Carboniferous rocks

Carboniferous rocks formed during the Carboniferous Period of Earth history, between approximately 354 and 290 million years ago. The first use of the term Carboniferous was in Britain and derives from the abundance of carbon-rich coal seams within these rocks.

Carboniferous rocks in Great Britain

Global continental movements initiated towards the end of the Devonian Period resulted in a general north-south extension of the earth's crust beneath the area now occupied by Britain. This produced a series of 'basins' separated by 'highs' or 'blocks' and caused the sea to flood much of the area which had been land at the end of Devonian times. In the early Carboniferous, the 'block and basin' topography resulted in the deposition of thick marine shale successions in the 'basins' and thin shallow-water limestone sedimentation on the 'blocks'. Some areas, such as the Southern Uplands and an area of upland that extended from what is now Wales, across eastern England into Belgium, and known to geologists as the Wales–Brabant High (or St George's Land) remained above the transgressing tropical sea. The blocks were separated from adjacent basins by hinge lines. These were fault zones along which movement occurred intermittently during sedimentation. Continued earth movements throughout Carboniferous times led to differential subsidence and uplift, with successive periods of flooding and emergence causing a cyclic pattern of sedimentation.

As long ago as the 18th Century, three main divisions of Carboniferous rocks, based predominantly on rock type, were recognised: Carboniferous (or Mountain) Limestone, Millstone Grit and Coal Measures. Whereas this early nomenclature has been substantially modified, the broad threefold division remains largely valid with Carboniferous time commonly divided into three time intervals or series, named in ascending order the Dinantian, Namurian and Westphalian. These correspond very approximately with the Carboniferous Limestone, the Millstone Grit and the Coal Measures.

Carboniferous rocks in the AONB

With an outcrop area of 18,6545 hectares, or 94% of the surface area, Carboniferous rocks comprise by far the most widespread group of rocks within the AONB.

The currently accepted classification of the Carboniferous rocks of the AONB, together with the equivalent obsolete terms found in older literature, is shown in the table opposite.

Whereas the names of individual beds of, for example, the Tynebottom Limestone, the Firestone Sandstone or the Little Limestone Coal, have remained more or less constant over the course of time, the names applied to larger subdivisions or groups of rock units have changed as ideas on stratigraphical classification and correlation have evolved. Research into the classification of Carboniferous rocks across the whole of Great Britain, mostly undertaken by the British Geological Survey in the past two decades, has led to a fundamental revision of the naming of Carboniferous strata over wide areas, including the North Pennines. This new nomenclature, which is intended to enable easier correlation of these rock sequences with their counterparts elsewhere in Great Britain and beyond, and to simplify national nomenclature, will be employed on future editions of British Geological Survey maps and in the technical Earth science literature.

However, as this terminology has yet to appear widely outside of the specialised technical literature, the stratigraphical nomenclature used in this audit is that employed on currently available 1:50 000 scale geological maps of the British Geological Survey. The new names applicable to subdivisions of the Carboniferous rocks of the AONB are indicated in the two right hand columns of the table.

Before looking in detail at the main subdivisions of Carboniferous rocks in chronological order, and in order to appreciate some of the features of these rocks present throughout the Carboniferous sequence, we will review briefly some of the most characteristic features, including the main rock types or lithologies, present in the area's Carboniferous rocks.

In common with much of the British Carboniferous, a conspicuous feature of the Carboniferous succession of rocks in Northern England is a cyclicity or regular repetition of rock types. Periodic change between marine and fresh water or fluviatile conditions allowed the deposition of the well developed and laterally extensive cycles of sedimentation (cyclothems) for which the region is famous. The cyclicity can be observed at a variety of scales and in varying degrees of complexity. The largest cyclothems occur at the scale of tens to hundreds of metres in thicknes. The term 'Yoredale cyclothem' is commonly applied to these repeated successions of Carboniferous rocks after the old name — Yoredale — for Wensleydale in the Yorkshire Pennines where they were first studied in detail. Such Yoredale cyclothems typically comprise, in upward succession limestone, shale , sandstone, seatearth and coal.

The key characteristics of the main rock types present within the AONB's Carboniferous rocks are summarised as follows:

Limestones

Limestones comprise a significant proportion of the lower part of the Carboniferous succession of the AONB, though they become fewer and are separated by increasing thicknesses of other sediments as the sequence is traced upwards. The lowermost limestones are typically pale grey rocks with comparatively few impurities. Higher limestones generally contain significant amounts of clay and bituminous impurities, giving them a rather darker grey colour. Most of the area's limestones contain an abundance of, mainly fragmentary, fossils. However, certain limestones, particularly within the Namurian part of the succession, are characterised by rich faunas of corals, sponges etc.

Mudstones, shales and siltstones

Dark to medium grey mudstones, commonly referred to as shales where they exhibit well-marked lamination, comprise a substantial part of the Carboniferous succession, particularly in the Namurian and Westphalian parts of the sequence . With an increase in silt content they pass imperceptibly into siltstones. Both mudstones and siltstones may contain fossils of marine or fresh water origin, depending on their environment of deposition. Indeterminate plant fragments are common in many freshwater mudstones and siltstones. Especially prominent are fossilised rootlet traces in original growth position in mudstone or siltsone beds which are known form their origins as the fossilised soil beds beneath coal seams as 'seatearths'.

Because they are usually weak and weather easily, these rocks are seldom well exposed except in rapidly eroding stream banks of in some quarry faces.

Ironstones

These occur at several horizons, mostly within the Namurian and Westphalian successions. Most common are concentrations of clay ironstone nodules, composed mainly of impure siderite, within beds of mudstone. An unusual oolitic ironstone, containing the iron silicate mineral chamosite, and known as the Knuckton Ironstone, is present locally in the Hunstanworth area.

Sandstones

The area's sandstones exhibit a considerable variation. The great majority are fine- to medium- grained rocks, although much coarser, locally pebbly, sandstones are present in places. The sandstones vary from hard, resistant rocks with a well-developed cement, to comparatively weak, in some instances almost friable rocks, where only a weak cement is present. Cross bedding is extremely common and ripple marks are conspicuous locally. Many sandstones provide clear evidence of erosive bases, clearly betraying their origins as the fillings of channels. Erosion surfaces within individual sandstone units are common. Well-preserved fossils are generally uncommon, though casts of marine brachiopods, bivalves and crinoids locally reveal a marine origin. More commonly, certain sandstones exhibit recognisable rootlet traces, or other plant remains, clearly indicative of their origins in a well-vegetated fresh-water or swamp environment. Such sandstones comprise fossil soils or 'seat earths', and may be overlain by a thin coal seam or a very bituminous parting representing the remains of abundant vegetation. It is common for such sandstones to be significantly richer in silica than many of the other sandstones, and for silica to be the major cementing mineral in the rock. These extremely hard silica-rich rocks are commonly known as 'ganisters'.

Coals

Coals occur throughout the Carboniferous succession of the AONB, though they are thickest and most abundant within the Westphalian beds. A feature of the coals of the North Pennines is their 'rank'. 'The rank' of a coal is its degree of maturity. The effects of temperature and pressure over long periods of geological time tend to expel water and volatile constituents from coal. Therefore a coal which has been subject to elevated temperatures typically exhibits a comparatively low votalile content, high carbon content and high calorific value. The coals of the North Pennines are generally of high rank and may be described as semi-anthracite. Their rank is a result of the heating effects of the concealed Weardale Granite.

Cherts

Very fine-grained siliceous rocks, called cherts, are present within the lower part of the Namurian succession in the southern part of the AONB.

Naming the Carboniferous rocks

It was the practice of miners and quarrymen to give local names to the rock units, with which they became extremely familiar, particularly the limestones and many of the sandstones. Most of these names were applied at an early date and were adopted by the emerging science of geology where they became formalised as names for rock units. They may reflect a variety of intrinsic characteristics, for example:

- The Four Fathom and Five Yard limestones reflect typical thicknesses of those units, 24 feet (7.3 m) and 30 feet (9.1 m) respectively.
- The Scar Limestone reflects its role in giving rise to landscape features.
- The Great Limestone reflects both its thickness and economic importance as a source lime or as a host for mineral deposits.
- The Melmerby Scar, Peghorn and Tyne Bottom limestones derived their names from the localities where these units are best developed.

In addition to these stratigraphical names, miners and quarrymen employed local names for rock types. These have not generally been adopted by geological science, though references to them abound on old mine plans and contemporary mine reports.

- Hazle (pronounced hezzle) means sandstone
- Sill usually refers to sandstone, or in some instances (e.g. the Coal Sills) a comparatively discreet group of beds consisting predominantly of sandstone.
- Flagstones are typically hard sandstones which tend to split readily along, or parallel with, the bedding planes. They may contain thin shale partings which facilitate this splitting.
- Grit usually refers to a hard, coarse-grained sandstone, commonly one with a proportion of comparitvely softer grains which ensures that the rock maintains a rough surface when exposed to wear in millstones.
- Plate refers to shales and silty shales.

Figures

(Figure 14) Stratigraphy of the Carboniferous table

(Figure 15) The formation of Yoredale Cyclothems. © Elizabeth Pickett

(Figure 16) Namurian shales in old ironstone workings © B. Young, BGS, NERC.

Full references

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Stratigraphy of the Carboniferous table.

The formation of Yoredale Cyclothems. © Elizabeth Pickett/NPAP

Namurian shales in old ironstone workings © B. Young, BGS, NERC.