

Upper Coal Measures, Westphalian, Carboniferous, Midland Valley of Scotland

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Upper Coal Measures (now known as the Scottish Coal Measures Group)

The Upper Coal Measures include the strata from the top of the Aegiranum Marine Band up to the unconformity at the base of the Permian. They are placed in Westphalian C and D in the Western European classification. The strata contain few mussels compared with the Middle Coal Measures but there is evidence that the Upper Similis-Pulchra, Phillipsii and Tenuis chronozones of the non-marine bivalve zonation are present in the region. There is insufficient evidence to separate the last two chronozones.

There is no evidence of marine conditions later than the Upper-Similis Pulchra Chronozone. In that zone in England there are three marine bands but in the Midland Valley the bands are poorly developed and only the uppermost one has been identified on faunal grounds in Ayrshire and part of the Central Coalfield. There is also a record of one of the two lower bands in Ayrshire.

The strata are stained red in most areas and were formerly called the Barren Red Measures because the processes of oxidation which produced the red coloration also caused the alteration or destruction of most of the coal seams. However, the lower limit of reddening is an irregular horizon which, in places, extends well below the Aegiranum Marine Band but elsewhere fails to penetrate to that level.

Lithology

The sediments of the Upper Coal Measures in the lower part at least are essentially a sequence of fluvio-deltaic coal-bearing cycles, similar to those of the Lower and Middle Coal Measures. In many places they have been chemically, and to some extent physically, altered by processes of oxidation.

Unaltered, predominantly grey-coloured Upper Coal Measures strata occur in parts of Ayrshire and the Douglas area. The rocks consist of sandstones, locally thick and coarse in south Ayrshire, grey mudstones, seatclays, thin coal seams and nodular clayband ironstones. The coals are poorly developed and they tend to be impersistent laterally. In Ayrshire and the Central Coalfield thin

bands of compact cream-coloured limestone occur and are fairly persistent. The limestones are normally less than 0.3 m thick and contain *Spirorbis*, ostracods, estheriids and fish fragments. The rocks are not well known because of poor exposure and a lack of borehole and mining information.

The alteration affects all rock-types to some degree. The colour of the rocks is changed mainly to red, but also in places to green, lilac or yellow. The reddening is most intense in the upper part of the sequence where about 300 m are affected, but partial oxidation penetrated deeper, facilitated in some instances by fault planes and more permeable layers. The red coloration is due to the alteration of various iron minerals to hematite.

The colour change is accompanied by a textural change in the case of the fine-grained sediments. Traces of bedding in rocks which were originally mudstones or silty mudstones become less distinct and such rocks have been described as clayrocks or marls. The bedding tends to be further obscured by an apparent brecciation which is in fact merely a colour pattern reflecting contrasting concentrations of hematite and other iron-bearing minerals. Carbonaceous material, including plant debris and rootlets in seatclays has been destroyed but impressions may be left, often with a green coloration.

Coals are altered either by transition to limestone (Mykura, 1960) or removed altogether with only a thin layer of fissile clay or ironstone remaining in the coal position. The complete removal of the coal occurs in the upper part of the reddened succession and the replacement by limestone occurs in the lower part where oxidation is not so far advanced. It is not clear whether this indicates two stages in the oxidation process or that carbonate has been introduced perhaps from the weathering of the Permian lavas.

The reddening of the strata is mainly secondary in origin but it is possible that primary red beds are also present. It is clear that where coal positions can be identified in reddened strata, the reddening must have been secondary. In Fife thick beds of clayrock, within reddened strata containing coal positions, have been described as primary red beds.

Lateral variation

The thickness of the Upper Coal Measures is everywhere a residual one as the Permian lavas unconformably overlies the Upper Coal Measures in Ayrshire. The maximum thickness occurs in the Mauchline basin in Ayrshire where there are about 465 m of strata. All the Upper Coal Measures north of the Kerse Loch Fault are reddened, but in the Dalmellington area and in the Littlemill Trough the lower limit of reddening is 70 to 80 m above the Aegiranum Marine Band. The occurrence of desiccation cracks and calcareous concretions in the uppermost part of the sequence is evidence of increasing aridity.

In the Douglas area there are about 270 m of strata, mostly grey with only local reddening. Comparable thicknesses remain in Midlothian, Fife and the Central Coalfield, but the strata are mostly reddened.

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