Geological structures

Geological structures are those features, including folds and faults, caused by the varying degrees of distortion suffered by rock units in response to earth processes. They may be viewed at a variety of scales ranging from huge structures affecting the entire region, to small folds or faults measurable in millimetres.

Currently protected sites of geological structures within the AONB SSSIs

No geological structures are currently notified as SSSIs,. However, numerous geological structures occur within the extensive Moorhouse–Upper Teesdale National Nature Reserve, and other SSSIs.

RIGS

Punchbowl Bridge, North Stainmore faults

Durham County geological sites

No geological structures are currently notified as Durham County geological sites. However, numerous geological structures occur within many of these sites notified for other features.

Other representative sites in the area

River Wear, Cowshill [NY 852 405] Steeply dipping strata in Burtreeford Disturbance

Closehouse Mine, Lunedale [NY 850 227] Spectacular folds in Dinantian rocks adjacent to Lunedale Fault

Slitt Wood, Middlehope Burn [NY 906 393] folded sandstones adjacent to Slitt Vein

Darngill Bridge, Tynehead [NY 775 371] Steeply dipping strata adjacent to Great Sulphur Vein

Smallcleugh Mine, Nenthead [NY 787 429] Numerous folds and faults exposed in underground workings

Rookhope Head [NY 877 450] Exposure of fault in Namurian shales

Forest Head Quarries, Hallbankgate [NY 584 574] Folds in Great Limestone

Geological structures in Great Britain

All rock units exhibit geological structures, which may be very simple or highly complex. Geological structures are vital to understanding the earth processes which have shaped and modified both individual rock units and larger blocks of country throughout 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, the predicting, exploring and working of mineral deposits, including groundwater resources, and in the design of major civil engineering projects.

Geological structures in the AONB

The North Pennines includes much of the Alston Block and the northernmost portion of the Askrigg Block. These 'blocks' comprise fault-bounded platforms of Ordovician and Silurian rocks upon which the succession of Carboniferous rocks rests. They are termed 'blocks' because over millions of years of geological history they have remained as largely rigid masses, affected only by comparatively modest amounts of internal faulting and gentle tilting to the east.

The 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. Of these, the Pennine Fault System is the most prominent and complex. It consists essentially of two sub-parallel faults, the Inner and Outer Pennine Faults, between which are numerous small fault-bounded blocks of mainly Ordovician and Silurian rocks. The overall effect of this fault belt is to juxtapose Carboniferous rocks of the Alston Block and the younger, Permo-Triassic rocks of the Vale of Eden. The aggregate displacement, or throw, of this fault system amounts to many tens of metres.

The Askrigg Block is bounded on its western side by the Dent Fault System, which may be regarded as a southerly continuation of the complex Pennine Fault System.

Numerous faults cut the rocks of the AONB. These form a rectilinear, or conjugate, pattern and many of them are filled with minerals, giving the veins of the North Pennine Orefield. The rocks adjacent to many mineral veins exhibit evidence of folding and tilting.

The outcrops of Ordovician and Silurian rocks, surrounded by outcrops of Carboniferous and Permo-Triassic rocks along the line of the Pennine Fault System, are collectively termed the Cross Fell Inlier. A similar outcrop of Lower Palaeozoic rocks surrounded by Carboniferous rocks, in Teesdale, is known as the Teesdale Inlier.

The Ordovician, Silurian and Devonian 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 Permo-Triassic rocks records a period of erosion following the folding and uplifting of the Carboniferous rocks during late Carboniferous and early Permian times.

Over much of the area the Carboniferous rocks are inclined, or dip, gently mainly to the north, east or south. This dip is interrupted 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.

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 by 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 in Teesdale and Weardale.

Impact on the landscape

Erosion of the comparatively flat-lying or gently dipping beds of Carboniferous rock gives rise to the almost flat, or gently inclined, hill-tops such as Cross Fell, which are such characteristic features of the North Pennine landscape.

The Pennine Fault System juxtaposes the comparatively resistant Carboniferous rocks of the North Pennines, with the relatively weaker Permo-Triassic rocks of the Vale of Eden. Differential erosion over millions of years has created the North Pennine escarpment, a prominent landscape feature of the AONB and one of the most conspicuous landscape features of northern England.

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 Burtreeford Disturbance, though generally very poorly exposed, almost certainly determines much of the course of East Allendale.

Impact on biodiversity

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

Economic use

Almost all of the area'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. Geological structures 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.

Wider importance

The Pennine Fault System brings to the surface important outcrops of Lower Palaeozoic rocks which give important clues to the concealed or basement rocks of northern England.

The major faults, the Stublick, Pennine and Lunedale–Boutterknowle faults, and the Alston Block which they bound, 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 North Pennine orefield.

Conservation issues

Major landscape features determined by the larger geological structures, for example the North Pennine escarpment, are extremely robust. Exposures of particular geological structures, for example folds and faults, are comparatively few. Examples may be seen in many working or abandoned quarries and interesting structural features are exposed locally in some abandoned underground mines. 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 collapse of underground workings.

Recent tree planting at Darngill Bridge in the South Tyne Valley threatens to obscure one of the area's most impressive sections of steeply dipping Carboniferous rocks adjacent to the Great Sulphur Vein.

Selected references

Arthurton and Wadge, 1981; Bott and Johnson, 1970; Burgess and Holliday, 1979; Dunham, 1990; Dunham and Wilson, 1985; Mills and Hull, 1976; Stone et al, 2010; Trotter and Hollingworth, 1932.

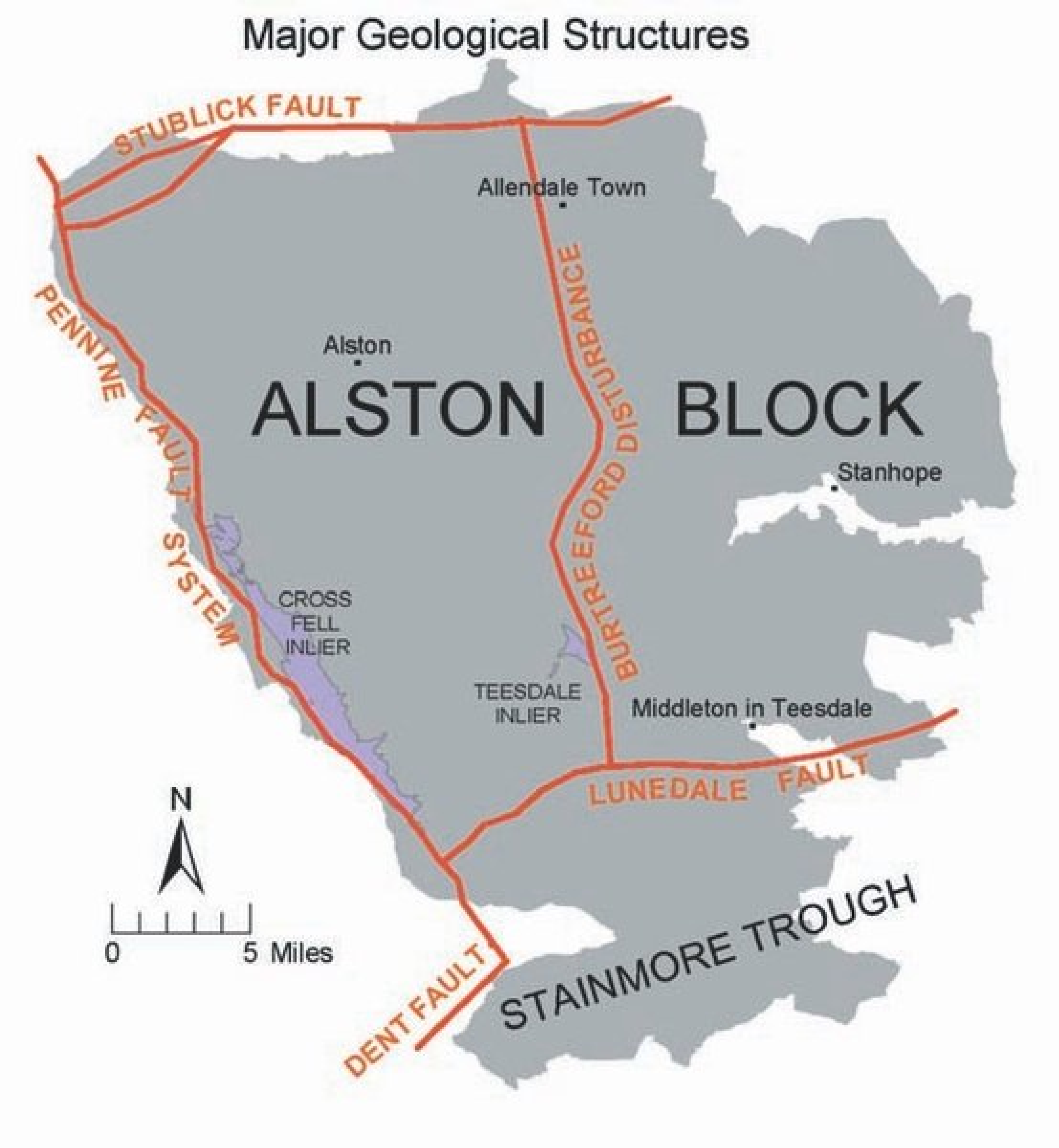
Figures

(Figure 36) Major geological structures.

(Figure 37) Normal fault in Great Limestone and overlying beds, Heights Quarry, Eastgate, Weardale © B. Young, BGS, NERC.

(Figure 38) Folded limestones adjoining the barites deposit, Closehouse Mine, Lunedale in 1984. © B. Young, BGS, NERC.

Full references



Major geological structures.

Normal fault in Great Limestone and overlying beds, Heights Quarry, Eastgate, Weardale © B. Young, BGS, NERC.

Folded limestones adjoining the barites deposit, Closehouse Mine, Lunedale in 1984. © B. Young, BGS, NERC