British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

The Scottish Government

EAST LOTHIAN, MIDLOTHIAN, WEST LOTHIAN and CITY OF EDINBURGH

Mineral Resource Information for Sustainable Communities

Mineral Resources

Scale 1:100 000

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SAND & GRAVEL

Superficial deposits

- Sub-alluvial and river terrace deposits: Inferred resources
- Glaciofluvial deposits
- Raised Beach deposits
- Blown sand

PEAT

- Peat

(Quaternary)

CRUSHED ROCK AGGREGATE

- Quartz-Dolerite sills and dykes (Midland Valley Sill-Complex)
- Alkali Dolerite (Midland Valley Alkaline Basic Sill Suite)

(Carboniferous to Early Permian igneous intrusions)

- Other igneous rocks, including basalts, dolerites, trachytes and andesites (Devonian to Early Permian igneous intrusions and volcanic rocks)

Sedimentary rocks

- Greywacke sandstone (Ordovician and Silurian)

BRICK CLAY

Superficial deposits

- Lake deposits (Quaternary)

Bedrock deposits

- Common shale for brick coincident with areas of shallow coal (Carboniferous: mainly Lower and Middle Scottish Coal Measures and Limestone Coal Formation)

BUILDING STONE

- Sandstone (Craigleith Sandstone, Hailes Sandstone, Ravelston, Sandstone and Binny Sandstone) (Carboniferous: West Lothian Oil-Shale and Gullane formations)
- ■ Important former quarries in Carboniferous sandstones

LIMESTONE

- Limestone (with adjacent mudstone used in cement manufacture) (Carboniferous: Lower and Upper Limestone formations)

SILICA SAND

- Resource coincident with fireclay (Carboniferous: Passage Formation)

SECONDARY AGGREGATE

- Selected bings (spoil heaps) of spent oil-shale

SHALLOW COAL

- Area of shallow coal coincident with brick clay and fireclay (Carboniferous: mainly Lower and Middle Scottish Coal Measures and Limestone Coal Formation)
- Opencast coal: worked area (up to 2004)

MINERAL WORKINGS

● Active site (with commodity)

Cl	Common clay and shale	Lst	Limestone
Co	Coal	Peat	Peat
Fr	Fireclay	Sg	Sand and Gravel
Ign	Igneous metamorphic rock	SiS	Silica Sand

ENVIRONMENTAL DESIGNATIONS

- National landscape designations (National Parks, National Nature Reserves, Sites of Special Scientific Interest and National Scenic Areas)
- International landscape designations (Special Areas of Conservation, Special Protection Areas and Ramsar sites)
- + Scheduled Monuments

ADMINISTRATIVE AREAS

- Local Authority boundary

Uncoloured areas on the map indicate undivided bedrock and superficial surface deposits. Unspecified mineral resources may be present locally at surface or at depth within this area

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 strategic decision making 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. Location information on national planning designations has been obtained from the appropriate statutory body (Scottish Natural Heritage, Scottish Government, Joint Nature Conservation Committee and Historic Scotland). For further information the relevant body should be contacted. Note that designated local biodiversity and geodiversity sites are not included in the environmental designation areas shown on the map.

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 the surface 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 locations of those quarries active in 2007 are shown. In addition former important building stone quarries are also shown. These have been extracted from the British Geological Survey's Britpits database in February 2008. While the compilers have tried to ensure that the site details are as accurate as possible, any map of active quarries is a snapshot in time. Moving the extraction location as reserves become exhausted or a new extension starts production, and renaming of sites are regular occurrences. Also sites may cease to be active at any time.

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.

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 (BS EN 12620), the term 'gravel' (or more correctly coarse aggregate) is used for general and concrete applications to define particle 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 and quartzite), but other rock types, such as microgabbro and basalt are included locally. The principal uses of sand are as fine aggregate in concrete, mortar and asphalt. The main use of gravel is as coarse aggregate in concrete. Substantial quantities of sand and gravel may also be used for constructional fill.

Glaciofluvial deposits

The main sand and gravel resources of the Lothian area are late Quaternary glaciofluvial deposits because they tend to be well sorted and lie above the watertable. Silt and clay are usually a minor component in glaciofluvial deposits. For example, those glaciofluvial deposits situated in the Dalkeith-Temple area include an active quarry at Temple that produces graded sand and gravel. Other defunct largely landfilled sites were at Oatslie, Clippens, Haveral Wood and Melville which were developed in glacial meltwater deposits, either in terraces or mounds, or from beneath a cover of glacial till. Potential deposits of sand and gravel occur at Upper Dalhousie.

In West Lothian glaciofluvial deposits mainly consisting of sand and gravel generally occur in mounds and elongate ridges as a result of deposition at ice-margins. These were quarried at Kettlestoun Mains, Linlithgow and North Couston, Bathgate until recently. Other small pits have been dug in the past, e.g. at Baron's Hill, Linlithgow, Philpstoun and Adam's Brae, Livingston, but most are now restored or infilled.

Potential economic resources of sand and gravel in the Haddington district lie in a discontinuous belt on the north-west flanks of the Lammermuir Hills from Tynehead to south of Gifford.

Currently Longyester Quarry, Gifford is producing washed and sorted sand and gravel and aggregate for concrete. Sand and gravel was formerly worked at Keith Marischal. Farther north at lower levels, glaciofluvial sands and gravels lie in the valley of the Tyne Water between Pathhead and Ormiston and in the Pencaitland and East Fortune areas. The deposits are partly in the form of terraces and partly form mounds and ridges. Near the Lammermuir Hills, medium to coarse gravel is dominantly greywacke sandstone pebbles and boulders. Farther north, fine- to medium-sands with lenses of gravel contain pebbles of sandstone and smaller amounts of greywacke sandstone, limestone and igneous rocks. Local layers of coal and carbonaceous shale fragments are a widespread deleterious feature of these deposits.

In the Dunbar district, glaciofluvial meltwater deposits occur along the margins of the Lammermuir Hills and along a coastal belt from Dunbar to south of Oldhamstocks. Those which can be classed as economic, on grounds of size and quality, include deposits adjacent to the Lammermuirs that are mainly of greywacke gravel. On the lower ground terraced deposits contain clasts of more mixed provenance, including sandstone and igneous origin as well as greywacke. Some ridges are up to 15 m high but most are generally lower (3-5 m).

Sub-alluvial deposits

Sub-alluvial sands and gravels, and those in buried channels, have not been used in this region as their quality tends to be variable and the deposits are commonly below the water-table. River terrace deposits in the Lothians tend to be limited in extent and thickness so they have been included with the sub-alluvial resources on the map. Together they form a subsidiary resource compared to the glaciofluvial deposits.

Raised beach deposits

Raised marine beach deposits of late-glacial or post-glacial age are mainly composed of sand and gravel but are limited in extent and thickness. They mainly lie under the northern part of Edinburgh, a sensitive scenic environment, which is likely to inhibit any future mineral extraction. Sand and gravel has been worked by Newhailes House.

Blown sand

In East Lothian, former pits at Gullane and Lochhouses Links worked blown sand on a small scale for building purposes. These cross-bedded fine-grained quartz sands included some shell debris and heavy minerals. Dunes also occur south from Peffer Sands to Belhaven Bay.

LIMESTONE

Limestones are sedimentary rocks composed mainly of calcium carbonate ($CaCO_3$). With an increase in magnesium carbonate ($MgCO_3$) content they grade into dolostone ($CaMg(CO_3)_2$). Most limestones and dolostones are hard and durable and therefore useful for aggregate. They are common rock types and consequently widely extracted for aggregate materials elsewhere in the UK, although generally this is not the case in central Scotland as there are numerous hard rock alternatives. Limestone is, however, also used for cement manufacture and both limestone and dolomite are valued for a range of industrial uses that, like cement manufacture, utilise their chemical properties.

Several Carboniferous limestones are considered to be resources in the Lothian region. Historically limestone was exploited from many small quarries for agricultural lime and as flux for smelting. Lime was also formerly used in plastering, the making of calc-silicate bricks and to dampen down dust in coal mines. Limestone beds of 3 m to 15 m in thickness are usually considered to be of workable thickness. The thickest and best quality occurs in the Carboniferous Lower Limestone Formation of the Clackmannan Group.

Currently in East Lothian the most widely exploited limestones for cement making are found in the lower part of the Lower Limestone Formation. At the Dunbar North site, the Middle Skateraw (Blackhall) down to the Upper Longcraig (Hurlet) limestones are worked together with the adjacent shales to produce cement. The works at Dunbar is the only cement producer in Scotland.

In the Edinburgh district, limestone resources occur in the Lower Limestone Formation and in the West Lothian Oil-shale and Aberlady formations of the Strathclyde Group. They have only been extracted where the limestone beds were at outcrop as the superficial overburden is usually too thick to permit exploitation.

The Burdiehouse Limestone in the Strathclyde Group was quarried and mined at and around Clippens Mine at Burdiehouse - Straiton until it closed in 1962. It is approximately 8 m thick and is relatively pure limestone. It was used as a flux in smelting iron, for plastering and cement and for agriculture. In the Lower Limestone Formation, the Hurlet (Gilmerton), Blackhall (North Greens) and Second Hosie (Bilston Burn) limestones have been quarried and mined. The Hurlet (Gilmerton) Limestone has been quarried at Mount Lothian and Middleton on the eastern side of the Midlothian Coalfield. On the western side, it was mined as well at Gilmerton (Ferniehill) and Hyvot's Bank. IThe Blackhall Limestone (North Greens), up to 27 m thick, was worked on a minor scale at Bilston and was the most extensively wrought seam at Mount Lothian and nearby Fullarton. It was worked also at Esperston on Chester Hill, Middleton, Upper Side and Currie Lee. In most cases only the lower purer part of the limestone was of commercial interest. The Second Hosie Limestone (Bilston Burn), up to 15 m thick, was worked at Bilston and in the Esperston quarries. In addition, the Blackhall (North Greens) Limestone, up to 30 m thick, has been mined and quarried in the inliers of the Lower Limestone Formation at D'Arcy and Cousland where only the basal 3 m were extracted. Cement manufacture took place at Cousland. Here, mining had ceased before May 1979. The last working operation was adjacent to the still active limeworks at Middleton. Currently, Middleton imports limestone from Ayrshire.

In the Haddington district, the Upper Longcraig (Hurlet) and Skateraw (Blackhall) limestones were once important economically. Quarried extensively from the late 18th century mainly for agricultural purposes, limestone quarries are now mostly filled in or overgrown. Limestones in the Strathclyde Group were formerly quarried in the North Berwick area and near Lennoxlove. These resources are limited and are therefore unlikely to be of further economic interest. Limestone of the Saltoun area might provide potential resources.

In West Lothian former limestone quarries, such as those at Petershill and Hillhouse (Mid and Main Hosie limestones of the Lower Limestone Formation), now have limited accessible resources. The Castlecary Limestone (Upper Limestone Formation) was mined at Halsburgh and Levenseat.

BUILDING STONE

Sandstone

Records exist for over seventy building stone quarries throughout the Lothians. Most of these produced pale-coloured Carboniferous sandstone and were concentrated in the Edinburgh area to supply the rapid urban development taking place from the late 18th to the early 20th century. As transport systems improved over time, stone was supplied to the city from quarries outside of Edinburgh. Although sandstone was quarried from many parts of the Carboniferous sequence, it principally came from the lower succession, Strathclyde and Inverclyde Groups.

The majority of quarries that operated within Edinburgh have been largely infilled and redeveloped with the exception of Craigmillar, Hailes, Ravelston, Barnton Park, and several others which have been retained as open spaces. Records show production in the Edinburgh quarries began as early as the 14th century in some locations (e.g. Craigmillar quarry), and continued as late as the 1940s in others (e.g. Hailes and Hawkhill Wood quarries). The best known Edinburgh quarry was Craigleith, worked from the early 17th to the mid-20th century. Its fine-grained, pale grey quartz-rich sandstone was used extensively in the city and exported throughout the United Kingdom and overseas.

Approximately eighteen significant Carboniferous sandstone quarries were located in West Lothian, including Hermand, Hopetoun, Humbie, Binny and Dalmeny. Many of these utilised the emerging canal and railway systems to supply Edinburgh during the 19th and early 20th centuries. Some of the quarries produced particularly distinctive stone, such as the thinly bedded laminated Hermand stone and the favoured fine-grained pale brown Binny, much used for prestigious buildings and monuments. Although most of the quarries ceased production by 1914 and none is currently active, some sites remain undeveloped. Binny Quarry was reopened temporarily in 1997 to supply stone for repairs to the Scott Monument in Edinburgh. Other quarries in West Lothian were significant local sources of stone. Those near Linlithgow (e.g. Hillhouse, Cauldhame and Kingscavil) provided distinctive reddish brown sandstone with a laminated texture, and Craigton Quarry near Philipstoun had a distinctive chocolate-brown colour. Stone from Craigton was used in both Edinburgh and Glasgow, and the quarry remained open until the 1930s.

In East Lothian, approximately fifteen significant sandstone quarries worked Carboniferous and Devonian outcrops to provide stone for local needs. Dunbar's distinctive character comes from Devonian red sandstone obtained from a number of nearby quarries. A lighter red sandstone with white spots, typical of some Devonian red sandstone, was used in the village of Garvald. Several Carboniferous sandstone quarries operated near Tranent until the first few decades of the 20th century, producing yellowish white, pale brown and grey stone.

A number of quarries in Midlothian also exploited Carboniferous sandstones for local use, particularly yellowish-brown stone around the towns of Penicuik, Newtongrange and Gorebridge. Some of these quarries operated until the early 20th century.

Rock types other than sandstone were used much less frequently for building purposes in Edinburgh and the Lothians, and very few significant quarries exclusively supplied these stone types. Various igneous rock types, including lavas and volcanic breccias, were used locally in Haddington and Dirleton, and dolerite was used in areas of West Lothian where it was conveniently exposed. Red trachyte was used extensively for building in North Berwick. Today there are no active building stone quarries of any type in Edinburgh or the Lothians.

CRUSHED ROCK AGGREGATE

A variety of hard rocks, such as basalt, trachyte and limestone, 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, such as quartz-dolerite, 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, which have less demanding specifications, lower quality materials, such as basalt, are acceptable.

Igneous rock

The crushed rock resources in the Lothian region are almost entirely of igneous rocks. These tend to produce strong aggregates with a degree of skid resistance and are therefore suitable for many road-surfacing applications, and in the construction of lower parts of the road pavement.

Numerous igneous rock quarries in the region have been exploited for hardrock aggregate in the past. Volcanic rocks are extensive within the Lothians but intrusive rocks intruded below the earth's surface are commonly stronger and more uniform in quality. The Devonian volcanic rocks in the Pentlands and the Carboniferous ones in the Bathgate Hills for example, are not as consistent in quality as the intrusive igneous, mainly doleritic intrusions. The Carboniferous or early Permian doleritic intrusions that form shallowly dipping sheets (sills) are generally thicker, more extensive and easier to work than dykes or plugs. The most voluminous, and most highly sought after resource is quartz-dolerite because of its high polished stone values (PSVs). High PSV aggregates have a high degree of skid-resistence when used in surfacing roads. It tends to be a harder, finer grained rock with higher quality than the alkali dolerite which tends to be coarser grained and more altered. The quartz-dolerite can be used in concrete and road surfacing; alkali dolerite is used for roadstone.

Quartz-dolerite sills are presently worked near Ratho but dykes have also been worked. The dyke on the Royal Musselburgh Golf Course is an example of this. Bonnington Mains Quarry and Hillwood Quarry near Ratho, Edinburgh, are both located on quartz-dolerites of the Midland Valley Sill-Complex. Similar rock occurs near Turnhouse and Dechmont Law in West Lothian. Ravelrig Quarry, near Kirknewton, is in the alkali doleritic Dalmahoy Sill.

The alkali-dolerite sills, such as those at Salisbury Craigs and Corstorphine Hill, have been exploited in the past for setts and kerbs, dimension stone, roadstone and over-size stone. The Gosford Bay alkali dolerite sill from Gosford Quarry produced good quality roadstone, and fine-grained analcime basalt was quarried in the Gifford area. A dolerite intrusion was at one time quarried near West Fenton.

Of the other igneous rocks, the intrusive trachyte of Pencraig Sill is worked at Markle Mains and was formerly worked at Pencraig Quarry. Considerable quantities of roadstone were formerly obtained from the phonolite (undersaturated sodic trachyte) intrusion of Traprain Law.

In the Haddington area trachyte lava was quarried at the former Craigs Quarry and trachyandesite found in the Garleton Hills Volcanic Formation is currently being worked at Bangley Quarry. In the Dunbar area potential igneous road metal could be obtained from the eastern end of the Garleton Hills Volcanic Formation but more uniform quality rock occurs in the trachyte intrusion at Garvald.

The Devonian lavas (and associated intrusions) of the Pentland Hills Volcanic Formation have been taken in the past from the defunct Blackford, Mortonhall, Torphin and Silverburn quarries. The Carboniferous lavas of the Arthur's Seat, Bathgate Hills and Clyde Plateau volcanic formations together with Carboniferous vent intrusions in this region are largely untouched mainly because they are variable in quality and thickness. They also tend to form high ground of scenic or amenity value, so are unlikely to be worked.

Sedimentary rock

The Ordovician and Silurian rocks in East Lothian contain extensive resources of compact grey sedimentary rocks, known as greywacke sandstone and mudstone. In the past the Ordovician greywacke sandstones (Kirkholm and Portpatrick formations of the Leadhills Group) were quarried locally for roadstone in the Haddington area. Small quarries were commonly opened for dry-stone walling in the past.

The Silurian Gala Group south of Dunbar contains resources of greywacke sandstone and mudstone. These are mainly where the sandstones are thick and form hard resistant rocks with high PSVs. The resource could be suitable for roadstone but production of aggregate may be more problematic in some applications due to its shrinkage in concrete.

BRICK CLAY

'Brick clay' is the term used to describe clay and common shale used predominantly in the manufacture of bricks and, to a lesser extent, roof tiles and clay pipes. These clays may sometimes be used as a source of constructional fill and for lining and sealing landfill sites. The suitability of these materials for brick manufacture depends principally on their behaviour during shaping, drying and firing. This dictates 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 dependant 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 to enable the continuing supply of bricks for construction.

There are currently no active sites working brick clay in the area covered by this map.

Common shale for brick

Common shale occurs throughout most of the Carboniferous succession except in the Kinnesswood Formation (Inverclyde Group) at the base. There are plentiful potential resources of common shale, in the Coal Measures, Upper Limestone, Limestone Coal, Lower Limestone formations, and in the Strathclyde Group. All of these sources have been used in the past.

In West Lothian, at Armadale Brickworks, Lower Coal Measures mudstones were obtained from a pit, now restored, and mudstones are imported from opencast sites in the Central Scottish Coalfield. In the past, Carboniferous mudstones and glacial till were mixed to produce bricks at works at Winchburgh, Camps and Ecclesmachan in West Lothian.

In the Midlothian Coalfield seatclay and seatearth were worked in the past from the Coal Measures at Whitehill Colliery and from the Limestone Coal Formation at Ramsay and Roslin collieries.

Clay deposits

Lake clays deposited after the latest glaciers melted have been extracted at Smeaton, Eskbank, Upper Dalhousie Farm and Newtongrange. Marine silty clays, laid down after the ice melted, were worked on a small scale near Edinburgh, e.g. at Portobello, Wardie and Granton, where they were up to 9m thick. At Joppa, bricks, tiles and pottery were produced.

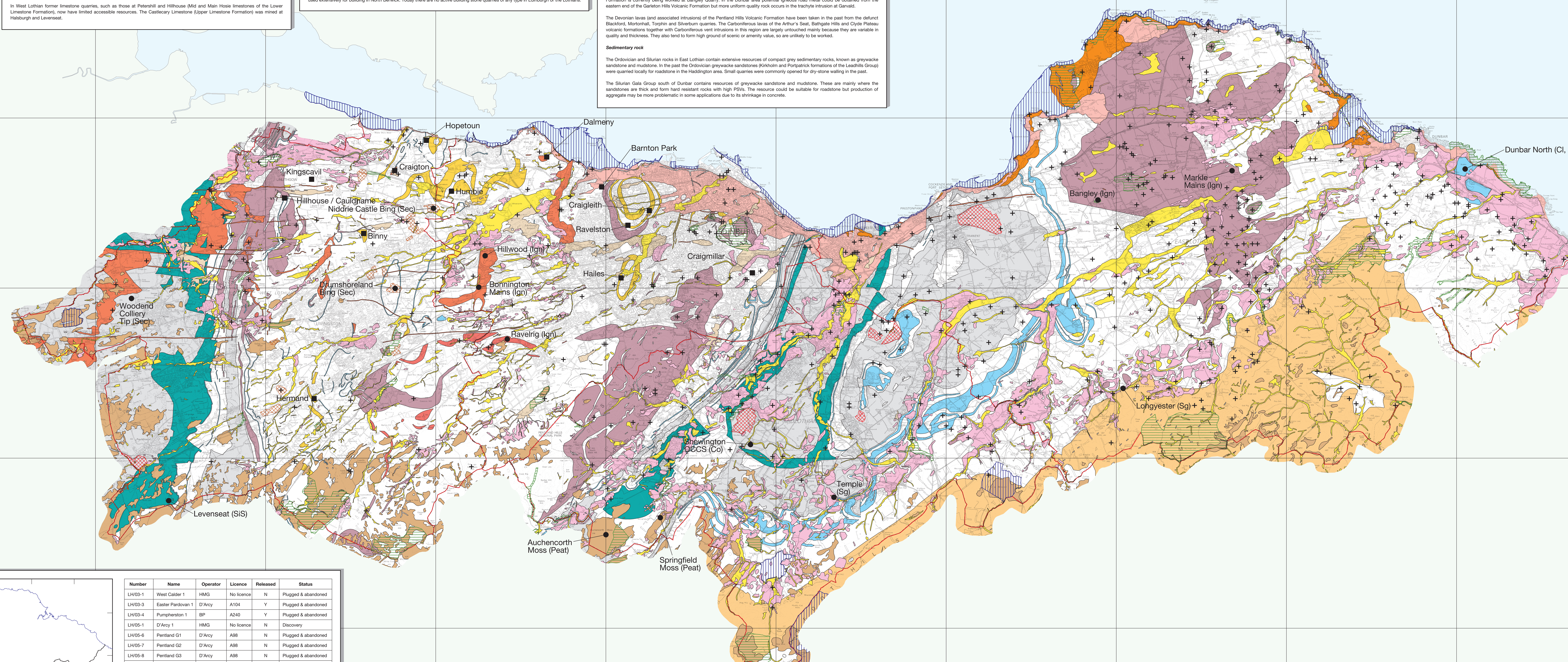
In the Haddington district, late-glacial clay, some of lacustrine origin, was worked formerly for bricks and tiles. There are records of pits in Aberlady, East Fenton, East Fortune, Gladsmuir and East Saltoun. While some clay deposits remain, most are too small to be considered economic.

SECONDARY AGGREGATES

Secondary aggregates include the waste from collieries and other mineral extraction or processing operations as well as material recycled from former man-made constructions. They are used as alternatives to primary aggregates.

Large bings or tips of spent oil-shale accumulated in the past after oil-shale was processed and nearly 75% of the shale was waste. These tips mainly occur in West Lothian, and several have been reworked for fill because the waste material is inert. Some bings are being restored. This is a sustainably derived secondary aggregate which has potential for other applications. Some of the bings have been landscaped and planted with trees; others have been used as landfill sites. Some of the West Lothian bings can still be regarded as a source of fill; in particular the Niddrie Castle and Drumshoreland bings are due to have million of tonnes of spent shale extracted. The Straiton oil-shale bing south of Edinburgh is to be remodelled and planted to become a Local Nature Reserve (LNR).

Tips of colliery waste are relatively few in the Lothians but have potential for provision of mudstone for brick-making or for the recovery of their coal content. After removal of combustible material such as coal, the waste can be used as fill. One tip that was worked for brick making i.e. Niddrie, is now landscaped and much of the material redistributed and used in land reclamation and in industrial redevelopment.

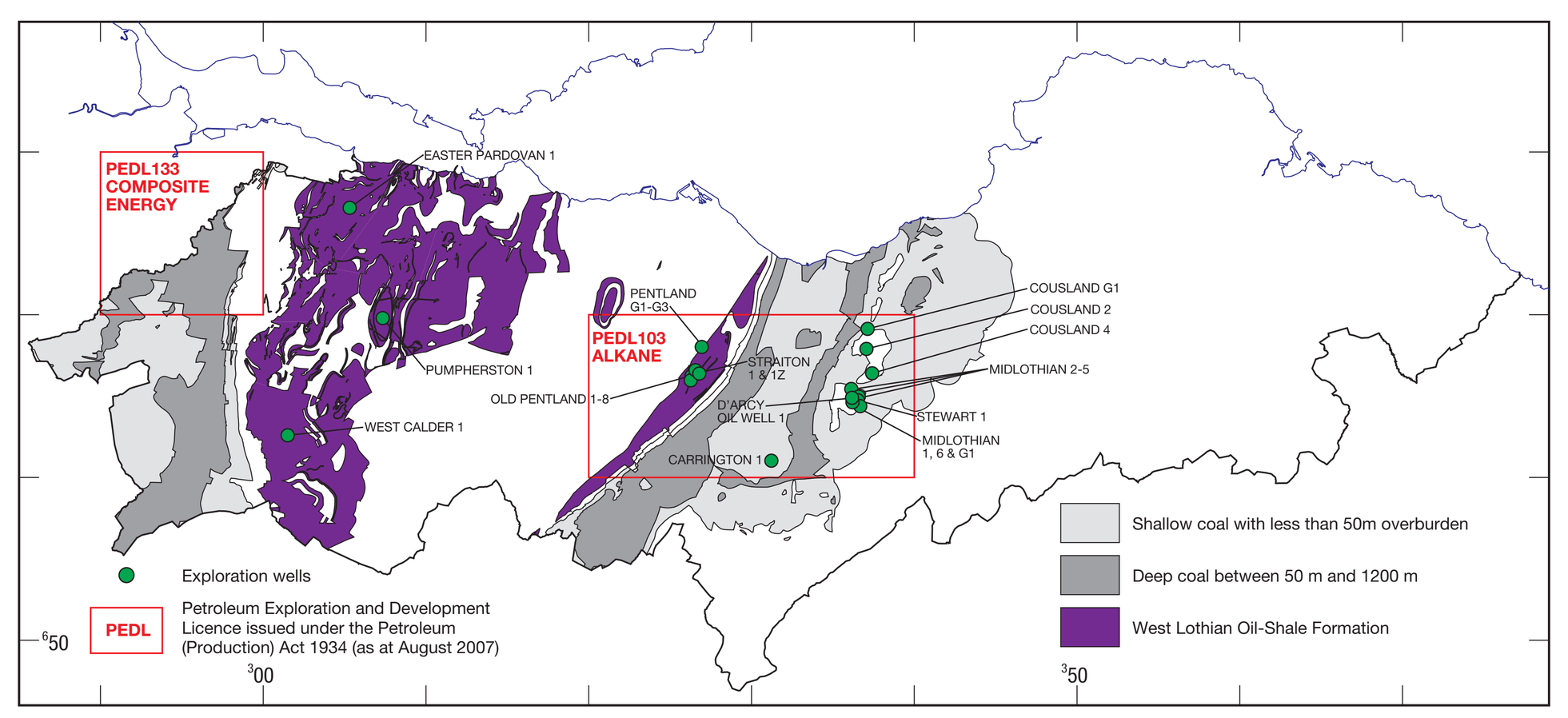


FIRECLAY

Fireclay is a non-marine sedimentary mudstone consisting essentially of the clay mineral kaolinite with varying proportions of hydrous mica and quartz, together with some minor impurities such as ironstone nodules and carbonaceous matter. In the past the uses of fireclay stemed from its refractory nature, that is its ability to withstand high temperatures without deforming or becoming chemically unstable. These properties are dependant on the alumina content which is generally between 40 and 45% for these kaolinitic clays. The value of the raw material depended greatly on the content of alkalis, iron oxides and carbon. However, fireclays are now valued chiefly as a raw material in the manufacture of high-quality, weather resistant, buff-coloured facing bricks.

Fireclay occurs commonly in association with Carboniferous coal-bearing strata or silica sandstones in the Passage Formation. These clays are therefore shown as coincident with coal and silica sand on the map.

Fireclay occurs commonly in association with Carboniferous coal-bearing strata or silica sandstones in the Passage Formation. These clays are therefore shown as coincident with coal and silica sand on the map. In West Lothian, a pit at Northrigg near Bathgate produced clay for (fire) brick manufacture from the Lower Coal Measures. Fireclay used to be mined and worked opencast in West Lothian (eg. Breich and Levenseat mines; Blaebery Hill opencast). A fireclay below the Index Limestone in the Limestone Coal Formation was extracted at Joppa for firebrick, pipes and gas retorts. Other fireclays in the Limestone Coal Formation were mined at the former Prestonlinks Colliery in the Haddington district and supplied a fireclay works near Tranent. There is potential for fireclay extraction at opencast coal sites.



COAL

Coal is a combustible sedimentary rock made of lithified plant remains. It is formed by the progressive biological and thermal degradation of vegetation, which is consolidated between other sedimentary rocks, notably seatearth, mudstone, siltstone and sandstone, to form coal seams (layers). These vary in thickness from a few centimetres up to rarely 3.5 m, although exceptionally thicker seams may also occur. Almost all onshore coal resources in Scotland occur in rocks of Carboniferous age (300 to 330 million years old) and the main strata containing coal seams at fairly regular intervals are referred to as 'Coal Measures'.

Deep-mined coal

After a long history, mining of coal in the Midlothian Coalfield ceased with the abandonment of the Monktonhall Colliery in 1997 and the sealing of the Blinkbonny Mine Adit in 2003. The coalfield produced mainly from the Coal Measures and the Limestone Coal Formation. With modern technology and favourable economic factors, there is future potential in developing the coalfield under the Firth of Forth. The main remaining potential is in the lower part of the Middle and in the Lower Coal Measures, the Limestone Coal Formation and to a lesser extent in the Passage and Lower Limestone formations. In situ coal gasification could tap resources presently not considered economic for mining. In the past the most extensively worked seams in the Limestone Coal Formation were the North, South, Bryans Splint, Peacock, Blackchapel, Stairhead and Great Seam coals. In the Coal Measures the seams were the Fifteen Foot, Nine Foot, Salters, Cowpits Five Foot, and Musselburgh Jewel, Rough and Splint coals. The North Greens Coal was mined from the Lower Limestone Formation.

Shallow coal

After the privatisation of the coal industry, the main interest in economic coal production switched to opencast methods working the Coal Measures and the Limestone Coal Formation. The Eskmouth Extra Coal near the top of the Passage Formation could be of future interest.

In Midlothian Newbigging Farm mainly worked the Great Seam Coal in the Limestone Coal Formation. It is finished and being restored. Shewington has started nearby. Earlier opencast sites were located at Blinkbonny and Oxenfoord both in the Limestone Coal Formation. The Lower Coal Measures were worked at the former Gourlaw site, which is now restored. Most Midlothian coals are low in sulphur (< 1%), but the North Coal is locally over 4%.

In the Midlothian Coalfield potential for opencast coal is limited to east of Dalkeith and east and north of Gorebridge.

In the Haddington area coal has been worked since the early 13th century. Apart from a few small workings in the Lower Carboniferous, all the coal in this area came from the Limestone Coal Formation. South-east of the Crossgatehall Fault much of the coalfield dips at less than 6̊, and this combined with the shallowness of some of the main seams made for relatively easy mining. At least 8 seams were mined and up to 5 extracted in the undersea extension of the coalfield from the Prestonlinks Colliery. When the NCB was set up in 1947, there were 6 collieries in the area but they are now all closed and the prospects for opencasting is limited since the closure of the Blindwells site, north-east of Tranent. In the vicinity of Tranent, where shallow mining of seams such as the Great Seam Coal has occurred over several centuries, opencasting provides an opportunity to stabilise potentially hazardous ground.

HYDROCARBONS

This area lies within the late Palaeozoic Midland Valley faulted basin (graben), which has a proven hydrocarbon system. A thick sequence of Carboniferous rocks includes oil-shale source rocks, thin sandstones as potential reservoirs and interbedded shale seals. Many compressive and transpressive structures were formed during the Variscan deformation at the end of the Carboniferous and may act as traps for hydrocarbons. The organic maturity of the source rocks has been shown to lie within the early oil window in most places, although overmaturity occurs in the vicinity of the Midland Valley Sill and other intrusions. Additionally torbanite, an organic-rich algal, rock occurs in the Lower Coal Measures with its type area at Boghead, near Bathgate. This covered a small outcrop area and was exhausted in the 19th century, before James 'Paraffin' Young turned to working the larger crop of lower productivity oil-shales for oil (see Oil-Shale).

Hydrocarbon prospectivity has focussed on the oil-shale bearing Strathclyde Group strata. These are the West Lothian Oil-shale Formation and its East Lothian equivalent of the Aberlady Formation and the underlying Gullane Formation, where reservoirs were thin cross-bedded sandstones. Migration into surface anticlinal reservoirs was probably from the west beneath the Midlothian Coalfield syncline. Drilling for hydrocarbons first took place in 1919-1922 at D'Arcy Farm. Natural gas (300k cu. ft. per day) and oil were struck but the latter not in encouraging quantities. The D'Arcy Well should be considered as the Midlothian field discovery well (Table 1). Fifty barrels of waxy oil were recovered in two months in 1922. Anglo-American (now Exxon) developed this field, which produced 30 000 barrels (0.0042 million tonnes) of oil between 1937 and 1965. During 1937-1940, nine wells were sunk in the Cousland-D'Arcy area. Little oil was produced but natural gas was for a number of years (e.g. Midlothian Nos 3 & 6 Wells producing 36k cu. ft. of gas a day). Between 1947 and 1954 further wells were sunk at Cousland. More recently in 1984, the Burdiehouse and Straiton Oil-shale Field was the subject of both shallow and deep test drilling for hydrocarbons. Deep drilling also tested the Carrington area west of Gorebridge and Cousland-D'Arcy in the same period. Drilling, based on seismic reflection data, by Lasmo (in 1981) at Stewart, near the Midlothian wells, failed to produce hydrocarbons.

The oil seepage in St. Catherine's Well (The Balm Well) in Edinburgh's suburb of Liberton and oil stained sandstones in Straiton Quarry suggests that migration west from the Midlothian Coalfield syncline may also have occurred, as far as the Pentland Fault. Shallow wells at Old Pentland and a deeper one at Straiton with oil shows (Lasmo) were drilled to test this possibility. Three boreholes near Mortonhall Cottage, by D'Arcy, aimed to find the dip on the Pentland Fault. Shows were present beneath the reverse fault in the Strathclyde Group. Migration southwards from the Midlothian Coalfield was tested by the Carrington Well (Lasmo 1984), which had oil shows.

In West Lothian three wells have been drilled. West Calder (in 1919) was drilled on a surface anticline and discovered some gas, Easter Pardovan (in 1945 by D'Arcy) and Pumpherston (in 1962 by BP). The latter is notable for an oil show in the Ballagan Formation, although a drill stem test produced only water.

Number	Name	Operator	Licence	Released	Status
LH/03-1	West Calder 1	HMG	No licence	N	Plugged & abandoned
LH/03-3	Easter Pardovan 1	D'Arcy	A104	Y	Plugged & abandoned
LH/03-4	Pumpherston 1	BP	A240	Y	Plugged & abandoned
LH/05-1	D'Arcy 1	HMG	No licence	N	Discovery
LH/05-6	Pentland G1	D'Arcy	A98	N	Plugged & abandoned
LH/05-7	Pentland G2	D'Arcy	A98	N	Plugged & abandoned
LH/05-8	Pentland G3	D'Arcy	A98	N	Plugged & abandoned
LH/05-15	Stewart 1	Lasmo	PL177	Y	Plugged & abandoned
LH/05-16	Old Pentland 1	Lasmo	PL177	Y	Plugged & abandoned
LH/05-17	Old Pentland 2	Lasmo	PL177	Y	Plugged & abandoned
LH/05-18A	Old Pentland 3A	Lasmo	PL177	Y	Plugged & abandoned
LH/05-19	Old Pentland 4	Lasmo	PL177	Y	Plugged & abandoned
LH/05-20	Old Pentland 5	Lasmo	PL177	Y	Plugged & abandoned
LH/05-21	Old Pentland 6	Lasmo	PL177	Y	Plugged & abandoned
LH/05-22A	Old Pentland 7A	Lasmo	PL177	Y	Plugged & abandoned
LH/05-23	Old Pentland 8	Lasmo	PL177	Y	Plugged & abandoned
LH/05-24	Straiton 1	Lasmo	PL177	Y	Plugged & abandoned
LH/05-24Z	Straiton 1Z	Lasmo	PL177	Y	Plugged & abandoned
LH/05-B25	Carrington 1	Lasmo	PL177	Y	Plugged & abandoned

Table 1. Exploration wells and others not related to producing fields

Field	Date	Company Discovery	Oil/gas/CBM	Operator	Exhaust date	Production (gas in billion cubic metres, oil in metric tonnes)
Cousland	1937	D'Arcy	Gas	BP	1965	0.00924
Midlothian	1922	HMG	Oil	Anglo-Amercian	1965	0.0042

Table 2. Abandoned fields in East Lothian

In the Haddington district, gas and oil were encountered in the upper part of the Strathclyde Group in the Spilmersford Borehole.

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

Methane gas was generally not a problem in the coal mines of the Lothians but there may be potential for coalbed methane from deeply buried coals in the Clackmannan and Strathclyde groups. PEDL 103 licence, currently operated by Alkane, covers the Midlothian Coalfield. The southern part of Composite Energy's coalbed methane licence PEDL 033 also extends into the West Lothian area. Two coal seams within the area have published gas content values. The Stairhead Coal in the Limestone Coal Formation at Monktonhall Colliery contained 0.8 m^3/tonne and the Woodmuir Jewel Coal in the same formation at Polkemmet Colliery 1.5 m^3/tonne.

OIL-SHALE

Oil-shale is the term used to described a fine-grained sedimentary rock with a high enough organic content to make it possible to extract hydrocarbons. This extraction is energy-intensive so to be economic deposits have to be sizable.

In the Lothians oil-shale mining was the petroleum industry of its day, based on James Young's patented distillation process to produce shale-oil which began at Bathgate in 1851. Mining of near surface, geochemically immature or marginally mature, petroliferous shales was then economically sounder than prospecting at depth far and wide, in areas remote from markets.

Most oil-shale was mined (from the 1850s until 1962) in West Lothian and also south of Edinburgh. As the raw material for the production of shale-oil, it yielded 70 to 200 litres per tonne of shale, but about 75% of the shale is waste. Seams of oil-shale occur at over a dozen horizons within the West Lothian Oil-Shale Formation. These mainly lie within the Hopetoun Member and to a lesser extent in the Calders Member. In West Lothian three multiple thick seams produced the bulk of the oil-shale mined: the Broxburn Shale, the Dunnet Shale and the Pumpherston Shale. The Fells and the Camps shales were also worked extensively. The other seams were thin variable and worked only in small areas or not at all. Nearly all the oil-shale was produced from deep mines, such as at Philpstoun, Newton, Winchburgh, Broxburn, Uphall, Pumpherston, Mid Calder, Deans and Seafield. Only in a few cases were the shales dug by opencast methods e.g. Bridgend, Fawnspark and Glendevon. A mine south of Edinburgh at Clippens Oil-shale works worked the Broxburn, Under Dunnet (Pentland) and Fells shales. As petroleum became readily available oil-shale became uneconomic to extract. Production of oil shale reached 500,000 barrels in 1878, 1 million barrels in 1885 and 2.1 million barrels during the First World War. Production continued at about 1 million barrels per year until a tax concession was withdrawn in 1964, making a cumulative production total of about 75 million barrels. A study of the resource in this region came to the conclusion that most of the accessible oil-shale had been exploited. Four possible opencast targets were identified, but mining oil-shale is probably uneconomic as a raw material to replace petroleum, although there may be chemical or pharmaceutical uses.

METALLIFEROUS MINERALS

Metalliferous mineral occurence locations are not shown on the map.

Silver

A metalliferous vein at Hilderston in the Bathgate Hills, 2 km east-south-east of Torphichen, contained ores of silver, nickel, cobalt and lead (galena). This vein was discovered in 1606 and was mined episodically until 1898 for silver-bearing galena with some native silver. The vein lies beside a dolerite dyke within faulted Lower Carboniferous sedimentary beds. Late-Carboniferous hydrothermal veins occur within the Petershill Limestone and overlying clastic sediments. At Hilderston two mineral assemblages are recognised in the vein: Ba-Fe-Ni-Co-Ag-As on a dyke margin adjacent to the clastic sediments and Fe-Pb-Zn-S at lower levels adjacent to the limestone. Zones of alteration in the dykes carry hydrocarbons and weak Ba-Fe-Cu-F mineralisation. Investigations by the British Geological Survey, including shallow drilling, showed that the silver and nickel mineralisation is restricted to fault infillings and is similar to that seen at Alva 20 km to the north. However, low-grade stratiform lead-zinc mineralisation occurs in the limestone with 0.14% Pb and 0.66% Zn over 11 m interval in one borehole. It is unlikely that any follow-up exploration will be carried out over such a small and low-grade target in this environmentally sensitive area.

Ochre

Historically, yellow ochre (hydrated iron oxide) has been quarried and possibly mined at Bilston Glen where the Hurlet (Gilmerton) Limestone had been altered to what was described as 'coarse ochre', 7 m thick.

Ironstone

Past mining of both nodular and bedded clayband ironstone and blackband ironstone is known in the Lothians, with the Lower Limestone and Limestone Coal formations being the chief sources. None is now an economic resource.

Blackband ironstone was mined in the 19th century from the Limestone Coal Formation in the Haddington area; mostly obtained from mines in the Preston-Macmerry area, south-east of Tranent. The seam between the Five Foot and Ball coals was of good quality but it is no longer a prospect.

Blackband ironstones (0.45 m) in the Lower Limestone Formation were mined in the 19th century in the Gilmerton and Moredun areas of south Edinburgh. Several ironstones in the Limestone Coal Formation have been mined especially the Loanhead Nos 1 and 2 beds above the Bryans Splint and below the Great Seam coals respectively. They were mined at Mauricewood, Burghlee, Ramsay and Roslin collieries.

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 aggregate. They are essential raw materials for the glass and foundry castings industries, but also have a wide range of other industrial applications. This includes ceramic and chemical manufacture, for water filtration media and sports and horticultural applications. They are produced from both loosely consolidated sand deposits and by crushing weakly cemented sandstones. As a specialist product, silica sands generally command a higher price than construction sands and they serve a wider geographical market, including exports.

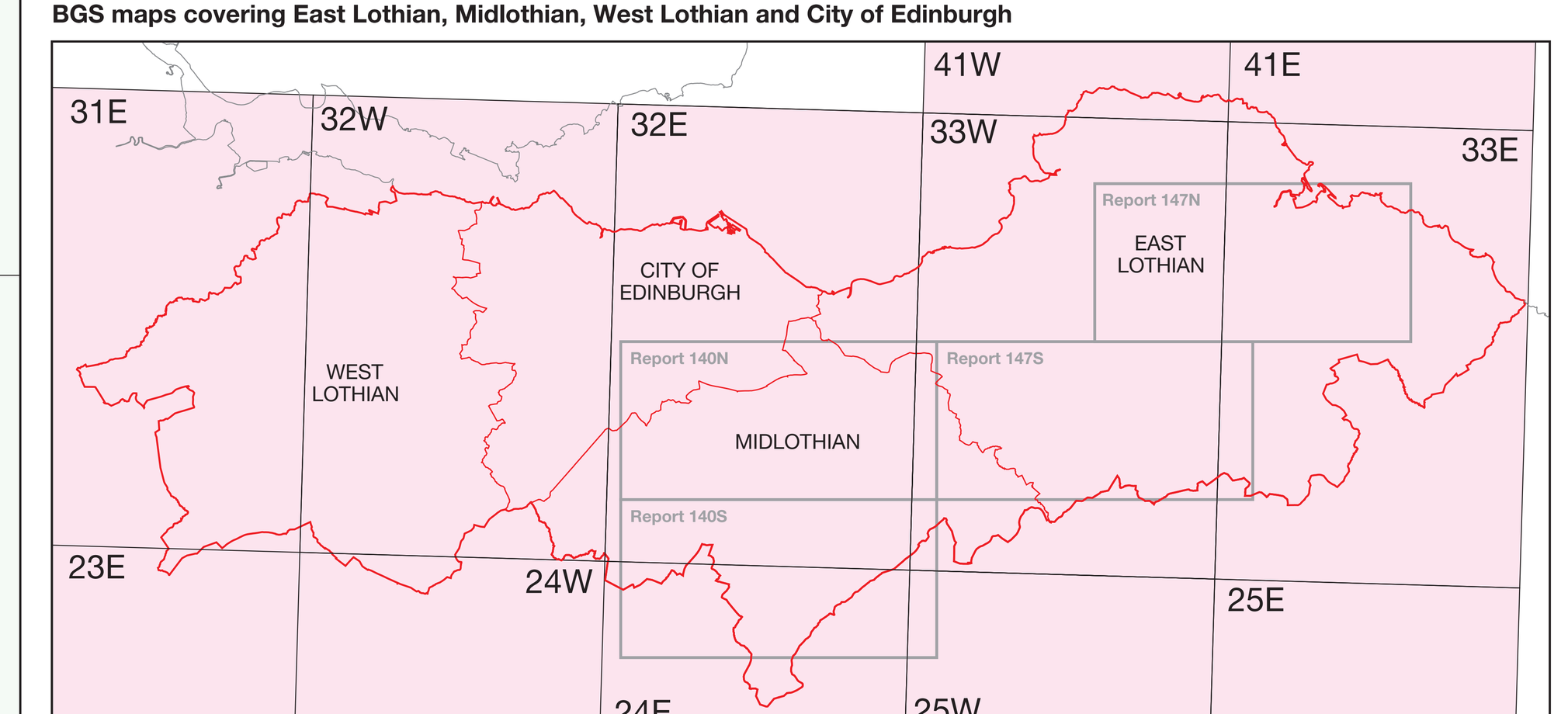
Silica sand can be used in industry for purposes other than constructional sand. Although Scotland has large resources of sand and sandstone, only a very small proportion are suitable for industrial use. These mainly occur within the Passage Formation and the thick sandstone quarried at Levenseat near Fauldhouse is the most prospective and the only one working in the Lothians. It produces construction sand, foundry and specialist sands. Levenseat is of national importance to the UK as a silica sand resource. Other silica sand resources may exist within the Passage Formation.

PEAT

The unconsolidated deposit of water saturated compressed plant remains usually form a bog or moss. These form in areas where inputs of water (almost exclusively from precipitation) have a low nutrient content and where rainfall is sufficient to maintain the ground surface in a waterlogged condition. The vegetation is characterised by acid-tolerant paint communities of which the moss genus *Sphagnum* is dominant. The two main types of bog are (i) raised bogs, formed on plains or broad valley floors and (ii) blanket bogs which form mainly on upland hills where conditions are suitably cool and wet. Many lowland bogs are designated sites of international or national conservation areas.

Peat of Quaternary age is obtained for horticultural uses at Auchencorth Moss and Springfield Moss in Midlothian. In West Lothian, Crosswoodhill Farm, Crosswoodhill and Westerhillhouse Farm near Armadale both worked peat for horticulture. Other large expanses of peat occur near Cobbinshaw Hill where the average thickness of peat is about 4 m. In the Haddington district there is an extensive area of peat on Fala Moor, which is a high-level blanket bog with a maximum known thickness of 7.9m.

BGS maps covering East Lothian, Midlothian, West Lothian and City of Edinburgh



- 1:50 000 map published
- 1:25 000 map published (Industrial Minerals Assessment Sand and Gravel Resource Map)

Current digital availability of these sheets can be found on the British Geological Survey website: www.bgs.ac.uk