British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Office of the Deputy Prime Minister
Creating sustainable communities

NORTH YORKSHIRE

(comprising North Yorkshire, Yorkshire Dales and North York Moors National Parks and City of York)

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

Mineral Resources (West)

Scale 1:100 000

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This map comprises part of a summary of the 'Mineral Resources of Yorkshire and the Humber'.
For more information see www.minerals.bgs.ac.uk

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SAND & GRAVEL

Superficial deposits

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

SANDSTONE

- Sandstone — Silurian and Ordovician

SILICA SAND

- Millstone Grit (Blubberhouses area only) — Carboniferous

LIMESTONE

- High purity limestone (>97% $CaCO_3$) — Carboniferous
- Limestone
- Dolomite and Dolomitic limestone — Permian: Cadeby and Brotherton formations

BRICK CLAY

- Laminated glacial clays — Quaternary

MINERAL PLANNING PERMISSION (as at 28.02.06)

Source: Mineral Planning Authorities

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

MINERAL WORKINGS

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

Mineral commodity

Ba	Barytes	Min	Mineral, unspecified	SiR	Silica Rock
Cht	Chert	Pb	Lead	SiS	Silica Sand
Cl	Clay and shale	San	Sand	St	Sandstone
Fl	Fluorspar	Sec	Secondary Aggregate	VM	Vein Minerals
Lst	Limestone, including dolomite	Sg	Sand and Gravel		

ENVIRONMENTAL DESIGNATIONS (as at 31.12.05)

- National nature conservation designations (SSSIs and NNRs)
- International nature conservation designations (SACs, SPAs and Ramsar sites)
- Area of Outstanding Natural Beauty (AONB): Nidderdale Hills, Forest of Bowland (part) and North Pennines (part)
- National Park: Yorkshire Dales
- Scheduled Monument

ADMINISTRATIVE AREAS

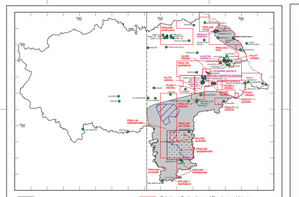
- Mineral Planning Authority (National Parks are also MPAs)
- District

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 retain these for selected nationally recognised planning designations. The maps are intended to assist strategic consideration and participation 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 or to 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.



HYDROCARBONS

Conventional Oil and Gas

North Yorkshire lies towards the southern margin of the Cleveland Basin, an important fault-bounded Jurassic and early Cretaceous structure, that itself overlies part of an early Carboniferous basin. Over the western part of the county, Carboniferous (Dinantian and Namurian) strata are all crop. Westphalian (Permine Coal Measures) strata have a limited occurrence, but are present beneath the Permian in the area of Robin Hood's Bay and in the south of the county where they extend eastwards from crop in West Yorkshire beneath the Permian to the coast just south of the line of the Vale of Pickering-Flamborough Head Fault Zone. As a result, the area potentially prospective for oil and gas is large. Over much of the Dinantian and Westphalian it is a mature province for conventional oil and gas. Phases of uplift and basin inversion have also led to the development of potential trapping structures and the area thus has the potential to contain commercial hydrocarbon accumulations.

The significant number of exploration wells (see inset map and Table 1) and the existence of a dense network of seismic reflection lines indicate that the area has been extensively explored for oil and gas. Many structures have been identified and some have been explored for oil and gas since before the Second World War. This has led to many discovery wells and the development of a number of producing gasfields in the county. To date, six gasfields have been developed, with the majority still producing and a number as yet to be developed. The status of each field is shown in Table 2.

In 1937 BP and CS drilled at Edale and tested gas from the Permian Upper Magnesian Limestone. The field was developed in 1960 and the gas fed from wells Eskdale-2 & 12 into the town gas system of the Whitby area until it was shut down in 1967. Hydrocarbons have subsequently been found in rocks of Namurian to Jurassic age within the county. The majority of the proven gas fields occur as a result of gas being trapped in fractured Permian carbonate and dolomite sequences and some basal Permian sandstones. However, gas has also been produced from Namurian sandstones in, for example, the Kirby Misperton and Malton gas fields.

Exploration to date indicates that the best potential for the discovery of further hydrocarbons lies in the eastern third of the county, where large tracts are currently licensed for oil and gas exploration and a number of prospects remain as yet untested or undeveloped. Using DX Grids, which represent the producing gas fields. Other small and focused operations have taken up acreage around these producing fields and it is likely that there will be further small gas and perhaps oil discoveries in the future. Dinantian strata crop out over much of the ground in the west and northwest of the county where hydrocarbon prospectivity is perceived to be lower. This is reflected in the fact that only two wells, at Weeton and Low Bradley on the border with West Yorkshire, have been drilled to date. Both proved dry and were abandoned.

Table 1: Hydrocarbon exploration wells in North Yorkshire (see Table 2 for gas field discovery and development wells)

Well name	Date drilled	Operator at time of drilling	Well status
Aldfield	1943	D'Arcy Exploration Ltd	Plugged & abandoned
Barlow	1973	Candecca Resources Ltd	Plugged & abandoned
Barton	1973	Home Oil of Canada Ltd	Plugged & abandoned
Cleveland Hills	1940	Gulf Exploration Company (Great Britain) Ltd	Plugged & abandoned
Cloughton	1986	Bow Valley Petroleum Ltd	Plugged & abandoned, with gas shows
Croyke	1964	Home Oil of Canada Ltd	Plugged & abandoned
Duggleby	1990	Amoco (UK) Exploration Company	Plugged & abandoned
Egton High Moor	1968	BP Development Ltd	Plugged & abandoned
Elwithwye	1945	D'Arcy Exploration Ltd	Plugged & abandoned
Fordon	1974	BP Development Ltd	Plugged & abandoned, with gas shows
Hartley	1965	Home Oil of Canada Ltd	Plugged & abandoned
High Hutton	1987	Enterprise Oil plc	Plugged & abandoned, with oil and gas shows
Hunmanby	1973	Burmah Oil (North Sea) Ltd	Plugged & abandoned
Kirby Grindalythe	1968	Gulf Exploration Company (Great Britain) Ltd	Plugged & abandoned
Kirk Smeaton	1985	RTZ Oil & Gas Ltd	Plugged & abandoned
Langtoft Wold	1986	Enterprise Oil plc	Plugged & abandoned
Marton	1979	British Geological Survey	Scientific hole
Newton Mulgrave	1965	Home Oil of Canada Ltd	Plugged & abandoned
North Fordon	1955	D'Arcy Exploration Ltd	Plugged & abandoned
Ralph Cross	1966	Home Oil of Canada Ltd	Shut in gas well
Rosedale	1966	Home Oil of Canada Ltd	Plugged & abandoned
Saxby	1945	D'Arcy Exploration Ltd	Plugged & abandoned, dry
Seaxby	1968	Kalt UK Ltd	Plugged & abandoned
Spaxton	1960	Shell UK Exploration and Development	Plugged & abandoned
Stoupe Beck	1967	Candecca Resources Ltd	Plugged & abandoned
Thornton le Clay	1990	Enterprise Oil plc	Plugged & abandoned
Weeton	1964	RTZ Oil & Gas Ltd	Plugged & abandoned, dry
Whitestone	1973	Candecca Resources Ltd	Plugged & abandoned
Wilsill	1973	Candecca Resources Ltd	Plugged & abandoned
Wintringham	1965	BP Exploration Company Ltd	Plugged & abandoned
Wykeham	1967	Home Oil of Canada Ltd	Plugged, gas well

Table 2: North Yorkshire gasfields

Name of field	Field Type oil or gas	Field Type offshore or onshore	Operator at time of discovery	Current operator of licence block	Discovery date	Production started	Production ceased	Total production (million m³ up to 2005)
Eskdale	Gas	Onshore	D'Arcy Exploration (Knaresborough SF)	Roc Oil (UK) Ltd	1937	1960	1967	860
Lockton	Gas	Onshore	Home Oil of Canada	Celtique Energie	1986	1971	1974	unknown
Kirby Misperton	Gas	Onshore	Taylor Woodrow	Viking Oil (UK)	1985	1995	Producing	unavailable
Malton	Gas	Onshore	Viking Oil (UK)	Viking Oil (UK)	1970	1995	Producing	unavailable
Marishes	Gas	Onshore	Kalt	Viking Oil (UK)	1988	1995	Producing	unavailable
Pickering	Gas	Onshore	Kalt	Viking Oil (UK)	1986	1995	Producing	unavailable

Abandoned Mine Methane (AMM), Coal Mine Methane (CMM) and Coalbed Methane (CBM) potential

Permine Lower to Middle Coal Measures forming part of the Eastern England Coalfield occur in the south of the county, but are entirely concealed beneath the Permian and younger cover rocks. These strata come to crop to the east in West Yorkshire, where they form part of the heavily worked Yorkshire and Nottinghamshire coalfields. Their northern extent is just to the south of the Vale of Pickering-Flamborough Head Fault Zone. Generally eastern-dipping from outcrop in the south of the county, their Permian subcrop pattern suggests that they are folded about a gentle NW-SE trending fold. The coals of the Yorkshire Coalfield are highly volatile bituminous types with an average total thickness of 15 m, and an average gas content of 4 - $5 m^3$ CH_4 per tonne. The Coal Measures in the Eastern England Coalfield have not been mined and are not well documented. However, where measured they have a gas seam thickness of 0.3-0.8 m^3 CH_4 per tonne and are thought to have an average total thickness of around 15 m, with non-likely to be thicker than 4 m.

Coal Measures also subcrop beneath the Permian in the area around Robin Hood's Bay, where they extend offshore. Here there is only 0.6 m of poor coal recorded and no mining has taken place.

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, suggests that CBM development from virgin coal seams in North Yorkshire is probably not economic at present. Future CBM potential will depend upon favourable changes in the economic situation when the Coal Measures beneath the county might prove prospective.

The prospects for Coal Mine Methane and Abandoned Mine Methane in areas of worked pits are analogous to other areas of the Yorkshire-Nottinghamshire Coalfield in general, being perceived as good. This is reflected in the acreage taken up for Coal Mine and Coalbed prospects by companies like Evergreen, Octane, Alkane and Strategas. Alkane Energy have already constructed and are operating AMM extraction plants at Mine Brethon and Wheldale in anticipation of the closure of Kellingley and West Yorkshire respectively. Rapid declines in the volumes of gas extracted and concerns in 2003 over the classification and being regimes of the resource have, however, led to double and concerns over the economic viability of this resource.

The concealed Permine Coal Measures around Robin Hood's Bay have not been mined and with the poor and thin coal recorded, provide little or no CBM prospects.

A potential future area for development in coalfield areas is Underground Coal Gasification (UCG). This is very much an unproven, new technology, which is under research and trial in a number of countries. Areas of suitable depth and coal quality in North Yorkshire probably exist, notably around York and eastwards, and therefore might provide potential for developing this technology.

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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 which extends beyond the boundary of scheduling cannot be represented here. Monuments scheduled since that date are not accounted for. © Copyright English Heritage.
Contact address:
English Heritage, 23 Savile Row, London, W1S 2ET, Tel: 020 7973 3132, Web page: www.english-heritage.org.uk

Digital AONB boundaries © Countryside Commission 1986 (now Countryside Agency).
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:
The Coal Authority, 200 Lichfield Lane, Mansfield, Nottinghamshire, NG18 4RG, Tel: 01623 427162, Fax: 01623 638038

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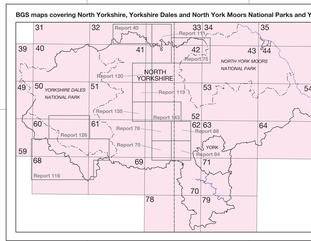
BGS maps covering North Yorkshire, Yorkshire Dales and North York Moors National Parks and York



SILICA SAND

Silica (industrial) sands contain a high proportion of silica (SiO_2) in the form of quartz and are used for purposes other than as construction aggregates. They are essential raw materials for the glass and foundry castings industries, but also have a wide range of other industrial applications, for example, as filtration media, abrasives, in the chemical industry, as fillers and in many other specialist applications. They are produced from both loosely consolidated sand deposits and by crushing weakly cemented sandstones. Unlike construction sands, which are used for their physical properties alone, silica sands are valued for a combination of chemical and physical properties. These include a high silica content in the form of quartz and, more importantly, low levels of iron oxide, particularly clay, iron oxides and refractory minerals such as chromite. Silica sands typically have a narrow grain size distribution, generally in the range 0.5 - 0.1 mm. The industrial applications of silica sand are very diverse, but the glass industry, for example, requires a product that can meet closely defined specifications and consistency in quality is of critical importance. Particular uses often require different combinations of properties. Consequently, different qualities of silica sand are usually not interchangeable in use. Silica sands command a higher price than construction sands. This allows them to serve a wider geographical market, including exports.

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

North Yorkshire has only limited resources of silica sand and current production is confined to a relatively small site at Burythorpe, near Malton. Here, fine-grained, pale-coloured sands from the Jurassic *Cleveland Formation* are quarried, mainly for the production resin-coated foundry sand. Current production is around 30,000 tonnes/year. Because of its only local importance, the maps shows the outcrop of the *Cleveland Formation* only in the Burythorpe area.

A large silica sand operation based on Carboniferous sandstones within the Millstone Grit Group (Hail Moor sandstone) at Blubberhouses, near Harrogate, formerly produced glass sand, mainly for the colourless glass container market. The quarry closed in 1991, after only three years operation, in part due to difficulties in processing the sand.

BUILDING STONE

Historically the county has produced and used a wide range of stones for building purposes. The oldest rocks of the area are the Lower Palaeozoic metasedimentary rocks of the Craven inliers near Settle and Ingleton that provided walling, roofi and flag stones for local use.

The Carboniferous rocks, however, are the main source of building stones in the county. The hard, pale grey Carboniferous limestones are commonly used across their outcrop in Swaledale, Ribblesdale and Wharfedale, in farm buildings, villages and railway viaducts. Occasionally the black, organic-rich limestone varieties were used decoratively, e.g. Niddersdale Marble. In some areas thin sandstones in the Lower Carboniferous succession ('Yoredale' Series) were also worked for flagstones and building stone.

The many sandstones of the Millstone Grit Group were extensively quarried over their outcrop, most notably in the Nidderdale-Harrogate area, supplying building and roofing stone to many of the nearby towns and cities. To the west of Pilgrim these sandstones were also used extensively for local building e.g. Fountains Abbey.

The dolomitic limestones of the Permian Cadeby Formation have been widely exploited as freestone. Quarries occur along much of the outcrop but are principally concentrated in the south, from Tadcaster to Sherburn-in-Elmet. Limestones from these quarries were used to construct York and Beverley Minsters, Selby Abbey and numerous parish churches and houses in the area. There are two operational quarries in the Tadcaster area.

INDUSTRIAL LIMESTONE

Limestone is an important economic resource because of its physical and chemical properties. It has a wide variety of applications but to be suitable for a particular application, it must possess the required physical and chemical properties and must be cheap to win and process to numerous chemical processes, as a mineral filler in paints, plastics and rubbers and in agricultural applications and waste treatment. In these non-constructional or industrial applications, limestone (or lime derived from the calcination of limestone) may be used either as a chemically reactive raw material or as an 'inert filler or pigment.' For these applications, limestone is generally required to be of high chemical purity. The industrial uses of limestone account for a small and decreasing proportion of total limestone output in Britain.

The Carboniferous limestones of the northern Pennines contain thick sequences of very pure limestone associated with other units of more variable chemical quality. The most consistently pure limestones are found within the Malham Formation and equivalent beds. These crop out widely between Ingleton and Grassington but further north they are largely concealed beneath limestones of lower and more variable quality. The Cove Limestone, forming the lower part of the Malham Formation, is chemically very pure and the overlying Malham Tarn Limestone is also very pure in places. High-purity limestones, Local variations in rock quality may result from bioconstitution, dolomitisation, lead-zinc mineralisation and clay contamination related to faults and fractures, but the Malham Formation forms a thick resource of high grade industrial limestone. Limestone for industrial use has been produced from several limestone quarries in the past but currently all limestone is used as aggregate.

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 uses such as tarmac (surface course), 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.

Sandstone

Sandstones are common rocks and occur in many parts of the county, but most sandstones are too weak and porous to make good quality aggregate for roadstone and concrete. The Lower Palaeozoic (Ordovician and Silurian) rocks of the Settle-Ingleton area, however, contain indurated sandstones which produce some of the best natural road surfacing materials available in Britain. These rocks are strongly folded and comprise a mixed sequence of siltstone and sandstones (often known generally as 'grittstone') and are quarried at Ingleton Quarry in Chapel-le-Dale and at Arncliffe and Cray Rigg quarries in Littledale. Because of their hard-wearing, skid-resistant properties, the Ingleton Group rocks are used in roadstones and marls as high-quality road surfacing aggregates. These deposits form an important regional resource of high specification aggregate.

Very small boreages of gritstone are also used for building stone and sandstones of Carboniferous age are also quarried on a small scale for the production of building stone at Kield in the Yorkshire Dales National Park and at Gatherly Moor near Richmond.

Limestone

North Yorkshire is rich in limestone resources with potential uses in many industries, although most is used in construction, as crushed rock aggregate.

Carboniferous limestones are the major source of limestone aggregate materials. These limestones are commonly thick-bedded, pale grey or grey, consistent deposits which are structurally simple and can be quarried extensively and economically. Other limestones being worked for aggregates are the Permian Magnesian Limestone and certain of the more indurated Jurassic limestones. Small amounts of Cretaceous chalk are also quarried at the margins of the Yorkshire Wolds, for less demanding aggregate applications.

Large areas of the northern Pennines are underlain by Carboniferous limestones which, in the more northern areas (Wensleydale, Swaledale, Teesdale) are dominantly of high purity and good quality. These rocks are commonly thick-bedded and consistent in quality, though thick (>100 m) Malham Formation and equivalent beds which crop out widely between Ingleton, Settle and Grassington. Most limestone quarries in the area are worked solely for aggregates but some quarries produce, or have the potential to produce, industrial limestone raw materials. Further north, these lower limestones are concealed beneath limestone units of lower and more variable quality (the Wensleydale Group) which are interbedded with mudstones and sandstones. Such limestones are generally not thick enough for economic extraction, although the Great Limestone at the base of the Namurian is thicker and is actively quarried for aggregate.

Dolomites (and subordinate limestones) of Permian age occupy a narrow outcrop of easterly dipping strata from Knottingley to the River Tees. These Permian limestones and dolomites - commonly known as the Magnesian Limestone - are highly variable lithologically and in their rock properties. They are much softer than typical Carboniferous limestones, with higher porosity and frequently are too weak and friable for use as aggregate. The Permian limestones are generally finer-grained than the Carboniferous limestones, with better crushing resistance and fit, and some of the rocks are sufficiently sound, strong and durable to be used as concreting aggregate or roadstone. In Yorkshire, the Permian sequence is made up of two carbonate units, separated by a 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 between 30-70 m in thickness and consists of a varied sequence of dolomites and limestones. The Brotherton Formation is usually less than 20 m thick and is a fairly homogeneous carbonate, with dolomite greatly exceeding limestone.

BRICK CLAY

'Brick clay' is the term used to describe clay used predominantly in the manufacture of bricks 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.

Both bedrock and superficial deposits have been used in the past to provide the raw material for brick and tile manufacture, and the laminated clays formed in glacial lakes in the Vale of York were a widely utilised source. The only working clay pits in the county are at Alne, which makes handmade bricks and drainage pipes, and at Littlethorpe, near Ripon which makes pottery and gardenware. Both pits work the laminated glacial clays. These clays are also used in the manufacture of lightweight expanded clay aggregate for block production and are worked at Hemingbrough and Eccrick.

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 North Yorkshire County Council, North York Moors National Park and Yorkshire Dales National Park. In addition, planning permission information was digitally acquired from Ministry of Housing and Local Government maps for the area and incorporated in the files. 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 procedures of the Town and Country Planning legislation and the permitted reserves 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.

Contact addresses:

North Yorkshire County Council, Environmental Services, County Hall, Northallerton DL7 8AH, Tel: 01609 780780, Fax: 01609 779838, web address: www.northyorks.gov.uk

Yorkshire Dales National Park, Yoredale, Bainbridge, Leyburn DL8 3EL, Tel: 0870 1666033, Fax: 01969 652399, web address: www.yorkshiredales.org.uk

North York Moors National Park, Planning Department, The Old Vicarage, Bondgate, Helmsley YO6 5BP, Tel: 01439 770657, Fax: 01439 770691, web address: www.moors.uk.net

City of York Council, Directorate of Environmental & Development Services, 9 St Leonard's Place, York YO1 2ET, Tel: 01904 613161, Fax: 01904 551380, web address: www.york.gov.uk

MINERALISATION

Base/lead/zinc/lead mineralisation occurs within the southern part of the Northern Pennine Orefield (Alston) as semi-vertical veins that are mainly confined to the uppermost Lower Carboniferous limestones. The most intensively worked areas were around Grassington and Greenhow, where veins occur in the unconformably overlying Namurian Grassington Grit, and in the North Swaledale area where deposits, such as Lovenathwaite, Old Gang and Arkengarthdale mines were worked in a linked system of faults. There has been little activity in the area for many years. Vein mineralisation is, encountered within limestones at the Coldstones Quarry near Pateley Bridge. Small amounts of fluorspar-bearing ore are transported to the Cavendish Mill in the Peak District for processing.

The Lower Carboniferous Craven Basin, which extends over an area approximately 40 km by 20 km from Lancashire into North Yorkshire, has potential for base-metal mineral deposits. BGS and industry have carried out mineral exploration in the area in the past and there were attempts to explore along the Craven Faults for 'Irish-style' stratabound lead-zinc mineralisation in the 1970s. The Craven Basin is still regarded as prospective for base metal mineralisation.

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 1979 and 2004 annual production of land won sand and gravel in North Yorkshire has varied between 2.5 million and 2.7 million tonnes. Recent production is shown on the graph and permitted reserves are estimated about 29 million tonnes.

Sand and gravel resources occur in a variety of geological environments. In North Yorkshire these resources occur mainly within superficial deposits, subdivided into river sand and gravel, glacial deposits, glaciofluvial, blown sand and beach deposits.

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 where available. 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 interest 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.

Glacial sand and gravel

This category comprises water-lain sands and gravels deposited in close proximity to the ice-sheets associated with the Quaternary glaciations. These deposits commonly occur on top of the sheet of till (boulder clay) or on, within or under the shoulders of the existing valleys including early down cutting along the present lines of drainage that were established by the Quaternary glaciations. In some areas, the sand and gravel deposits are associated with ice-marginal features such as moraines and eskers. The sand and gravel present in the eskers is a moderately well-sorted sand and gravel though a broad range of sizes, from silt to boulders may also be present in places. Clast lithologies are dominated by Carboniferous sandstones with minor amounts of Carboniferous and Permian limestones. Elsewhere the deposits show less structure and occur as irregular spreads and ridges of red-brown clayey sand with variably rounded pebbles, cobbles and sparse boulders of quartzite, sandstone, mudstone, chert and both Jurassic and Carboniferous limestones. These deposits can be up to 8 m thick in places although other deposits in the Thirsk area, e.g. between Topcliffe and Brafferton, reach 20 m thickness.

Glaciolacustrine deposits

During the Devensian glaciation, ice occupying the present coastal zone blocked the eastward-draining valleys including the Humber Gap between Brough and Bridlington and thus impounded 'Lake Humber' in the southern part of the Vale of York. Deposits associated with this lake, termed glaciolacustrine deposits, occur from south of York to the Humber estuary. When the ice began to melt, the lake spread round its northern side, depositing laminated clays with sand from Tholthorpe southwards to north of Knaresborough.

The deposits associated with Lake Humber were originally termed the '20-foot drift' as they lie at an average height of about 25 feet OD and fill and conceal the former valley features. The deposits of the 20-foot drift are predominantly laminated clay and silt with sand deposits occurring below, flanking and overlying the silt and clay. The lower part of the 20-foot drift consists in most places of sand, which is fine grained and is commonly silty and clayey, with locally abundant coal particles. Thicknesses of up to 10 m are recorded but generally the lower sand is not more than 5 m thick. Sand deposits occur marginal to the silt and clay and thin out against the surrounding higher ground. The silt and clay deposits are typically 10 - 15 m thick but may be up to 30 m thick in places. Generally silty and clayey with abundant coal particles and a few small pebbles and is generally not more than 3 m thick. The upper sand is not more than 2.5 m thick and is discontinuous, forming low ridges and mounds. It is fine grained, increasingly silty and clayey towards the top and contains thin beds and lenses of clay. In some areas the sand contains coal particles.

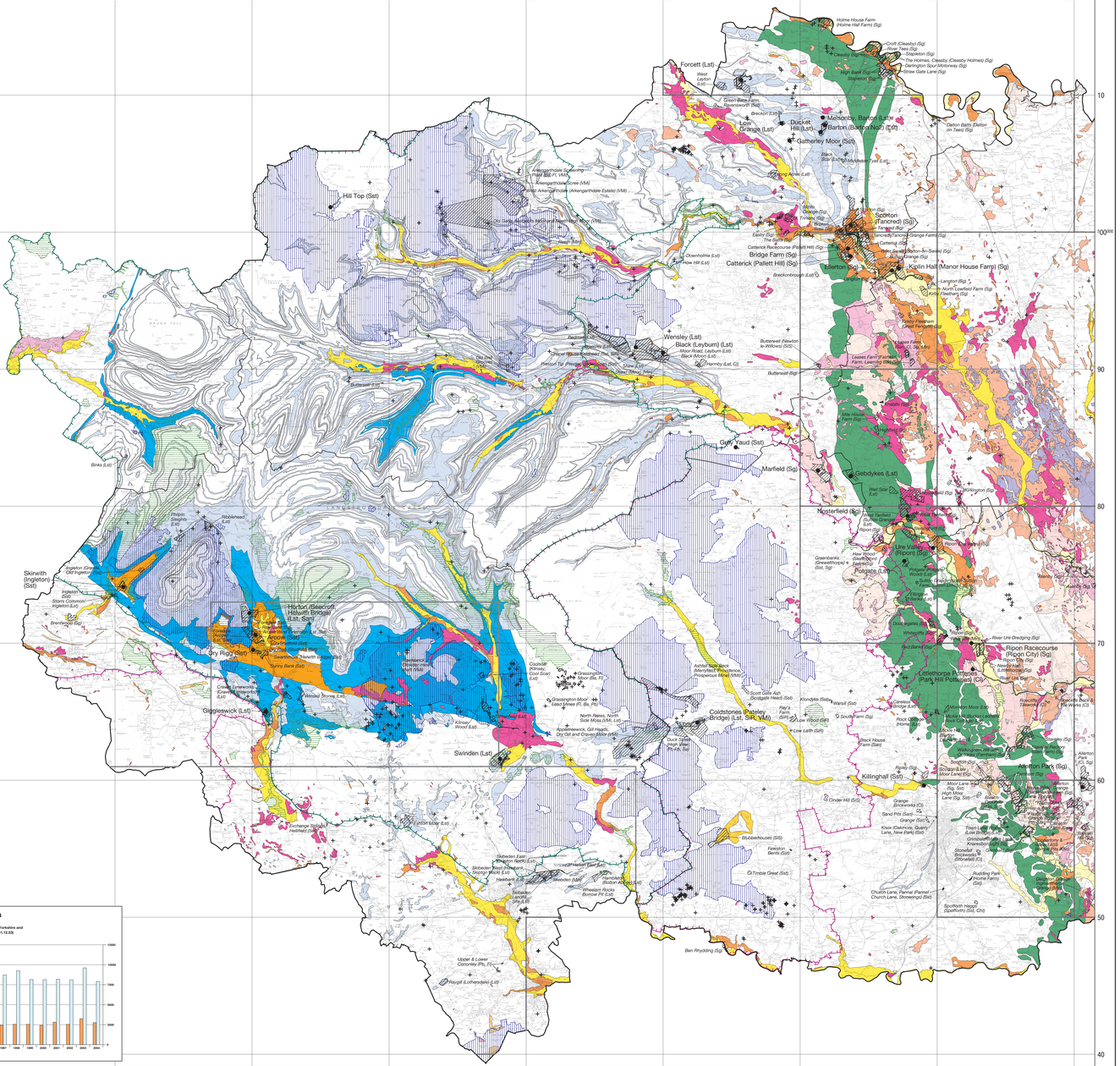
Glaciofluvial deposits

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- or delta-like layers above till deposits or as complex, irregular lenses within the till sequence. Areas of wholly consistent, and thus unknown, bodies of sand and gravel may occur under spreads of till and other drift deposits.

In North Yorkshire, extensive spreads of these deposits occur in the mid and lower reaches of the Esk, Ure, Swale, Ouse, Wharfe, Nidd and Aire valleys. Some of these deposits form broadly rounded and elongate ridges which overlie and clearly postdate the till and other glacial sand and gravel deposits. They are composed of yellow to reddish-brown, fine-grained sands with varying proportions of gravel, pebbles, cobbles and occasional boulders. In the Hambleton Hills, these deposits have a sloping, steep sided, terrace-like form and are composed of poorly sorted, poorly bedded, sandy gravel with occasional lenses of laminated silt and clay. In the Vale of Pickering and Flamborough Yorkshire, limestone and siltstone with a few pebbles of Carboniferous limestone. North of Thirsk, these glaciofluvial deposits form broad ridges of red-brown sandy gravel associated with underlying glaciolacustrine sediments. Glaciofluvial sediments also occur in terrace deposits where drainage from the glaciers in the Pennine valleys entered the west side of the Vale of York. Accepting spreads of sand and gravel in front of the ice sheets. The deposits are generally gravelly, with Carboniferous limestones and sandstones the dominant clast lithologies. Some of the deposits have been worked in the past for brick clay, but the majority have been worked for sand and gravel. Thicknesses of up to 30 m are known. The bulk of these deposits is typified in the workings at Marfield Quarry, on the River Ure near Masham, where up to 15 metres of coarse-grained sand and gravel is dry worked for concreting aggregate. The deposit is typically 60 per cent gravel and 35 per cent sand with a significant proportion of oversized material rejecting the coarse gravel nature of many of these deposits.

River sand and gravel (Terrace and Sub-alluvial deposits)

Resources occur in both raised river terrace sequences flanking the modern floodplains and in flood plain terrace deposits associated with, and underlying, present day alluvium. This sequence of deposits is best developed along the Rivers Swale, Nidd, Wharfe, Aire, Calder, Ouse, Derwent, Esk and Tees and comprises a complex interbedded sequence of sand and gravel, silt and clay, peat and organic silt and peat gravel layers. The pattern of these deposits was largely controlled by both the existing bedrock and by previous glacial features. The extensive terraces associated with the River Ure are the result of reworking of the glaciofluvial deposits in the area. The terraces flank the river alluvium at various heights above the floodplain and are mainly composed of sandy gravel but with thin layers of silt and clay in the lower terraces, representing overbank deposits. The terrace deposits associated with the River Swale are worked at various localities between Catterick and Topcliffe. Here, where overlain 250,000 tonnes of aggregate are extracted per annum. The deposits are 60-70 per cent gravel with the remainder mostly sand, but with up to 15 per cent silt and clay in places. The deposit is up to 15 m thick, with the upper 3 m worked dry and the remainder wet worked.

Production of land-won natural aggregates, 1979 - 2004

Sand and gravel total permitted reserves = 28.86 million tonnes (as at 31.12.05)
Crushed rock (Totals for the period 1981-87 include both North Yorkshire and 136.17 million tonnes in the Yorkshire Dales and North York Moors national parks) (as at 31.12.03)
Source: Yorkshire and the Humber Regional Aggregates Working Party