

Carboniferous central outliers - Whitecleugh, Sanquhar and Thornhill

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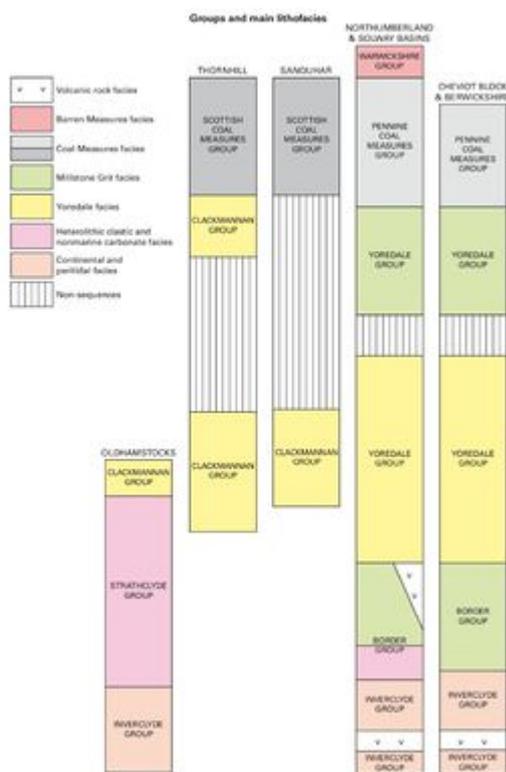
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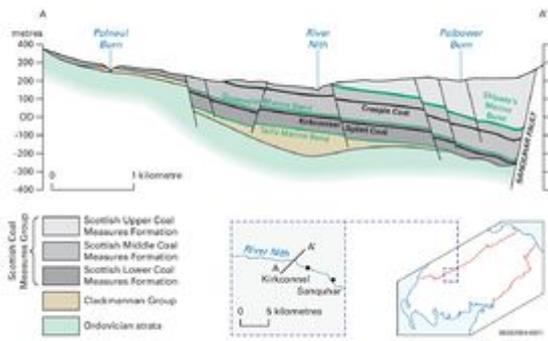
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Introduction





Representative cross-section of the Sanquhar coalfield. P912357.



Section of a mussel band with species of the nonmarine bivalve *Carbonicola*. P693035.

STAGE	SUBSTAGE	NONMARINE BIVOLVE ZONE	MIDEPORIFEROUS ZONE	STANDARD MARINE BAND NAMES	MARINE BANDS		LITHOSTRATIGRAPHY		
					Canonbie	Sanquhar	Canonbie	Sanquhar	
Westphalian	Ashtonian (Westphalian D)	terule	Thymopora obacra					WARWICK SPUR GROUP	
	Bolslovan (Westphalian C)	philipal	Tortosora aculeata	Canonbie	Widdings			Permo Upper Coal Measures Formation	
		Upper similia-pulchra		Shelton	Waverburnfoot			Scottish Upper Coal Measures Formation	
	Dudmanston (Westphalian B)	Lower similia-pulchra	Montopora magna	Edmondia	Vielicki	Logan			
				Asplenium	Shelton	Slippery's			
		modiolaria	Dicystrocladia benticulata	Houghton	Knottshelm	Eastside			
			Schulospira rara	Clovene	Sandwich	Bankhead			
	Langsettian (Westphalian A)	communis	Apollonaria aligena	Melby					
				Vanderbeek	Queenie	Queenie			
		articulata		Kilburn					
			Burton-Jones						
			Langley	Templeman's					
			Amalie						
	Triquetria alata - Conostrodites alata	Meadow Farm							
		Parkhouse							
		Upper							
		Healey							
		Springwood							
		Holness							
		Subcranium							

Stratigraphical classification of Westphalian strata in the south of Scotland. P912387.

Carboniferous rocks occupy a series of outliers mostly located in what were palaeovalleys in Upper Palaeozoic times, with only limited connection to the contemporaneous Midland Valley and Solway basins. During the early Carboniferous, these valleys were probably areas of erosion rather than deposition, since the oldest Carboniferous rocks present belong either to the Strathclyde Group or to the Clackmannan Group. All three inliers are fault controlled to some extent. The Whitecleuch

outlier is essentially an isolated fragment of the Douglas Coalfield of the Midland Valley of Scotland, preserved by downfaulting in a small graben within Ordovician rocks immediately south of the Southern Upland Fault. Its stratigraphy therefore closely matches that of its parent, the Douglas Basin. A similar situation is seen nearby at New Cumnock, where part of the Ayrshire Coalfield succession oversteps the Southern Upland Fault. The Sanquhar outlier is formed by a half-graben structure orientated north-west to south-east, with the bounding Sanquhar Fault on the north-east margin downthrowing Carboniferous against Ordovician rocks. For the Thornhill outlier, a plexus of north-south orientated faults associated with the major Carronbridge Fault controls the eastern side of a complex half-graben. At both Sanquhar and Thornhill, some smaller subsidiary outliers with limited stratigraphy occur to the east of the main outliers, suggesting that deposition intermittently overstepped the basin boundary faults.

Strathclyde Group

The Strathclyde Group has very restricted outcrops at the north-west and south-east margins of the Whitecleuch outlier, and to the south-east of New Cumnock. In both cases the lowermost beds rest directly on Ordovician strata. In the Whitecleugh outlier, a thin succession of sandstone and some mudstone is assigned to the Lawmuir Formation. Much of the sandstone is variably mottled green and red, but some is white and quartzose and prominent in exposure. The New Cumnock outcrop consists of thinly interbedded sandstone and mudstone. No strata of the Strathclyde Group are known from either the Sanquhar or Thornhill outliers.

Clackmannan Group

Sanquhar outlier

At the south-west margin of the Sanquhar outlier, strata assigned to the Clackmannan Group form a condensed sequence up to 30 m thick of coarse-grained and carbonaceous sandstone and grey siltstone. They rest with abrupt angular unconformity on Ordovician strata, and include the Polhote Marine Band mudstone, of Pendleian age. This mudstone, with a composite fauna of plant scraps, brachiopods, bivalves and gastropods, records a rare marine incursion into the outlier and allows valuable, if limited, correlation with the Clackmannan Group in the Midland Valley of Scotland.

Around the south-eastern margin of the main outlier, and in several of the adjacent minor outliers at Bogs Burn, Auchentaggert, and Muirhead, sandstones, siltstones and mudstones referred to the Clackmannan Group form isolated lenses preserved between the supra-Ordovician unconformity and the unconformity at the local base of the Scottish Coal Measures Group. The mudstones and calcareous siltstones contain plant remains and a marine fauna that includes bryozoa, brachiopods, gastropods, bivalves, and nautiloids. The fauna is most probably late Visean in age, with the presence of the brachiopod *Latiproductus latissimus?* indicative of the Brigantian substage.

Thornhill outlier

Within the Thornhill outlier, the Closeburn Limestone Formation of Visean (upper Asbian to Brigantian) age crops out around the southern margin and consists of about 25 m of dolomitic limestone, sandstone, siltstone and mudstone. The limestone was of sufficient thickness and quality to have been mined at Closeburn and Barjarg and burned for agricultural lime in the late 18th century, with well-preserved limekilns present at Croalchapel on the east bank of the River Nith. It has a fauna of corals, bryozoa, brachiopods, gastropods, bivalves, large orthocone nautiloids and fish. The partly coeval Enterkin Mudstone Formation forms the base of the Carboniferous succession in the north of the outlier and consists of up to 25 m of mudstone, limestone, siltstone and sandstone

that crop out discontinuously in small areas on its western and northern margins. The mudstone and limestone include at least two marine beds with a fauna of bryozoa, brachiopods, gastropods, bivalves and nautiloids that suggest a Brigantian (to perhaps early Pendleian) age.

The Townburn Sandstone Member of the Passage Formation comprises pebbly sandstone (with plant stems) up to 40 m thick and rests unconformably on the Enterkin Mudstone, the Closeburn Limestone, or where these are overstepped, Lower Palaeozoic rocks. Whilst the member lacks age-diagnostic fossils, it is the youngest unit in the Clackmannan Group of the Thornhill Basin, and is most probably a Namurian and/or Westphalian deposit.

Whitecleuch and New Cumnock

In the Whitecleuch outlier, the Lower Limestone Formation, the lowest division of the Clackmannan Group ([P912347](#) and [P912348](#)), crops out in several fault-bounded blocks where it is represented by a transgressive cyclic sequence of marine limestone and mudstone, passing up into siltstone, sandstone and sporadic seatearth and coal. It is succeeded across a low-angle disconformity by the pebbly sandstone and siltstone of the Passage Formation.

The small lenticular area of Carboniferous rocks which overstep the Southern Upland Fault immediately south of New Cumnock contains representatives of the Lower Limestone, Limestone Coal, Upper Limestone and Passage formations of the Midland Valley of Scotland, which rest with gross angular unconformity on Ordovician sandstones of the Marchburn Formation. These Clackmannan Group rocks form a southern extension of the Carboniferous succession seen in the Ayrshire Coalfield and are best considered, in context, in the companion volume for the Midland Valley of Scotland, British Regional Geology series.

Scottish Coal Measures Group

Coal Measures strata, sandstone–mudstone–seatearth–coal cyclothem ([P912353](#)), occupy most of the Sanquhar outlier and form a substantial part of the Thornhill outlier. Much smaller outcrops are present within the Whitecleugh outlier, and at the base of the mostly Permian succession occupying the Stranraer Basin.

Strata of the Scottish Lower Coal Measures Formation crop out in the north-west of the Whitecleugh outlier. They conformably succeed the Passage Formation but the top of the sequence is faulted out. Less than 100 m of sandstone and mudstone are present, with a few interbedded seatearths and thin coals, but there is a lack of distinctive horizons and only general correlation with the Douglas Coalfield is possible.

On the west (less-faulted) side of the Loch Ryan half-graben, north-west from Stranraer, a thin Westphalian sequence rests with marked angular unconformity on steeply inclined Lower Palaeozoic sandstone, and is covered unconformably by Permian breccias. The Westphalian sequence, the Leswalt Formation, comprises about 30 m of grey, red, and mottled yellow-brown sandstones interbedded with purple-grey mudstone and rare seatearth. The micaceous sandstone beds, and more particularly the thin interbedded silty mudstones, contain a Westphalian plant assemblage, most probably correlating with either the Scottish Lower or Middle Coal Measures.

Sanquhar

Scottish Coal Measures Group strata form the bulk of the Carboniferous succession in the Sanquhar outlier ([P912356](#) and [P912357](#)). On the western margin of the basin, there are about 120 m of the Scottish Lower Coal Measures Formation, but this division thins eastwards due to overlap onto an

irregular topography of subvertical Ordovician sandstone beds. The lower part of the succession is mainly arenaceous, with rare thin coal seams, while the upper part includes a group of up to eight Swallowcraig Coals and the important Kirkconnel Splint Coal, the most extensively worked seam in the coalfield and normally between 0.75 and 1.5 m thick.

Towards the base of the Sanquhar succession lies Tait's Marine Band, a possible correlative of the Lowstone Marine Band that elsewhere is taken to define the base of the Scottish Coal Measures Group. Tait's Marine Band has a composite fauna including miospores, brachiopods, gastropods, bivalves, nautiloids and crinoids, but passes abruptly northwards into a '*Lingula* band' mudstone with a more restricted fauna. Higher in the succession there are several mudstone beds containing nonmarine bivalves (mussel bands). The Fauldhead Mussel band, below the Swallowcraig Coals, has a fauna of nonmarine bivalves, ostracods and fish remains. The mussel band below the Kirkconnel Splint Coal, contains nonmarine bivalves ([P693035](#)) and fish remains whilst another mussel band is locally developed in the roof of that seam.

The Scottish Middle Coal Measures Formation includes strata between the base of the Queenslie (Vanderbeckei) Marine Band and the base of Skipsey's (Aegiranum) Marine Band and has a maximum thickness of about 135 m at Sanquhar ([P912356](#)). Apart from several named and extensively worked coal seams, the succession consists mainly of sandstone, siltstone, mudstone and seatearth, with ironstone ribs in places. As with the underlying Scottish Lower Coal Measures, there is a general thinning of the succession towards the eastern part of the Sanquhar Basin, consistent with its palaeo-connection into the thicker and more extensive Carboniferous succession to the north-west, in the Midland Valley.

The Queenslie Marine Band has a fauna of foraminifera, sponge spicules and bivalves. There are several mussel bands ([P693035](#)) higher in the succession, including one just above the Queenslie Marine Band, one in the roof of the Sanquhar Parrot Coal, and one in the roof of the Daugh Coal; the fauna in the roof of the Sanquhar Parrot Coal is relatively the richest of the three. There are several higher mussel bands: one about 12 m above the '*Estheria* band' that overlies the Twenty Inch Coal; one above an '*Estheria* band' below the Target Coal; the Bankhead (Haughton) Marine Band, which contains fish in addition to *Lingula mytilloides*; and the Eastside (Sutton?) Marine Band with a more varied assemblage of foraminifera, sponge spicules, inarticulate brachiopods and trace fossils.

The Scottish Upper Coal Measures Formation at Sanquhar comprises about 300 m of mainly mudstones, siltstones and sandstones with minor thin coals. It includes strata between the base of Skipsey's Marine Band and the regional unconformity at the base of the Permian succession ([P912356](#)); at Sanquhar (and Thornhill, see below) the unconformity is partially overlain by weathered, olivine basalts of the lower Permian Carron Basalt Formation. The lower part of the Scottish Upper Coal Measures Formation is grey in colour but reddened strata appear towards the top, as seen in the late Westphalian sequences farther south. Skipsey's Marine Band is a carbonaceous siltstone (or locally an impure limestone) with a varied benthonic fauna that includes foraminifera, brachiopods, bivalves, nautiloids, ammonoids, ostracods, crinoids, conodonts and fish. Higher in the succession, the Lagrae (Edmondia) Marine Band contains foraminifera, inarticulate brachiopods, bivalves and fish remains. Several mussel bands are present: one a little above Skipsey's Marine Band and two more much higher in the succession, respectively about 113 m and about 195 m above Skipsey's Marine Band.

Thornhill

In the Thornhill Basin, some 140 m of strata from the Scottish Coal Measures Group have been proved in the Crichope Linn Borehole (NX 9093 9511), a highly attenuated succession compared to that at Sanquhar. The main lithologies are sandstones, mudstones and seatearths, with the intervals

where coals would be expected commonly represented by thin iron-rich red mudstones, sometimes with relict coaly matter. Perhaps because of the limited thickness of Carboniferous strata, the reddening seen only in the Scottish Upper Coal Measures Formation at Sanquhar extends throughout the entire Scottish Coal Measures Group at Thornhill.

Lithologies in the Scottish Lower Coal Measures Formation (Langsettian) at Thornhill are mainly medium-grained, grey-white sandstone, purple and red siltstone and mudstone, and mottled seatearth. The strata are almost 50 m thick in the Crichton Linn Borehole. Although there are no coals present, five levels can be tentatively correlated by their nonmarine bivalves with mussel bands in the Sanquhar succession ([P912356](#)).

The Scottish Middle Coal Measures Formation (Duckmantian) in the Crichton Linn Borehole consists of 75 m of cyclical red mudstone, siltstone, sandstone and seatearth between the Vanderbeckei Marine Band at the base of the formation and the base of the Aegiranum Marine Band at the base of the Scottish Upper Coal Measures Formation. Other boreholes at Closeburn (NX 903 945) and Carronbank (NS 882 013) confirm the presence of six marine and nonmarine fossil horizons in the Thornhill outlier, which can be correlated with assemblages at Sanquhar to the north and the Solway Basin to the south ([P912356](#)).

The Scottish Upper Coal Measures Formation (Bolsovian) is only about 15 m thick in the Crichton Linn Borehole where it consists of red or purplish red mudstone and siltstone with ironstone nodules and plant detritus, as well as thin sandstone and seatearth. The Aegiranum Marine Band at the base of the Formation has been identified at several localities at Thornhill (including the Crichton Linn Borehole) as a foraminifera-bearing, mudstone mussel band. It can be correlated with the Skelton Marine Band of the Canonbie succession and Skipsey's Marine Band in the Sanquhar outlier ([P912356](#) and [P912387](#)). At Thornhill, strata above this level and up to the base of the Permian Carron Basalt Formation have proved unfossiliferous.

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