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## Westphalian rocks

Westphalian rocks were formed during the Westphalian Epoch of the Carboniferous Period between about 316 and 306 million years ago. The name Westphalian is derived from Westphalia in north Germany.

### Currently protected sites of Dinantian rocks within the AONB

#### SSSIs

Westphalian rocks are exposed within a number of areas scheduled as SSSIs. However there are no sites within the AONB specifically designated for Westphalian rocks within the Geological Conservation Review.

#### RIGS

There are no RIGS sites within the AONB.

#### Durham County geological sites

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

#### Other representative sites in the area

Quarterburn, Hamsterley [NZ 017 0267]

Clough Plantation Sand Pit [NZ 111 380]

Quarry Wood Quarries [NZ 074 421]

Greenfield Quarry [NZ 096 410]

### Westphalian rocks in Great Britain

In Great Britain Westphalian rocks are most commonly known as the 'Coal Measures'. These rocks typically consist of repeated cyclical successions of sandstones, siltstones and shales with numerous coal seams and associated fossil soil beds, or 'seatearths'. In addition to the great abundance of economically important coal seams, the Coal Measures also locally contain important deposits of sedimentary iron ores and clay. The Coal Measures therefore comprise one of the most economically significant parts of the British geological succession.

The Coal Measures rocks of Great Britain were deposited as sediment within a series of large delta complexes in discrete basins, separated by barriers which formed areas of non-deposition and sometimes erosion. The rivers building the deltas deposited thick beds of sand, silt and mud.

Equatorial forests of huge primitive trees, ferns and other vegetation flourished on swampy delta slopes. Thick deposits of peat, derived from the partial decay of this vegetation, accumulated from time to time on this surface and, when buried and compacted beneath further layers of sediment, became the coal seams we see today. Repeated subsidence and rebuilding of the deltas resulted in the deposition of cyclic sequences of rocks, reminiscent of the 'Yoredale' successions of earlier Carboniferous times, though without beds of limestone. The typical order, in upwards succession, in which the main rock types follow one another within the Coal Measures is: coal, mudstone, siltstone, sandstone, seatearth, coal (of the next cycle above).

Because of their economic importance, and in order to exploit their coal reserves most efficiently, it was important to be able to correlate these coal-bearing rocks between different coalfields. In the absence of many distinguishing features

within the coals themselves, two types of 'marker' beds have long been of importance in correlation. These are marine bands and tonsteins. Marine bands are thin layers of sediment deposited during discrete marine incursions formed during periods of high world sea level. They are present over very wide areas and contain characteristic fossil assemblages, so that they have become the primary means of correlation within and between coalfields. Tonsteins are mudstones rich in the clay mineral kaolinite, which are thought to have originated as layers of fine airborne volcanic dust. They typically occur as thin beds in coal seams and have proved important for establishing correlations in continental Europe.

The Westphalian rocks are normally divided into a number of zones based on fossils. Five main groups of fossils have been used: goniatites (ammonoids), conodonts, non-marine bivalves, miospores and plants.

Carboniferous swamp. © Elizabeth Pickett

## **Westphalian rocks in the AONB**

The AONB includes parts of the western extremity of the Durham Coalfield, together with small outliers of Coal Measures rocks along the line of the Stublick Fault System in the Tyne Valley and associated with the Pennine Fault System in the Brough area of Cumbria. Westphalian rocks occupy an outcrop area of 5,963 hectares (3%) of the surface area of the AONB. The Westphalian rocks of the Durham and adjacent coalfields were laid down in a single depositional basin, which occupied an upland area corresponding closely to what is today the Southern Uplands of Scotland High and another Carboniferous upland area that extended from present day Wales to Belgium, and known to geologists as the Wales–Brabant High.

Only rocks of the Lower Coal Measures (Westphalian A) are present within the AONB. In the east, the lowest beds of the Coal Measures are exposed at the westernmost edge of the Durham coalfield. In the north, portions of the Midgeholme, Plenmeller and Stublick coalfields, small faulted outliers of Coal Measures rocks, fall within the AONB and in the south-west the AONB includes portions of the small Stainmore Coalfield, near Brough.

The Midgeholme, Plenmeller and Stublick coalfields are mostly elongated east-west and consist of southward-dipping Coal Measures rocks which terminate abruptly against faults to the south. The faults form part of the Stublick-Ninety Fathom fault system, an important regional structural lineation, and were exposed during the excavation of the Plenmeller Opencast Coal site.

## **Lower Coal Measures rocks**

Traditionally the base of the Coal Measures (Westphalian) in County Durham was taken at the Ganister Clay Coal, considered to be the lowest workable coal. This no longer accords with palaeontological evidence from other coalfields in Britain and north-west Europe, where the base of the Coal Measures is defined by a marine band containing the goniatite *Gastrioceras subcrenatum*. This fossil has yet to be found in north - east England, but in its absence the base of the Coal Measures in north - east England is now taken at the position of Quarterburn Marine Band, which is exposed in Quarter Burn, near Hamsterley. The rocks between Quarterburn Marine Band and the Ganister Clay Coal contain only thin and sporadic coals and are characterised by a high proportion of sandy strata. In older geological literature they were referred to collectively as the Third Grit, of the old 'Durham Millstone Grit Series', thereby emphasising the similarity between this part of the Coal Measures and the highest beds of the underlying Namurian.

A marine band at the top of this 'Third Grit', known as the Roddymoor Marine Band, can be seen in Spurlwood Beck. Coals thicker than 0.9m and most of the productive seams are largely confined to the beds above the Brockwell Coal. Below the Brockwell seam sandstones tend to be coarse and some are siliceous enough to be called ganister.

Traditionally, each colliery applied its own set of seam names. This led to much confusion. Thus, not only were individual seams given numerous local names, but, where the same name was used in different collieries it was commonly applied to different coals. Eventually, standard sets of names and index letters were established for County Durham and Northumberland combined. It is now accepted that these largely hold good throughout the main coalfield, but different names have been used in the outlying areas. The National Coal Board (NCB) developed a series of standard index

letters for each seam as a means of aiding and standardising correlation within and between coalfields. The table below indicates the names and index letters of the seams present in the Lower Coal Measures of the main Durham Coalfield and the equivalent names applied in the Plenmeller and Stublick areas in the north of the AONB.

## Impact on the landscape

The soft and thinly bedded sandstones, shales and coals of the Coal Measures generally give rise to gently rounded convex slopes. Occasional thicker sandstone beds are marked by steeper bluffs. Small becks and burns drain the upper valleys, occasionally incised in narrow gills. Soils are typically heavy and seasonally waterlogged.

County Durham	Plenmeller	Stublick	Letter applied by County Index by British Coal
Tilley	Bounder		P
Top Busty	Upper Craig Nook	Upper Craig Nook	Q or Q1
Bottom Busty	Lower Craig Nook	Upper Craig Nook or Five Quarter	Q2
Three Quarter (not named)	Little	Little	R
(not named)	Three Quarter	(not present)	
Top Brockwell	Half	Three Quarter	
Bottom Brockwell	Quarter	Quarter	S or S1
Victoria Fish Bed	Well Syke or Coom Roof	Well Syke or Main	
Victoria	High Main	High Main	S/T
Marshall Green	Slag or Seven Quarter	Slag (or little)	T
Ganister Clay	Low Main	Low Main	U
			V

## Impact on biodiversity

Over moorland parts of the AONB, Westphalian rocks support a vegetation pattern, which is extremely similar to that found on the Namurian rocks above the Great Limestone. On poorly drained ridges and plateaux, peaty gleys and deeper peats have formed, supporting heathland vegetation of heather, bilberry and acid grassland.

## Economic use

No mining in Westphalian rocks within the AONB is now taking place, but evidence of previous mining activity is seen in pit-fallen land, abandoned shafts and adits and several spoil heaps. Of the various areas mined, those at Stublick and south of Plenmeller are the most significant. Records of coal working near Midgeholme appear in the household book of Lord William Howard in 1618 and the colliery has additional fame as, after its use as a ballast engine, Stephenson's Rocket was sold for use in the colliery. Opencast extraction also took place at Plenmeller in the late 1980's and early 1990's. Although coal has been extensively worked from the Coal Measures of County Durham over many centuries, the county has comparatively few workable seams within the boundaries of the AONB. In the south of the area, the Brockwell (S) and Busty (Q) seams were worked along Arn Gill from a series of adits and shafts in the Woodland area indicate that coal may have been worked there. At the north east tip of the AONB the Victoria (T) coal was worked just south of Rowley from Victoria colliery and opencast extraction from two leaves of the underlying Brockwell (S) seam took place in the same area during the 1940s and 1950s.

Coal Measures mudstones and seatearths were commonly worked as brick-clays, as by-products of coal mining. It is likely that 'common' bricks were produced from such materials at the collieries in the Tyne Valley. Coal Measures sandstones are important building stones in the AONB.

## Wider importance

Exposures of Westphalian rocks within the AONB are insignificant by comparison with the extensive coastal sections of Northumberland, though there are some good natural and quarry exposures in the lower part of the succession. The AONB does, however, include the type locality of the Quarterburn Marine Band, the important horizon adopted as marking the base of the Coal Measures in north east England. On the northern margin of the AONB, the Westphalian outliers are important as examples of fault-bounded coalfields within northern England and help to define and demonstrate the geological structure of the area. The buildings at Stublick Colliery are one of the best surviving groups of 19th Century colliery buildings in the country.

## **Conservation issues**

Whereas most of the few exposures of these rocks and features associated with them, in natural exposures and abandoned quarries, are robust elements in the landscape, suitable vigilance should be exercised to ensure that no operations or activities damage the most important of these features. The progressive deterioration of long-abandoned quarry faces, together with risks of quarries being filled, may pose some long-term threats. The fine group of colliery buildings at Stublick Colliery deserves protection.

## **Selected references**

Arthurton and Wadge, 1981; British Geological Survey, 1992, 1996; Burgess and Holiday, 1979; Burgess and Wadge, 1974; Cleal and Thomas, 1996; Dunham, 1990; Dunham and Wilson, 1985; Henderson and Lelliot, 1978; Johnson, 1958, 1970, 1995; Johnson and Dunham, 1963; Mills and Hull, 1976; Scrutton, 1995; Stone et al, 2010; Turner, 1999; Trotter and Hollingworth, 1932.

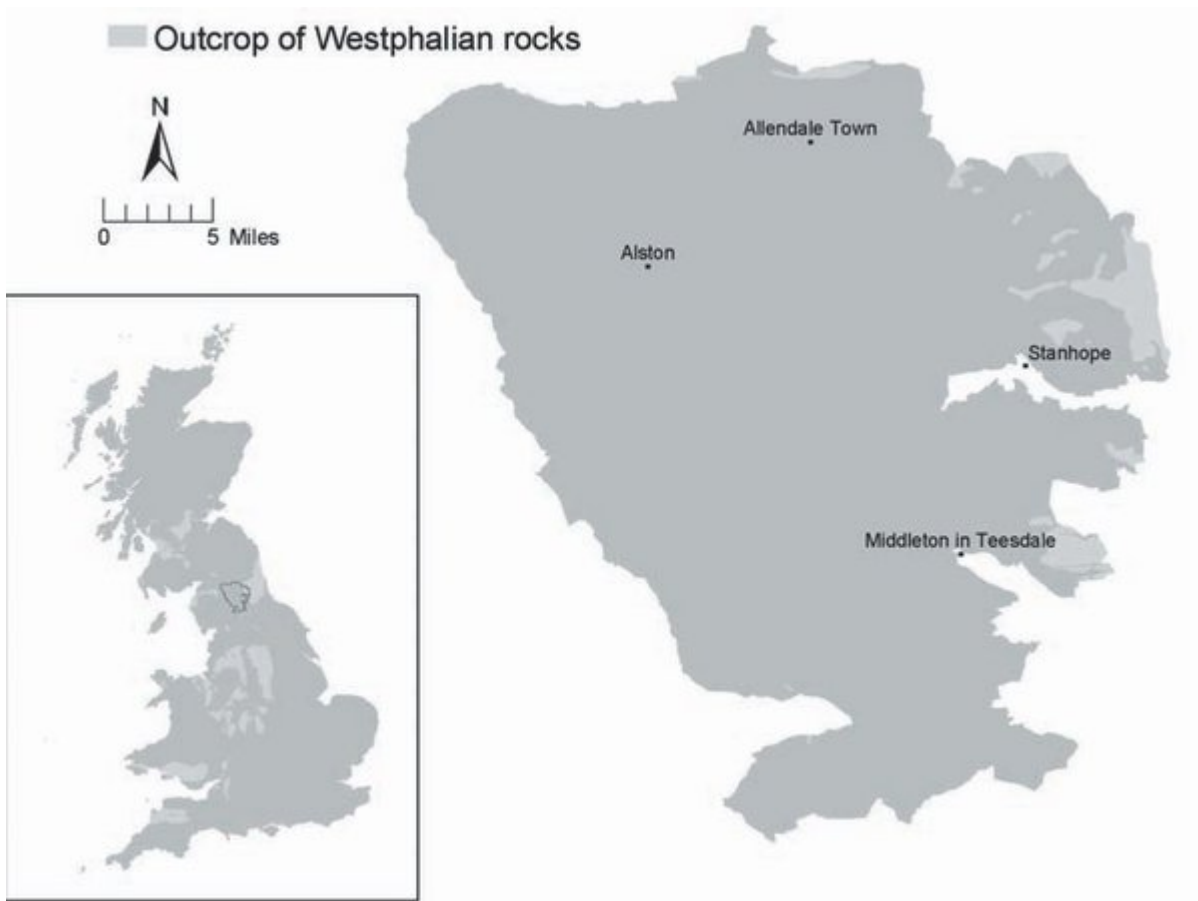
## **Figures**

(Figure 24) Outcrop of Westphalian rocks

(Figure 25) Carboniferous swamp. © Elizabeth Pickett

(Figure 26) Plenmeller Opencast Coal Site in 1980's. © B. Young, BGS, NERC.

## **[Full references](#)**



*Outcrop of Westphalian rocks.*



*Carboniferous swamp. © Elizabeth Pickett.*



*Plenmeller Opencast Coal Site in 1980's. © B. Young, BGS, NERC.*