Namurian rocks

Namurian rocks formed during the subdivision, or epoch, of the Carboniferous Period known as the Namurian, generally regarded as having extended from approximately 327 to 316 million years ago. The name Namurian is derived from the province of Namur in Belgium where these rocks are well developed and have been extensively studied.

Namurian rocks in Great Britain

The distribution of surface outcrops of Namurian rocks in Great Britain is summarised in (Figure 12). In addition to these surface outcrops substantial areas of these rocks are known to lie concealed beneath more recent geological deposits.

Within Britain almost all rocks of Namurian age are sedimentary rocks. These comprise a variety of different rock types and distinctive assemblages of rock types to which the term 'facies' is usually applied. These facies reflect the geological environments in which the rocks were deposited. Over substantial areas of the central and southern Pennines and the Peak District, Namurian rocks mainly comprise thick successions of hard, coarse-grained sandstones to which the term 'Millstone Grit' is commonly applied. The Millstone Grit, which derives its name from the suitability of many of its sandstone beds for making grindstones, is one of the most important influences in the landscape of these areas. These sandstones give rise to the bleak moorlands and gritstone 'edges' of the central Pennines around Kinder Scout and the so-called Black Peak, and the gritstone country which lies to the east and west of the Peak District.

In North-East England and Cumbria, Namurian rocks typically comprise thick successions of shales, siltstones and sandstones with some, generally thin, beds of limestone and coals. The broad pattern of 'troughs' and 'blocks' which was established during Dinantian times persisted into the Namurian. The varying thicknesses of the rock sequences deposited clearly reflect the continued influences of these structural units. The alternations of marine limestone with influxes of deltaic muds, silts and sands, established late in Dinantian times continued into the Namurian. The Namurian rocks of Northern England reveal evidence of the transformation from the predominantly marine conditions of the early Carboniferous, or Dinantian, to the almost exclusively freshwater deltaic environments of the late Carboniferous Coal Measures.

Geological SSSIs

All within GCR Block "Namurian of England and Wales"

SSSI Name/GCR Name/Grid Reference

Botany Hill/Botany Hill [NY 955 204]

Crag Gill/Crag Gill [NZ 026 235]

Rogerley Quarry/Rogerley Quarry [NZ 019 375]

Sleightholme Beck Gorge/'The Troughs' Sleightholme Beck [NY 965 116]

Namurian rocks are also exposed within a number of areas scheduled as SSSIs that are not specifically designated for Namurian rocks within the Geological Conservation Review.

Durham County geological sites

Chestergarth Quarry, Rookhope [NY 943 418]

Derwent River Gorge, [NZ 090 530]–[NZ 050 497]

Fine Burn, Bollihope [NZ 023 351]

Greenfield Quarry, Cowshill [NY 851 422]

Harehope Quarry, Frosterley [NZ 038 367]

Harthope Head Quarries, St John's Chapel and Langdon Beck [NY 864 339]

Middlehope Burn [NY 906 381]

Killhope Lead Mining Centre [NY 823 433]

Roundhill Quarry, Stanhope [NZ 011 383]

Stanhope Burn [NY 987 398]

Sedling Burn, Cowshill [NY 855 405]

Spurlswood Beck and Quarter Burn, Eggleston [NZ 022 268]

Stable Edge Quarry, Newbiggin [NY 919 282]

Teesdale Cave (Moking Hurth Cave) [NY 868 310]

Namurian rocks in County Durham

Outcrops of Namurian rocks comprise approximately 84,530 hectares, or almost 38% of the surface area of County Durham (Figure 13). These rocks have extensive outcrops in the North Pennines where they form much of the higher ground between the Derwent, Wear and Tees valleys and much of the moorland country of the Stainmore area. Namurian rocks dip eastwards where they pass beneath Westphalian rocks. Within County Durham, Namurian rocks have been subdivided in various ways. The classification adopted in this publication is based on that used in the most recently published 1:50 000 scale geological maps.

Stainmore Group

In County Durham the lowest geological formation of Namurian age is the Great Limestone. However, the greater part of the Namurian succession in the county consists of a rhythmic succession dominated by shales and sandstones with a small number of interbedded thin limestones and coals. The limestones in the Namurian succession are typically medium grey, fine-grained, slightly bituminous rocks in which fragments of crinoid and other marine fossils can commonly be seen. Apart from the Great Limestone, the Namurian limestones are typically only a few metres thick at most and commonly exhibit a rather characteristic brown, earthy weathering. The term 'famp' is locally applied to such soft, earthy weathered limestone. Towards the top of the Namurian succession limestones become fewer and much more impure, locally becoming difficult to distinguish from calcareous sandstones or mudstones.

Namurian sandstones exhibit the characteristics of Carboniferous sandstones described briefly above (see page 28). However, many provide clear evidence of erosive bases, betraying their origins as the fillings of channels within the Namurian deltaic environment. More commonly, sandstones exhibit recognisable rootlet traces, clearly indicative of their origins in a well- vegetated fresh-water or swamp environment. The very large cast of a tree stump and root system, recovered from one of these sandstone beds, and preserved today in Stanhope Churchyard, is a particularly spectacular example of a plant fossil from a seatearth sandstone.

Although the term 'grit' has been applied to several of the area's sandstones, some of which have proved suitable for the making of grindstones, it is important to recognise that the sandstones of the North Pennine Namurian succession do not generally exhibit the same lithological characteristics, and were not deposited in precisely the same environment, as the

'Millstone Grit' of the central and southern Pennines. The use of the term 'Millstone Grit' for these sandstones of the North Pennines, although applied in some older geological literature, is today regarded as quite inappropriate for this area.

Most of the coals are very thin, usually a few centimetres thick at most, and impersistent. The thickest and most persistent, which have locally been worked, have acquired local names. The Little Limestone Coal is perhaps the thickest and most widespread of these coals.

Ironstones, typical of the clay ironstones described above, occur at several horizons within the Namurian succession. More unusual ironstones, which seem not yet to have been described in the geological literature, include the distinctive oolitic Knuckton and Rookhope ironstones. The latter is distinguished by the local abundance of chamosite ooliths.

Mudstones and siltstones make up the greater proportion of the local Namurian succession, though they are seldom well exposed and have not acquired local names.

Many of the individual beds within this succession have been named by miners and quarrymen. Although some of these beds may only be present in comparatively small areas, or may occur intermittently across the county, others are persistent and can be recognised across the county and beyond. These named beds are listed below in stratigraphical order. Those known by more than one name, or the names of the correlatives or equivalents elsewhere are indicated:

Second Grit First Grit Grindstone Sill Botany Limestone

Upper Felltop = Top Botany Limestone

Upper Felltop Limestone

Hipple Sill High Grit Sills Coalcleugh Marine Beds

Coalcleugh (=Yoredale or Winston) Coal

Coalcleugh Beds

Lower Felltop (=Corbridge) Limestone

Rookhope Shell Beds

High & Low Slate sills

Low Grit Sill

Hunder Beck Limestone

Low Stonesdale Limestone (?=Knuckton Shell Beds)

Knuckton Shell Beds (?= Low Stonesdale Limestone)

Knucton Ironstone

Low Slate Sill

Slate Sills

Oakwood Limestone

Crag Limestone = Lower Felltop Limestone

Firestone Sill

White Sill

Pattinson('s) Sill

Little Limestone Little Limestone Coal(s)

White Hazle

High Coal Sill = White Hazle

Coal Sills

Main Chert

Great Shale

Great Limestone (=Main Limestone in the Richmond area)

The Great Limestone is one of the thickest and most extensive limestones within the Carboniferous succession of County Durham see (Figure 13). Its name, given to it by early lead miners and quarrymen, reflects both its thickness and economic importance. Over much of the county the Great Limestone averages around 20 metres in thickness, but this increases to around 22 metres in the Stanhope area. Like the majority of the underlying Dinantian limestones, the Great typically comprises a medium-grey, slightly bituminous limestone, in which small fragments of the marine animals crinoids are usually abundant. Complete or fragmentary shells of brachiopods and some bivalves are locally conspicuous and in places both solitary and colonial corals are common. The limestone typically occurs as thick beds, known to local quarrymen and miners as 'posts', which vary from a few centimetres up to almost 2 metres thick. The uppermost 4.5 metres of the formation comprises well-marked 'posts' of limestone separated by beds of dark grey shale up to 0.6 metres thick. The term 'Tumbler Beds' is applied collectively to these upper beds, from their troublesome instability during mining or quarrying.

The following extremely distinctive beds, recognisable over a substantial part of the county, occur within the Great Limestone:

The **Chaetetes Band** occurs commonly within 1–2 metres of the base of the Great Limestone. It is a bed, in places up to around 1 metre thick, in which superbly preserved encrusting mats of the fossilized sponge Chaetetes depressus, accompanied by colonial corals and a variety of brachiopods, bivalves etc are preserved in growth position. Although very conspicuous in many localities this bed is absent at others.

The**Brunton Band** is a bed rich in microscopic algae which occurs locally around 5 metres above the base of the limestone.

The **Frosterley Band** or **Frosterley Marble**, is a bed widely, though not invariably present, around 6 to 7.5 metres below the top of the Great Limestone. It is rarely more than 0.5 metres thick, but locally up to 1 metre thick, and is distinguished by containing variable, but often very abundant, concentrations of the solitary coral Dibunophyllum bipartitum, together with other corals and brachiopod remains. Fine natural exposures of the bed are to be seen in Harehope Burn and in Killhope Burn. It is exposed in most of the quarries in the Great Limestone, though is often rather inaccessible in high quarry faces. Particularly good exposures are visible in the abandoned workings of Harehope, Eastgate, Greenfield and Chestergarth quarries in Weardale. The bed, which can locally be extracted in large slabs, takes a high polish. It is not a true marble, but a dark grey to almost black, rather bituminous, fossiliferous limestone.

The **Knucton and Rookhope Shell Beds** are examples of Namurian sandstones which contain concentrations of marine shells and have been shown to have value as correlative horizons.

Influence on the the landscape Because of their extensive outcrop in the Durham Dales these rocks are of fundamental importance in shaping the landscape and giving it its distinctiveness.

The Great Limestone is well exposed in the sides of many of the valleys and along the Pennine escarpment. It typically forms distinctive pale grey rocky scars or low crags, partially clothed in limestone grassland which commonly contrasts strikingly with the more acid vegetation on the overlying rocks. In common with other limestones, the Great manifests a number of features characteristic of limestone country, collectively known as 'karst' (see Karst). Prominent lines of 'sink' or 'shake' holes clearly mark the top of the Great Limestone along many hillsides (Photo 57). As one of the thickest of the area's limestones, the Great has been extensively quarried: abandoned quarries, which expose the limestone and its overlying beds, are conspicuous features in the landscape of Weardale around Stanhope and Frosterley (Photo 76). The Great Limestone's role as a host for mineral veins has also impacted significantly on the area's landscape (see Mineral Veins and Flats).

Above the Great Limestone the Namurian succession, known as the Stainmore Group, comprises rhythmic alternations of mudstones, siltstones and sandstones with only a few thin limestones and some very thin coals. It is this sequence of rocks which underlies much of the open, and sometimes rather bleak, moorland fell country which typifies much of the Northern Pennines. Much of the outcrop of Namurian rocks is substantially free of any significant cover of superficial deposits. Weathering of the flat- lying, or very gently inclined, mainly shale/sandstone succession has produced extensive areas of rolling moorland with comparatively few natural exposures of rock except in deeply incised streams. Differential weathering of the more resistant sandstones and intervening shales has produced prominent terraced hillsides on which sandstone, and locally thin limestone outcrops, form steep-sided terrace features. In places, where the rock is especially resistant, low grey-weathering sandstone crags occur. Some of the limestones locally give rise to low scarp features. Elsewhere the nature of the underlying rock is betrayed by scattered blocks in the soil or in small pits and quarries opened to provide local sources of building stone for the many miles of drystone walls which are such distinctive elements in the enclosed landscapes of these dales.

The Stainmore Group outcrop in the south of the county around Barnard Castle and Staindrop is much concealed beneath superficial deposits, though a number of prominent sandstones give rise to distinctive ridge-like features.

Influence on biodiversity

In common with their influence on the landscape, the area's Namurian rocks have a significant influence upon the area's biodiversity.

Outcrops of Great Limestone, where free, or substantially free, of superficial deposits, support areas of limestone grassland. The comparatively brighter green, more species-rich, vegetation on the limestone outcrops, compared with the duller vegetation on the more acidic soils on the overlying beds, is often a conspicuous landscape feature visible from some distance, and a useful clue to identifying limestone outcrops. Exposures of weathered limestone, in natural outcrops and abandoned quarries, are important substrates for lichens and other lower plants. Limestone, where exposed in cliffs beyond the reach of grazing sheep, may be refugia for plants such as alpine cinquefoil and rare grasses. Fragments of upland ash woodland occur on some limestone outcrops. Caves and enlarged joints within natural outcrops and quarries locally serve as important bat roosts. Extensive quarrying of the Great Limestone has left a legacy of abandoned quarries which exhibit varying degrees of degradation and regeneration and are commonly hosts to a rich limestone flora.

Although limestones within the Stainmore Group have much smaller outcrops than the Great, and have been much less frequently quarried, small exposures of these rocks locally provide habitats similar to those associated with the Great Limestone.

In common with the outcrops of Dinantian rocks, the diversity of gill woodlands in part reflects the cyclical nature of the underlying Namurian strata with a mix of ash woodland on alkaline soils developed on limestone outcrops alternating with oak-birch woodland on the acidic soils formed over outcrops of shales and sandstones.

However, the bulk of the Stainmore Group comprises shales and sandstones which typically weather to a range of mainly acid soil types. The wide outcrops of these rocks are distinguished by expanses of moorland vegetation, including some fine examples of heather moorland, though management and grazing regimes have resulted in the widespread development of Nardus grassland, known locally from its distinctive pale colour in the winter months, as 'White lands'. Blanket peat of varying thickness, mantles substantial parts of the Stainmore Group outcrop, and there are areas of upland bog and mire.

Economic use

By far the most important economic product of the Namurian succession has been limestone. Whereas many of the limestone units may been employed on a very small scale for the making of quicklime and hydrated lime as a soil improver, by far the most significant has been the Great Limestone. Limestone production assumed large- scale industrial proportions during the late 19th and 20th centuries. Huge quarries in the Great Limestone of Weardale supplied limestone flux to the iron and steel plants at Consett and elsewhere in the adjoining Durham Coalfield. In addition, limestone from the Great became an important source of crushed rock aggregate, for building and road making. In the second half of the 20th century a new cement works was opened at Eastgate in Weardale, using the Great Limestone as its main raw material. With the recent closure of the works cement making has now ceased. The local demand for limestone flux ended some time ago, and although many of the area's limestone quarries have long been abandoned, the area remains a major source of crushed limestone products from the Great Limestone at Broadwood and Heights quarries in Weardale and from Selset Quarry in Lunedale.

The Frosterley Marble is known to have been worked as an ornamental stone for use in Durham Cathedral and elsewhere as early as the 14th Century (see Built Environment). It has been worked intermittently ever since, although the amounts produced over this long period of working are likely to have been very small. For many years little, if any, Frosterley Marble was worked as an ornamental stone except on a very small scale for small ornaments. In recent years Frosterley Marble has been recovered during quarrying of Great Limestone at Broadwood Quarry Frosterley.

The importance of the Great Limestone as a host for metalliferous and related mineral deposits is discussed elsewhere (see Mineral Veins and Flats).

Almost all of the sandstones within the Stainmore Group have found use in building drystone walls, farm buildings etc. The names of some of these units gives important clues to their properties and local uses. The Grindstone Sill provided material for grindstones, the Slate Sills commonly offered flaggy sandstones suitable for roofing slabs, the Firestone Sill was locally used as a source of hearth stones. Certain sandstones have, however, found more extensive commercial uses. Siliceous sandstone, or ganister, for making refractory products, was worked from a number of the sandstones. The most extensive of these workings are in the sandstones considered to be part of the Coalcleugh Beds, at Harthope Quarries at Harthope Pass, Weardale.

A variety of other sandstones have been worked for building stone, paving stone and roofing stone. It is generally difficult or impossible to distinguish many of the Namurian sandstones from Dinantian sandstones in buildings.

The Namurian sandstones of County Durham are today an important source of building stone for use both within the county and beyond. Currently active quarries are:

Baxton Law, Hunstanworth [NY 936 467]

Huland, Bowes [NZ 015 140]

Dead Friars, Stanhope [NY 969 454]

Catcastle, Staindrop [NZ 014 165]

Dunhouse, Staindrop [NZ 114 193]

Harthope Head, Weardale [NY 864 338]

Shipley Banks, Barnard Castle [NZ 018 208]

Stainton, Barnard Castle [NZ 070 188]

Windy Hill, Eggleston [NZ 022 217]

Woodburn, Satley [NZ 084 437]

Lingberry, Staindrop [NZ 085 206]

Several of the Namurian coal seams have been worked, both for local domestic use and for lead smelting. The most extensive workings have been in the Little Limestone Coals. The Yoredale Coal was mined near Winston, east of Barnard Castle and is the only Namurian coal in County Durham to have been worked opencast. Some 111,000 tons of this coal were extracted at the Stubb House site between 1951 and 1953.

Several horizons of thin ironstone beds, or concentrations of nodules, are known within the Namurian rocks of the Stainmore Group. It is likely that some of these may have attracted small scale working in early centuries. Some of the scattered patches of bloomery slags recorded in the North Pennines may mark the sites at which such ores were smelted. There are no records of any substantial working, or exploration, for such sedimentary ironstones.

Future commercial interest

The Great Limestone is likely to remain a source of crushed rock for the foreseeable future, both from existing working sites and conceivably, in the longer term, from new, or currently inactive, sites. Substantial reserves of Frosterley Marble exist within the county. If a means can be devised to extract and dress sufficiently large blocks there may be a small but valuable market for this unusual domestically produced ornamental stone.

Working of sandstone for building stone is also likely to continue both from existing sites and possible from new, or currently inactive, sites.

Threats

Many of the exposures of, and features associated with, these rocks are robust elements in the landscape. However, suitable vigilance should be exercised to ensure that no operations or activities pose threats to these features.

Numerous abandoned quarries expose important sections through parts of the Namurian succession, particularly the very extensive sections of Great Limestone and overlying beds in the huge abandoned quarries around Stanhope and Frosterley. The progressive deterioration of long-abandoned quarry faces, together with risks of quarries being filled and obliterated, poses some long-term threats. The face at Greenfield Quarry, Weardale, noted for its exposure of the Frosterley Band, has been damaged by fossil hunters and research workers. The disused workings of Eastgate Quarry expose several superb sections through important parts of the Namurian succession, most notably the extensive bedding-plane surface exposures of the Frosterley Band. There is a need to address the protection of these features in plans for the after-use of this abandoned quarry. The Frosterley Band exposures, in particular, are worthy of some form of preservation, and would be of great value were they to be made accessible to educational groups or the public.

Wider significance

The Namurian rocks of County Durham provide a wealth of evidence of the geological environments and processes which prevailed during this part of the Carboniferous Period. Comparing and contrasting the detailed nature of individual rock units and the overall succession within the county with adjoining areas is vital to understanding the complex history of Britain's evolution during Carboniferous times.

The lowest formation of the Namurian succession in North-East England, the Great Limestone, marks the last significant episode of limestone formation in the Carboniferous succession. Like all of the marine limestones, it contains abundant evidence of the contemporary marine fauna and flora, and in places, e.g. the Frosterley and Chaetetes bands, exhibits striking examples of complete marine ecosystems fossilised in situ.

Above the Great Limestone, mudstones and sandstones become the dominant rock types in the Stainmore Group, as deltaic conditions became progressively more important. Many of the sandstones formed at this time record abundant evidence of their origins as widespread flood deposits or as the fillings of channels within the deltas of which they were part. Namurian sandstones in County Durham contrast both lithologically and in their environment of deposition from the classic 'Millstone Grit' of the central and Southern Pennines.

Selected references

Burgess and Holliday, 1979; Cleal and Thomas, 1996; Dunham, 1990; Dunham and Wilson, 1985; Johnson and Dunham, 1963; Johnson, 1970; 1973; 1995; Mills and Holliday, 1998; Mills and Hull, 1976; Scrutton, 1995; Taylor et al. 1971.

Figures and photographs

(Figure 12) Distribution of Namurian rocks in Great Britain .

(Figure 13) Distribution of Namurian rocks in County Durham.

(Photo 8) Exposures of 'Second Grit' in banks of River Derwent, Shotley Bridge. BGS, ©NERC, 2004.

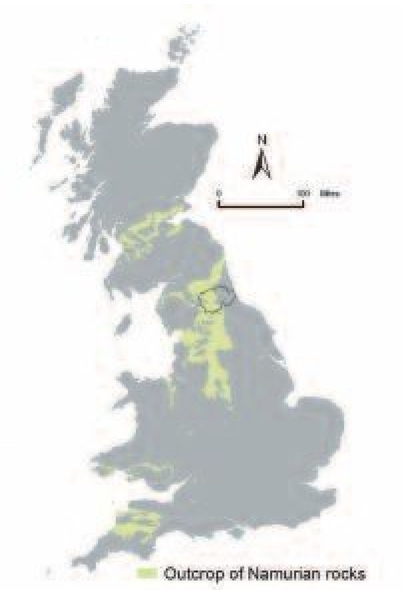
(Photo 9) Rogerley Quarry, Frosterley. Great Limestone. The tunnel is one of the experimental drives for the Kielder Water scheme. Photographed 1977. BGS, ©NERC, 2004.

(Photo 10) Frosterley Marble. Polished surface. BGS, ©NERC, 2004.

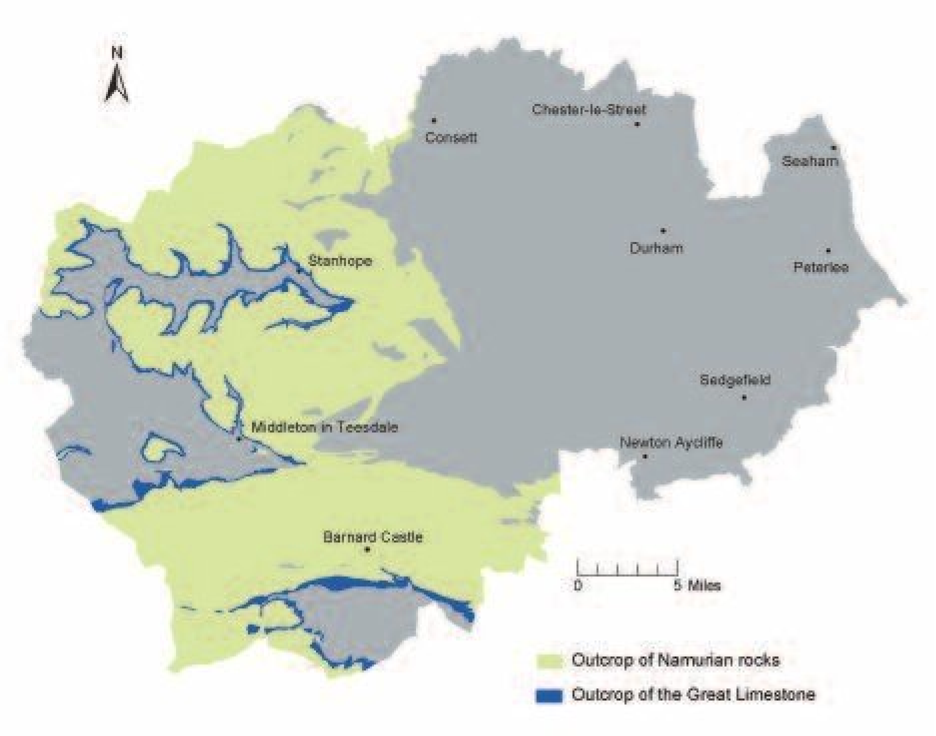
(Photo 11) Coldberry Mine Shop, Hudeshope Valley, Teesdale. Prominent terrace features formed by differential erosion of Namurian rocks. B Young, BGS, ©NERC, 2004.

(Photo 12) Lime kilns at Skears Quarry, in the Great Limestone, Middleton-in-Teesdale. DJD Lawrence, BGS, ©NERC, 2004.

Full references



(Figure 12) Distribution of Namurian rocks in Great Britain .

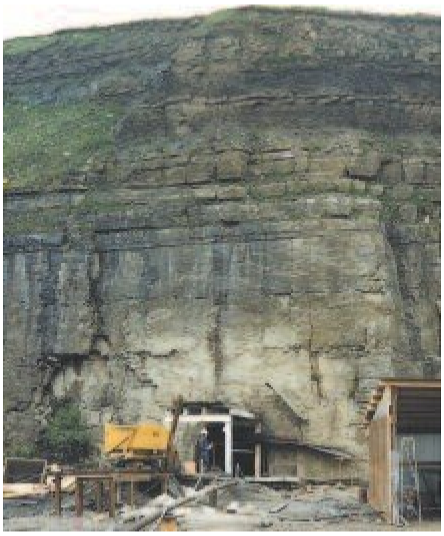


(Figure 13) Distribution of Namurian rocks in County Durham.

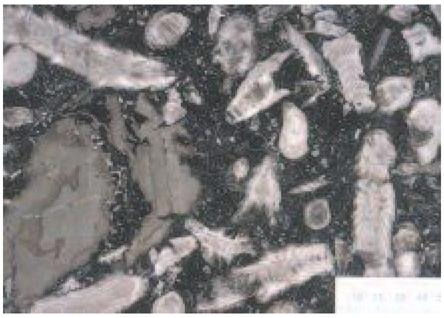
(Photo 57) Aerial photograph of sink holes into Great Limestone, Teesdale. Aerial photograph by ukperspectives.com.

(Photo 76) Bollihope, Weardale. Abandoned quarries in Great Limestone. CL Vye, BGS, ©NERC, 2004.

(Photo 8) Exposures of 'Second Grit' in banks of River Derwent, Shotley Bridge. BGS, ©NERC, 2004.



(Photo 9) Rogerley Quarry, Frosterley. Great Limestone. The tunnel is one of the experimental drives for the Kielder Water scheme. Photographed 1977. BGS, ©NERC, 2004.



(Photo 10) Frosterley Marble. Polished surface. BGS, ©NERC, 2004.

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