Brunton Bank Quarry, Northumberland

[NY 928 699]

Introduction

Situated to the north of the B6318 and approximately 1 km to the south-east of Chollerford, Northumberland, the Brunton Bank Quarry GCR site is a disused quarry [NY 928 699], with a unique exposure of the Great Limestone (basal Namurian, Pendleian, E_{1a}) lying close to the southern margin of the Northumberland Basin. Johnson (1958) recorded two prominent organic buildups from the sequence, including the 'Brunton Band', containing the rare alga *Calcifolium,* and a spectacular development referred to as the '*Chaetetes* Band' — the finest Carboniferous example of a sponge biostrome in Britain. Fairbairn (1980) and Frost and Holliday (1980) recorded details of the succession, but the original account by Johnson, (1958) remains the most useful site description to date. Further palaeontological detail relating to the *Chaetetes* biostrome is provided by Shiells (1961), Johnson (1979), Brunton and Mundy (1988a) and Cossey and Mundy (1990).

Description

At this site, the Great Limestone succession (*c.* 15 m) is divisible into three parts ((Figure 3.19); and see Johnson, 1958): a lower division (*c.* 2 m) of dark-grey, dolomitic limestone, which includes the highly fossiliferous Chaetetes Band; a middle division (*c.* 7 m) of well-bedded, paler-grey limestone, which includes the Brunton Band with its rich microfaunas; and an upper division (*c.* 6 m) of dark-grey limestone with interbedded calcareous shales. These three divisions correspond broadly with the long-established 'Bench Posts', 'Main Posts', and 'Tumbler Beds' units of the traditional Great Limestone terminology, although Fairbairn (1980) recognized a fourth subdivision in the quarry, the 'Transitional Posts', which broadly equates to the lower part of the Tumbler Beds.

The Chaetetes Band (Figure 3.20) forms the most prominent limestone 'post' in Johnson's 'lower division' and ranges from 0.5 m to just over 1 m in thickness. The bed is packed with large discoidal and laminar sheets of *Chaetetes depressus,* which locally grow together to form a complex organic buildup referred to by Johnson (1958) as a 'corallirke biostrome'. Individual chaetetid colonies apparently grew to a considerable size, and Shiells (1961) reports some specimens reaching up to several metres in length. Within each colony the irregular and sometimes broken sheets of *C. depressus* vary in thickness from a few millimetres to several centimetres and are separated by layers of dolomitized sediment and occasional spar-filled cavities (Figure 3.21). Shiells (1961) also noticed chaetetid 'trials' in the underlying bed and that turbidity and substrate consistency were a major influence on chaetetid development. A variety of carbonate phases are developed in the biostrome including both ferroan and non-ferroan calcites and dolomites, although details concerning their distribution and significance have yet to be fully evaluated.

Johnson (1958) described a rich fauna from the Chaetetes Band characterized by the occurrence of numerous coral and brachiopod taxa, rare echinoids and a remarkable cryptic fauna of adherent bryozoans, annelids and brachiopods attached to the undersurfaces of the chaetetid colonies. Subsequent investigation of this highly specialized cryptic fauna has revealed spectacular examples of the rare cementing aulostegacean brachiopod *Sinuatella johnsoni,* complete with its creeping adherent spines and cementation scars (Johnson, 1979; Brunton and Mundy, 1988a), and the loosely attached foraminifer *Tetrataxis* (Cossey and Mundy, 1990). A similar cryptic community associated with laminar chaetetid colonies has been described by Suchy and West (1988) from the Middle Pennsylvanian Pawnee Limestone of Iowa, USA. The origin of the cryptic cavities beneath the chaetetids most probably resulted from sediment scouring (Suchy and West, 1988; Cossey and Mundy, 1990).

The rich fauna from the Chaetetes Band includes *Tetrataxis,* '*Serpula*', '*Spirorbis*' cf. *laxus, C. depressus, C. septosus, Aulopora?, Caninia cornucopiae, Cladochonus brevicollis, Dibunophyllum bipartitum, Diphyphyllum lateseptatum, Koninckophyllum echinatum, Siphonodendron pauciradiale, Actinocyathus floriformis laticlavia, Syringopora geniculata, Fenestella, Polypora, Stenopora,* indeterminate stick bryozoans, *Actinoconchus planosulcatus, Athyris lamellosa, Brachythyris decora, Crania quadrata, Pugilis pugilis, Echinoconchus punctatus, Eomarginifera longispina, Leptagonia* *caledonica, Overtonia fimbriata, Rhipidomella michelini, Schellwienella crenistria, S. johnsoni, S. sinuata, Spirifer, Tylothyris* cf. *subconica castletonensis* and *Archaeocidaris urii* (Johnson, 1958; Brand, 1972; Frost and Holliday, 1980; Brunton and Mundy, 1988a; Cossey and Mundy, 1990).

Although Johnson (1958) clearly regarded *C. depressus* as a tabulate coral, comparisons made with Recent sponge taxa (Hartman and Goreau, 1970, 1972, 1975) and the discovery of spicule pseudomorphs in chaetetids in the Tynant Limestone at Eglwyseg Mountain (Gray, 1980; and see Egjwyseg Mountain GCR site report, Chapter 8) lend support to the more recent view of chaetetids as demosponges (West and Kershaw, 1991).

In the upper part of the 'middle division', Johnson (1958) recorded a 3.5 m-thick algal limestone, the Brunton Band, containing a rich microfauna that included *Calcifolium bruntonense* (a codiacean alga now regarded as the junior synonym of *C. okense*;Holliday *et al.,* 1975; Frost and Holliday, 1980) in abundance, textulariid, ammodiscid, endothyrid, nodosariid and tetrataxiid foraminifera, ostracodes, dasycladacean algae and *Girvanella.* A fragmented macrofauna of coral, crinoid, bryozoan, brachiopod, gastropod and echinoid (*Archaeocidaris*) debris also occurs at this level. Although the '*Calcifolium* Band' (Johnson *et al.,* 1995) was originally described by Johnson (1958) as an algal 'biostrome', Shiells (1961) indicated that algae do not occur in sufficient quantity here to justify use of the term 'biostrome'. Although best developed at this locality, *C. okense* is also known from Pendleian and upper Brigantian Yoredale limestones elsewhere in northern England and in Scotland (Burgess, 1965).

Frost and Holliday (1980) tentatively suggested that scattered specimens of *Dibunophyllum bipartitum* from above the Brunton Band at this site may mark the presence of the Frosterley Band, the third 'biostrome' described by Johnson (1958) from the Great Limestone, but this development is better seen at its type locality (Harehope Quarry) in Weardale, on the Alston Block to the south.

Interpretation

The formation of the Great Limestone represents the depositional response to a significant transgressive event that took place at the beginning of Namurian times when marine conditions were established across a wide area of northern England over earlier-formed deltaic deposits of the 4 Fathom Cyclothem. A detailed evaluation of the conditions of deposition and sedimentary environments of the Great Limestone at this site awaits further sedimentological study, but the presence of a rich coral–brachiopod fauna associated with calcareous demosponges in the Chaetetes Band and the abundance of calcareous algae in the Brunton Band, are indicative of deposition in clear, shallow seas, above wave-base and within the photic zone.

The palaeoecology of the Chaetetes Band was considered by Shiells (1961), who stressed how important it was for the chaetetids to keep their living surfaces above the sediment-water interface. Shiells further suggested that their laminar growth form may have been an adaptive strategy to prevent sinking in soft sediment. He also suggested that the interfingering of sediment layers and chaetetid laminae resulted from periodic influxes of argillaceous material which killed off parts of the organism, followed by a re-establishment phase in which a spread of lateral growth took place from a surviving part of the colony. In addition, Shiells (1961) related the initiation of the *Chaetetes* biostrome to reduced levels of turbidity and a coarsening of the substrate sediment, while its termination was attributed to increased levels of turbidity and a fining of the substrate sediment, although little petrographical evidence was presented in support of these claims.

Studies of chaetetids from North America have indicated that the major factors influencing chaetetid growth form were substrate type, sedimentation rate, turbidity, turbulence and water depth (Kershaw and West, 1991; West and Kershaw, 1991). These authors suggested that although laminar chaetetids occurred in both high- and low-energy facies, they were better adapted to environments of high energy and generally confined to areas of very shallow water, well within wave-base. Considering all available evidence, it is suggested that the *Chaetetes* biostrome most probably developed in a relatively quiet, shallow, subtidal environment in which there was a good oceanic circulation.

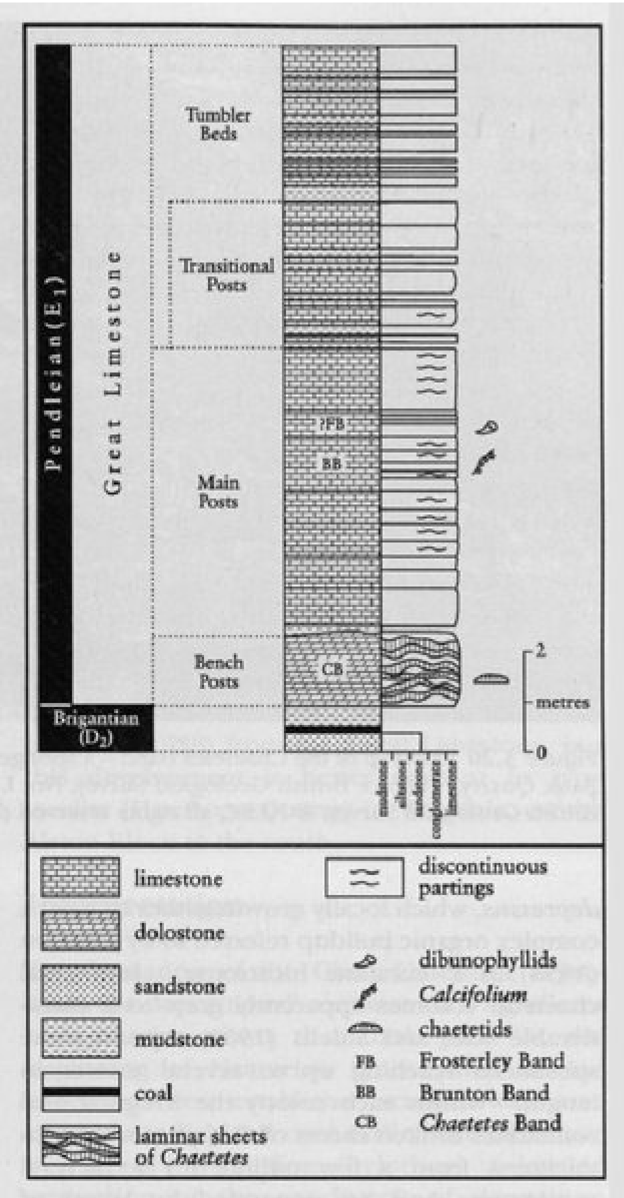
The Great Limestone was originally used to define the base of the Upper Limestone Group in the Tweed Basin (Fowler, 1926), and later to mark the base of the Stainmore Group from the Northumberland Basin across the Alston Block and into the Stainmore Basin (Burgess and Holliday, 1979; Frost and Holliday, 1980; Smith and Holliday, 1991). It is the thickest and most prominent of the Yoredale limestones, and as such it forms one of the most useful lithostratigraphical marker horizons in northern England. Fairbairn (1978, 1980) noted the remarkable lateral continuity of individual beds in the Great Limestone and successfully correlated beds from the northern part of the Alston Block across the Ninety Fathom–Stublick Fault System and into the Northumberland Basin. Unsurprisingly, therefore, the sequence at Brunton Bank closely resembles that of the Great Limestone at Greenleighton Quarry, where goniatite evidence was used by Johnson *et al.* (1962) to establish an E_{1a} (basal Pendleian) age for the unit. The discovery of '*Eumorphoceras*' in the Black Pasture

(Sandstone) overlying the Great Limestone at Brunton Bank substantiates this view (Johnson, 1986).

Conclusions

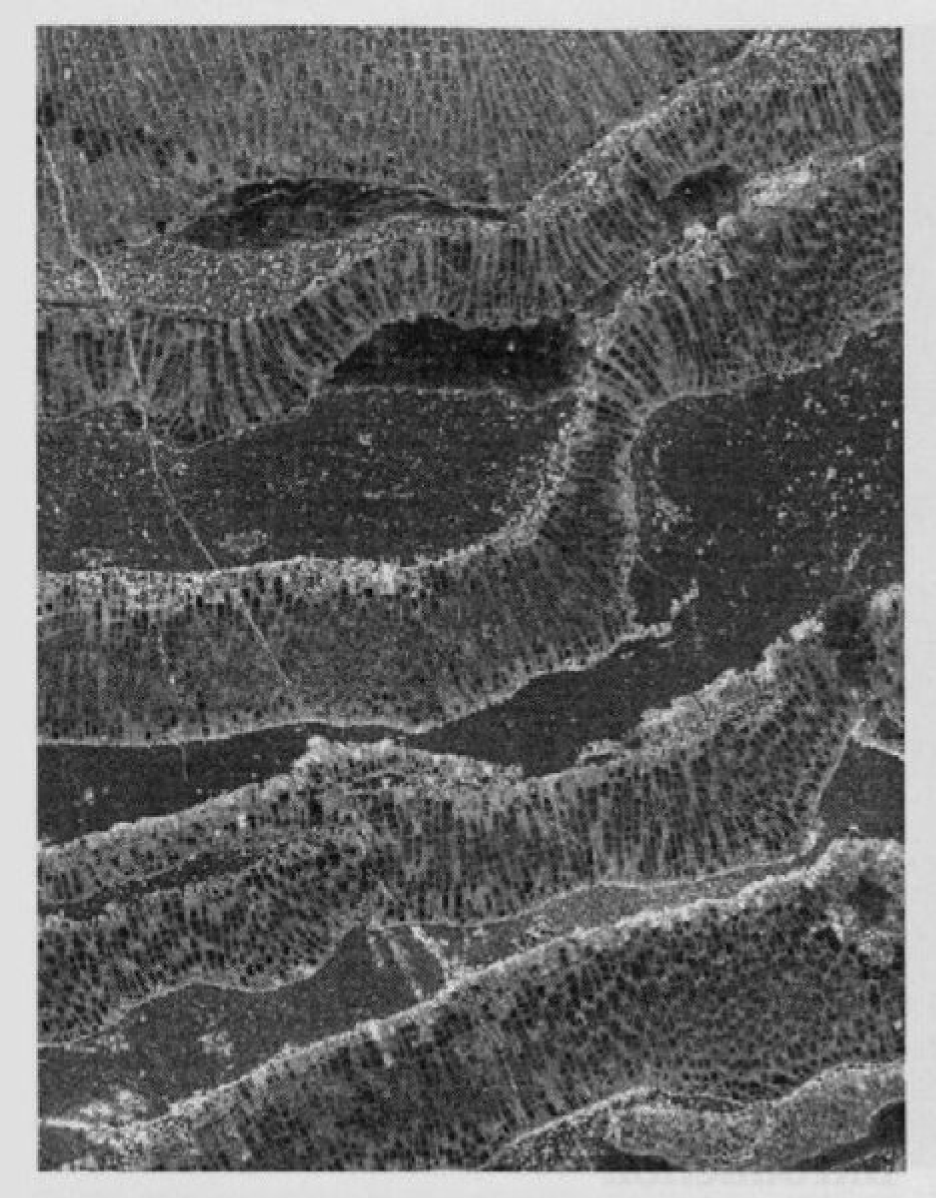
The Brunton Bank Quarry GCR site provides the best available exposure of sponge biostromes and algal limestones in the Great Limestone. As the type locality for the Brunton Band, the Chaetetes Band and a number of spectacularly well-preserved fossils, Brunton Bank Quarry is one of the most important palaeontological sites of Lower Carboniferous age in the north of England. The poor understanding of the depositional environments represented by the Great Limestone and the lack of knowledge concerning the ecology and development of sponge biostromes in the Carboniferous Period means that this site has great potential for future research, particularly in the fields of sedimentology and palaeoecology.

References



(Figure 3.19) Sedimentary log of the Great Limestone (Pendleian) succession in Brunton Bank Quarry illustrating the position of key biostromar developments referred to in the text. Compilation based on information in Johnson (1958), Fairbairn (1980) and Frost and Holliday (1980).

(Figure 3.20) Outcrop of the Chaetetes Band — a sponge bioherm at the base of the Great Limestone in Brunton Bank Quarry (Photo: British Geological Survey, No. L1551, reproduced with the permission of the Director, British Geological Survey, © NERC, all rights reserved (IPR/19–39C).)



(Figure 3.21) Laminar sheets of C. depressus separated by irregular bands of dolomitized sediment associated with geopetal fabrics, from the Chaetetes biostrome at Brunton Bank Quarry. Negative print of stained acetate peel (x 3.9). (Photo: P.J. Cossey.)