

Stratigraphical principles, Carboniferous, Northern England

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Introduction

LITHOSTRATIGRAPHY		CHRONOSTRATIGRAPHY											
N	S	European			International								
		Substage	Stage	Subsystem	Stage	Subsystem							
WARWICKSHIRE GROUP PENNINE COAL MEASURES GROUP	MILSTONE GRIT GROUP YOREDALE GROUP *GRAVEN GROUP	Westphalian D	Autunian	SILESIAN ¹	Gabellian	PENNSYLVANIAN							
			Stephanian		Kasimovian								
		Bolsvian [Westphalian C] Duckmantian [Westphalian B] Langsettian [Westphalian A]	Westphalian		Moscovian		Bashkirian						
								Yeadonian Marsdenian Kinderscoutian Alportian Chakierian Arnsbergian	Namurian	Serpukhovian			
											Pendleian Brigantian	Visean	Visean
		Courseyan	Tournaisian		Tournaisian								
		BORDER GROUP INVERCYLDE GROUP	GREAT SCAR LIMESTONE GROUP RAVENSTONE-DALE GROUP										

¹The Craven Group overall in adjacent regions is Chadian to Yeadonian

Approximately the Maryport, Skellick and Ninety Fathom fault system

Stratigraphical classification of the Carboniferous rocks of northern England.

Note 1 Although the Carboniferous Subcommittee of the International Commission on Stratigraphy has recommended that the terms 'Dinantian' and 'Silesian' should no longer be used, they are such fundamental units in the description of British Carboniferous rocks that they are likely to be encountered throughout the currency of this guide. P916112.

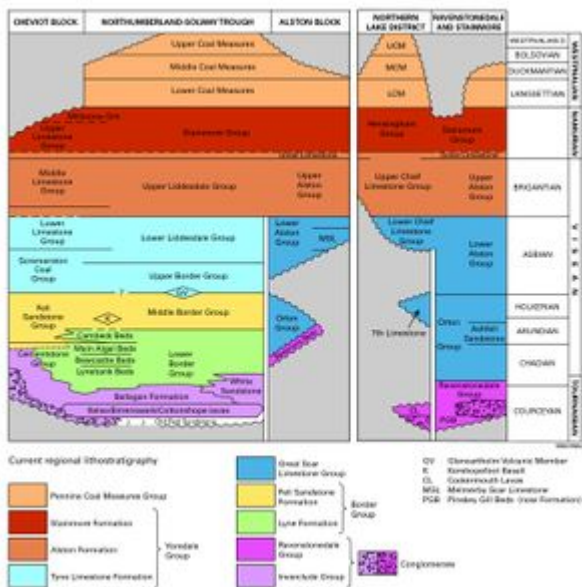


Selection of Carboniferous macrofossils: a Crinoid, *Woodocrinus?* from shale at the base of the Stainmore Formation, immediately above the Great Limestone Member, at Mootlaw Quarry, Northumberland (DL4741, P589464); b Goniatite, *Cravenoceras* cf. *lineolatum* from shale at the base of the Stainmore Formation, immediately above the Great Limestone Member, at Mootlaw Quarry, Northumberland. (P587665), c Brachiopod, *Brachythyris* sp. from shale at the base of the Stainmore Formation, immediately above the Great Limestone Member, at Mootlaw Quarry, Northumberland (DL4353, P587666); d Brachiopods, large Gigantoproductids in the Sugar Sands Limestone, Stainmore Formation, at Sugar Sands Bay, Alnwick, Northumberland. (P643515); e Corals, a polished surface of 'Frosterley Marble' from the Great Limestone Member of the Alston Formation, showing detail of the abundant coral *Dibunophyllum bipartitum*, Weardale, County Durham. (P524822) x0.5; f Trace fossils, *Teichichnus*-type animal burrows preserved in sandstone from the upper part of the Appletree Limestone cycle of the Tyne Limestone Formation, Hindleysteel Quarry,

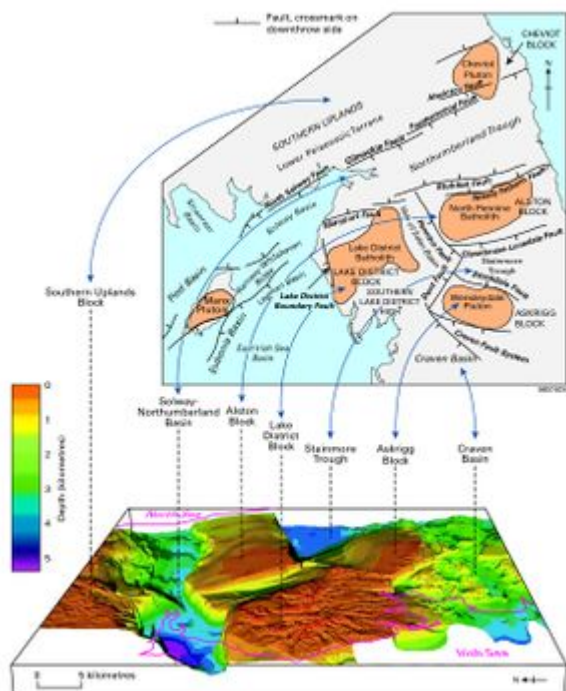
Henshaw Common, Northumberland [NY 7496 7291]. (P222338).

[File:P916113.jpg](#)

Summary of the lithofacies characteristics of the Carboniferous successions in northern England (after Waters et al., 2007. BGS Research Report RR/07/01). P916113.



Correlation chart for the traditional district-based Carboniferous lithostratigraphies (named on the figure) and the regional group lithostratigraphy adopted in this account (identified by colour). P916068.



3D model showing depth to the Lower Palaeozoic 'basement' across northern

England, viewed from the west. The principal structural features that influence Upper Palaeozoic and later geology are identified and related to a 'blocks and basins' sketch map rotated into a top-to-north orientation. P916037.

In common with Carboniferous rocks elsewhere in Britain, those of northern England have long attracted attention on account of their economic potential. Generations of underground and opencast workings for coal, vein ores, sandstone, mudstone and limestone have provided a wealth of information as to the distribution and nature of the strata. More recently, oil exploration has encouraged deep boreholes and geophysical investigations that have provided further data for concealed strata at depth. As long ago as the late 18th century, a threefold division of the Carboniferous rocks was recognised: the Carboniferous (or 'Mountain') Limestone, the Millstone Grit, and the Coal Measures. These lithostratigraphical (rock) divisions became broadly equated with the chronostratigraphical (time) divisions: Dinantian, Namurian and Westphalian. In the 1970s and 1980s a more detailed framework of chronostratigraphical divisions was established for use in the comparison of rocks from area to area within Europe. Three of these divisions — Holkerian, Asbian and Brigantian — are defined from sections in Cumbria. [\(P916112\)](#) shows the relationship of the European scheme to the global subdivisions of the Carboniferous.

Chronostratigraphical subdivision is largely based on biostratigraphy, which relies on the identification of key fossils and fossil assemblages, and the recognition of how these changed with time through successions of strata. Such a classification of Carboniferous stratigraphy across Britain and Europe is possible because the key species were rapidly evolving and widely distributed marine animals, and their fossilised remains enable a firm chronostratigraphical framework to be erected. The framework was initially based largely upon macrofauna assemblages, mainly of corals, brachiopods and bivalves; subsequently, microfauna such as foraminifera and conodonts were employed to allow correlation at international level. Particularly useful are the foraminifera, corals and conodonts in the early Carboniferous, and the ammonoids (goniatites) in the late Viséan, Namurian and Westphalian. In northern England, goniatites are generally rare and nonmarine bivalves and, more recently, palynomorphs (spores) have proved important zonal indicators. A selection of Carboniferous macrofossils is shown in [\(P222338\)](#).

The application of sequence stratigraphy allows an alternative approach to the description, interpretation and correlation of the Carboniferous succession. Sequences are defined as stratigraphical units bounded by regional unconformities or discontinuities related to cyclical changes of sea level. Sequence stratigraphical models then distinguish between sedimentary units, or systems tracts, produced during different parts of the cycle of variation in relative sea level. So, for example, transgressive systems tracts form when sea level is rising, high-stand systems tracts form when sea level is high, and low-stand systems tracts form when sea level is low. Sequences are on different scales, and are arranged in a hierarchy from 1st order (of longest duration) to 5th order. Sequence stratigraphy emphasises the allocyclic controls on sedimentary successions (tectonism, climate and eustasy) and can provide an improved understanding of depositional history and sedimentary system development. In places, especially in concealed sequences with limited borehole control, it can enable a higher resolution correlation than can be obtained by existing palaeontological methods alone. In northern England, sequence stratigraphy has been applied in the continuing debate regarding the origin of Yoredale cycles (discussed below), but has proved of most value in developing a high-resolution sequence stratigraphic framework for the Westphalian strata. This has enabled an improved correlation of the succession onshore with that offshore, beneath the North Sea.

Despite the advantages of sequence stratigraphy, the recognition of surfaces bounding systems tracts can be very difficult. In view of this, and given the fossiliferous nature of most Carboniferous rocks, biozonation continues to be an important tool for stratigraphical subdivision and provides a chronological framework for the succession. Ideally, the different methods should be used in combination. Hence, the long-established and well-tested use of marine bands as an important key to stratigraphical correlation, equates with identification of maximum flooding surfaces in sequence terminology.

Beds of economic importance, such as sandstone, limestone, coal or claystone, are commonly identified with local names, the principle of lithostratigraphy. Each district has its own set of names, but the same name is commonly used for beds in different locations and at different levels. The British Geological Survey has recently rationalised the nomenclature of British Carboniferous lithostratigraphy, grouping together eight broad types of sedimentary lithofacies associations ([P916113](#)). These regional group names will be implemented in future BGS publications and have been adopted here; their lithofacies associations and formational components are summarised in ([P916067](#)). The correlation between the traditional, district stratigraphies and the newly adopted regional lithostratigraphy is summarised in ([P916068](#)). Across northern England the group names reflect an early Carboniferous situation wherein the effect of a pronounced block and basin topography ([P916037](#)) produced locally variable successions. Subsequent deposition patterns became progressively (but diachronously) more uniform right across the region as synsedimentary fault control waned. However, even then, cycles of marine flooding and retreat continued intermittently at the trough margins in response to both global sea-level changes and asymmetric, or ramped, subsidence along the block boundary faults.

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