Westphalian (WPH)

Block Description

Visit https://jncc.gov.uk/gcr-site-list, for more information on GCR blocks and sites
For Palaeozoic Stratigraphy GCR block descriptions and GCR site lists,
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Introduction

The GCR sites selected for this GCR Block represent the British geological record of Earth history from about 310 to 300 million years ago (Ma). This interval is part of Late Carboniferous Period (the Carboniferous Period spans from about 354 to 292 Ma). Underlying rocks formed during Namurian time (**see Namurian of England & Wales (NAM-E-WL**)).

There has been much confusion as to the exact meaning of the term ‘Upper Carboniferous’. In northern Europe, it has been taken to include all of the Namurian, Westphalian and Stephanian series, as this represents an interval of largely fluvio-deltaic clastic rocks, which can be readily separated from the mainly marine shelf limestones of the underlying Viséan. It is placed just above the base of the Chokierian Stage in the European classification. For convenience, the base of the Chokierian Stage is used in the GCR as an approximation to the lower limit of the Lower Carboniferous subsystem.

Now, all of the eight stages of the Late Carboniferous Series, the Chokierian, Alportian, Kinderscoutian, Marsdenian, Yeadonian, Langsettian, Duckmantian and Bolsovian are defined by stratotypes in this country. The Langsettian, Duckmantian and Bolsovian stages form the Westphalian Series.

Namurian rocks in Britain can be roughly equated to the informal term ‘Millstone Grit’, which is overlain by the ‘Coal Measures’ and underlain by the Dinantian ‘Carboniferous Limestone’.

Outcrop pattern

Britain has some of the best-exposed sequences of non-marine Upper Carboniferous strata anywhere in Europe. Nowhere else has such extensive coastal exposures of these beds, as can be seen in Pembrokeshire, Northumberland, Cumbria and Fife. Even outside of Europe, one would struggle to find comparable coastal exposures, at least within the palaeoequatorial belt, with the possible exception of Nova Scotia in Canada (e.g. Joggins Bank, Point Aconi). Britain also has many natural, inland exposures. In the Westphalian, South Wales stands unrivalled (at least in Europe) for its well exposed sequences of mainly non-marine, coal-bearing strata; for example, this is the only place to have a more or less continuously exposed section through the Langsettian, Duckmantian and Bolsovian strata (Cwm Gwrelych–Nant Llyn Fach).

There is considerable variation in the lithostratigraphical development of the Upper Carboniferous strata of Britain, and different areas often have their own set of formations. Only ‘the Productive Coal Formation’ (the mainly Westphalian, grey, coal-bearing deposits) has a reasonably wide distribution. However, there is an underlying pattern of lithofacies recognizable over much of the country, and this is recognized here as five groups listed as follows.

- Culm Group
- Yoredale Group
- Millstone Grit Group
- Passage Group
- Coal Measures Group

Palaeoenvironment and palaeogeography

The Upper Carboniferous of Britain was formed in an elongate belt of deposition lying between Poland and Ireland, that marks the contact-zone between the Gondwana and Laurasia continental plates. Originally separated by deep ocean (the ‘Proto-Tethys’), the Gondwana plate progressively drifted north relative to the Laurasia plate during Late Palaeozoic times. By Late Carboniferous time, the deep ocean had totally disappeared, and eventually the collision caused significant uplift and deformation of the Laurasian foreland.

This tectonic episode is termed the ‘Variscan (or Hercynian) Orogeny’ (**see Variscan Structures of South-West England (VAR-STR-SW); Variscan Structures of South Wales and the Mendips (VAR-STR-WM)**). However, between the times of ocean closure and basin inversion, a complex set of localized, synorogenic basins developed on the foreland.

There are four main mechanisms that have been proposed for how these basins were generated: (1) the northwards subduction of Gondwana under Laurasia, (2) transtension due to east–west mega-shear along the Gondwana-Laurasia plate boundary, (3) nappe loading due to the northwards migration of the Variscan front, and (4) north–south rifting and ocean spread due to the opening of a ‘Proto-Atlantic’ Ocean.

The result has been five discrete areas of deposition, separated by areas of non-deposition and sometimes erosion. These are, from south to north, Sabrina, the Wales–Brabant Barrier and the Southern Uplands Massif.

(1) The Culm Trough in south-west England. This was a shallow marine basin that was progressively filled during the Namurian by northerly derived deltaic sediments. Basin inversion and tectonic deformation here was rather earlier than in the rest of Britain, probably sometime in the middle part of the Westphalian Epoch.

(2) The Kent Coalfield, which is effectively a western extension of the Franco-Belgian Basin. This coalfield is known only through boreholes and underground mine workings, therefore as there is no exposure.

(3) The area immediately south of the Wales–Brabant Barrier, including principally South Wales, the Forest of Dean and the Bristol–Somerset coalfields. Like the Culm Trough, the Namurian strata are characterized by the progressive infill of a shallow marine basin by deltaic sediment, although it seems to have been ‘less marine’ than the Culm deposits. During the early and middle Westphalian times (up to the middle Bolsovian), deposition was characteristically in a fluvio-delatic regime, with extensive peat deposits. In late Westphalian times, however, uplift mainly to the south resulted in the influx of mainly arenaceous fluvial deposits (the Pennant Formation).

(4) The area between the Wales–Brabant Barrier and the Southern Uplands Massif, and including the northern English Midlands, the Pennines, and northern England. Again, the Namurian is characterized by mainly northerly-derived deltaic deposits filling a shallow marine basin, and the lower and middle Westphalian by fluvio-deltaic deposition. Unlike further south, however, there is no evidence of major fluvial deposits in upper Westphalian strata, except in the southern margins of the area. Instead, the progressive development of Variscan movement resulted in the formation of red beds such as the Etruria Formation.

(5) The Midland Valley of Scotland. The general facies development here is similar to the area south of the Southern Uplands Massif, with predominantly arenaceous deposits in the Namurian, coal-bearing deposits in the lower Westphalian and red beds in the upper Westphalian. However, marine influence was significantly reduced, with the result that marine bands are fewer and less well developed. Also volcanicity was a much greater influence, both as an influence on basin configuration, and on sedimentation itself (e.g. the Ayrshire Bauxitic Clay Formation).

GCR site selection

For the Upper Carboniferous stratigraphy of Britain sites were selected according to palaeogeographically defined GCR networks

- Culm Trough
- South Wales
- Forest of Dean and Severn coalfields

• Bristol-Somerset Basin

• English Midlands

• North Wales

• Millstone Grit of the Central Province

• Coal Measures of the Pennine Basin

• Northern England

• Scottish Basin

Although the relatively common invertebrate fossils do not have a separate selection category in the GCR in their own right, the scientific importance of many stratigraphy sites lies in their fossil content. Therefore, some of the GCR sites are selected specifically for their fossil fauna, which facilitates stratal correlation and enables the interpretation of the environments in which the animals lived. Moreover, some sites have international significance because they have yielded fossils that are the 'type' material for a taxonomic group.

In contrast to the manner in which most invertebrate fossils are represented in the GCR, fossils of vertebrates, arthropods (except trilobites) and terrestrial plants do have their own dedicated selection categories, owing to the relative rarity of the fossil material.
See Arthropoda (APD); Carboniferous - Permian Fish/Amphibia (C-P-FA); Palaeozoic Palaeobotany (PAZ-PALBOT); Palaeoentomology (PALENT).

Palaeontology

Five main groups of fossils have been used for biostratigraphical work in the British Upper Carboniferous strata: ammonoids (goniatites), conodonts, non-marine bivalves, microspores and plant macrofossils.

Most stratigraphical correlations in the British Upper Carboniferous are based on biostratigraphical criteria. However, there are two types of 'marker horizon' available in these strata that provide valuable, abiotic means of establishing time-planes.

The most widely used are the marine bands. During the Late Carboniferous, Britain saw a progressive change from predominantly marine to predominantly non-marine conditions, and the preserved sedimentary sequence can be interpreted in terms of the interplay between these two broad environments.

The second type of 'marker horizons' consists of cineritic tonsteins, which were the result of volcanic ash-falls.