Dinantian rocks

Dinantian rocks were formed during the Dinantian Epoch of the Carboniferous Period. This period of earth history is generally believed to have extended from approximately 354 to 327 million years ago. The name Dinantian is taken from the Belgian town of Dinan, where there are good sections in the limestone cliffs of the River Meuse.

Dinantian rocks in Great Britain

The surface outcrop of Dinantian rocks in Britain is shown in (Figure 10).

Sedimentary rocks make up the bulk of the Dinantian succession, although volcanic rocks are present locally in the English Midlands, Cumbria and southern and central Scotland. Over much of Britain the pattern of Dinantian outcrops reflects deposition within the pattern of fault-bounded blocks and basins which characterised the Carboniferous period. Within northern Britain these blocks and basins include: the Midland Valley of Scotland Basin, Northumberland Trough, Alston Block, Stainmore Trough, Askrigg Block and the Craven Basin. It is likely that the margins of these block and basins reflect reactivation of existing faults.

The Northumberland Trough, separated from the Midland Valley by the Southern Uplands, was bounded by two active faults which controlled sediment deposition: the North Solway Fault to the north and the Stublick — 90-Fathom Fault to the south. Within the area that is now County Durham, the highs and lows included the Alston Block and the Stainmore Trough, a half-graben bound to the south by the Stockdale Monocline. The Askrigg Block, that extended southwards to the Craven Fault System, lay just to the south of the area under consideration.

Dinantian rocks include a diverse range of sediments which reflect a wide range of depositional environments. Although the succession of Dinantian rocks varies considerably from area to area, across much of northern Britain the rocks record a progressive change from thick marine limestones to the highly characteristic repeated sequences know as Yoredale cyclothems (Figure 9). The Carboniferous Dinantian successions of Northern England generally comprise cyclic repetitions of marine limestone alternating with deltaic mudstones and sandstones. Much greater thicknesses of sediments accumulated within the basins than on the intervening blocks, though widespread marine limestones enable correlation between basins and blocks.

Within the Peak District, North and South Wales, the Mendips and Forest of Dean, limestones make up much of the Dinantian sequence. Thin basaltic lava flows and tuffs are locally interbedded with the limestones in the Peak District. In South West England sandstones and mudstones, locally known as the Culm, occupy most of the Dinantian sequence.

The Dinantian rocks of Britain provide evidence of the structural setting during this early part of the Carboniferous period and contain abundant fauna that provides a key for correlation of these strata with those in Europe.

Geological SSSIs

Dinantian rocks are exposed within a number of areas scheduled as SSSIs. However there are no sites within County

Durham specifically designated for Dinantian rocks within the Geological Conservation Review.

Durham County geological sites

Black Cleugh, Burnhope [NY 853 394]

Bow Lees Beck [NY 907 283]

Green Gates Quarry [NY 934 236]

Horsley Burn Waterfall, Eastgate [NY 975 384]

Middlehope Burn [NY 906 381]

Killhope Burn, Copthill Quarry and Wear River at Butreeford Bridge [NY 855 406]

Killhope Lead Mining Centre [NY 823 433]

Scoberry Bridge to Dine Holm Scar [NY 910 274]

Sedling Burn, Cowshill [NY 855 405]

Stanhope Burn [NY 987 398]

Widdybank Fell [NY 820 290]

Dinantian rocks in County Durham

Outcrops of Dinantian rocks comprise approximately 25,332 hectares, or 11.3%, of the surface area of County Durham They are mainly in the upper parts of Weardale and Teesdale, with a further outcrop in the extreme south of the county south of Barnard Castle (Figure 11). Because of their general easterly regional dip, the oldest beds crop out in the west, and are succeeded eastwards by progressively younger beds.

Within County Durham, Dinantian rocks have been subdivided in various ways. The classification adopted in this publication is based on that used in currently available 1:50 000 scale geological maps:

Basement Group

The Basement Group was the first Carboniferous sediment deposited, following a period of erosion in the Devonian and thus rests unconformably upon older rocks. On the Pennine escarpment these beds include conglomerates composed of fragments of the underlying rocks. In County Durham the base of the Carboniferous succession includes similar conglomerates in the Teesdale Inlier. Although these rocks were originally assigned to the Basement Group, more recent work suggests that they may in fact be representatives of the overlying Orton Group. Basement Group rocks appear to have been penetrated in the Roddymoor Borehole at Crook.

Orton Group

In County Durham Orton Group rocks are exposed only in a limited area in Upper Teesdale where up to 40 metres of these rocks include conglomerates, sandstones, shales and impure limestones.

Alston Group

The Alston Group consists of a succession of well-developed typical Yoredale cylothems. Up to 17 named limestones are recognised, though several of these are only developed locally. Individual cyclothems are conventionally named from the limestone at the base of each cyclothem. Whereas most of these cyclothems can be traced across the county and beyond, some are incomplete and cannot be traced across the whole area.

Limestones are the most widespread and consistent in composition and thickness of the rock types within this succession. The thickest Dinantian limestone within County Durham is the Melmerby Scar Limestone. Apart from the Melmerby Scar and Robinson limestones, which are typically pale grey coloured rocks, the limestones of the group are mostly medium to dark grey, in colour. Between the limestones the succession of rock-types, mainly comprising mudstones and sandstones, is much more varied in character and thickness from place to place. Immediately above the

limestones, the shales are locally fossiliferous and calcareous and normally pass upwards into dark grey or black rocks, in places with clay-ironstones. Although several of the more prominent sandstones can be traced over large areas, their thickness may vary markedly, and in places the sandstone may be absent. The sandstones are generally fine to medium-grained, composed of subangular quartz grains, commonly with abundant kaolinised feldspar and some white mica. The top of the sandstone may be a seatearth with abundant rootlet traces and a strong siliceous cement, giving the distinctive rock known as 'ganister'. Coal, if present, is rarely more than a few centimetres thick. Only a few coals in the Alston Group have ever been worked.

In addition to the limestones, all of which were named at an early date by miners and quarrymen, many of the most persistent sandstones were also named. Only one shale unit, the Tynebottom Plate, has acquired a widely used name.

The Alston Group succession within the county may be summarised as follows:

Tuft (Sandstone)

*Iron Post Limestone

Quarry Hazle (Sandstone)

Four Fathom Limestone

Nattrass Gill Hazle (sandstone)

Three Yard Limestone

Six Fathom or High Brig Hazle

Five Yard Limestone

Slaty or Low Brig Hazle

Scar Limestone

*Cockle Shell Limestone

*Single Post Limestone Alternating Beds

*Maize Beck Limestone

Tynebottom Plate (shale)

Tynebottom Limestone

Jew Limestone

Lower Little Limestone

*Grain Beck Limestone

Smiddy = Upper Smiddy Limestone

Rough=Peghorn=Lower Smiddy Limestone

*Birkdale Limestone

Robinson Limestone

Melmerby Scar Limestone (Alston Block)

=Great Scar Limestone (Askrigg Block)

* Indicates those limestones which are typically impersistent and not found across the whole of the county.

= Indicates equivalent names used for this unit in different parts of the area.

Influence on the landscape

Dinantian rocks have a profound influence on the landscape of western County Durham. Weathering of the alternately hard and soft beds within the Yoredale cyclothems has produced a highly distinctive terraced form to many of the hillsides. Limestones and many sandstones are typically resistant to erosion, compared to interbedded shales and softer sandstones. These hard beds thus tend to find expression as steeper slopes, in places marked by small rocky scars: softer beds give rise to low angled slopes or areas of 'slack' ground. In numerous streams and rivers, waterfalls mark the outcrop of many of the harder limestones and sandstones. Fine sections through these rocks, including excellent exposures of complete or near complete cyclothems, may be seen in Bowlees Beck in Teesdale and Middlehope Burn in Weardale. Extensive outcrops of the lowermost limestones, including the Melmerby Scar Limestone, are to be seen around Cow Green in Teesdale. Lines of sinkholes typically mark the position of many of the area's limestone outcrops.

Countless miles of drystone walls, which are such characteristic features of the North Pennines landscape, are built from locally quarried Dinantian rocks, mainly sandstones. These sandstones are also extensively employed as building stones in farms and villages within the Durham Dales. Some thinly bedded sandstones have provided the very distinctive roofing slabs seen on many buildings.

Influence on biodiversity

As with their effect upon the landscape, the Dinantian rocks exert a fundamental influence on the area's biodiversity.

The Melmerby Scar, Robinson and Smiddy limestones in the Cow Green area locally form areas of small bare limestone crags. These provide extremely important habitats for a number of specialised plant communities, including lichens and other lower plants. Outcrops of limestone, where free, or substantially free, of superficial cover, typically support areas of limestone grassland and locally upland ash woods. The comparatively brighter green, more species-rich, vegetation on the limestone, compared to the rather sombre vegetation of the more acidic soils developed on the intervening shales and sandstones, is often a conspicuous landscape feature visible from some distance, and may be a useful clue to identifying limestone outcrops. Carboniferous limestones, where exposed as cliffs tall enough to exclude grazing sheep, are refugia for plants such as alpine cinquefoil and rare grass species. Some cliffs may support nesting sites for birds such as buzzards and ravens. Caves and enlarged joints within natural outcrops and quarries locally serve as important bat roosts.

Outcrops of shales or sandstones, where substantially free of superficial cover, typically support a range of neutral to acidic soils upon which occur neutral to acid grassland and in places oak-birch woodlands.

The diversity of gill woodlands in part reflects the cyclical nature of the underlying Carboniferous 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.

The pattern of improved pastures and fields, so characteristic of the Pennine dales, owes much to the use of slaked lime produced from locally quarried limestones, including those from the Dinantian succession.

Economic use

Dinantian rocks have been of considerable economic significance within County Durham.

Most of the limestones have been quarried, at least on a small scale, and burnt to provide local supplies of quicklime and slaked lime for use as a soil improver. Countless small quarries and associated limekilns mark the outcrops of these limestones. None of the county's Dinantian limestones is worked today.

The use of Dinantian sandstones as building stones, and their influence on the landscape, has been noted above.

The Dinantian rocks are important host rocks for metalliferous veins and associated replacement deposits.

Future commercial interest

Under present, or currently foreseeable, economic conditions it is unlikely that these rocks will attract significant commercial interest.

Threats

Most 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 Dinantian succession. The progressive deterioration of long-abandoned quarry faces, together with risks of quarries being filled and obliterated, pose some long-term threats.

Wider significance

County Durham includes some of the best and most complete examples of 'Yoredale' cyclothems to be seen in Great Britain. These rocks thus provide a wealth of evidence of the geological environments and processes in addition to the important influence of the structural setting on sedimentation during this period of the Carboniferous. They provide an excellent illustration of the effects of blocks and basins and continuing movement of faults that bound them, on sedimentary facies and their thickness.Comparison of this area with adjacent sedimentary basins, such as of the Solway, Midland Valley and Craven basin, allow correlation of rock units to further under- standing of the UK's evolution during Carboniferous times.

Selected references

Burgess and Holliday, 1979; Dunham, 1990; Dunham and Wilson, 1985; Johnson and Dunham, 1963; Johnson, 1958; 1970; 1973; 1995; Mills and Hull, 1976; Scrutton, 1995; Taylor et al. 1971.

Figures and photographs

(Figure 10) Distribution of Dinantian rocks in Great Britain.

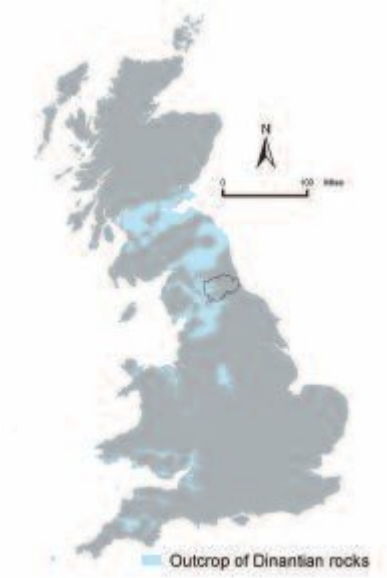
(Figure 11) Distribution of Dinantian rocks in County Durham.

(Photo 5) Bank of River Tees, Falcon Clints, Teesdale. Exposure of conglomerates belonging to the Orton Group. B Young, BGS, ©NERC, 2004.

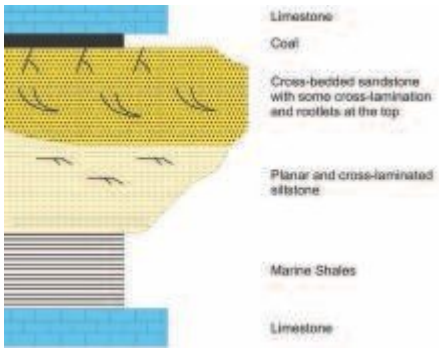
(Photo 6) Greengates Quarry, Lunedale. Rocks of the Three Yard Limestone cyclothem exposed in the quarry face. B Young, BGS, ©NERC, 2004.

(Photo 7) Lanehead, Weardale. Upland fields on outcrops of Dinantian rocks. B Young, BGS, ©NERC, 2004.

Full references



(Figure 10) Distribution of Dinantian rocks in Great Britain.



(Figure 9) Idealised 'Yoredale' cyclothem.

(Figure 11) Distribution of Dinantian rocks in County Durham.

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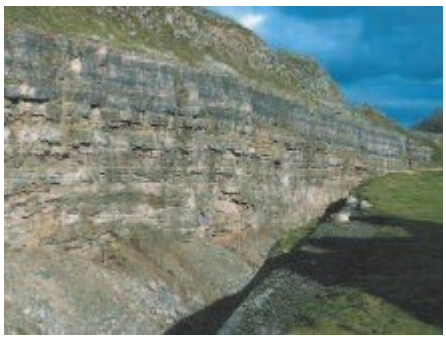

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