How Gill, County Durham

[NY 955 205]

Introduction

The How Gill GCR site is situated 11 km WSW of Barnard Castle on the northern limb of the Cotherstone Syncline, and 20 km south of the Closehouse–Lunedale Fault. This site [NY 955 205] provides a critical 45 m section of the cyclothemic Stainmore Group that includes, at its top, one of the most important exposures of the Botany Limestone in the Stainmore Basin, noted here for its rich and distinctive Arnsbergian (E_{2b}) fauna. The Botany Limestone forms a prominent marker horizon that facilitates the correlation of lower Namurian successions throughout the Stainmore Basin and onto the adjacent Askrigg and Alston blocks.

The locality (formerly known as the 'Botany Hill' GCR site) includes a stream section (How Gill) and the remains of a small disused quarry (How Gill Quarry). Details of the site geology are recorded by Carruthers (1938), Reading (1957), Burgess and Holliday (1979) and Johnson *et al.* (1980b).

Description

The sequence begins in How Gill immediately above the marine 'Fossil Sandstone' of the Fossil Sandstone Cyclothem (Reading, 1957; Brenner and Martinsen, 1990), and within it three distinctive units can be recognized. These comprise a lower coarsening-upward clastic unit (29 m) topped by the Botany Grit, a middle shale unit (9 m) and an upper limestone–shale unit, the Botany Limestone (6–8 m). Moving upstream, progressively younger parts of the succession are encountered.

At the base of the lower unit are 20 m of silty mudstones and dark shales with thin, sharp-based sandstones. Mica and sporadic plant fragments characterize this part of the succession and scattered ironstone nodules occur towards the base. Up sequence the section gets progressively more sandy as the lower mud-dominated interval is overlain by 9 m of Baggy, micaceous, trough cross-bedded sandstones, which are capped by a quartzose feldspathic sandstone, the Botany Grit (0.6 m). The base of the Botany Grit is conglomeratic and an erosion surface separates it from the underlying sandstones. Palaeocurrent data from this grit indicate a flow direction from the north (Reading, 1957). A thin seatearth–coal couplet with rootlets and plant fragments above the grit marks the base of the succeeding shale unit, which is otherwise devoid of plant remains. A few thin siltstones in this middle unit show evidence of bioturbation.

Above this, the Botany Limestone is a highly fossiliferous but heterogeneous mix of nodular and thinly bedded limestones with intercalated shales of variable thickness (Figure 5.17). A thin but distinctive brachiopod-rich limestone (0.35 m) lies close to the base of the unit (also the base of the Botany Limestone Cyclothem) and is overlain by a metre of shale containing a rich marine fauna. Above this, nodular bioclastic limestones and thin shales give way progressively to better bedded and more fossiliferous limestones at the top of the unit. Limestone composition is highly variable, with individual beds containing variable quantities of lime, silica, sand and mud.

Garwood (1913), Reading (1957), Burgess and Holliday (1979) and Johnson *et al.* (1980b) recorded an exceptionally rich fauna from the Botany Limestone, including sponges, corals, annelids, bryozoans, brachiopods, bivalves, gastropods, nautiloids, goniatites, echinoids, crinoids and fish remains. Taxa from this horizon include *Hyalostelia paralella, Dibunophyllum bipartitum, Diphyphyllum, Fenestella, Penniretepora, Polypora, Thamniscus?, Brachythyris, Buxtonia, Chonetipustula,* '*Dielasma*'*, Echinoconchus punctatus, Eomarginifera, Leptagonia, Orbiculoidea, Pliochonetes buchianus, Productus carbonarius, Quasiavonia aculeata, Sinuatella sinuata, Straparollus* (*Euomphalus*)*, Aviculopecten interstitialis, Limipecten dissimilis, Pernopecten sowerbii, Streblochondria, Cravenoceratoides, Epidomatoceras,* trilobite fragments and fish debris. Other significant records from the Botany Limestone include *Tylonautilus nodiferus, Dictyoclostus* and a variety of rugose corals, namely *Aulina rotiformis, siphonoderuiron pauciradlale, Michelinia tenuisepta* (Burgess and Holliday, 1979), *Aulina botanica* (Nudds, 1977) and *Lithostrotion decipiens* (J. Nudds, pers. comm., 2000).

Interpretation

Early stratigraphical work focused attention on the age of the Botany Limestone and its rich macrofauna. Garwood (1913) suggested a Viséan age for the 'Botany Beds', while later detailed lithostratigraphical work (Carruthers, 1938; Reading, 1957) and biostratigraphical studies (Hill, 1938–1941; Smith and Yu, 1943; Nudds, 1977), which considered especially the distribution of coral taxa (e.g. *Aulina*), indicated that they were of Namurian (Arnsbergian, E_2) age. Smith (1917) and Carruthers (1938) equated the Botany Limestone with the Fell Top Limestone but Reading (1957) placed it higher in the sequence as the lateral equivalent of the Shunner Fell Limestone of the Askrigg Block, a unit generally considered to be of high E_2 age (King, 1914; Hudson, 1939; Rayner, 1953). Its position at the base of the middle Arnsbergian succession (E_{2b}) and its correlation with the Grindstone Limestone of the Alston Block, the Shunner Fell Limestone of the Askrigg Block (Figure 5.4), the High Wood Marine Beds of the Stainmore Outlier and both the Newton Limestone and Styford Limestone of the Northumberland Basin, is now generally well accepted (Ramsbottom, 1977a; Ramsbottom *et al.,* 1978). The occurrence of the goniatite *Cravenoceratoides* in the Botany Limestone and the common E_{2b} nautiloid *Tylonautilus nodiferus* in the Botany Limestone, Grindstone Limestone, Newton Limestone and Styford Limestone (Burgess and Holliday, 1979; Holliday and Pattison, 1990) supports this view. Beds of the 'Fossil Sandstone Cyclothem' beneath the Botany Limestone are therefore assumed to be of early Arnsbergian (E_{2a}) age.

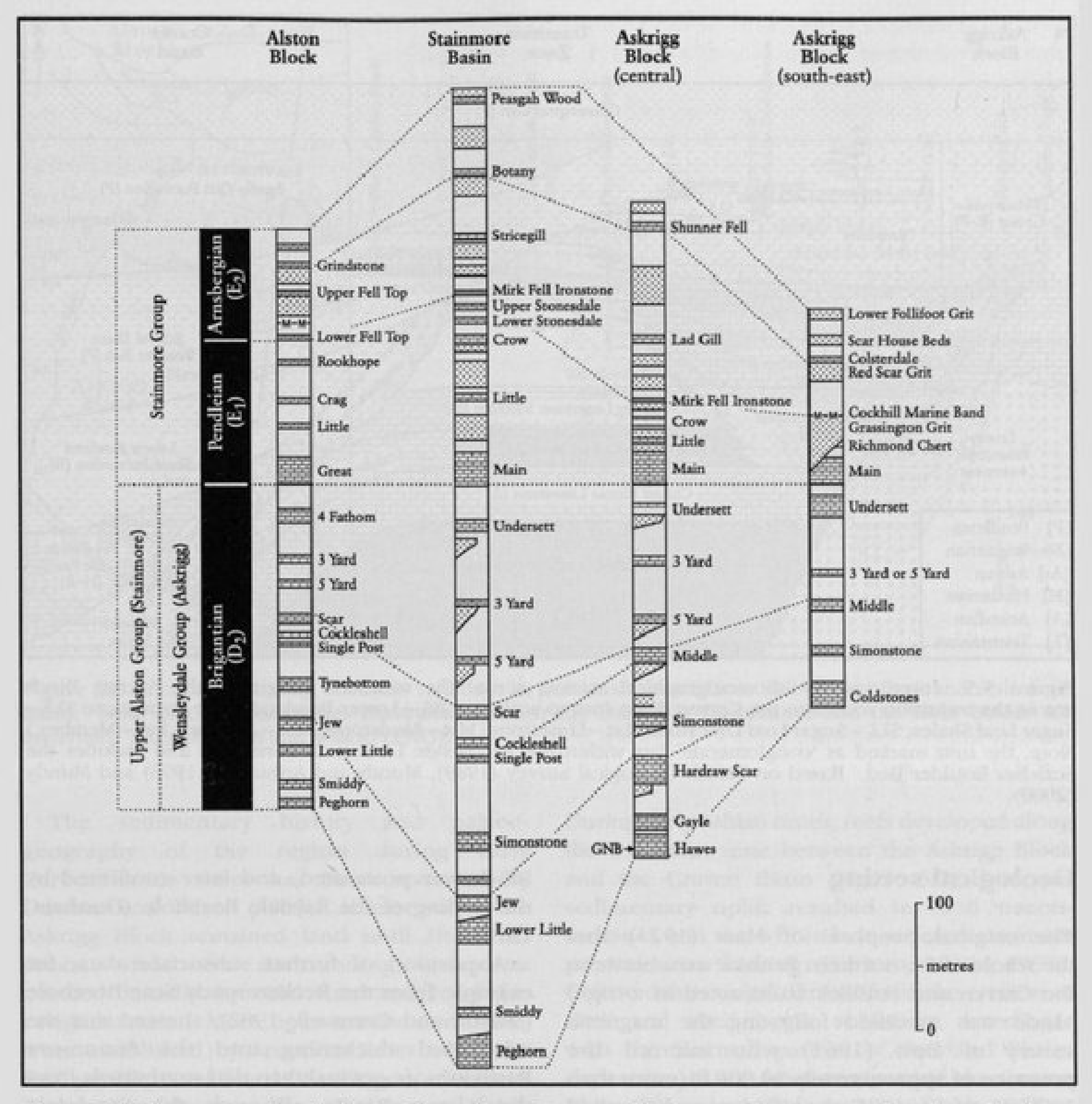
Apart from the work of Elliot (1974a, 1975) and Brenner and Martinsen (1990), little has been published on the sedimentology of lower Namurian cyclothems in the Stainmore Basin. Despite this, the How Gill succession shows clear and unequivocal evidence of the interaction between the deltaic and marine sedimentary processes that were so influential in the development of Yoredale cyclothems throughout northern England in early Namurian times. The development of the lower coarsening-upward clastic unit and its seatearth–coal cap reflects deposition from a prograding delta lobe advancing from the north and the gradual establishment of delta-top conditions. This was followed by a period of marine flooding in which the Botany Limestone was deposited.

Conclusions

How Gill provides one of the finest and most complete (i.e. unfaulted) sections of the Botany Limestone Cyclothem in the Stainmore Basin and was formed by deltaic and marine processes during middle Arnsbergian (E_{2b}) times. The site is the type locality of the highly fossiliferous Botany Limestone, a distinctive lithostratigraphical unit widely used in the correlation of lower Namurian cyclothemic successions across northern England. In addition, the section remains a promising prospect for future micropalaeontological and sedimentological research.

References

(Figure 5.17) The highly fossiliferous nodular bioclastic limestones and shales of the basal Arnsbergian (E_{2b}) Botany Limestone at How Gill. (Photo: P.J. Cossey.)



(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).