British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL
Office of the Deputy Prime Minister
Creating sustainable communities

SOUTH YORKSHIRE

(comprising Metropolitan Boroughs of Barnsley, Doncaster and Rotherham and City of Sheffield)

Mineral Resource Information in Support of National, Regional and Local Planning

Mineral Resources

Scale 1:100 000

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Published 2006.

This map comprises part of a summary of the 'Mineral Resources of Yorkshire and the Humber Region'.
For more information see www.mineralsUK.com

BIBLIOGRAPHIC REFERENCE

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SAND & GRAVEL

Superficial deposits

- Sub-alluvial: Inferred resources
- Sub-alluvial: Indicated resources (only in areas assessed by BGS)
- River Terrace deposits
- River Terrace deposits: Concealed (only in areas assessed by BGS)
- Glaciofluvial deposits
- Glaciofluvial deposits: Concealed (only in areas assessed by BGS)
- Glaciolacustrine deposits
- Glaciolacustrine deposits: Concealed (only in areas assessed by BGS)
- Blown Sand
- Boundary of area assessed for sand and gravel at the indicated resource level

Bedrock deposits

- Construction sand — Triassic: Sherwood Sandstone Group

BRICK CLAY

- Brick clay and fireclay (coincident with areas of shallow coal) — Carboniferous: Pennine Coal Measures

LIMESTONE

- Dolomite and dolomitic limestone — Permian: Cadeby and Brotherton formations (Magnesian Limestone)

SANDSTONE

- Carboniferous: selected sandstone units within the Millstone Grit and Pennine Coal Measures

COAL

- Area of shallow coal — Carboniferous: Pennine Coal Measures
- Opencast coal: worked area

PEAT

- Lowland raised bogs

COAL LICENCE AREAS (as at 01.02.06)

Source: The Coal Authority

- Deep mine
- Opencast coal

MINERAL PLANNING PERMISSION (as at 31.12.05)

Source: Mineral Planning Authorities

- Surface planning permission (valid and expired)
- Underground planning permission other than coal (valid and expired)

MINERAL WORKINGS

- Harrycroft — Active site
- *Nunnery* — Inactive (including yet to be worked), worked-out and/or restored site

Mineral commodity

AMM	Abandoned Mine Methane	Gas	Natural Gas	Sg	Sand and Gravel
Cl	Clay & Shale	Lst	Limestone, including dolomite		
Co	Coal	Min	Unspecified	SiS	Silica Sand
Fr	Fireclay	Oil	Oil	SiR	Silica Rock
Gan	Ganister	Peat	Peat	Sst	Sandstone

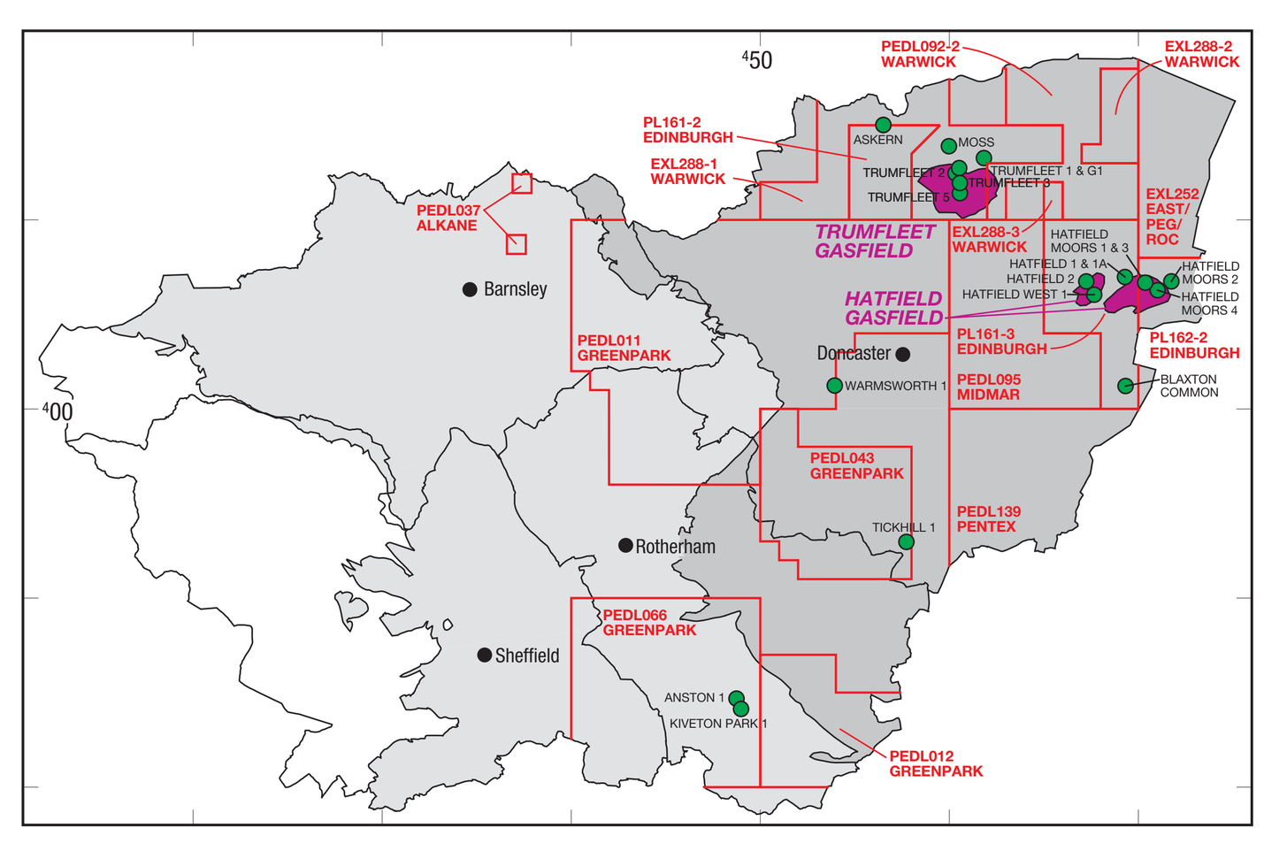
▲ Active underground mine

ENVIRONMENTAL DESIGNATIONS (as at 01.01.06)

- National nature conservation designations (SSSIs and NNRs)
- International nature conservation designations (SACs, SPAs and Ramsar sites)
- National Park: Peak District (part)
- \+ Scheduled Monument

ADMINISTRATIVE AREAS

- Mineral Planning Authority



● Hydrocarbon Well — PEDL Petroleum Exploration and Development Licence issued under the Petroleum (Production) Act 1934 (as at November 2005)

Shallow coal with less than 50 m overburden — Deep coal between 50 m and 1200 m

HYDROCARBONS

Conventional Oil and Gas

Upper Carboniferous (Namurian and Westphalian) strata occur at outcrop or depth over most of South Yorkshire. Coal Measures (Westphalian) strata constitute part of the major East Pennine Coalfield, which is divided into important regions, the majority of which have been heavily mined.

Permian and Mesozoic strata crop out over the eastern part of the county providing, in addition to Carboniferous sequences, potential reservoir rocks for hydrocarbons generated from the Carboniferous rocks.

South Yorkshire lies towards the northwestern end of two major Carboniferous basins: the Gainsborough Trough and Edale Gulf. Within these areas source rocks were deposited which have since produced significant quantities of oil and gas, forming a series of important oil and gas fields to the southeast that make up the East Midlands oil province. Within the county, seismic reflection data indicate that the main prospective areas have, to date, been in western, central and eastern areas of the county, influenced to a large extent by coal mining activities and urban development. Several exploration wells have been drilled in the county between 1940 and 1983 (refer to Tables 1 and 2). All were plugged as dry and abandoned with the exception of two wells. Trumfleet 1 proved a significant gas discovery but was only developed in 1998. To the southeast, Hatfield 1 followed as a gas discovery in 1981 and proved to be the discovery well for the series of wells that confirmed the two related Hatfield West and Hatfield Moors gas fields (Table 2), which were developed in the mid 1980s. Trumfleet was producing in late 2005, whilst the role of the Hatfield gasfields has changed to that of gas storage facilities, gas being injected into the reservoir during periods of low demand and then pumped out during peak demand.

The pattern of exploration to date indicates that the hydrocarbon potential of the county is perhaps relatively poor, due to previous exploration and the level of coal mining activity. As seen in the Hatfield fields, depleted oil and gas fields across the county could be increasingly used for gas storage. The majority of the exploration licences held in the county relate to the extraction of coalbed methane (see below).

Well name	Date drilled	Operator at time of drilling	Well status
Anston	1983	BP Development Ltd	Plugged and abandoned, dry
Askern	1957	BP Exploration Company Ltd	Plugged and abandoned, dry
Blaxton Common	1982	Taylor Woodrow Energy Ltd	Plugged and abandoned, dry
Hatfield 1	1981	BP Development Company Ltd	Shut-in as gas well
Kiveton Park	1940	BP Development Ltd	Plugged and abandoned, dry
Moss	1979	NCB/BP Exploration Company Ltd.	Plugged and abandoned, dry
Tickhill	1958	BP Exploration Company Ltd	Plugged and abandoned, dry
Trumfleet 1	1956	BP Exploration Company Ltd	Shut-in as gas well, Well No.5 proved oil
Warmsworth	1982	RTZ Oil & Gas Ltd	Plugged and abandoned, dry

Table 1. South Yorkshire exploration wells

Name of field	Field Type (oil or gas)	Operator at time of discovery	Operator licence block, late 2005	Discovery date	Production started	Current status
Hatfield Moors	Gas	Taylor Woodrow Energy Ltd	Edinburgh Oil & Gas plc	1983	1986	Field use converted to gas storage facility at end 2000
Hatfield West	Gas	Taylor Woodrow Energy Ltd	Edinburgh Oil & Gas plc	1983	1986	Field use converted to gas storage facility at end 2000
Trumfleet	Gas	BP Exploration Company Ltd	Energy	1956-65	1998	Still producing late 2005

Table 2. South Yorkshire gas fields

Abandoned Mine Gas Drainage (AMM), Coal Mine Methane (CMM) and Coal Bed Methane (CBM) potential

Pennine Lower to Middle Coal Measures forming part of the Yorkshire Coalfield crop out or are below the Permian cover in much of the county. These Coal Measures are generally simple, eastwards dipping strata and locally folded. They continue eastwards beneath the Permian cover rocks in the east of the county, being continuous with the concealed Eastern England Coalfield.

The Pennine Coal Measures have been very heavily worked, with thicker seams almost totally worked out. By 2005 of the 50 plus pits operating in 1978, all but Rossington and Maltby pits in the area had closed. The coal across the county is a high volatile bituminous coal with a seam gas content of between 4.1 and 6.1 m^3 CH_4 per tonne.

In the USA, most CBM production is from coals containing 7 or more m^3 CH_4 per tonne. The lower gas content of the coal in the county, combined with the fact that the coalfield has been heavily worked suggests that CBM development from virgin coal seams in South Yorkshire is probably not economic at present. However, the gas seam content in the South Yorkshire region is 6.1 m^3 CH_4 per tonne and is therefore perhaps only just marginal. Future CBM potential and prospectivity will be dependent on areas of undisturbed coal, which in the county will probably be limited to the east.

Initially AMM and CMM potential in the county appears good, given the intense coal mining. Extraction of gas from abandoned coal mines is being carried out, with schemes at Monk Bretton, near Barnsley and at Shirebrook and Hickleton, near Thurnscoe. The gas produced is commonly used on site for power generation or supplied direct to local consumers. However, the potential for water entering and flooding areas of the mines, that are often interconnected, could impact greatly on any prospects identified in the county. Water is currently pumped from the Barnsley area to protect Maltby Colliery.

Prospects for AMM in the county are thus thought to be good if the mines are not flooded. The schemes operated by Alkane Energy have, however, seen rapid declines in the volumes of gas extracted and concerns in 2003 over the classification and tax regimes of the resource have led to doubts and concerns over the economic viability of this resource. Coal Mine Methane is recovered from existing operating mines.

A potential future area for development in coalfield areas is Underground Coal Gasification. This is very much an unproven, new technology, which is under review and test in a number of countries. Again, the level of mining across the county and the depth of the coals might rule against this being a realistic potential resource in South Yorkshire.

INDUSTRIAL DOLOMITE

Dolomite (or dolostone) is an important economic mineral because of its physical and chemical properties. It has a wide variety of applications but its primary use is in the construction industry. Dolomite is also important in certain industrial applications where its chemical properties are important. The principal uses of industrial dolomite are in steel making as a flux and for refractory use, and in glassmaking. For these applications, dolomite is required to be of high chemical purity. Dolomite for industrial purposes accounts for a relatively small and decreasing proportion of total dolomite output in Britain.

Dolomites with sufficiently low levels of impurities to be used in steelmaking and glassmaking are relatively scarce in Britain. The Permian, Cadeby Formation in the Cadeby, Sprotborough and Warmsworth area is, however, of higher purity and is extracted for glassmaking at Warmsworth and Cadeby quarries. The quality of the stone is variable and selective quarrying of specific horizons is required to ensure that the stone meets the low iron requirements for glassmaking. Dolomite is also used for agricultural lime and filler applications.

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Contact address:
English Nature, Northminster House, Northminster, Peterborough, PE1 1UA, Tel: 01733 455000, Fax: 01733 455103, Web page: www.english-nature.org.uk

Positions of Scheduled Monuments at 25th September 2003 as supplied by English Heritage.
The majority of monuments are plotted using a centred NGR symbol. Consequently the actual area and/or length of a monument protected by the legal constraints of scheduling cannot be represented here. Monuments scheduled since that date are not accounted for.
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Contact address:
English Heritage, 23 Savile Row, London, WS1 2ET, Tel: 020 7973 3132, Web page: www.english-heritage.org.uk

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Contact address:
Countryside Agency, John Dower House, Crescent Place, Cheltenham, Gloucestershire, GL50 3RA, Tel: 01242 521381, Fax: 01242 584270, Web page: www.countryside.gov.uk

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Contact address:
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BRICK CLAY, including fireclay

'Brick clay' is the term used to describe clay used predominantly in the manufacture of bricks and pavers and, to a lesser extent, roof tiles, clay pipes and decorative pottery. These clays may sometimes be used in cement manufacture, as a source of constructional fill and for lining and sealing landfill sites. The suitability of a clay for the manufacture of bricks depends principally on its behaviour during shaping, drying and firing. This will dictate the properties of the fired brick such as strength and frost resistance and, importantly, its architectural appearance.

Most facing bricks, engineering bricks and related clay-based building products are manufactured in large automated factories. These represent a high capital investment and are increasingly dependent, therefore, on raw materials with predictable and consistent firing characteristics in order to achieve high yields of saleable products. Blending different clays to achieve improved durability and to provide a range of fired colours and textures is an increasingly common feature of the brick industry. Continuity of supply of consistent raw materials is of paramount importance.

The major brick clay resources in South Yorkshire occur within the mudstones of the Pennine Coal Measures which are interbedded with siltstones, sandstones, coal seams and seatearths. The mudstones are dark grey, with a variable carbon content. They are typically up to 5 m thick, but much thicker (20 to 30 m) in places. There are several large production units working Pennine Coal Measures mudstone concentrated around Barnsley and a further large works at Maltby. South Yorkshire also accounts for the bulk of UK production of vitrified clay drainage and sewerage pipes, with manufacture concentrated in the Penistone area to the west of Barnsley. Historically, the industry was based on the extensive Pennine Lower Coal Measures fireclays which occur in the area. With the advent of improved firing technology in the late 20th Century, the use of fireclays in these products declined sharply. The principal mineral raw material used in pipemaking is Pennine Lower Coal Measures mudstones derived from several sites close to the manufacturing centres at Hazelhead and Cawthorne.

Fireclays typically occur beneath coal seams and resources are confined to coal-bearing strata. The close association of fireclay and coal means that opencast coal sites are one of the few viable sources. Resources of fireclay are thus coincident with opencast coal resources and consequently the future supply of fireclay is largely dependent on the future of the opencast coal industry. Although originally valued as refractory raw materials, fireclays are now valued by the brick industry for their combination of good technical properties allied to their cream/buff-firing characteristics. However, not all fireclays are suitable for buff brick production because of the presence of impurities.

Small quantities of fireclay are produced in the area for use in the blend of clays used in the manufacture of vitrified clay pipes.

CRUSHED ROCK AGGREGATES

A variety of hard rocks are, when crushed, suitable for use as aggregates. Their technical suitability for different applications depends on their physical characteristics, such as crushing strength and resistance to impact and abrasion. Higher quality aggregates are required for coating with bitumen for road surfacing, or for mixing with cement to produce concrete. For applications such as constructional fill and drainage media, with less demanding specifications, lower quality materials are acceptable.

Dolomite

Dolomites (and subordinate limestones) of Permian age occupy a narrow outcrop of easterly dipping strata from north of Doncaster to Worksop. These Permian rocks - commonly known as the Magnesian Limestone - are highly variable lithologically and in their rock properties. They are relatively soft, with high porosity and are frequently too weak and friable to make high quality aggregate. Nevertheless, they are extensively quarried for low-grade applications, such as sub-base roadstone and fill, but some of the rocks are sufficiently sound, strong and durable to be used as concreting aggregate or coated roadstone. About 2.8 million tonnes of dolomite was produced as crushed rock aggregate in 2004.

In South Yorkshire, the Permian sequence is made up of two carbonate rock units, separated by about 20 m of calcareous mudstone. The carbonate units are known as the Cadeby Formation (formerly Lower Magnesian Limestone) and the Brotherton Formation (formerly Upper Magnesian Limestone). The Cadeby Formation is around 50 m in thickness and consists of a varied sequence of dolomites and limestones. The Brotherton Formation is less than 20 m in thickness and is fairly homogeneous, consisting mostly of hard flaggy limestones and dolomites. The outcrop of these formations is shown on the map.

Sandstone

Most sandstone is too weak and porous to make good quality aggregate for roadstone and concrete, but may be suitable for fill or for the production of manufactured sand to produce reconstituted stone products.

Sandstones form a substantial part of the Upper Carboniferous sequence in South Yorkshire where they are interbedded with mudstones and coals. Where thick beds of sandstone are developed they have been widely extracted for building stone, although there is little current quarrying activity. There is no production of aggregate materials due, in part, to more readily available local supplies of crushed dolomite and natural sand and gravel.

For consistency with the map of West Yorkshire, where sandstone is extensively worked, selected sandstone units within the Millstone Grit Group (Huddersfield White Rock, Midgeley Grit, Rough Rock and Rough Rock Flags) and the Coal Measures Group (Ackworth Rock and Greenmoor Rock) are shown.

SAND AND GRAVEL

Sand and gravel are defined on the basis of particle size rather than composition. In current commercial practice, following the introduction of new European standards from 1st January 2004, the term 'gravel' (or more correctly coarse aggregate) is used for general and concrete applications to define particles between 4 and 80 mm, and the term 'sand' for material that is finer than 4 mm, but coarser than 0.063 mm. For use in asphalt 2 mm is now the break point between coarse and fine aggregate. Most sand and gravel is composed of particles that are rich in silica (quartz, quartzite and flint), but other rock types may occur locally.

Between 1997 and 2004 annual production of sand and gravel in South Yorkshire (comprising Metropolitan Boroughs of Barnsley, Doncaster and Rotherham and City of Sheffield) has varied between 529,000 and 1,045,000 tonnes. Production is shown on the graph and permitted reserves are estimated at about 13.2 million tonnes.

Sand and gravel resources occur in a variety of geological environments. In South Yorkshire these resources occur mainly within superficial deposits, subdivided into river sand and gravel, glaciofluvial sand and gravel and blown sand with additional resources of bedrock sand and gravel.

SUPERFICIAL DEPOSITS

Parts of the areas assessed for sand and gravel by BGS resource surveys are identified on the map. Resources shown here are taken from these maps. In these areas, the possible extent of sand and gravel concealed beneath other material is shown. These indicated resources were defined by overburden to mineral ratios. Outside these areas, available data are more limited. Generally, only exposed sand and gravel is defined, although sub-alluvial inferred resources of sand and gravel occurring beneath modern river flood plains may be extensive in some places. Narrow (< 200 m) spreads of sub-alluvial deposits are mainly excluded from the map. Their limited width is likely to preclude economic working of any sand and gravel present.

River Sand and Gravel (Terrace and Sub-alluvial deposits)

Resources occur in both raised river terrace sequences flanking the modern floodplains and in floodplain terrace deposits associated with, and underlying, present day alluvium. This sequence of deposits is best developed along the River Don with a succession of deposits formed, representing accumulations of sand and gravel in response to falling sea level in Pleistocene times. In the southwest, localised terrace deposits occur in the upper reaches of the Don between Sheffield and Rotherham and are predominantly sterilised by urban development. More extensive terrace deposits occur around Bentley at up to 12 m above OD. These deposits consist of sand, some of which is coarse-grained, thin beds of fine gravel in which most of the pebbles are of Carboniferous rocks, and thin clay beds. Coal particles are present in the sand fraction. The deposits pass laterally into glaciolacustrine silt and clay deposits.

East of Doncaster, fluvial deposits of sand and gravel form extensive flattish spreads, commonly referred to as Older River Gravels. These deposits consist of beds, lenses and layers of both pebble-free sand and well-sorted fine to medium gravel with a sand matrix. There is a wide variation in the composition of the sand and gravel, as shown in the inset map. Variations in composition of the gravel fraction show that the more northerly deposits, around Dunsville and Holme Wood, were derived from the west, presumably via the Don, with the predominant composition of the pebbles being Carboniferous sandstone. In areas rich in Carboniferous-derived materials, coal detritus, usually in the form of coarse sand-sized particles can comprise up to 1 per cent of the deposit.

The more southerly deposits (see inset map) were derived from farther south, via the River Idle and to a lesser extent the Torne. The predominant composition of the pebbles in these deposits is Triassic quartzite. Near Misson and Finningley, the deposits have an average grading of 28 per cent gravel, 59 per cent sand and 13 per cent fines. The pebbles are typically subrounded and comprise about 50 per cent quartzite, 25 per cent quartz and 15 per cent sandstone, with minor amounts of limestone, mudstone, chert and igneous rock. Thin clay seams are present in the deposits but coal fragments are generally absent. The Older River Gravels are worked at several sites in the Doncaster district, primarily in the Finningley area and to the northeast of Doncaster for example, at Dunsville Quarry. At both Finningley and Austerfield Quarries, Older River Gravels, the original focus of extraction, have now been depleted. Current extraction at Finningley is from adjacent glaciofluvial deposits while extraction at Austerfield is from the underlying Sherwood Sandstone Group.

Sub-alluvial gravels are encountered beneath the alluvium of the major valleys throughout the region. The extent of alluvium in this region has been modified in places by land management practices, including the construction of drainage channels and the deposition of Warp (silt and clay) during periods of artificially controlled flooding. The deposits are compositionally similar to the river terrace deposits, indeed some are their downstream equivalents where they pass below OD. They were mainly laid down during periods of deep downcutting during the ultimate Devensian cold phase when sea-levels fell to at least -100 m OD. The subsequent rise in sea level enabled silting up of these river channels producing thick overlying alluvial deposits (silty clays, peat). The deposits rest on an irregular channelled surface and are thus of very variable thickness. These deposits are always saturated and require wet working.

Glaciofluvial deposits

These are deposits mapped as the products of deposition by glacial meltwaters and are nowadays commonly labelled on BGS maps as glaciofluvial deposits, a more accurate description of their origin. The sequence of these deposits is complex with mappable units commonly exhibiting intricate relationships. Bodies of sand and gravel may occur as sheet-like layers or ridges on top of the sheet of till (boulder clay) or as elongate, irregular lenses within the till sequence. Areas of wholly concealed, and thus unknown, bodies of sand and gravel may occur under spreads of till and other drift deposits.

Glaciofluvial deposits occur in the east of the county, where they form elongate ridges and mounds capping the Doncaster and Rossington ridges and adjacent hills. These deposits have been described in detail in Mineral Assessment Reports Nos. 37 and 92 of the British Geological Survey and are shown on the map. The deposits comprise beds, lenses and layers of both pebble-free sand, and gravel with a sand matrix. They are fairly well sorted, though a few cobbles and small boulders are present. The deposits rest mainly on the Sherwood Sandstone Group and transgress locally over clay, till and glacial channel deposits.

The glaciofluvial deposits near Rossington have an average grading of 24 per cent gravel, 65 per cent sand and 11 per cent fines, although the deposits vary laterally and vertically from a pebble-free sand to a sandy gravel. The pebbles are typically subrounded and comprise 60 per cent quartzite, 20 per cent quartz and 15 per cent sandstone, with minor amounts of limestone, chert and igneous rock. The Rossington Ridge deposits are thought to be derived from the Sherwood Sandstone Group in Nottinghamshire and the northern Midlands. These deposits are worked at Finningley Quarry. This deposit contains around 6 per cent silt and clay, with an equal ratio of sand to gravel. The deposit is variable with pockets of silty material which are thought to represent small lake features. The pebbles in the gravel fraction comprise predominantly vein quartz and quartzite.

The more northerly Doncaster Ridge deposits differ in composition in their absence of pebbles of limestone, chert and igneous rock. The deposits, almost exclusively covered by urban development, were derived from the Pennine Coal Measures to the west.

Glaciolacustrine deposits

During the Devensian glaciation, ice occupying the present coastal zone farther east blocked the eastward-draining valleys including the Humber Gap between Brough and Winterton and thus impounded 'Lake Humber' in the southern part of the Vale of York. Deposits associated with this glacial lake, termed glaciolacustrine deposits, occur in the western most part of South Yorkshire. These deposits occupy a wide irregular channel incised into Older River Gravels (see River Sand and Gravel) and Sherwood Sandstone, running from Doncaster Racecourse northeastwards towards Hatfield Woodhouse. They are present in the West Moor depression, in other low-lying localities towards the east (where they pass under the peat on Hatfield Moors) and under the alluvium of the River Don in the northwest. These deposits are predominantly bedded fine-grained sands and laminated clays up to 5 m in thickness. They have a mean grading of 17 per cent fines and 83 per cent sand, although beds with low fines content are locally present. The sand fraction is predominantly fine-grained quartz; up to 35 per cent of medium-grained sand has been recorded but coarse-grained sand nowhere accounts for more than 1 per cent of these deposits.

Blown Sand

These deposits are generally composed of fine- to medium-grained sand with a mean fines (<0.063 mm) content of around 8 per cent. The sand comprises sub-rounded to well-rounded quartz grains. These deposits are believed to be largely of late Quaternary age resulting from aeolian reworking of fluvial and glaciofluvial sands, particularly those associated with the Vale of York superficial deposits.

Blown sand deposits occur in the east of the county and are largely concealed beneath peat and alluvium. The most extensive blown sand deposits crop out on the flanks of Thorne Moor, Hatfield Moor and south of Finningley. Extensive deposits of sand, that rest in turn on glaciolacustrine silt and clay, also extend under the peat and alluvium of Thorne Moor and adjacent areas. This concealed sand varies from 0 to 3 m in thickness, with appreciable variations across short distances due to its undulating top. Blown sand is not currently worked in the county.

BEDROCK SAND AND GRAVEL

The sandstones and conglomerates of the Triassic, Sherwood Sandstone Group, in particular the Nottingham Castle Sandstone has been worked at several sites in South Yorkshire, mainly as a minor component worked in the floor of sites working superficial sand and gravel deposits. This material is mainly friable, loosely consolidated and easily worked. It is largely composed of a fine "clayey" sand with generally <2 per cent gravel and is generally more suitable for building sand and asphalting than the 'sharper' alluvial sands which are used for concreting. Where more gravel is present or conglomeratic horizons occur, the clasts are mainly rounded and sub-rounded quartz and quartzite pebbles with subordinate Carboniferous sandstone fragments. The Sherwood Sandstone Group is currently worked at Austerfield Quarry. The sand, which is dry screened, is predominantly used for mortar sand and asphalt sand and to a lesser extent for fill and pipe bedding sand.

Aims and Limitations

The purpose of the maps in this series is to show the broad distribution of those mineral resources which may be of current or potential economic interest and to relate these to selected nationally-recognised planning designations. The maps are intended to assist in the consideration and preparation of development plan policies in respect of mineral extraction and the protection of important mineral resources against sterilisation. They bring together a wide range of information, much of which is scattered and not always available in a convenient form.

The maps have been produced by the collation and interpretation of mineral resource data principally held by the British Geological Survey. Information on the extent of mineral planning permissions has been obtained from the relevant Mineral Planning Authority (MPA). Some of these permissions may have lapsed or expired. The status of individual areas can be ascertained from the appropriate MPA. Location information on national planning designations has been obtained from the appropriate statutory body (Countryside Agency, English Nature and English Heritage). For further information the relevant body should be contacted.

The mineral resource data presented are based on the best available information, but are not comprehensive and their quality is variable. The inferred boundaries shown are, therefore, approximate. Mineral resources defined on the map delineate areas within which potentially workable minerals may occur. These areas are not of uniform potential and also take no account of planning constraints that may limit their working. The economic potential of specific sites can only be proved by a detailed evaluation programme. Such an investigation is an essential precursor to submitting a planning application for mineral working. Extensive areas are shown as having no mineral resource potential, but some isolated mineral workings may occur in these areas. The presence of these operations generally reflect very local or specific situations.

The maps are intended for general consideration of mineral issues and not as a source of detailed information on specific sites. The maps should not be used to determine individual planning applications or in taking other decisions on the acquisition or use of a particular piece of land, although they may give useful background information which sets a specific proposal within context.

PLANNING PERMISSIONS FOR MINERAL EXTRACTION

The extent of all known extant and former planning permissions for mineral working is shown on the map, irrespective of their current planning or operational status. The polygons were supplied as digital files by Rotherham Metropolitan Borough Council and were also digitised by BGS from Plotting Sheets and other documents supplied by Barnsley Municipal Borough Council, Doncaster Metropolitan Borough Council and Sheffield City Council. In addition, planning permission information was digitally acquired from Ministry of Housing and Local Government maps for the area and incorporated in the data. This data has been checked and amended by the local authorities shown below. Any queries regarding the sites shown should be directed to these authorities at the addresses shown below. The polygons cover active, former and restored mineral workings and, occasionally, unworked deposits.

Planning permissions represent areas where a commercial decision to work mineral has been made, a successful application has been dealt with through the provisions of the Town and Country Planning legislation and the permitted reserve will have been depleted to a greater or lesser extent. Current planning status is not qualified on the map but is available in the underlying database.

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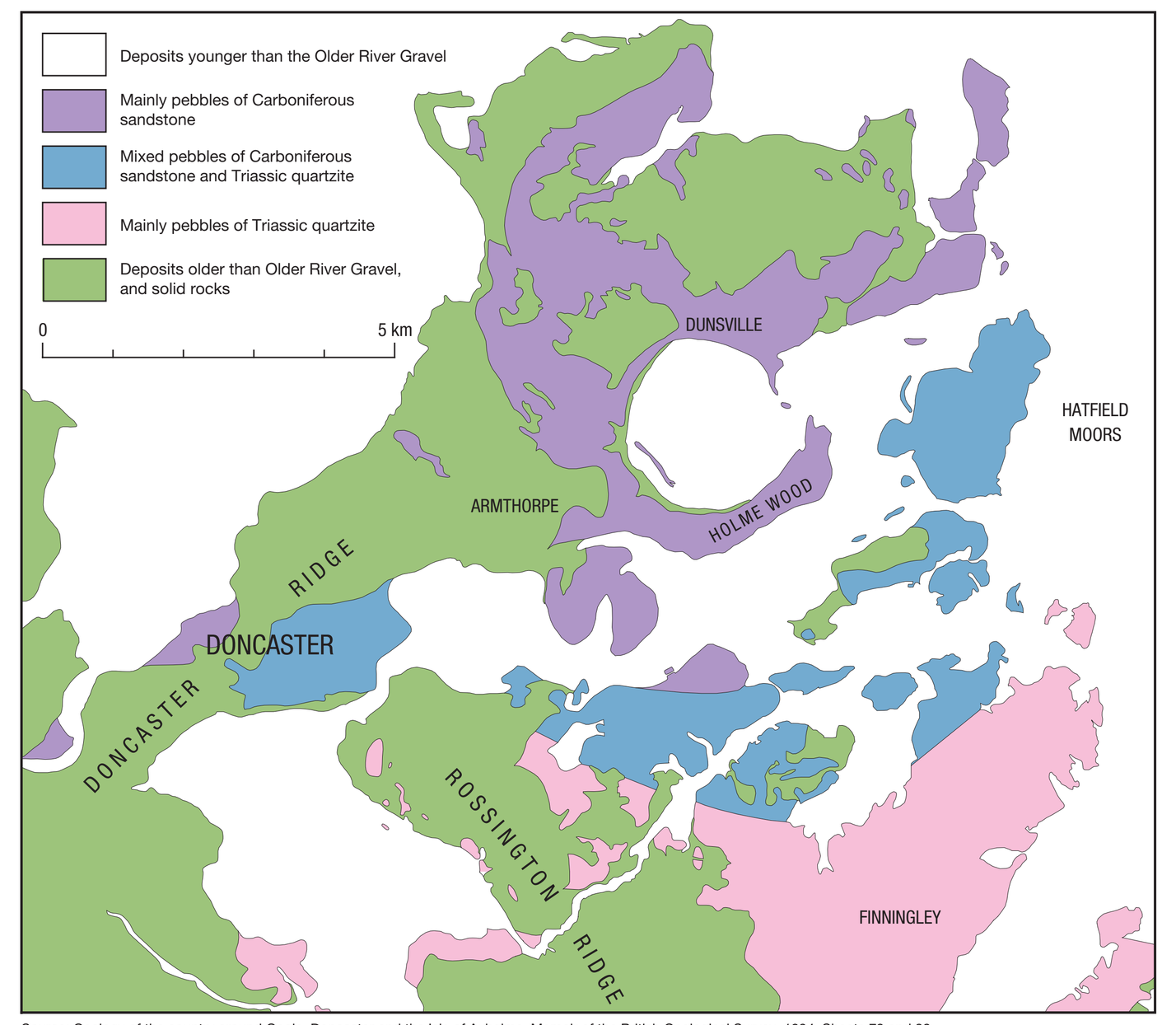
Barnsley Metropolitan Borough Council, Planning Services Department, Central Offices, Kendray Street, Barnsley S70 2TN, Tel: 01226 770770, Fax: 01226 772697, web address: www.barnsley.gov.uk

Doncaster Metropolitan Borough Council, Directorate of Planning & Design Services, 2nd Floor, Danum House, St. Sepulchre Gate, Doncaster DN1 1UB, Tel: 01302 734444, Fax: 01302 734949, web address: www.doncaster.gov.uk

Rotherham Metropolitan Borough Council, Planning Services, Bailey House, Rawmarsh Road, Rotherham S60 1QT, Tel: 01709 382121, Fax: 01709 823865, web address: www.rotherham.gov.uk

Sheffield City Council, Planning, Transport & Highways Department, Town Hall Extension, Sheffield S1 2HH, Tel: 0114 272 6444, Fax: 0114 273 5002, Web address: www.sheffield.gov.uk

Schematic map showing the variation in composition of the pebbles in the Older River Gravels around Doncaster



Source: Geology of the country around Goole, Doncaster and the Isle of Axholme. Memoir of the British Geological Survey. 1994. Sheets 79 and 88.

BUILDING STONE

Historically the county has been a prolific source of Carboniferous building sandstones quarried from the Millstone Grit and Pennine Coal Measures groups. These sandstones were generally marketed under the generic name 'York Stone'. The sandstones were also the principal local source of millstones prior to the industrial revolution and, in the 19th Century, of grindstones for use in the Sheffield cutlery trade. Limestone from late Permian rocks has also been quarried for building use.

The oldest rocks that have been used for building are the quartzose sandstones of the Millstone Grit Group. They have been quarried for block stone, rubblestone, flagstone and roofing stone throughout the area of their outcrop. Extensive local quarrying of the many sandstones beds present in the Group has generally been associated with the development of the principal settlements in the area, notably in the area west of Barnsley and around Rotherham. The western outcrops of the Group were only quarried for local use, notably around Stocksbridge. The principal sandstone unit that has been worked commercially is the Rough Rock Formation, however, there is evidence of local quarrying from all sandstones in the Group.

The overlying Pennine Coal Measures Group has also been a prolific source of building sandstones, and all of the many sandstones that occur in the succession have been used for local building purposes, most notably around Barnsley, Mexborough, Sheffield and Rotherham. The sandstone from the Rotherham area has a distinctive red coloration and is known as Rotherham Red.

The magnesian limestones of the late Permian, Cadeby Formation crop out in a narrow, north-south strip across the area. These pale coloured dolostones have been extensively quarried for local building along much of their outcrop, most notably around Brodsworth, Doncaster, Conisborough and Anston.

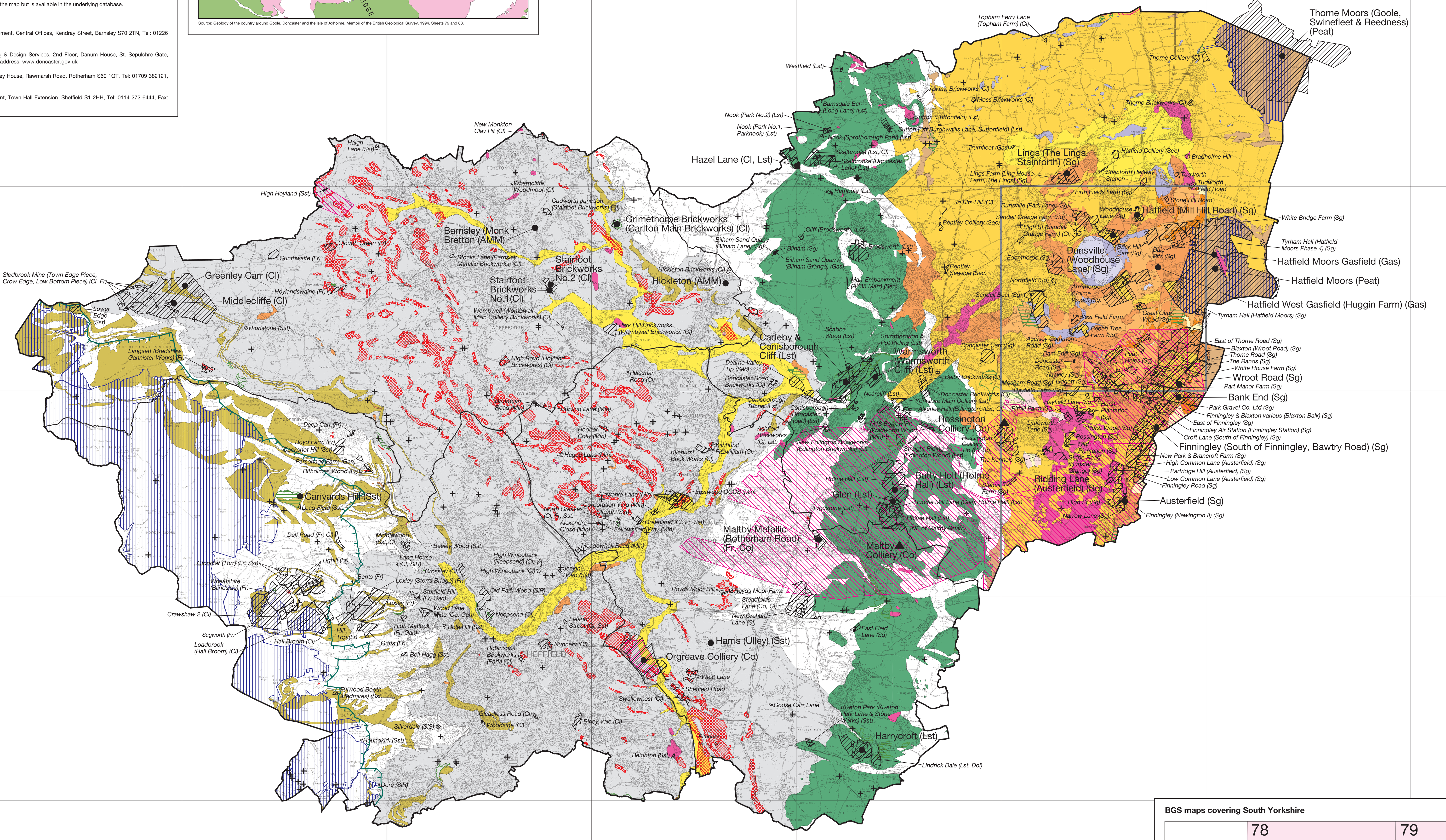
There is currently one active building sandstone quarry and four active building limestone quarries in the area, although the latter are mainly sources of crushed rock aggregate.

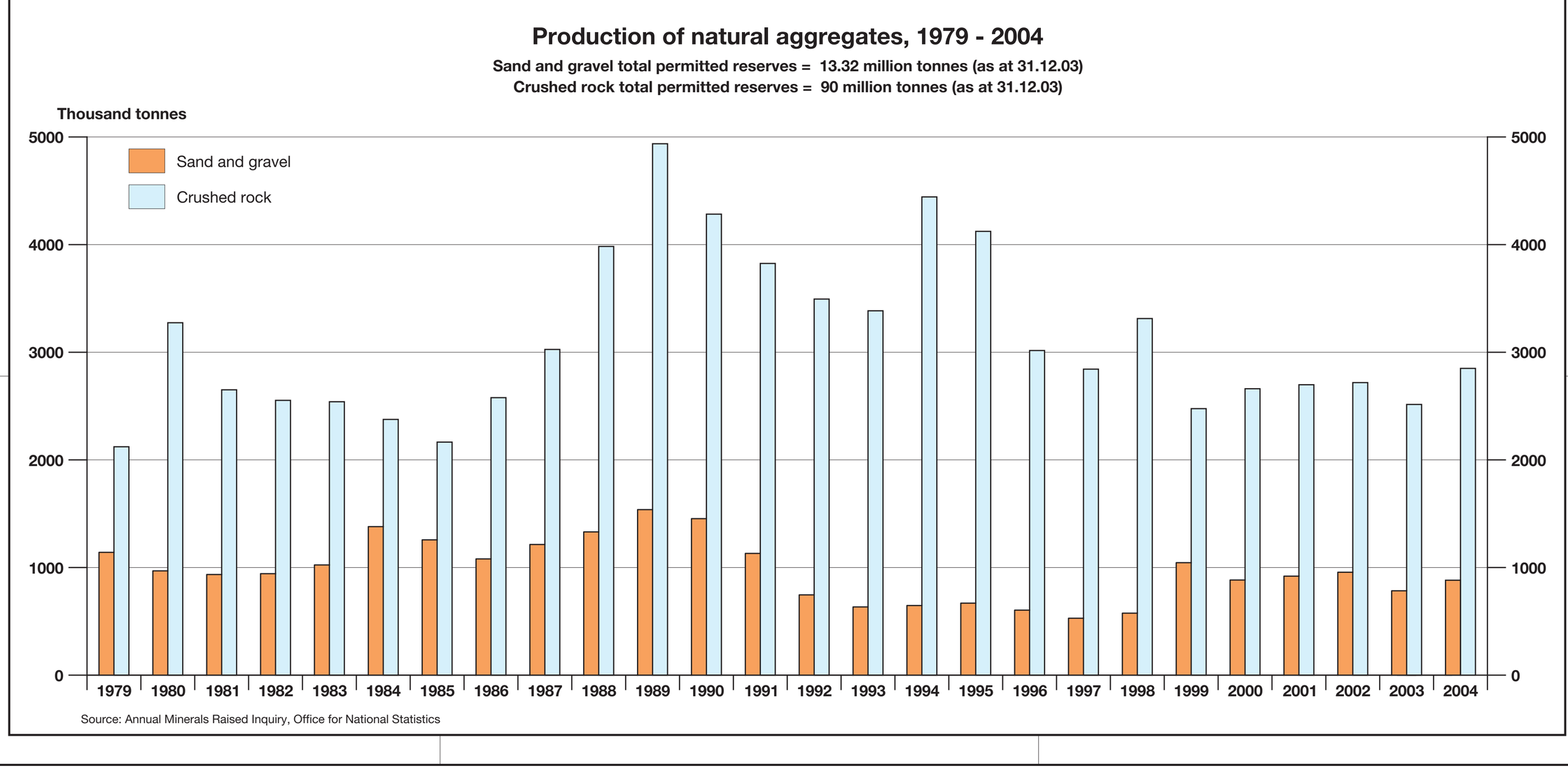
PEAT

Peat is an unconsolidated deposit of compressed plant remains in a water-saturated environment such as a bog or fen. Bogs occur in areas where inputs of water (almost exclusively from precipitation) have a low nutrient content and where the rainfall is sufficient to maintain the ground surface in a waterlogged condition. The vegetation is characterised by acid-tolerant plant communities in which the moss genus *Sphagnum* is dominant. The two main types of bog are (i) raised bogs, characteristic of flat underlying topography and found on plains and broad valley floors and (ii) blanket bogs, which occur mainly in upland areas where conditions are suitably cool and wet, both of which occur in South Yorkshire. Many lowland raised bogs have been designated as sites of international and national conservation areas. Peat is dug in England predominantly from lowland raised bogs, almost entirely (98 per cent) for horticultural purposes, either as a growing medium, or as a soil improver.

In South Yorkshire, extensive peat deposits occur in the extreme west and east of the county. In the west of the county, peat deposits occur on the Millstone Grit along the eastern side of the Pennines, from west of Penistone to Sheffield. The Millstone Grit outcrop in the upland Pennine areas gives rise to acid soils on which extensive upland blanket peat bogs contain peat up to several metres thick. These deposits almost exclusively occur within the Peak District National Park and South Pennine Moors conservation areas and are not shown on the face of the map.

In the east of the county, peat deposits occur on Hatfield Moors and Thorne Moors, the latter including Crowle, Swinefleet and Goole moors. These deposits have been exploited for many years and the industry based on these resources is currently one of the largest in Great Britain. The peat is extracted by both a mechanised block cutting method and a surface milling technique, the latter accounting for an increasing proportion of the output. The peat is used for a variety of horticultural applications. The upper part of the deposit produces a light brown, open-textured peat which is of premium quality. A darker, more compact material from lower levels is of less value. These deposits occur within designated conservation areas (SSSI, SPA and SAC).



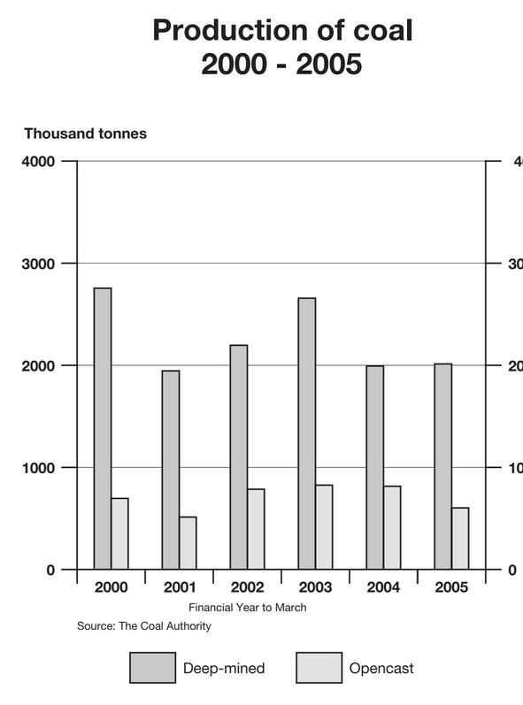


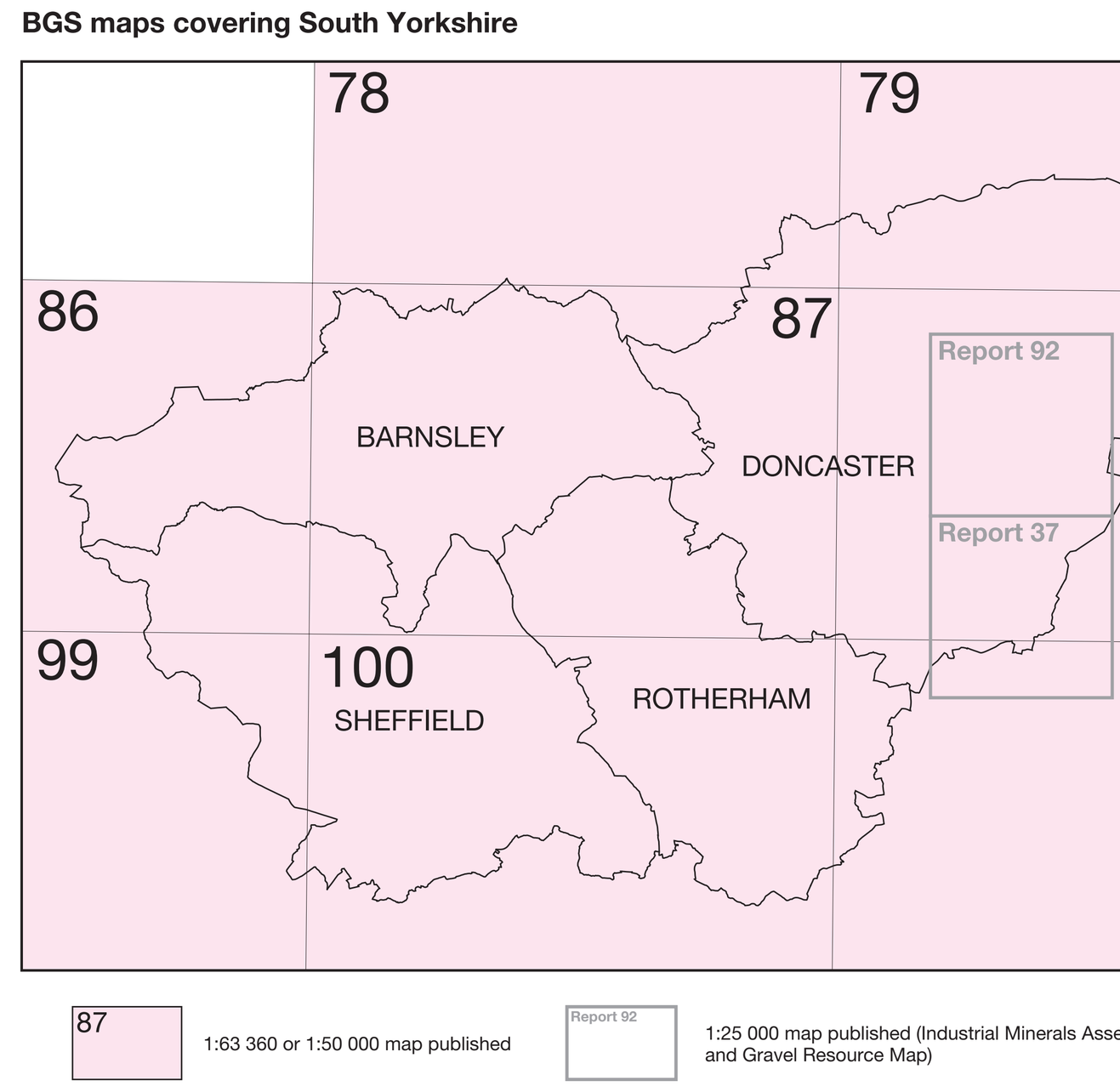
COAL

South Yorkshire lies predominantly within the East Pennines Coalfield. The coal-bearing strata of the Pennine Lower and Middle Coal Measures (Upper Carboniferous) generally dip to the east or south. Coal seams crop out at the surface in the west and become concealed by younger rocks, down to depths of 1200 m below Ordnance Datum, east of Rotherham. Coal seams are numerous and many are developed at a regional scale. They vary laterally in both thickness and composition, chiefly by variation in the number of dirt partings present within the seam. Twenty-two coal seams are recognised in the Pennine Lower Coal Measures and nine in the Pennine Middle Coal Measures. The seams are mainly bituminous and the calorific value and rank of the coals broadly increases eastwards. Sulphur is an impurity associated with all Yorkshire coals, with the most easterly parts of the coalfield recorded as moderately high in sulphur.

Although UK domestic production of coal has declined in recent years, South Yorkshire remains an important coal-mining region in the UK with five opencast coal sites and two deep coal mines being in recent operation. In the last five years, from 1999 to 2004, total coal production in South Yorkshire fell from 3.5 Mt to 2.6 Mt. Recent opencast coal production was from the Ferry Moor, Low Barugh and Woodhead sites in Barnsley and from the Orgreave site in Rotherham. Total South Yorkshire opencast production in 2005 was 0.44 Mt; at the end of 2005 only the Orgreave site in Rotherham was in operation, but near completion.

Two underground coal mines are currently in operation: Rossington in Doncaster and Maltby in Rotherham, although Rossington is to be placed into care and maintenance in 2006. Total underground production in 2005 was 2.6 Mt. Underground production in Yorkshire has been concentrated in the Barnsley seam complex, a thick, relatively undivided seam with lower values of sulphur (1.01 per cent). However, in the extreme northeast of the county, the Barnsley seam is split by mudstone partings and is less prospective. At the former Hatfield Colliery, substantial workings have occurred in the Hatfield High Hazel Seam; the mine is currently mothballed. Otherwise, workings are, or were, virtually confined to the Barnsley Seam.





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