Gill Beck

Highlights

Gill Beck is the international stratotype for the boundary between the Arnsbergian and Chokierian stages, and is effectively the standard for the Mid-Carboniferous boundary in Europe (Figure 2.1).

Introduction

This is a stream section (also known as Stonehead Beck) west of Stone head Lane, 2 km west of Cowling, North Yorkshire [SD 957 433]. It lies in the southern part of the Craven Basin and is the boundary stratotype for the base of the Chokierian Stage. Exposure is generally good, although the actual level of the boundary was until recently obscured. This was remedied by the excavation of a trench for the 1981 visit by the SCCS, dug as part of the GCR Unit's site cleaning programme. Goniatites have been known from here since the early part of the century (Hind, 1918; Bisat, 1924), and the field geology described by Earp *et al.* (1961), Riley *in* Ramsbottom (1981) and Riley *et al.* (1987).

Description

Lithostratigraphy

The exposed sequence here is about 56 m of Sabden Shales, which is a mainly argillaceous formation between the Warley Wise Grit and Cobden Sandstone (Figure 2.2). The lower 20 m of the outcrop are mainly blue-grey mudstones, with occasional black mudstones containing concretions. Above this, the mudstones become more consistently black or very dark grey, with thin ribs of ferruginous limestone.

Biostratigraphy

Marine bands

Nine marine bands have been identified in this sequence, and referred to as bands 1–9 by Ramsbottom (1981); Band 4 is further subdivided into Beds T1–T13. Bands 1 and 3 contain abundant goniatites of the *Nuculoceras nuculum* Zone, including *N. nuculum* Bisat, *Kazakhoceras hawkinsi* (Moore), *Eumorphoceras beta* (Riley) and *Fayettevillea darwenensis* (Moore), which indicates that they are the Nuculum Marine Bands in the upper Arnsbergian (Riley, 1987; Riley *et al.,* 1987). The exposure of Band 1 here is the type locality for *N nuculum.*

The lowest of the ferruginous limestones (bed T1) marks a major biostratigraphical change, with the extinction of the *N. nuculum* Zone assemblages and the appearance of goniatites belonging to the *Isohomoceras subglobosum* Zone. This lowest limestone has only yielded the bivalve *Caneyella semisulcata* (Hind) together with gastropod spat. Riley *et al.* (1987) claim that this bivalve is normally associated with *L subglobosum* (Bisat), and indeed this association occurs in bed T5, *c.*1 m higher up the section. For this reason, they place the base of the *I. subglobosum* Zone at T1. Bed 4 of Ramsbottom (1981) evidently equated to the lower Subglobosum Marine Band. The overlying three marine bands (numbers 5–7) also include assemblages diagnostic of the *I. subglobosum* Zone; beds 5 and 7 are the Middle and Upper Subglobosum Marine Bands. This is the type locality for *I. subglobosum,* which along with *N. nuculum,* and *F. darwenensis* have recently been re-described by Riley (1987).

The upper part of the succession sees another biostratigraphical change, with the introduction of assemblages of the *Homoceras beyrichianum* Zone, indicating the Beyrichianum Marine Band in the upper Chokierian. The band 8 assemblage is particularly diagnostic, including *H. beyrichianum* (Haugh), *Metadimorphoceras* and *Caneyella.*

Conodonts

Riley *et al.* (1987) and Varker *et al.* (1991) record conodonts from 12 horizons in this section, and a number of biostratigraphically sensitive forms were noted. From the lower Nodosum Marine Band, Riley *et al.* record an assemblage of 170 specimens, which is diagnostic of the *Gnathodus bilineatus bollandensis* Zone of Higgins (1985). The Middle and Upper Nodosum Marine Bands also yield assemblages probably belonging to that zone, although they were significantly less diverse.

Two samples either side of the Lower Subglobosum Marine Band provided assemblages consisting exclusively of *Rhachistognathodus minutus* Dunn. Higgins (1975) placed such assemblages in a separate zone of the same name, but they have been subsequently included within the *G. bilineatus bollandensis* Zone (Higgins, 1985). The biostratigraphical significance of this platform conodont has been the subject of some debate (e.g. Lane and Baesemann, 1982; Baesemann and Lane, 1985; Lane *et al.,* 1985b). However, Riley *et al.* (1987) have concluded that, at least in NW Europe, its taxonomy and distribution are still inadequately understood for any emphasis yet to be placed on it.

From 0.4 m below the Middle Subglobosum Marine Band, a major change occurs in the conodonts, marking the base of the *Declinognathodus noduliferus* Zone. In particular, there is the appearance of *Declinognathodus inaequalis* (Higgins), which Higgins (1985) claims to characterize the base of the zone. A further five closely spaced samples between this level and the Beyrichianum Marine Band yielded similar assemblages (a sixth proved barren), although they also see the appearance of *Declinognathodus noduliferus* (Ellison and Graves), typical of slightly higher levels in the zone.

Palynology

Being a relatively deep water sequence, miospores are neither abundant nor diverse here. Ramsbottom (1981) and Riley *et al.* (1987) list the species found at 22 horizons in both the Arnsbergian and Chokierian parts of this section. They all belong to the *Lycospora subtriquetra–Kraeuselisporites ornatus* Zone, which ranges from mid-Arnsbergian to the top of the Alportian. The presence of *Cirratriradites rarus* (Ibrahim) Schopf *et al.* throughout the sequence suggests that it is some distance above the base of the zone. There is no marked change in the palynomorphs across the Arnsbergian–Chokierian boundary here, which is consistent with observations elsewhere in northern Britain (Owens, 1982).

Chronostratigraphy

The base of the Chokierian Stage is defined at 'the base of the first marine band above the barren beds which overlie the highest *Nuculoceras nuculum* band of Arnsbergian age' (Ramsbottom, 1981). This is the marine band no. 4. According to Riley *et al.* (1987), the Mid-Carboniferous boundary occurs (and could perhaps be defined at) just below Band 5, which sees the base of the *Declinognathodus noduliferus* conodont zone.

Interpretation

In the classification introduced by Bisat (1924), strata belonging to the E_2, H_1 and H_2 zones were referred to the Sabdenian Stage, but this proved too large an interval for detailed stratigraphical

Hudson and Cotton (1943) proposed that the stage should be restricted to the H_1 and H_2 zones. However, Hodson (1957) argued that this did not really solve the problem and proposed a totally new classification, in which the H_1 zone was referred to the Chokierian Stage.

The stage was named after a famous ammonoid locality in Belgium, but when a search was undertaken for a Belgian locality to act as a boundary stratotype for the base of the stage, nowhere suitable could be found (van Leckwijck, 1964). Ramsbottom (1969b) proposed the River Darwen site (see below) as an alternative, but the critical part of the section there is not particularly well endowed with marine bands and is now poorly exposed. It was therefore proposed to take Gill Beck as the stratotype (Ramsbottom, 1981).

The marine band containing *Isohomoceras subglobosum,* which marks the base of the Chokierian, is not present in all of the British Namurian sequences. In the Culm Trough, it is probably present along the Crackington Coast (see Chapter 3).

In South Wales, it is well developed on the south crop, such as at Barland Common (see Chapter 4), but is only patchily developed on the north crop. It is best known in the Craven and Pennine basins, where there are numerous outcrops (including the present one). On the Askrigg and Alston blocks and in Scotland, however, it appears to be totally absent.

Gill Beck has also been proposed as the stratotype for the Mid-Carboniferous boundary (Riley *et al.,* 1987), which is intended to provide a globally-applicable datum line. The main criterion to be used for placing the boundary is the level of the base of the *Declinognathodus noduliferus* conodont zone (Lane *et al.,* 1985b). On currently published evidence, therefore, the Mid-Carboniferous boundary would be located 0.4 m below Band 5, or 9.4 m above the base of the Chokierian.

The main alternative contender as stratotype for the Mid-Carboniferous boundary is at Arrow Canyon in Nevada, USA (Lane *et al.,* 1985a). This sequence is in a carbonate shelf setting and, not surprisingly perhaps, there are discrepancies in the ranges of the conodonts compared with the clastic sequences in Britain. This has led to a debate as to whether there is a significant gap in the British or the Nevada sequences at the level of the Mid-Carboniferous boundary (compare Lane and Baesemann, 1982, fig. 3 and Riley *et al.,* 1987, fig. 7), which will obviously be important when the stratotype comes to be selected. The argument essentially revolves around the reliability of the refined ammonoid biostratigraphy that has been developed for the European clastic shelf sequences, and whether it provides a robust framework against which to plot the conodont ranges. If the ammonoid scheme is deemed robust, then a gap in the British sequences is difficult to accept, since a similar gap would have to be present throughout Europe, as far east as the Urals. On the other hand, there is little palaeontological or sedimentological evidence of a major gap in the Arrow Canyon sequence. The SCCS working group on the boundary is still investigating the matter but, what ever the outcome, Gill Beck will be an important site for identifying the boundary, if only in a regional context.

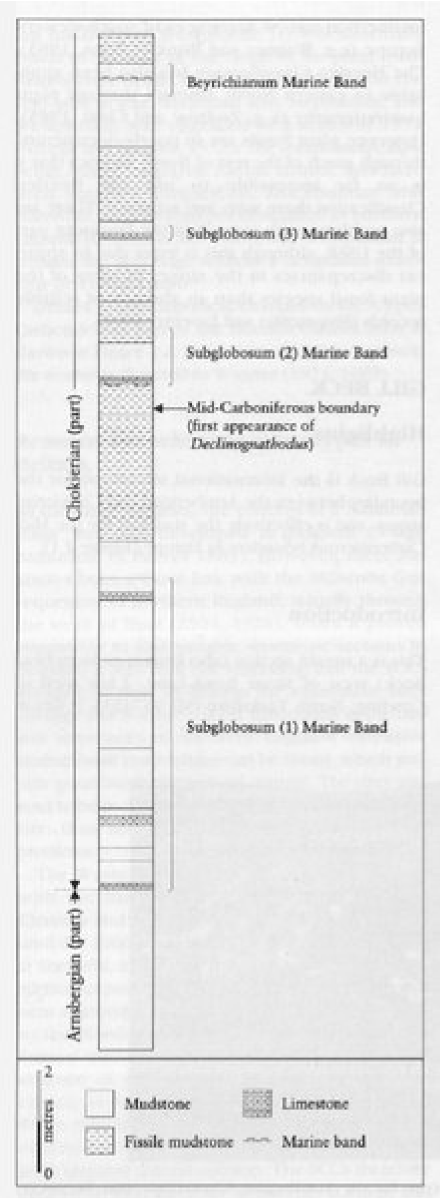
Conclusions

Gill Beck is an internationally recognized standard for defining a time plane 322 million years before the present, and which is taken as the start of the Chokierian Age. It is also taken as the start of the Late Carboniferous Subperiod.

References

(Figure 2.1) Gill Beck GCR site. International stratotype for the Arnsbergian–Chokierian stage boundary. Photographed during the visit to the site by the IUGS Subcommission on Carboniferous Stratigraphy, August 1981. (Photo: W.A.

Wimbledon.)



(Figure 2.2) Log of section at Gill Beck. Based on Riley et al. (1987, fig. 2).