Geological structures

Geological structures are those features which reflect the varying degrees of distortion suffered by rock units in response to earth processes. Geological structures may be viewed at a variety of scales. Minute folds and faults may be measurable on the millimetre, metre, decimetre, or even greater scales.

All rock units exhibit geological structures. These may be very simple or highly complex, depending on the degree of distortion suffered by the rocks during earth movements over geological time.

Geological structures are vital to understanding the earth processes which have shaped and modified individual rock units, and larger blocks of country, during earth history. Recording and measurement of visible geological structures enables the overall structure of an area or region to be deciphered. Such observations and deductions are fundamental to making geological maps and in predicting, exploring and working mineral deposits, including groundwater resources, and in the design of major civil engineering projects.

Geological SSSIs

No geological structures are currently notified as SSSIs. However, numerous examples of geological structures occur within the extensive Moorhouse–Upper Teesdale NNR and other SSSIs within the county.

Durham County geological sites

Exposures of steeply inclined strata within the Burtreeford Disturbance are present at the following DCGS site:

Killhope Burn, Copthill Quarry & Wear River [NY 855 406]

Geological structures are present at a number of other DCGS sites identified primarily for other features of interest. These include:

Cement Works Quarry, Eastgate [NY 935 360]

Closehouse Mine, Lunedale [NY 84 22]–[NY 85 22]

Coldberry Gutter, Teesdale [NY 940 292]

Middlehope Burn, Weardale [NY 906 381]

Raisby Railway Cutting [NZ 345 350]

Scoberry Bridge to Dine Holm Scar, Teesdale [NY 910 274]

Geological structures in County Durham

County Durham includes numerous examples of geological structures on a variety of scales.

The county includes much of the Alston Block.

This 'block' comprises a fault-bounded platform of Ordovician and Silurian rocks upon which the succession of Carboniferous rocks rests. Such areas are termed 'blocks' because over millions of years of geological history they have remained as more or less rigid masses affected only by comparatively modest amounts of internal faulting and gentle tilting to the east.

This Alston Block is bounded by major fault systems on three sides, the Stublick Fault to the north, the Pennine Faults to the west, and the Lunedale–Butterknowle Fault to the south. The two former faults lie outside County Durham: the Lunedale–Butterknowle Fault crosses the southern part of the county.

Numerous faults cut the rocks of the county. These form a rectilinear, or conjugate pattern and in the west of the county many of them are filled with minerals, giving the veins of the North Pennine Orefield.

The displacement on faults in the Permian rocks is generally much less than the displacement measured where these faults cut the underlying Coal Measures. This records two phases of movements on these faults.

The post-Carboniferous displacement was followed by renewed, or reactivated, post- Permian displacement. Recent research has suggested that some faults within the Magnesian Limestone may be exhibiting evidence of recent, or continuing, reactivated movement since the abandonment of underground coal mining (see The Magnesian Limestone).

The outcrop of Ordovician rocks surrounded by Carboniferous rocks in Upper Teesdale is known as the Teesdale Inlier.

The Ordovician rocks, and the Weardale Granite, were subject to millions of years of erosion prior to deposition of the Carboniferous rocks. The term unconformity is used to describe the erosion surface upon which these Carboniferous rocks lie. A similar unconformity at the base of the Permian rocks records the folding and erosion of the Carboniferous rocks during late Carboniferous and early Permian times.

The Alston Block is more or less bisected by a rather complex structure termed the Burtreeford Disturbance. This comprises an eastward facing monocline, an asymmetrical fold rather like one half of an anticline, associated along much of its length with a complex belt of faulting. Although this is poorly exposed over much of its outcrop, good small sections of steeply inclined strata can be seen locally.

Over much of the county the Carboniferous and Permian rocks are gently inclined, or dip, mainly to to the north, east or south. This dip is interupted in some places by 'up' folds known as anticlines, and 'down' folds, known as synclines.

The Carboniferous rocks of the Alston Block are folded into a gentle half-dome structure, sometimes referred to as the Teesdale Dome.

Influence on the landscape

Erosion of the very gently inclined beds of Carboniferous rock give rise to the almost flat, or gently inclined hill-tops which are so characteristic of the North Pennine landscape.

The Alston Block, bounded by major faults, is a prominent upstanding landscape feature.

Erosion of steeply-inclined Carboniferous limestones and sandstones adjacent to the Lunedale Fault in Lunedale, has produced a distinctive landscape of steep scarp and dip slopes.

The Teesdale Fault brings the Whin Sill to the surface on the south side of Teesdale where it gives rise to prominent crags such as Holwick Scars: on the north side of the valley the sill lies concealed at depth.

Some of the smaller faults, including many of the mineral veins give rise to conspicuous gully-like features in the landscape.

The Permian rocks of the east of the county form a prominent, almost continuous, west-facing escarpment above their unconformable base on the Coal Measures.

Influence on biodiversity

The geological structures themselves have little impact upon biodiversity, though the nature and disposition of the rocks affected by these structures clearly do.

Economic importance

A number of geological structures, particularly faults, place constraints upon the mining and quarrying of some rocks and minerals. This is especially so in places where faults displace, and thus effectively limit, the extent of workable rock units. Faults commonly limited the extent of underground coal workings and in places partly determined the extent and boundaries of individual collieries.

Geological structures are also of prime importance in understanding the movement of groundwater and thus are important in the assessment of groundwater resources.

Almost all of the county's mineral veins occupy faults.

An understanding of geological structure has lain at the heart of successful mining and prospecting. This understanding pre-dates the emergence of geology as an organised science: the earliest miners undoubtedly understood and applied many of the concepts and principles of modern structural geology.

Environmental issues

The importance of geological structures in constraining the working of mineral reserves has been noted above.

Ground movements associated with known faults within the Magnesian Limestone outcrop may indicate reactivated fault movement related to underground coal mine abandonment (see The Magnesian Limestone). Although research on this topic in relation to County durham is at an early stage, account should be taken of these phenomena when considering a wide range of engineering, land-use, waste disposal and environmental planning issues.

An accurate modern understanding of geological structures is of prime importance in relation to potential discharges of mine gases and contaminated ground water in areas of former underground workings, especially in parts of the coalfield.

Threats

Major landscape features determined by the larger geological structures, for example the Whin Sill crags in Teesdale, are robust.

Exposures of particular geological structures, for example folds and faults, are comparatively few. Examples may be seen locally in working or abandoned quarries, in stream sections and in the coastal cliffs. Those in working quarries are likely to be destroyed during quarrying. Others could be damaged or destroyed by inappropriate restoration of old workings, or by coastal erosion.

Wider significance

The major structures within the county, the Lunedale-Butterknowle fault, the Burtreeford Disturbance and the Alston Block, are all known to have had a long and complex history through geological time. Movement along these faults has influenced the Carboniferous and later geological history of northern Britain.

The conjugate pattern of mineralised faults of the Alston Block comprise the veins of the Northern Pennine orefield (see Mineral veins and flats).

Evidence of recent ground movement associated with faults in the Magnesian Limestone, and possibly related to coal mine abandonment, may have important implications for ground engineering and planning in other areas of abandonded underground mines.

Selected references

Bott and Johnson, 1970; Burgess and Holliday, 1979; Dunham, 1990; Dunham and Johnson, 2001; Dunham and Wilson, 1985; Johnson, 1970, 1995; Johnson and Dunham, 1963; Magraw, 1963; Mills and Holliday, 1998; Mills and Hull, 1976; Smith, 1994; Smith and Francis, 1967; Taylor et al. 1971.

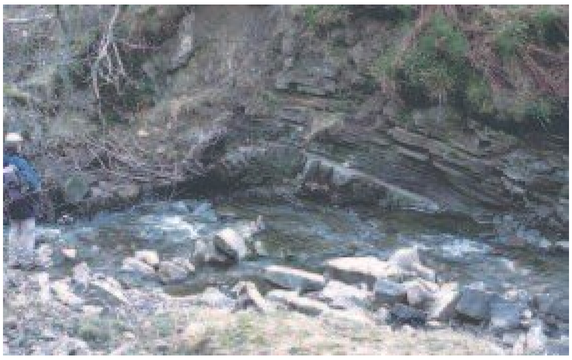
Photographs

(Photo 41) Closehouse Mine, Lunedale. The wide barytes vein adjacent to the Lunedale Fault . Photographed 1984. B Young, BGS, ©NERC, 2004.

(Photo 42) Middlehope Burn, Westgate, Weardale. Folded Dinantian sandstones on north side of Slitt Vein. B Young, BGS, ©NERC, 2004.

Full references

(Photo 41) Closehouse Mine, Lunedale. The wide barytes vein adjacent to the Lunedale Fault . Photographed 1984. B Young, BGS, ©NERC, 2004.



(Photo 42) Middlehope Burn, Westgate, Weardale. Folded Dinantian sandstones on north side of Slitt Vein. B Young, BGS, ©NERC, 2004.