Pennine Coal Measures Group, Carboniferous of the Tweed and Northumberland-Solway basins

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Introduction

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Map showing the main structures associated with Carboniferous deposition and subsequent late Carboniferous to early Permian deformation. P912349.

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Warwickshire Group in the south of Scotland. P912356.

Westphalian Coal Measures strata crop out in the Canonbie Coalfield, a limited area of such strata that lies mainly to the north of the border in south-west Scotland, but has a concealed extent in southwards into Cumbria, linking with the Cumbrian Coalfield (P912355), as described in the companion volume for Northern England. The Canonbie Coalfield is situated at the north-west margin of the north-east to south-west-trending Solway Syncline, beneath which some coal seams may persist to reappear in Cumbria. Although their continuation has not been proved by deep boreholes, it is supported by seismic surveys. Application of both of these techniques in the 1980s indicated that the concealed coalfield is larger and has more economic potential than was previously envisaged. The exposed Canonbie coalfield is relatively small and was exploited on a limited scale in the 19th and early 20th centuries; deep mining ceased in the 1920s.

Deposition in much of the Solway Basin continued unbroken from the Namurian into the Westphalian, but along the northern margin of the basin there is an unconformity at the base of the Pennine Coal Measures Group, such that strata high in the Pennine Lower Coal Measures Formation rest unconformably on Yoredale Group rocks. There is also evidence for at least one unconformity in the overlying, late Westphalian ‘red beds’ that in the Canonbie Coalfield form part of the Warwickshire Group (see below).

The Pennine Coal Measures Group is predominantly nonmarine and is characterised by coarsening-upward cycles, commonly up to 15 m thick, composed of mudstone, siltstone and sandstone capped by a seatearth and coal, though coal forms only a minor part of the total sequence (P912353); clay ironstone occurs within some mudstones. The Solway Basin and its Westphalian strata were subject to some uplift and deformation during the late Carboniferous to early Permian Variscan tectonic episode, with development of open folds (P221694) and much faulting, whilst regionally the strata of the Solway Basin were compressed into the major Solway Syncline (P912349). Uplifted areas were soon eroded and Westphalian beds are now preserved only in the downwarped, coalfield areas. Subsequent sedimentation produced an unconformable cover of Permo-Triassic rocks over the Westphalian beds, which are commonly reddened to a depth of more than 100 m beneath the sub-Permian unconformity. Whilst erosion has since removed parts of the cover, much of the Canonbie Coalfield remains concealed beneath Permo-Triassic strata (P912355).

In the Scottish part of the Canonbie Coalfield, the Pennine Lower Coal Measures Formation is about 110 m thick, the Middle Coal Measures about 250 m and Upper Coal Measures about 150 m (P912355 and P912356): the sequence thickens into the hinge zone of the Solway Syncline. Coals in the Pennine Lower Coal Measures Formation are commonly unnamed and difficult to correlate, with borehole information showing them to be generally less than 0.8 m in thickness. The main seams are from the Duckmantian part of the Pennine Middle Coal Measures Formation, with only a few thin coals present in its uppermost, Bolsovian section. The few coals in the Pennine Upper Coal Measures are mostly located close to the base of the formation but an exception is the aptly named High Coal, which occurs about 150 m above the base of the Upper Coal Measures. It forms a convenient marker for the base of the overlying Warwickshire Group.

**Pennine Lower Coal Measures**

At Canonbie, the Pennine Lower Coal Measures (Langsettian) rest unconformably on Namurian strata of the Yoredale Group. In common with the situation seen in other coalfields of Formation the region, the Subcrenatum Marine Band, which defines the base of the Langsettian, is not present. Instead, correlation rests on the likely equivalence of the stratigraphically higher Langley Marine
Band of west Cumbria and Templeman’s Marine Band, identified at Canonbie near the bottom of the Becklees Borehole (NY 3517 7158). Mudstone–siltstone–seatearth cyclothsms are most common, but substantial sandstone bodies occur as likely channel fills, and several thin coals are present. A distinctive mudstone ‘mussel band’, with nonmarine bivalves and ostracods lies near the top of the formation some 4–6 m below the Vanderbeckei (Queenslie) Marine Band.

**Pennine Middle Coal Measures Formation**

The Pennine Middle Coal Measures (Duckmantian to lower Bolsovian) at Canonbie include strata between the Vanderbeckei (Queenslie) Marine Band and the Cambriense Marine Band, both of which can be identified. The Vanderbeckei Marine Band contains mega-spores, the inarticulate brachiopod *Lingula*, and fish remains; slightly higher is a ‘mussel band’ in about 7.5 m of mudstone with ironstone bands that also contains nonmarine bivalves and fish material. Mudstone–sandstone–seatearth cyclothsms tend to be well developed on a scale of 3 to 30 m, with a few nonmarine mussel bands in the mudstone. Several coals are also well developed so that the lower half of the Pennine Middle Coal Measures has been the most economically important part of the Canonbie succession. A ‘mussel band’ just below the Archerbeck Coal has a particularly varied fauna of at least 20 species of non-marine bivalves. In the upper part of the Pennine Middle Coal Measures, above the Archerbeck Coal, marine bands become more common and there is a commensurate reduction in coal development.

The Aegiranum (Skelton) Marine Band, marking the base of the Bolsovian Substage is developed in mudstone with foraminifera, inarticulate brachiopods, fish remains and conodont elements. Above this, two further marine bands appear in the succession before the Cambriense (Riddings) Marine Band marks the onset of the Pennine Upper Coal Measures. It appears as a bioturbated mudstone with ironstone nodules and contains foraminifera, inarticulate brachiopods, fish fragments, and conodont elements.

**Pennine Middle Upper Coal Measures Formation**

The Pennine Upper Coal Measures Formation (upper Bolsovian) at Canonbie largely comprises mudstone–siltstone cyclothsms with few substantial sandstones and only sporadic coals. Those that are present are relatively thin and located close to the base of the formation. The exception is the High Coal, which occurs about 150 m above the base and marks the onset of the overlying Warwickshire Group.

**Bibliography**


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