be several decades before complete detailed model coverage of UK geology is achieved.

Traditionally, geological field observations were recorded using pencil, paper field slip and a notebook. This analogue information was subsequently digitised when the geologist was satisfied with the completed paper map. However, as digital methods are introduced into the mapping process data are transferred between analogue and digital formats several times resulting in inherent inefficiency. In an effort to improve the mapping workflow the BGS instigated SIGMA (System for Integrated Geospatial MApping) to investigate and produce effective digital alternatives to analogue routines. The SIGMA project has been run in conjunction with the DGSM and standard digital field mapping methodology and tool kit for all BGS fieldwork is now being rolled out.



Figure 14: Extent of 3-D geological models created during the DGSM Programme. Note that the models with the larger extents will be at lower resolution than those with smaller extent.

Model	Approximate Resolution	Depth modelled	Description
Cheshire Basin	1:250,000	5km	To model the Cheshire Basin, to the base of the Permo-Triassic, based on the multi-disciplinary project that investigated the deep structure and processes that drove the accumulation of minerals & hydrocarbons in the Cheshire Basin reported in 1999.
SE England	1:100,000	2km	High quality models of the Mesozoic and younger strata of SE England Includes models of the chalk (Yorkshire to Dorset – Figure 15), the Weald and London Gateway.
Midland Valley	1:10,000	1km	Systematic development of detailed models of key stratigraphic units mostly of Upper Palaeozoic coal- bearing strata in the onshore & offshore of this Upper Palaeozoic terrain.
Atlantic Margin	1:500,000	3km	Development of models at a regional resolution for the UK Continental Shelf covered by the NE Atlantic. This is a poorly understood region, parts of which are being actively explored for hydrocarbons resources.
Humber Estuary	1:25,000	10's m	Models of the Quaternary and Holocene succession of this active estuary. Focused on the coastal and glacial deposits and assess their role in interacting with shallow aquifers.
UK	1:1,000,000	50km	A low resolution model of the UK showing key geological surfaces (Figure 16)
Nottingham - Melton	1:50,000	1km	Development of models based on the recent geological mapping, seismic reflection and borehole data from two map sheets 12 key surfaces modelled. Resolution of model decreases with depth
West Midlands	1:100,000	2km	Comprehensive earthVision and GoCAD models of an area of the West Midlands underlain by Permo- Triassic rocks, including key stratigraphic information and groundwater levels and water quality data.
Glen Lochy	1:50,000	1km	Model of a small part of the Tay Nappe complex to establish methodology for modelling in structurally complex areas.
East Anglia	1:10,000	10's m	Model of Quaternary sediments over an area of 8 1:10k map tiles with a focus on aggregate resources.
Lake District	1:100,000	3km	Construction of models from poorly constrained data sets from the structurally deformed terrain of the Lower Palaeozoic volcanic succession and underlying batholith of the English Lake District.
Central Wales	1:50,000	2km	Model of part of the central Wales area (Builth Wells)

Table 1: Summary of DGSM Pilot Population projects.



Figure 15: Model of the chalk (green) and Tertiary sediments (brown) of the Wessex Basin (looking west).



Figure 16: Perspective view of 3-D UK model (lowest (purple) layer is the Moho, granites in red, major faults dark grey)

4 Review of Existing Deep Borehole Records

The purpose of this review is to collate information from existing, recently drilled deep boreholes (1000 m depth or deeper) that have been drilled in onshore areas of the UK to enable Nirex to review these data. Information has been assessed on:

- location
- hole depth (vertical depth and drilled length);
- hole diameter;
- geological sequence penetrated;
- extent of coring undertaken, with core diameters;
- date drilled;
- length of time required to complete the drilling of the borehole;
- depth of casing;
- name of company undertaking the drilling and client;
- type of drilling rig used; and
- an indication of the nature of any pressure controls systems used during the drilling.

A query was run on the BGS Single On-Shore Borehole Database (SOBI) to identify all boreholes with depths reported to be greater that 1000m. SOBI is an index of over one million boreholes (including a few springs and trial pits) the records of which have been notified to the BGS. There are legal requirements for BGS to be notified about the drilling of any boreholes for water abstraction and mineral exploration (including exploration for and development of hydrocarbon resources) and the BGS is a non-statutory repository for information on boreholes drilled for many other purposes, however they are not notified of all boreholes drilled. As well as the index, BGS holds records on most of the indexed boreholes and these have recently been scanned and are now held digitally. It also holds additional information on many boreholes including core logs, geophysical logs, analytical information and core photographs but this information is held on the media that it was supplied on (mainly hard copy). As well as the records the BGS retains over 220 km of borehole core from over ten thousand boreholes. The result of the SOBI query was a list of nearly 1500 boreholes drilled since 1854 and Figure 17 shows the distribution of these boreholes (small black dots). For the purposes of this study the list was reduced to those boreholes with reported drilling dates post 1980. In areas with multiple deep boreholes, such as oil field developments, only one borehole was selected, on the basis of a combination of depth, availability of information and age, for review. This selection process reduced the list for more detailed review to about 180 boreholes. For each of these the scanned borehole records were examined. The weighting introduced by the date cut off biases the sample to England, though the overall sample is similarly biased. A quick examination of records in under-represented areas suggests that the information required for this study is not available and wider coverage at earlier drilling date was not pursued further. Another factor in using a post 1980 data set is that the majority of deep boreholes were drilled for hydrocarbon exploration/exploitation with a few of the earlier ones being drilled for coal. The boreholes drilled by Nirex at Sellafield and Dounreay have not been included (though these boreholes have the highest specification of any deep boreholes drilled in the UK).

The digital borehole records of this shortlist were all examined and the list reduced to 67 boreholes (Table 2) by rejecting boreholes with minimal information on the logs, boreholes where the digital log was not available or incomplete and boreholes that were drilled from other boreholes or from underground sites. In Table 2 all depths have been converted to metres though

bit diameters and casing sizes have been reported in the units used in the original record. NR = Not Recorded and N/A = Not Applicable. Table 3 provides a summary of the key information contained in Table 2.



Figure 17: Location of all boreholes greater than 1000m drilled depth (small black dots) and the boreholes listed in Table 2 (larger red dots) (source – SOBI).

BGS Registration No	Borehole Name	Easting	Northing	Depth Drilled m	TVD m	Diameter (Drill bit)	Geological sequence penetrated	Coring	Core Diameter	Date Drilled	Drilling Duration	Casing Depths	Drilling Company	Drilled for	Type of Rig	Pressure controls
NY37SE 3	Becklees	335166	571578	1370.00	1370.00	NR	Triassic to Carboniferous (Coal Measures)	NR	NR	04/08/1982	76 days	NR	Foraky Ltd	National Coal Board N.C.B.	NR	NR
NZ19SW 6	Long Horsley 1	414442	592553	1828.80	NR	NR	Carboniferous (Coal Measures to Namurian?)	2 sidewall cores only	NR	10/07/1986	52 days	18 5/8" to 74.1m, 13 3/8" to 294.7m and 9 5/8" to 1204.6m	Houlder Marine	Candecca Resources Ltd.	Rig 2	NR
SE50SW 64	Warmsworth 1	453940	401240	1605.69	NR	NR	Permian/ Carboniferous (Coal Measures to u. Namurian)	NR	NR	1982	NR	18 5/8" to 87.5m, 13 3/8" to 476.1m and 9 5/8" to 692.2m	NR	Rio Tinto Zinc	NR	NR
SE55NE 53	Clifton Airfield No.2	458293	455484	1053.00	NR	NR	Triassic/ Permian / Carboniferous (Coal Measures)	Spot cored though coal seams	NR	22/04/1985	25 days	NR	Foraky Ltd	NCB/British Coal	NR	NR
SE64SE 20	East Lodge	469019	440612	1138.18	NR	NR	Triassic/ Permian / Carboniferous (Coal Measures)	Spot cored though coal seams	NR	Oct-90	~25 days	NR	BDF	British Coal	NR	NR
SE73SW 10	Breighton Surf. Bh. (Lund Lane)	470560	433046	1133.00	NR	NR	Triassic/ Permian / Carboniferous (Coal Measures)	Spot cored though coal seams	NR	1980	NR	9 5/8" to 31.4m	Boldon	National Coal Board N.C.B.	NR	NR
SE91SW 465	Crosby Warren 2	491187	412908	2,050.00	NR	NR	L. Jurassic/ Triassic/ Carboniferous (Coal Measures to Namurian)	8 spot cores 1636 to 1897m	NR	12/05/1988	28 days	20" to 47m, 13 3/8" to 75.3m and 9 5/8" to 1166m	Kenting	Elf Oil and Gas	Rig 31E	Oil based mud
Table 2:	Borehole	data fi	rom rec	ently dr	illed (p	ost 1980)) on-shore	borehole	s							

Frbistock	334767	343213	1000 10			1						1 2			
			1888.40	1860.60	NR	Carboniferous (Coal Measures to Carb. Lst.)	?spot	NR	07/04/1986	40 days	13 3/8" to 66.5m and 9 5/8" to 720.4m	Kenting	British Petroleum	Rig 21	NR
Sealand 1 Also Known As Yew Tree Farm	336760	368160	1074.00	NR	NR	NR	NR	NR	09/03/1992	30 days	9 5/8" to 306.3m and 7" to 1075.0m	BDF	NR	Rig 5	Water/bento nite to 306.3m then loe Ph polymer to TD
layfield Farm Vidnes	354321	388514	1132.00	NR	NR	Triassic/ Permian / Carboniferous (Coal Measures)	NR	NR	26/09/1989	48 days	NR	BDF	National Coal Board N.C.B.	NR	NR
Burford 1	363831	354119	1208.23	NR	17 1/2" to 184.4m, 12 1/2" to 579.1m and ~8" to 1208.23 m	Triassic (Mercia Mudstone and Sherwood Sandstone Groups)	?spot	NR	16/10/1987	19 days	20" to 17.1m, 13 3/8" to 152.7m and 9 5/8" to 566.9m	Kenting	Shell	Rig 31E	KCI/Polymer
Cawley Farm	366271	395281	1525.17	NR	NR	Triassic/ Permian / Carboniferous (Coal Measures)	Spot	NR	22/09/1988	44 days	9 5/8" to 43.5m	BDF	NCB	NR	NR
Elworth 1	373137	361733	1421.89	NR	17 1/2" to 227.4m, 12 1/4" to 794.6m and 8 1/2" to 1421.89 m	Triassic (Mercia Mudstone and Sherwood Sandstone Groups)	Spot 1115.3 to 1128.4m	NR	19/06/1988	19 days	30" to 11m, 20" to 39.3m, 13 3/8" to 226.5m and 9 5/8" to 781.2m	KCA	Mobil North Sea Ltd	Rig 84	water/ brine
Nasa laavi lau laavi lau	so Known Yew Tree rm ayfield Irm idnes Irford 1 awley Irm	so Known Yew Tree rm ayfield irm idnes irford 1 363831 awley irm worth 1 373137	so Known Yew Tree rm 354321 388514 irm idnes 354321 388514 irm idnes 363831 354119 wley irm 366271 395281 worth 1 373137 361733	so Known Yew Tree rm 354321 388514 1132.00 ayfield irm idnes 354321 388514 1132.00 irford 1 363831 354119 1208.23 awley irm 366271 395281 1525.17 worth 1 373137 361733 1421.89	So Known Yew Tree rm 354321 388514 1132.00 NR ayfield Irm idnes 354321 388514 1132.00 NR irford 1 363831 354119 1208.23 NR awley Irm 366271 395281 1525.17 NR worth 1 373137 361733 1421.89 NR	so Known Yew Tree rm 354321 388514 1132.00 NR NR ayfield Irm idnes 354321 388514 1132.00 NR NR NR irford 1 363831 354119 1208.23 NR 17 1/2" to 184.4m, 12 1/2" to 579.1m and ~8" to 1208.23 m awley Irm 366271 395281 1525.17 NR NR worth 1 373137 361733 1421.89 NR 17 1/2" to 227.4m, 12 1/4" to 794.6m and 8 1/2" to 1421.89 m	so Known Yew Tree rmYew Tree rmTriassic/ Permian / Carboniferous (Coal Measures)ayfield rm idnes3543213885141132.00NRNRTriassic/ Permian / Carboniferous (Coal Measures)irford 13638313541191208.23NR17 1/2" to 184.4m, 12 1/2" to Triassic Mudstone and S79.1m and ~8" to 1208.23 m17 1/2" to Sandstone Groups)Triassic Mudstone and Sherwood Sandstone Groups)iwley irm3662713952811525.17NRNRTriassic/ Permian / Carboniferous (Coal Measures)iwley irm3731373617331421.89NR17 1/2" to 227.4m, 12 1/4" to 794.6m and 8 1/2" to 1421.89 m17 1/2" to Triassic (Mercia and 8 1/2" to 1421.89 m	so Known Yew Tree rmYew Tree rmImage: So Known Yew Tree rmTriassic / Permian / Carboniferous (Coal Measures)NRinford 13638313541191208.23NR17 1/2" to 1208.23Triassic Measures)?spotinford 13638313541191208.23NR17 1/2" to 12 1/2" to Mudstone and 579.1m and ~8"Triassic Serwood Sandstone Groups)?spotinford 13662713952811525.17NRNRTriassic/ Permian / Carboniferous (Coal Measures)Spotinford 13731373617331421.89NR17 1/2" to 12 1/4" to 794.6m Sherwood Sandstone (Goal Measures)Spot 1115.3 to 1128.4m	so Known Yew Tree rm3543213885141132.00NRNRTriassic/ Permian / Carboniferous (Coal Measures)NRNRinford 13638313541191208.23NR17 1/2" to 1208.23Triassic (Mercia 12 1/2" to Mudstone and S79.1mSpotNRweley irm3662713952811525.17NRNRTriassic (Coal Measures)SpotNRwerth 13731373617331421.89NR17 1/2" to 1208.23 mTriassic (Mercia 1208.23 mSpotNRworth 13731373617331421.89NR17 1/2" to 1421.89 mTriassic (Mercia 127.4m, (Mercia 127.4m, (Mercia 127.4m, (Mercia 128.4mSpotNRm112.1/4" to Mudstone and 579.1mNR17 1/2" to 1421.89 mSpotNR	so Known Yew Tree m So Known Yew Tree m Name Triassic/ Permian / Carboniferous (Coal Measures) NR NR NR 26/09/1989 uyfield rm idnes 354321 388514 1132.00 NR NR Triassic/ Permian / Carboniferous (Coal Measures) NR NR 26/09/1989 urford 1 363831 354119 1208.23 NR 17 1/2" to 184.4m, 12 1/2" to Mudstone and 579.1m and -8" Triassic Sherwood and -8" Spot NR 16/10/1987 uwley rm 366271 395281 1525.17 NR NR Triassic/ Permian / Carboniferous (Coal Measures) Spot NR 22/09/1988 worth 1 373137 361733 1421.89 NR 17 1/2" to 12/2" to Massures) Spot NR 19/06/1988 1/2" to 1421.89 m NR 17 1/2" to 1421.89 m Sherwood Sandstone Measures) Spot NR 19/06/1988	so Known Yew Tree m So Known Yew Tree m So Known Yew Tree m So Known (Measures) NR NR NR NR NR NR So Known Permian / Carboniferous (Coal Measures) NR NR NR 26/09/1989 48 days Irford 1 363831 354119 1208.23 NR 17 1/2" to 184.4m, 12 1/2" to 1208.23 m Triassic Measures) ?spot NR 16/10/1987 19 days wley Irm 366271 395281 1525.17 NR NR Triassic 1208.23 m Spot Nerwood and 8 to 1208.23 m Spot Sandstone Groups) Spot Sandstone Groups) NR 22/09/1988 44 days wrm 366271 395281 1525.17 NR NR Triassic 227.4m, Measures) Spot Spot Sandstone Groups) NR 12/06/1988 19 days worth 1 373137 361733 1421.89 NR NR 17 1/2" to 127.4m, M Triassic 227.4m, M Spot Sandstone Groups) NR 19/06/1988 19 days	so Known Yew Tree m So Known Yew Tree m So Known Yew Tree m So Known So Known So Known S	so Known rm So Known (Mercia 12 NZ So Known (Mercia 12 NZ So Known (Mercia 12 NZ NR NR Triassic/ Permian / Carboniferous (Coal Measures) NR NR 26/09/1989 48 days NR BDF Inford 1 363831 354119 1208.23 NR 17 1/2' to 12 NZ' to Mudstone and Sandstone to m ?spot NR 16/10/1987 19 days 20" to 17.1m, 13 3/8" to 152.7m and 9 5/8" to 566.9m weley irm 366271 395281 1525.17 NR NR Triassic 1208.23 m Spot m NR 22/09/1988 44 days 9 5/8" to 43.5m BDF worth 1 373137 361733 1421.89 NR 17 1/2" to 1421.99 m Triassic permian / Carboniferous (Coal Measures) Spot NR 19/06/1988 19 days 30" to 11m, 23.5m KCA 22.6.5m and 9 5/8" to 781.2m	so Known rm Set Image: solution of the set	sio Known rm Sew Tree m Sew Tree to 1075.0m NR NR NR Sew Tree to 1075.0m NR Sew Tree to 1075.0m Sew Tree tree to 12.00.2m Sew Tree to 12.00.2m Sew Tree to 12.00.2m Sew Tree tree to 12.00.2m Sew Tree tree to 12.100 Sew Tree tree to 12.100 Sew Tree tree tree to 12.100 Sew Tree tree tree tree to 12.100 Sew Tree tree tree tree tree tree Sew Tree tree tree tree Sew Tree tree tree tree tree Sew Tree tree tree tree Sew Tree tree tree tree Sew Tree tree tree Sew Tree tree tree Sew Tree tree tree Sew Tree tree tree Sew Tree tree Sew Tree tree Sew Tree tree Sew Tree tree Sew Tree tree Sew Tree Sew Tree tree Sew Tr

BGS Registration No	Borehole Name	Easting	Northing	Depth Drilled m	TVD m	Diameter (Drill bit)	Geological sequence penetrated	coring	Core Diameter	Date Drilled	Drilling Duration	Casing Depths	Drilling Company	Drilled for	Type of Rig	Pressure controls
SJ79NW 73	Cutnook	371810	396285	1568.00	NR	NR	Triassic/ Permian / Carboniferous (Coal Measures)	Spot	NR	16/11/1988	61 days	9 5/8" to 46.1m	BDF	National Coal Board N.C.B.	NR	NR
SJ83NE 152	Beechcliffe	385636	339243	1207.73	NR	NR	?/ Coal Measures/ ?	NR	NR	Mar-89	~40 days	9 5/8" to 46.1m	BDF	NCB	NR	NR
SJ84SW 150	Little Paddocks	381530	340999	1440.80	NR	NR	Triassic/ Carboniferous (Coal Measures)	799 to 1173.5m	NR	Mar-86	~60 days	9 5/8" to 26.5m	British Drilling	British Coal	NR	NR
SJ96NW 13	Bosley 1	393438	367825	2006.40	NR	NR	Carboniferous (Coal Measures to Carb. Lst.)	Spot	NR	01/06/1986	70 days	18 5/8" to 36.4m, 13 3/8" to 337.7m and 9 5/8" to 1089m	Kenting	British Petroleum	Rig 21	Mud
SK10SW 96	Hungry Lane Borehole	413754	304069	1223.00	NR	NR	Triassic/ Carboniferous (Coal Measures)/ ?Basement	None?	N/A	Feb-80	~60 days	NR	Kenting	NR	NR	NR
SK52NW 72	Ratcliffe On Soar	450818	329125	2242.00	NR	NR	Triassic/ Carboniferous (Namurian to Carb. Lst.)	Spot	NR	22/07/1986	39 days	18 5/8" to 32.42m, 13 3/8" to 256.4m and 9 5/8" to 1100m	Kenting	British Petroleum	Rig 36	NR
SK59NW 45	Nearcliff Quarry Bh	452701	399381	1091.69	NR	NR	Permian/ Carboniferous (Coal Measures)	?spot	NR	Mar-83	~40 days	10 3/4" to 42.7m and 7" to 323.7m	Foraky Ltd	National Coal Board N.C.B.	NR	NR

BGS Registration No	Borehole Name	Easting	Northing	Depth Drilled m	TVD m	Diameter (Drill bit)	Geological sequence penetrated	coring	Core Diameter	Date Drilled	Drilling Duration	Casing Depths	Drilling Company	Drilled for	Type of Rig	Pressure controls
SK63NE 74	Saxondale 1	467746	339308	1058.00	993.10	NR	Triassic/ Permian / Carboniferous (Coal Measures to Carb. Lst.)	Spot	NR	01/03/1986	15 days	13 3/8" to 26.6m and 9 5/8" to 382.98m	Kenting	BP	Rig 20	Mud
SK63SE 33	Kinoulton 1	469224	330114	1490.20	NR	NR	L. Jurassic/ Triassic/ Permian / Carboniferous (Coal Measures to Carb. Lst.)	Spot	NR	24/11/1985	26 days	18 5/8" to 40m, 13 3/8" to 343m and 9 5/8" to 893m	Kenting	BP	Rig 36E	Mud
SK67NW 41	Manton	461351	379473	1590.00	NR	NR	Triassic/ Permian / Carboniferous (Coal Measures to Carb. Lst.)	Spot	NR	28/05/1985	26 days	13 3/8" to 94m and 9 5/8" to 674m	Kenting	British Petroleum	Rig 12	Mud
SK68NW 46	High House Farm Ranskill	464912	387559	1032.89	NR	NR	Triassic/ Permian / Carboniferous (Coal Measures)	Cored through Coal Measures	NR	1985	NR	NR	Foraky Ltd	National Coal Board N.C.B.	NR	NR
SK69SE 56	Scaftworth 2	467178	392280	2326.00	NR	NR	Triassic/ Permian / Carboniferous (Coal Measures to Carb. Lst.)	?spot	NR	Feb-82	~40 days	13 3/8" to 235m, 9 5/8" to 1098m and 7" to 1433.5m	Kenting	British Petroleum	NR	NR
SK72NW 13	Long Clawson 2	472452	325658	1450.00	NR	NR	L. Jurassic/ Triassic/ Carboniferous (Coal Measures to Carb. Lst.)	Spot	NR	12/02/1986	36 days	13 3/8" to 70.3m, 9 5/8" to 497m, 5 1/2" to 639m and 4 1/2" to 1050m	Boldon	BP	Rig 41	Mud
Table 2:	Borehole	data fi	rom rec	ently dr	illed (p	ost 1980)) on-shore	borehole	es (conti	inued)						

BGS Registration No	Borehole Name	Easting	Northing	Depth Drilled m	TVD m	Diameter (Drill bit)	Geological sequence penetrated	coring	Core Diameter	Date Drilled	Drilling Duration	Casing Depths	Drilling Company	Drilled for	Type of Rig	Pressure controls
SK72NW 34	Long Clawson C2	472707	325405	1032.00	NR	NR	NR	NR	NR	05/01/1991	NR	13 3/8" to 30m	NR	Pentex Oil Limited	NR	Water
SK73SE 70	Plungar 31	476964	331787	1083.00	991.60	NR	L. Jurassic/ Triassic/ Permian / Carboniferous (to top Carb. Lst.)	Spot	NR	18/09/1986	45 days	140mm to 40m, 98mm to 492.6m and 74mm to 990.6m	NR	British Petroleum	Microdrill MD3	NR
SK74NW 10	Fiskerton 1	473546	349826	1110.00	NR	NR	Triassic/ Permian / Carboniferous (to top Carb. Lst.)	Spot	NR	09/10/1985	17 days	13 3/8" to 53.5m and 9 5/8" to 339m	Kenting	British Petroleum	Rig 26	NR
SK76NE 73	Egmanton 68	475759	368224	2162.50	2124.10	NR	Triassic/ Permian / Carboniferous (to top Carb. Lst.)	Spot through reservoirs	NR	03/06/1980	56 days	13 3/8" to 61m, 9 5/8" to 822m and 7" to 1124m	Kenting	British Petroleum	Rig 12	NR
SK77SE 10	Wimpton Moor	478495	373827	1022.00	NR	NR	Triassic/ Permian / Carboniferous (Coal Measures)	Spot	NR	Sep-86	~30 days	NR	British Coal	British Coal	NR	NR
SK77SW 40	Farleys Wood 4	470500	371939	1156.30	NR	NR	Triassic/ Permian / Carboniferous (Namurian)	Spot	NR	08/04/1984	13 days	13 3/8" to 34m, 9 5/8" to 386m and 5 1/2" to 1154m	Kenting	British Petroleum	Rig 26	NR
SK79SW 22	Everton 1	470175	392959	2072.64	NR	NR	Triassic/ Permian / Carboniferous (Namurian and ?Carb. Lst.)	Spot	NR	05/11/1988	30 days	20" to 36.6m, 13 3/8" to 258.5m and 9 5/8" to 744.0m	Boldon	Enterprise	Rig 81	NR
Table 2:	Borehole	data fi	rom rec	ently dr	illed (p	ost 1980)) on-shore	borehole	es (conti	inued)			•	•		

BGS Registration No	Borehole Name	Easting	Northing	Depth Drilled m	TVD m	Diameter (Drill bit)	Geological sequence penetrated	coring	Core Diameter	Date Drilled	Drilling Duration	Casing Depths	Drilling Company	Drilled for	Type of Rig	Pressure controls
SK86SW 112	Collingham 1	481333	363190	1051.56	NR	NR	Triassic/ Permian / Carboniferous (to top Carb. Lst.)	None	N/A	06/03/1987	15 days	20" to13.1m and 10" to 413.6m	Dan Smedvig Drilling Co	North Sea Sun Oil	West Intrepid	NR
SK88SW 45	Gate Burton	483055	384006	1298.42	NR	NR	Triassic/ Permian / Carboniferous (Coal Measures)	685.02 to 687.04m and 994.89 to 1298.42m	NR	Mar-81	NR	surface to 22.5m	Kenting	National Coal Board N.C.B.	NR	NR
SK89SE 123	Corringham 11	489572	392880	1359.30	NR	NR	L. Jurassic/ Triassic/ Permian / Carboniferous (Coal Measures)	NR	NR	05/04/1986	15 days	13 3/8" to 40.5m, 9 5/8" to 762.8m and 5 1/2" to 1359.0m	Boldon	British Petroleum	Rig 41	NR
SP22SW 20	Ash Farm 1	420870	224410	1313.69	NR	12 1/4" to 312.1m and 8 1/2" to 1284.4m	L. Jurassic/ Triassic/ Carboniferous (Coal Measures)/ Devonian	1307.0 to 1314.9m	NR	18/08/1981	20 days	13 3/8" to 18.7m and 9 5/8" to 312.1m	Kenting	Bearcat Exploration Petroleum	Rig 26	NR
ST72SE 1	Fifehead Magdalen 1	379850	121000	1369.16	NR	NR	L. Jurassic/ Carboniferous / late Devonian	2 spot cores 1207.9 to 1217.1m and 1362.2 to 1369.2m	NR	26/07/1985	17 days	18" to 18.6m and 10 3/8" to 371.86m	КСА	Carless	KCA 84	NR
SU04SW 5	Yarnbury 1	403357	141053	1679.75	NR	NR	L. Cretaceous/ Jurassic/ Permo- Triassic/ Cambrian (Tremadoc)	None	N/A	28/10/1980	40 days	20" to 3m, 13 3/8" to 264.3m and 9 5/8" to 715.4m	Boldon	Carless	T32	NR

BGS Registration No	Borehole Name	Easting	Northing	Depth Drilled m	TVD m	Diameter (Drill bit)	Geological sequence penetrated	coring	Core Diameter	Date Drilled	Drilling Duration	Casing Depths	Drilling Company	Drilled for	Type of Rig	Pressure controls
SU61SE 83	Hinton Manor 1	467951	114885	2093.98	NR	NR	U. Cretaceous to L Jurassic	NR	NR	1985	NR	NR	NR	Carless	NR	NR
SU74NW 12	Humbly Grove A5(H1)	470527	145281	1450.84	NR	NR	U. Cretaceous to L Jurassic	None	N/A	30/08/1985	22 days	16" to 171.3m, 10 3/4" to 705.6m and 7 5/8" to 1447.8m	Kenting	Carless	Rig 35E	NR
SU75SW 99	Odiham 1	473917	150479	1439.88	1400.56	NR	Cretaceous/ Jurassic	NR	NR	03/12/1987	~25 days	NR	NR	North Sea Sun Oil	NR	NR
SU81SW 16	Chilgrove 1	481876	113725	2142.13	NR	NR	Cretaceous/ mid. Jurassic	spot 1986.4 to 2035m	NR	28/11/1987	41 days	conductor to 3m, 9 5/8" to 415.7m and 7" to 1187.2m	Kenting	Carless	Rig 40E	NR
SU82NW 16	Rogate 1	480342	126314	2145.80	NR	NR	Mid. Cretaceous/ Jurassic	1 spot 1859.3 to 1896.2m	NR	18/07/1985	45 days	13 3/8" to 385m, 9 5/8" to 1001.6m and 7" to 1835.5m	Kenting	Carless	Rig 34E (National 61OUE)	NR
SY98NW 20	Stoborough 2	391260	86610	1240.54	NR	17 1/2" to 87.2m, 12 1/2" to 652.3m and 8 1/2" to 1240.5m	Tertiary/ Cretaceous/ Jurassic	860.1 to 1107.6m	NR	02/01/1981	17 days	30" to 18.3m, 13 3/8" to 84.1m, 9 5/8" to 649.2m and 7" to 1240.5m	Houlder Marine	British Gas Corporation Brit-Gas	National 80UE	NR
SY98NW 22	Wareham C6z	390590	87210	1873.30	NR	26" to 199.0m, 17 1/2" to 658.4m and 12 1/4" to 1873.3m	Tertiary/ Cretaceous/ Jurassic/ Triassic/ ?Permian	1683.7 to 1694.7m	NR	26/11/1980	30 days	20" to 192.3m and 13 5/8" to 653.2m	Houlder Marine	British Gas Corporation Brit-Gas	National 80UE	NR

BGS Registration No	Borehole Name	Easting	Northing	Depth Drilled m	TVD m	Diameter (Drill bit)	Geological sequence penetrated	coring	Core Diameter	Date Drilled	Drilling Duration	Casing Depths	Drilling Company	Drilled for	Type of Rig	Pressure controls
SY98SE 5	Bushey Farm A1z	396940	83050	1247.85	NR	26" to 169.8m, 17 1/2" to 341.4m, 12 1/4" to 662.9m and 8 1/2" to 1247.9m	Tertiary/ Cretaceous/ Jurassic	1120.3 to 1134.9m	NR	15/02/1981	52 days	20" to 168.6m and 9 5/8" to 660.8m	Houlder Marine	British Gas Corporation Brit-Gas	National 80UE	NR
SZ07NW 8	Southard Quarry 1	402339	77750	2894.00	NR	NR	Jurassic/ Triassic/ Permian	NR	NR	1989	NR	NR	NR	British Petroleum	NR	NR
SZ19NE 26	Bransgore 1	419580	95040	1741.00	NR	NR	Tertiary/ Cretaceous/ Jurassic/ Triassic/ ?Permian	Spot	NR	03/10/1986	18 days	18 3/8" to 120m, 13 3/8" to 782m and 9 5/8" to 1369m	Kenting	BP	Rig 35E	NR
SZ59SW 17	Cowes 1	450036	94169	1785.52	NR	NR	NR	NR	NR	1983	NR	13 3/8" to 918.1	NR	North Sea Sun Oil	NR	Mud
TA00NW 123	Brigg 2	503770	406390	1990.00	1742.90	NR	Jurassic/ Permo- Triassic/ Carboniferous (Namurian)	3 spot cores	NR	15/07/1983	51days	13 3/8" to 69m and 9 5/8" to 1136m	Kenting	British Petroleum	Rig 36	Mud
TA15SE 11	Atwick 4	517260	451770	1,861.11	NR	26" to 44.8m, 17 1/2" to 557.8m, 12 1/4" to 1729.7m and 8" to 1861.7m	Cretaceous/ Jurassic/ Permo- Triassic	None	N/A	08/01/1980	46 days	20" to 43.6m, 13 3/4" to 553.2m and 9 5/8" to 1729.7m	Boldon	British Gas Corporation Brit-Gas	National T32	Gelchem to 1850m then Interdrill Invert to TD

BGS Registration No	Borehole Name	Easting	Northing	Depth Drilled m	TVD m	Diameter (Drill bit)	Geological sequence penetrated	coring	Core Diameter	Date Drilled	Drilling Duration	Casing Depths	Drilling Company	Drilled for	Type of Rig	Pressure controls
TA16NW 10	Caythorpe 1	512222	467920	2066.54	NR	NR	Cretaceous/ Jurassic/ Permo- Triassic/ Carboniferous (Coal Measures)	?spot	NR	13/06/1987	31 days	20" to 18.6m, 13 3/8" to 264.6m, 9 5/8" to 1326.2m and 7" to 1988.8m	KCA	Taylor Woodrow Energy	Rig 84	NR
TF07NE 23	Stainton 3	506281	378509	1806.00	1688.57	NR	Mid. Jurassic/ Permo- Triassic/ Carboniferous (Carb. Lst.)	Spot	NR	13/07/1981	18 days	13 3/8" to 137m, 9 5/8" to 935m and 5 1/2" to 1802.5m	Kenting	British Petroleum	Rig 36E	Mud
TF07NW 139	Welton A32	503620	376808	1947.80	1407.53	4 1/8"	Coal Measures	NR	NR	13/03/1998	7 days	5" to 1365	NR	Candecca Resources Ltd.	Rambler	Mud
TF07NW 14	Welton A1	503605	376808	2,559.00	NR	NR	Jurassic/ Permo- Triassic/ Carboniferous/ Basement	NR	NR	1980	NR	NR	NR	British Petroleum	NR	NR
TF07SW 36	Nettleham 1	500524	374623	1481.00	NR	NR	Jurassic/ Permo- Triassic/ Carboniferous	NR	NR	1982	NR	NR	NR	British Petroleum	NR	NR
TF28SW 11	Biscathorpe 1	523050	383714	2075.00	2058.60	NR	U. Jurassic/ Permo- Triassic/ Carboniferous (Carb. Lst.)	Spot	NR	06/07/1987	22 days	9 5/8" to 462m and 7" to 1466m	Kenting	British Petroleum	Rig 21	NR
TF29SE 12	Kelstern 1	525865	392034	2510.33	NR	NR	U Cretaceous/ Jurassic/ Permo- Triassic/ Carboniferous (Coal Measures to Carb. Lst.	NR	NR	1989	NR	NR	NR	NR	NR	NR
Table 2:	Borehole	data fi	rom rec	ently dr	illed (p	ost 198()) on-shore	borehole	es (conti	inued)						

BGS Registration No	Borehole Name	Easting	Northing	Depth Drilled m	TVD m	Diameter (Drill bit)	Geological sequence penetrated	coring	Core Diameter	Date Drilled	Drilling Duration	Casing Depths	Drilling Company	Drilled for	Type of Rig	Pressure controls
TF38NE 39	Keddington 1 L47/16-4	536651	388170	1,999.50	NR	NR	NR	Spot	NR	14/10/1997	65 days	18" to 42.66m and 10 3/4 " to 410m	NR	Candecca Resources Ltd.	NR	NR
TF49SW 62	Saltfleetby 3z	542460	391350	2986.00	2274.40	NR	? To Coal Measures	NR	NR	23/05/1999	25 days	16" to 73.5m, 10 3/4 to 629.5m, 7 5/8" to 1535.4 and 6 1/2" to 73m then 5 1/2" to 2572.5m	NR	Candecca Resources Ltd.	Explorer	NR
TQ03SW 5	Alfold 1	504337	134437	1255.00	NR	12 1/2" to 1783' and 8 1/2 " to	Lower Cretaceous to Upper Jurassic	4 spot cores of ca 20m	NR	05/02/1986	15 days	13 3/8" to 75' and 9 5/8" to 1779'	K.C.A.	Conoco	Rig 85	L.S.N.D MILPAC/Pol ymer to 1783' and SHALETRO L/MILPAC to 4120'
TQ11NW 25	Ashington 1	512750	118230	1723.00	NR	12 1/2" to 1816' and 8 1/2" to 5653'	Lower Cretaceous to Lower Jurassic (M. Lias)	4 spot cores of ca 20m	NR	18/12/1985	27 days	9 5/8 to 1800' and 7" to 4804@	Kenting	Conoco	Rig 31E	DRISPAC mud to 1816@ and DRISPAC/Po lymer to TD
TQ11SW 50	Washington 1	510899	110936	1,438.00	1201.22	NR	U. Cretaceous to mid Jurassic	Spot cored	NR	27/02/1989	12 days	20" to 19.2m, 13" to 279.2m and 9" to 459.9m	Kenting	Kelt	Rig 35	NR
TQ43NW 6	Holtye 1	544743	139773	2208.00	1877.80	NR	Cretaceous/Jura ssic/Triassic into Palaeozoic	Spot cored	NR	05/06/1987	40 days	13 3/8" to 18.5m, 9 5/8" to 91.86, 7" to 137.48 and 5" to 2197.5m	Boldon	BP	Rig 41	NR
TQ45NE 166	Knockholt 1	548900	159110	1203.00	1263.00	NR	Cretaceous/Jura ssic into Devonian?	Fully cored ?	NR	28/09/1991	12days	20" to 76' and 9 5/8" to 1236'	Kenting	Cairn Energy PLC	Rig 40	NR
TR24SE 10	Meggot Farm	625446	141066	1349.00	NR	NR	Mesozoic, Coal Measures into Carb. Lst.	Spot cored	NR	01/11/1979	5 months	NR	Foraky Ltd	NCB	NR	NR
Table 2:	Table 2: Borehole data from recently drilled (post 1980) on-shore boreholes (continued)															

Number of borehole records reviewed	Number borehole records reporting bit diameter	Number borehole records reporting coring	Number borehole records reporting core diameter	Number borehole records reporting pressure control
68	10 of which: 3 reported starting @ 26" 3 reported starting @ 17 1/2" 3 reported starting @ 12 1/2" 1 reported starting @ 4 1/8" and: 8 reported ending @ 8 5/8" 1 reported ending @ 12 1/4" 1 reported ending @ 4 1/8"	 26 of which: 19 spot cored (various lengths) 5 un-cored 1 fully cored? 1 side wall cores only 	None	 18 of which: 2 reported water/brine 15 reported mud/polymer 1 oil based mud

Table 3: Summary of key information from Table 2.

The majority of the deep boreholes drilled since 1980 have been drilled for coal or hydrocarbon exploration/development purposes through Mesozoic and Upper Palaeozoic sedimentary rocks. Relatively few boreholes have been drilled post 1990. All boreholes drilled by the BGS and the geothermal energy programme boreholes pre-date 1980. The majority of the boreholes for which the records were examined, and for which information was recorded, were drilled using drilling mud for pressure control. The use of blow out protection is not recorded for any of the boreholes examined though this may be because of a lack of recording rather than a lack of installation. All were drilled with relatively large diameters (mainly in the range 17 $\frac{1}{2}$ to 8 5/8 inch range for the majority of drilled length), to allow for reduction if drilling problems were encountered and multiple casing strings were usually used. Coring, normally only spot coring over short (a few metres) intervals has been carried out in about 40% of boreholes.

5 References

Allsop, JM: 1985 Geophysical investigations into the extent of the Devonian rocks beneath East Anglia: Proceedings of the Geologists' Association 96(4) p.371-379.

Cornwell, JD; Kimbell, GS; & Ogilvy, RD; 1996 Geophysical evidence for basement structure in Suffolk, East Anglia: Journal of the Geological Society of London 153(2) p.207-211.

G-BASE - BGS geochemical survey data holding can be found at http://www.bgs.ac.uk/gbase/data.html

GDI – BGS Geological Data Index.

HiRES – further information on BGS high resolution geophysical surveys can be found at http://www.bgs.ac.uk/programmes/landres/segs/hires/home.html

Jackson, I (editor); 2004 Britain Beneath Our Feet, British Geological Survey Occasional Publication No 4.

Pharaoh, T; England, R; and Lee, M; 1995 The concealed Caledonide basement of Eastern England and the southern North Sea - a review: Studia Geophysica et Geodaetica. 39 p330-346.

SOBI - BGS Single On-shore Borehole Database.

Wellmaster – BGS database of water wells and springs.