Stainmore Formation

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Stainmore Formation (SMGP), Carboniferous, Northern England Province

Stainmore Formation is part of the Yoredale Gorup

Name

The name is derived from the former Stainmore Group, a chronostratigraphical term for the entire Namurian succession (Burgess and Holliday, 1979[1]). In west Cumbria the Stainmore Formation now replaces the Hensingham Group of Akhurst et al. (1997)[2].

Lithology

The Stainmore Formation comprises a cyclical succession of sedimentary rocks, with repetitive mudstones, laminated siltstones, sandstones, thin limestones and thin coals. It is distinguishable from the underlying Alston Formation by a decrease in the number and thickness of the limestones, which also tend to be darker grey and more impure. It extends from the top of the Great Limestone (or a correlative) to the base of the Subcrenatum Marine Band (SBMB) (or its equivalent) at the base of the Pennine Coal Measures Group. The limestones, which are more prominent in the south of the Askrigg Block, are dark grey with a diverse marine fauna. Limestones are rare or absent from the upper part of the formation. The sandstones are typically fine- to medium-grained, white to pale brown, commonly bioturbated and rooty. The mudstones may be very dark grey. On the Askrigg Block there are up to four main levels of chert within the formation, typically developed above the limestone component of the cyclothem. The Richmond Chert is the thickest at up to 40 m thick. It contains sponge spicules and displays rapid lateral transitions to crinoidal limestones. In west Cumbria the succession includes distinct, laterally discontinuous, major channel sand bodies, such as the Hensingham Grit and has an unusual limestone development the '*Tylonautilus*' or Snebro Gill Beds. At Canonbie, the Stainmore Formation is poorly exposed, but comprises repetitive cycles of sandstone, siltstone and claystone with thin beds of coal.

(It should be noted that the formerly widespread use across Northumberland and Durham, of the term ‘Millstone Grit’ to encompass sandstone-rich beds beneath undoubted Coal Measures rocks, appears to be traceable back to the long-obsolete threefold division of the British Carboniferous sequence into Mountain Limestone, Millstone Grit and Coal Measures. Whereas the first and third of these divisions could be readily recognised, it is clear that the original geological surveyors felt constrained, apparently with some difficulty, to define representatives of the Millstone Grit, even as recently as the latter half of the 20th century. Accordingly, beds between the former Upper Limestone Group and Coal Measures in Northumberland, and between the former Alston Group and Coal Measures of the Northern Pennines, have been classified as Millstone Grit. This usage was applied as recently as 1989 in the compilation of Geological Sheet 20 (Newcastle upon Tyne), though further confusion was introduced here with the synonymous use of the term Stainmore Group to classify these rocks. A more cautious, and arguably realistic, approach had previously been adopted on Geological Sheet 13 (Bellingham). Here the succession above the Liddesdale Group was classified as Stainmore Group, with no reference to Millstone Grit. Dunham (1990, p. 36)[3] drew attention to the difficulty of correlating sandstones beneath the Coal Measures with the classic Millstone Grit of the mid Pennines, Yorkshire and Lancashire, adding that the difficulty of making this correlation had by then been appreciated for at least half a century.

Whereas use of the term Millstone Grit cannot at present be justified in this part of northern England, it is important to recognise that coarse-grained sandstone bodies, which exhibit many ‘Millstone Grit’ characteristics with strongly erosive bases and with channel-like morphologies are present within the succession classified as the Stainmore Formation. Current knowledge indicates that these are present at several horizons within the Stainmore Formation succession, though no clear evidence has yet emerged to view these as other than local lithofacies variations within the rocks classified as Stainmore Formation. In Northumberland such sand bodies include the Rothley and Shaftoe Grits of Geological sheets 14 (Morpeth) and.9 (Rothbury), which exhibit deep erosive bases close to the horizons of the Little and Oakwood limestones respectively (Young and Lawrence, 2002REF NOT FOUND). Although not recently mapped in detail, the Longhoughton Grits of Geological Sheet.6 (Alnwick) appear to comprise a channel-based sandstone at the horizon of the Foxton limestones. In all of these cases there is evidence of contemporaneous tectonic control on sedimentation. Clearly, in these examples, ‘Millstone Grit’-like sandstones occur at a variety of stratigraphical levels, and are underlain and overlain by successions of rocks characteristic of the Stainmore Group lithofacies.

Notwithstanding Dunham’s (1990)[3] comments on the stratigraphical affinities of certain coarse-grained, locally pebbly sandstones, noted above, evidence from recent mapping of the northern margin of the Alston Block (Whitfield to Hexhamshire Common) has shown that coarse-grained, channel, sand-bodies dominate the succession in the upper part of the Stainmore Formation. Thus, in this area, the formation comprises a lower division consisting of mudstone interbedded with tabular units of fine and medium-grained sandstone and thin limestone beds, and an upper division of coarse-grained sandstone, lacking limestone. Work in progress on the Alston Block will determine the distribution and significance of this upper division and hence its lithostratigraphical status.)

Genetic interpretation

Cyclical marine and deltaic environments.

Stratotype

The type area of the Stainmore Formation is the Stainmore Trough. Reference sections include Mousegill Beck (BGS Registration Number NY81SW/7) (NY 8369 1242) from the base of the Subcrenatum (Swinstone Top) Marine band at 136.25.m depth to the top of the Great Limestone at 582.47 m depth (see Burgess and Holliday, 1979) and the Throckley Borehole (BGS Registration Number NZ16NW/45) (NZ 1456 6762) from about 69 to 577 m depth. In west Cumbria the formation occurs in the Distington Borehole (BGS Registration Number NX92SE/84) (NX 9972 2334) from below the inferred position of the Subcrenatum Marine Band (SBMB) at about 20 m depth to the top of the First Limestone, Eskett Limestone Formation, at about 121.m depth (see Akhurst et al., 1997, fig. 24[2]); the Rowhall Farm Borehole (BGS Registration Number NY03NE/49) (NY 0851 3664) from the non-sequence at about 61.5 m depth to the top of the First Limestone, Eskett Limestone Formation, at about 203.2 m depth (see Akhurst et al. 1997, fig. 24[2]; Brand, 2003[4]); Bigrigg Quarry (disused) (NY 0052 1270) which includes Yeadonian strata (see Eastwood et al., 1931[5]; Akhurst et al., 1997[2]); Brigham Quarry (disused) (NY 083 302) which exposes more than 30 m thickness of the Hensingham Grit which is locally developed at the base of the formation (see Young and Boland, 1992[6]; Akhurst et al., 1997[2]); and Snebro Gill (NX 9835 1685) where stream sections and cuttings in the Hensingham inlier include impure marine limestones and mudstones.

Lower and upper boundaries

The base of the formation is conformable on the Great Limestone Member (or correlatives) at the top of the Alston Formation (Figure 6, Column 7; Figure 8, Columns 11, 12; Figure 9, Columns 13, 5–7; Figure 10, Column.3; Figure 11, Columns 1, 3; Figure 12, Columns 1, 3, 4; Figure.13, Columns 3, 4; Figure 14, Columns 2, 3; Figure.15, Columns 2–4). However, in west Cumbria, in the Egremont–Whitehaven–Maryport–Cockermouth area, the lower boundary occurs where the shelf carbonate sequence of the First Limestone Member is terminated and conformably overlain by the mostly clastic marine and deltaic facies of the Stainmore Formation (Figure.14, Column.1). Here, at outcrop the basal part of the Stainmore Formation generally comprises the coarse-grained, fluvial, Hensingham Grit with a thin basal mudstone.

The top of the formation is generally conformable beneath the Subcrenatum Marine Band (SBMB) at the base of the mostly fluviodeltaic mudstones, siltstones and sandstones of the Pennine Lower Coal Measures (PLCM), or at the base of the coal-bearing sequence if this marker band (or an equivalent) cannot be identified.

On the Askrigg Block, the top of the formation is at the base of the Pendleton Formation, Millstone Grit Group (Figure 9, Column 17; Figure 15, Columns 2–4). Here, the mixed shelf carbonate and deltaic succession of the Stainmore Formation is succeeded, at an unconformity of E1c age by sandstone-dominated strata (see Brandon et al., 1995[7]).

In the Canonbie Coalfield, the boundary with the Pennine Lower Coal Measures Formation is uncertain in both position and nature. The Subcrenatum Marine Band has not been recognised here, and the unconformities inferred by Lumsden et al. (1967)[8] and Picken (1988)[9] have been discounted by Jones and Holliday (2006)[10] on sedimentological and seismic reflection evidence.

Thickness

The formation tends to thicken into troughs and half-grabens. In north and west Cumbria it thickens northwards, the relatively thin succession on the Lake District Block being separated from the Solway Basin by the syndepositional Maryport Fault (Barnes et al., 1988[11]; Chadwick et al., 1995[12]).

The formation is 50.m thick in the Lamplugh area (Young and Boland, 1992[6]) and 110.m and 140.m thick in the Distington and Rowhall Farm boreholes respectively (Akhurst et al., 1997). Over 500.m of strata are present in boreholes north of Maryport (Ramsbottom, 1978[13]). The thickest development on the Askrigg Block is about 180.m at the northern margin where the deltaic component of the cyclothems is thicker. The formation is up to 200 m thick in the Appleby district. Around Canonbie, seismic reflection data indicate that the formation is more than 400 m thick.

Distribution and regional correlation

Northern England, north of the Askrigg Block, including west Cumbria.

Age and biostratigraphical characterisation

Namurian (Pendleian to Yeadonian). The type localities of the Yeadonian ammonoids *Cancelloceras cancellatum* and *Gastrioceras cumbriense* occur within the mudstone beds at Bigrigg (NY 0010 1305). In west and north Cumbria the formation is also Pendleian to Yeadonian, but there is a large non-sequence above the Snebro Gill Beds in which strata of Chokierian to Marsdenian age are absent (Akhurst et al., 1997[2]). The limestones that are more prominent in the south of the Askrigg Block notably include crinoid debris and the nautiloid *Tylonautilus nodiferus*. The first appearance of common *Crassispora kosankei* miospores about 14 m above the base of the first thick sandstone ('First Grit') in the Throckley Borehole (see above) marks the base of the KV Zone (Stephenson et al., 2008[14]) of Kinderscoutian age. The upper 140 m of the Stainmore Formation in the Langholm area includes strata of the FR miospore Zone (late Marsdennian to Yeadonian in age) in the Rowanburnfoot Borehole (BGS Registration Number NY47NW/27) (NY 41031 75743) (Owens, 1980[15]).

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