Whitfield Gill–Mill Gill, North Yorkshire

[SD 920 931]–[SD 945 909], [SD 928 928] and [SD 924 931]–[SD 931 929]

Introduction

This locality comprises a 4 km stream section extending from Askrigg village [SD 945 909] in a WNW direction up Mill Gill and then Whitfield Gill to [SD 920 931]. It also includes scars on the hillside on the north side of Whitfield Gill: Whitfield Scar [SD 928 928] and High Scar [SD 924 931] to [SD 931 929]. The site provides an outstanding Brigantian–Pendleian section of the Wensleydale Group extending from the Gayle Limestone to the Main Limestone. It also represents one of the finest developments of the Yoredale facies on the Askrigg Block, thus facilitating the study of this classic style of cyclicity first recognized early in the study of the geology of northern England. The most detailed account of the section can be found in Moore (1958), with further details provided by Dunham and Wilson (1985). Foraminiferal faunas from part of the section are described by Hallett (1970) and Strank (1981).

Description

The stream section provides almost complete exposure of the succession from the Gayle Limestone to the Middle Limestone (Figure 5.28). The former is exposed in Mill Gill immediately west of Askrigg village [SD 943 911]. It consists of bedded limestones with shale partings overlain by more massive crinoidal limestones (Moore, 1958). A feature of the Gayle Limestone at this locality is the presence of an irregular upper surface (Hudson and King, 1933) consisting of small buildups with abundant corals and bryozoans (Moore, 1958).

Above the Gayle Limestone, some 28 m of siliciclastic deposits are exposed in a coarsening-upward succession. The lower part consists of shales with siderite nodules containing a diagnostic fauna including *Goniatites sphaericostriatus* and *Posidonia becheri,* described by Hudson (1924, 1925). Further goniatite discoveries from these shales reported by Dunham and Wilson (1985) include *Sudeticeras* cf. *turneri.* The upper part of the shales is unfossiliferous and passes up into flaggy-weathering siltstones and fine-grained sandstone. The top of this sandstone floors the waterfall at Millgill Force [SD 938 915]. The top 15 m of the coarsening-upward succession was logged by Lees (1991) as part of his study of trace fossils in Yoredale cyclothems. Siltstones near the base of the logged section contained *Macaronichnus, Teichichnus* and *Chondrites* and were placed in the author's *Planolites montanus–Chondrites* trace-fossil association. Lees (1991) recorded *Crossopodia, Macaronichnus, Asterosoma* and *Helminthopsis* from the overlying wave-rippled and cross-bedded fine-and medium-grained sandstones. These were placed in his *Crossopodia–Macaronichnus* trace-fossil association.

The overlying limestone, originally known as the 'Hardraw Limestone' (Phillips, 1836), was re-designated the 'Hardrow Scar' Limestone by Moore (1958). However, the definitive stratigraphical chart of the Kirkby Stephen 1:50 000 geological map (British Geological Survey, 1997b), uses the spelling Hardraw Scar Limestone and this usage is followed in the present account. The limestone forms the waterfall at Millgill Force and exposures upstream as far as Slape Wath [SD 937 918].

The Hardraw Scar Limestone is about 20 m thick. The lower part comprises massive crinoidal limestone which becomes better bedded upwards. A brachiopod band referred to as the 'Orthotetid Bed' by Moore (1958) occurs near the middle of the limestone. It contains *Schellwienella crenistria, Gigantoproductus dentifer* and *Productus concinnus* (Prentice, 1949; Moore, 1958). The upper part of the limestone is also massively crinoidal with rubbly weathering bands caused by concentrations of pressure solution seams. The uppermost unit is a partially dolomitized fine-grained limestone (Moore, 1958).

The succession between the Hardraw Scar Limestone and the Simonstone Limestone is complex and less well exposed than the lower part of the succession. It contains three minor limestones, numbered IIIA, B and C by Moore (1958) (Figure 5.28). Beneath Limestone IIIA, a thin fossiliferous shale rests on a coal and seatearth. The shale is plant-rich at the base and passes through a unit with flattened bivalves and fish debris to become more calcareous with colonial corals and brachiopods at the top (Moore, 1958). Limestone MA is a sparsely crinoidal fine-grained limestone. Beds above the limestone are poorly exposed with mostly fine sandstones present, capped by a thin coal and succeeded by Limestone IIIB which is sandy, especially at the base.

About 10 m of shale and sandstone separates Limestone IIIB from Limestone IIIC. The latter is about 30 cm thick and contains scattered fine crinoid debris. The Simonstone Limestone appears a few metres above Limestone IIIC. It is about 7 m thick, with coarsely crinoidal limestone succeeded by interbedded limestones and shales, further crinoidal limestones and, at the top, fine-grained 'algal' limestones (Moore, 1958). The fauna includes small colonies of *Siphonodendron junceum,* found throughout the limestone, and *Orionastraea,* seen particularly at the top.

Approximately 50 m of predominantly silliciclastic deposits occur between the Simonstone Limestone and the Middle Limestone in Whitfield Gill. Broadly, this consists of shales overlain by sandstones, but the sandstones are interrupted by two thin limestones (IVA and IVB of Moore, 1958) overlain by shale units (Figure 5.28). The shale immediately overlying the Simonstone Limestone is especially fossiliferous; a typical Yoredale coral–brachiopod fauna from this horizon is listed by Moore (1958). Current ripple-laminated, fine-grained sandstones above these shales and beneath Limestone IVA are well exposed at 'Whitfield Gill Force [SD 934 922] (Dunham and Wilson, 1985). Trace fossils recorded from this level by Lees (1991) include *Crossopodia, Eione* and *Helminthopsis.*

The Middle Limestone is divided into three massive units separated by shales and thinly bedded limestones. The lowest massive limestone unit has at its base a coral bed, containing *Lithostrotion decipiens, Diphyphyllum fasciculatum* and *Orionastraea* (J. Nudds, pers. comm., 2000), and a palaeokarstic surface at the top (Dunham and Wilson, 1985). Separating the lower and middle parts of the Middle Limestone are mudstones, including a nodular band of limestone containing the sponge *Erythrospongia lithodes* first recorded by Hudson (1929). The central part of the Middle Limestone consists of dark-coloured limestones with gigantoproductids and chert nodules, and the uppermost unit includes a band of oncoids near its top. Abundant and diverse foraminiferal faunas were recorded from the Middle Limestone in Whitfield Gill by Strank (1981), contrasting with the observation by Hallett (1970) that Middle Limestone foraminiferal faunas were generally rather scarce. An abundant conodont assemblage also from the Middle Limestone was recorded by Varker (1968).

Strata above the Middle Limestone are poorly exposed in Whitfield Gill. The Undersett Limestone and Main Limestone are seen respectively at Whitfield Scar and High Scar. The Undersett Limestone is particularly notable for its abundant bryozoan fauna, a feature that sets it apart from other Yoredale limestones (Moore, 1958). The Main Limestone is one of the more prominent scar-forming limestones, typically being more than 20 m thick. It comprises medium- to dark-grey bioclastic, often crinoidal, limestones with bands of corals and gigantoproductids. *Actinocyathus floriformis* and *Lonsdaleia duplicata* are particularly common.

Interpretation

Wensleydale, formerly known as 'Uredale' or Yoredale', is the type area for the 'Yoredale Series' of Phillips (1836) who was responsible for naming many of the limestones. The initial [British] Geological Survey work also concentrated on the limestones and the nomenclature was slightly revised (Dakyns et *al.,* 1890, 1891). Although the cyclicity of the succession was implicit in these studies, it was not until the work of Hudson (1924, 1933) that the nature of the cyclicity — limestone overlain consecutively by shale then sandstone and sometimes a seatearth-coal couplet — was flinily stated. The biostratigraphy of Yoredale successions on the Askrigg Block is reviewed by Dunham and Wilson (1985). Brigantian faunas are found up to the Undersett Limestone, with fossils of Namurian aspect appearing in the siliciclastic beds between the Undersett Limestone and Main Limestone. In Mill Gill, the goniatites in the shales above the Gayle Limestone indicate a Pic age (Dunham and Wilson, 1985). Correlations of early Brigantian limestones between the Askrigg Block and the Alston Block have been considered by Burgess and Mitchell (1976), with the Gayle Limestone correlated with the Grain Beck Limestone and Lower Little Limestone. Higher in the succession, the three parts of the Middle Limestone were correlated by Dakyns *et al.* (1891) with the Single Post Limestone, Cockleshell Limestone and Scar Limestone, the Middle Limestone thus splitting northwards (Figure 5.4), a correlation that is now generally well accepted (e.g. British Geological Survey, 1997b). The term 'Wensleydale Group' is now applied to these Yoredale facies Brigantian strata of the Askrigg Block area (Arthurton *et al.,* 1988; British Geological Survey, 1997b,c).

The Whitfield Gill–Mill Gill site provides a section of the late Dinantian Yoredale facies that is typical of the Askrigg Block area. The Gayle Limestone and Its overlying siliciclastic beds (comprising the Gayle Limestone Cyclothem) make up a typical Yoredale cyclothem consisting of marine limestone overlain by a coarsening-upward succession of terrigenous origin. The overlying Hardraw Scar Limestone Cyclothem, comprising the Hardraw Scar Limestone and overlying beds to the base of the Scar Limestone, is more complex, the thin limestones occurring here within the otherwise siliciclastic part of the succession suggesting several superimposed orders of cyclicity.

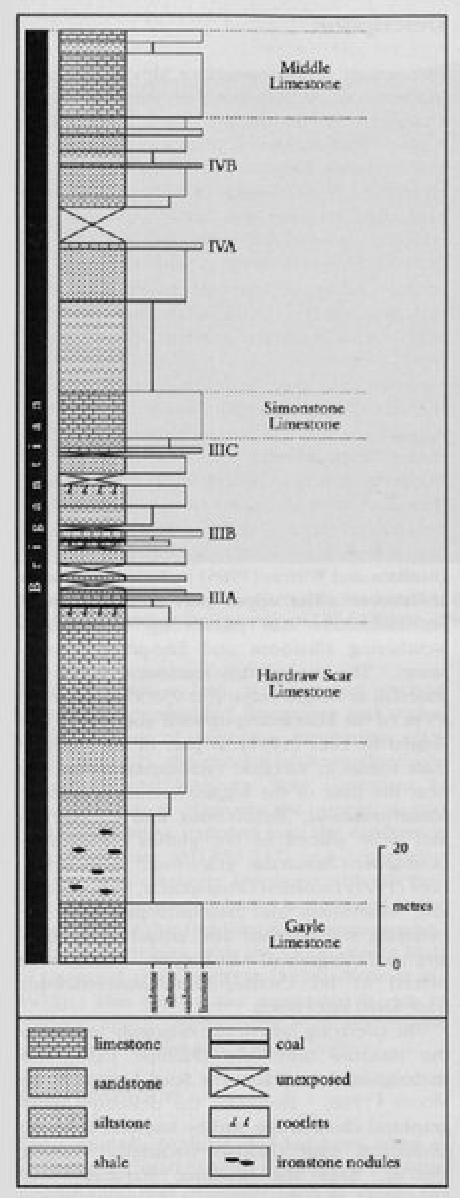
Moore (1958, 1959, 1960) was the first to study the sedimentology of the Yoredale facies in detail and to establish that they were deposited from deltas periodically building out into a shallow marine carbonate-producing environment, followed by periods of abandonment, subsidence, re-establishment of the shallow marine environment and then repetition of the whole process. Lees (1991) stressed the importance of wave and storm reworking In the Brigantian Yoredales of England, citing the Gayle Limestone Cyclothem of Mill Gill as an example. In his model, Lees (1991) interpreted the *Planolites montanus–Chondrites* trace-fossil association as representing distal, offshore deposits and the *Crossopodia–Macaronichnus* association as representative of wave-reworked sandstones at the coastal interface (beach zone) between the open sea and delta front.

The origin of the Yoredale-style cyclicity has been much debated and is reviewed by Bott and Johnson (1967) and by Leeder and Strudwick (1987). Moore (1958, 1959) suggested that shifting of delta distributaries coupled with regional subsidence was sufficient to produce the repetitions. Others favoured a tectonic (e.g. Bott and Johnson, 1967) or eustatic (e.g. Ramsbottom, 1973) mechanism, leading to relatively rapid sea-level rise, to account for the more extensive limestones. Leeder and Strudwick (1987), in their preliminary studies of the causes of Yoredale cyclicity, favoured a combined tectono-sedimentary mechanism while not ruling out the possibility of eustatic effects.

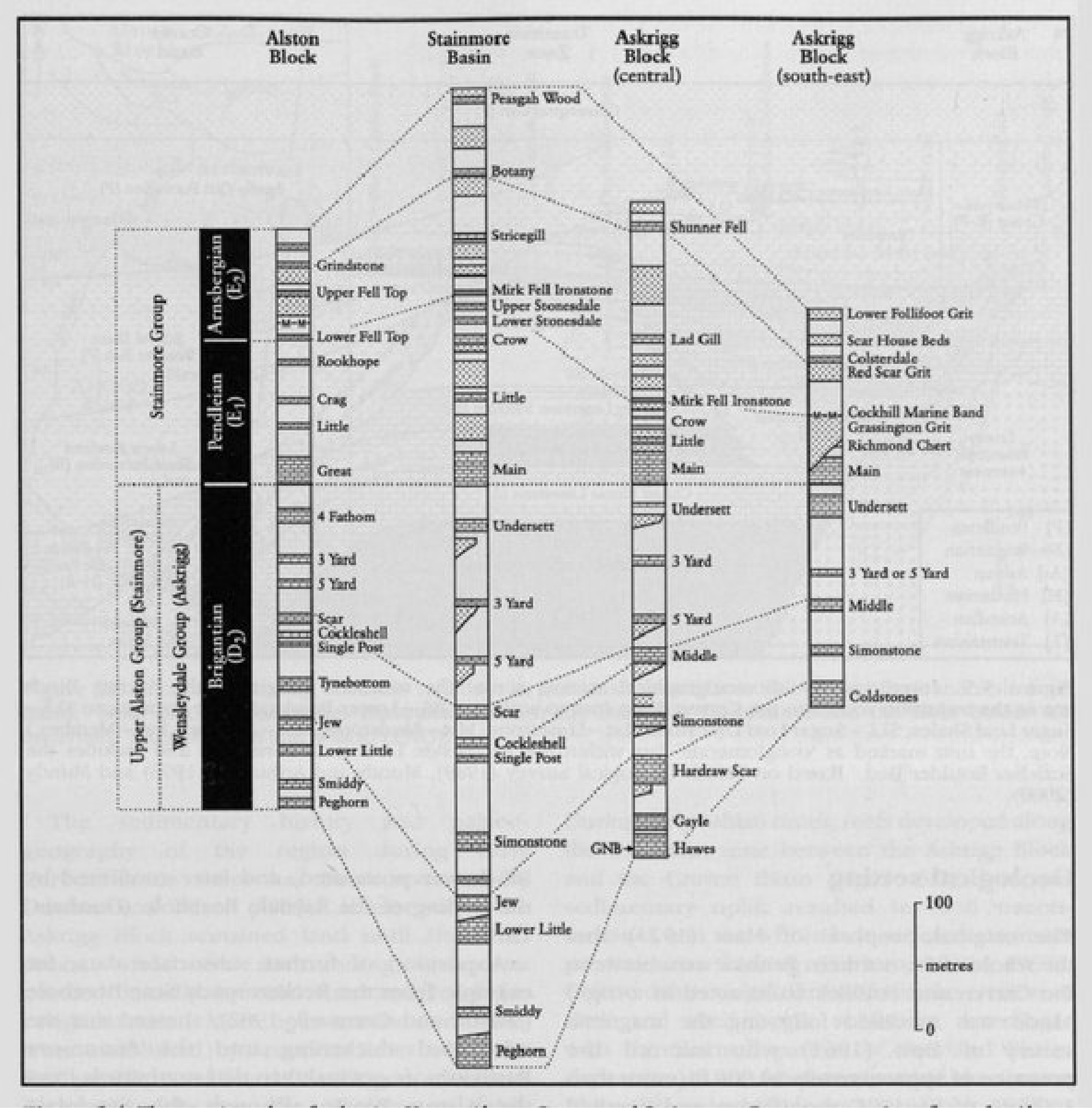
Conclusions

Whitfield Gill–Mill Gill provides one of the best and most easily accessible sections of the Yoredale facies on the Askrigg Block. Much of the succession from the Gayle Limestone to the basal Namurian Main Limestone is visible. The site is particularly valuable for exposing a complete and 'typical' Yoredale cyclothem as well as more complex cycles. It is thus one of the most important sites for studying the causes and effects of late Dinantian cyclicity in Britain.

References



(Figure 5.28) Sedimentary log of the lower part of the Brigantian 'Yoredale' succession at the Whitfield Gill-Mill Gill GCR site. After Moore (1958).



(Figure 5.4) The stratigraphy of selective Upper Alston Group and Stainmore Group successions from the Alston Block, Stainmore Basin and Askrigg Block. Note that all units with a brickwork ornament are 'Limestones' unless otherwise specified. (GNB — Girvanella Nodular Bed.) Based on Ramsbottom (1974) and Ramsbottom et al. (1978).