Doe Lea

Highlights

Doe Lea is the international stratotype for the base of the Bolsovian (Westphalian C *auct.*) Stage.

Introduction

This small exposure [SK 460 692] lies below a weir on the River Doe Lea, 2 km south-west of Bolsover, Derbyshire. It is in the northern part of the Notts–Derbyshire Coalfield, and is thus in the middle of the Pennine Basin. The only published descriptions of the geology are by Owens *et al.* (1985) and Riley *et al.* (1985), when it was being proposed as the stratotype for the Duckmantian–Bolsovian boundary.

Description

Lithostratigraphy

The exposed sequence here is less than 2 m thick (Figure 2.12). It consists of 55 cm of seat earth overlain by a 25 cm thick coal, which in turn is overlain by about 1 m of mudstones. Part of the mudstone has been replaced by ankerite (a cal-cium/ferrous/manganese carbonate) known locally as 'calk'.

Biostratigraphy

Marine band

A diverse assemblage of marine fossils occurs in the mudstones overlying the coal. Ammonoids are particularly abundant, and Owens *et al.* (1985) have recorded *Donetzoceras aegiranurn* (Schmidt), *Metacoceras costatum* (Hind) and *cf. Peripetoceras dubium* (Hind). In addition, there are bivalves (*Dunbarella, Pterinopecten, Aviculopecten, Posidonia*), inarticulate brachiopods and ostracods. This is clearly indicative of the Aegiranum Marine Band in the classification introduced by Ramsbottom *et al.* (1978).

Conodonts

Owens *et al.* (1985) and Riley *et al.* (1985) list a number of species from this exposure of the Aegiranum Marine Band, belonging to the genera *Idiognathoides, Declinognathodus, Hindeodella* and *Ligonodina.* Of interest is the presence of *Neognathodus kanumai* (Igo), previously described from beds thought to be equivalent to the lower Westphalian of Japan. Otherwise, however, the rest of the assemblage consists of elements described by Higgins (1975) from lower stratigraphical levels in Britain.

Palynology

Riley *et al.* (1985) record numerous palynomorphs from eleven levels within the section. In most biostratigraphical schemes (e.g. Smith and Butterworth, 1967; Clayton *et al,* 1977; Owens, 1984), the Duckmantian–Bolsovian boundary does not coincide with a biozonal boundary. The evidence from Doe Lea seems to corroborate this; what changes that can be seen seem to be controlled by the ecological changes between swamp and marine conditions.

Chronostratigraphy

The base of the Bolsovian Stage is defined at this site at the base of the Aegiranum Marine Band, which is 3 cm above the coal seam exposed here (Owens *et al.,* 1985).

Interpretation

The Westphalian C was originally the top unit in the tripartite division of the Westphalian Stage, as outlined by Jongmans (1928). Shortly after, its range was restricted by the recognition of a 'fourth substage (Westphalian D). This was for the upper part of the original Westphalian C, and representing strata thought not to be well developed in the classic paralic coalfields (e.g. Notts–Derbyshire, Nord-Pas-de-Calais, Ruhr). The redefined Westphalian C was subsequently raised in rank to a stage (George and Wagner, 1972) and renamed the Bolsovian (Owens *et al.,* 1985).

The Aegiranum Marine Band marks the base of the Bolsovian. The marine band is widespread and readily identified in the classic European paralic coalfields, and so the stage boundary can usually be identified easily in these areas. Unlike the marine bands used for the base of the Langsettian and Duckmantian, however, the Aegiranum Marine Band does not coincide with any significant changes in plant fossils (macro- or micro-) or non-marine animal fossils (although it is characterized by an influx of planktonic marine acritarchs). Consequently, it is very difficult to identify the stage boundary outside of the European paralic coalfields. Bouroz *et al.* (1969) proposed that the boundary should be moved to a higher level, corresponding to the Cambriense Marine Band. This caused considerable discussion (recorded by George and Wagner, 1969, 1970, 1972) as to whether or not particular marine bands could be located in the Ruhr or Nord-Pas-de-Calais coalfields. The 1971 report by the SCCS working group on this boundary (Bless *et al.,* 1972) eventually decided to retain the Aegiranum Marine Band as the marker horizon. However, the working group had only considered evidence from the European paralic coalfields plus the Saar–Lorraine basin, and ignored (what is the real crux of the matter) the identification of the boundary in other areas. Furthermore, much of those areas where the boundary can be accurately located is now inaccessible, as there are no natural outcrops and much of the mining activity has ceased. For better or worse, however, the SCCS has accepted their working group's proposal, and the base of the Bolsovian is retained at the Aegiranum Marine Band.

One of the few good things to come out of this debate is the recognition that both the Ruhr and Nord-Pas-de-Calais coalfields were totally unsuitable to act as a stratotype for the base of the Bolsovian. A search for a candidate site was first made in South Wales, but was soon after switched to the Pennine Basin. At the 1971 SCCS meeting, two candidates were put forward: Wales Railway Cutting in Derbyshire and Stairfoot Brickpit in South Yorkshire (George and Wagner, 1972). Despite being designated an SSSI, the railway cutting was shortly afterwards infilled and so, by default, the brickworks became the nominated site (Calver and Owens, 1977). This was far from satisfactory, however, as there were conservation problems (it was still being actively worked for brick-clay) and it did not yield a particularly diverse marine fossil assemblage (Ramsbottom, 1981). In the early 1980s, a previously unknown exposure at Doe Lea seemed to offer a solution to these problems; although it was only a small outcrop, it yielded a much more diverse fossil assemblage and should have been much easier to conserve. However, a matter of only a few weeks after the SCCS 1983 decision to accept it as the stratotype (Manger, 1985), the Doe Lea exposure was covered by a new weir, constructed to control erosion. Fortunately, the weir only just extended over the outcrop and it proved possible to excavate a new exposure a few metres downstream from the original site (Anon. 1987).

The Aegiranum Marine Band is very widely distributed, having been identified in most coalfields in Britain (Ramsbottom *et al.,* 1978). The similarity between the fossils found in the band in South Wales and the Pennine Basin suggests that the St George's Landmass was not a major obstacle to faunal migration by this time and may have been at least two separate islands (Bless and Winkler Prins, 1972). One of the best British exposures was at Aberbaiden in South Wales (Ramsbottom, 1952), but the site has unfortunately been destroyed. Otherwise, the known exposures of this marine band in southern Britain have yielded assemblages of relatively low diversity. In the Pennine Basin, more diverse assemblages have been reported (Calver, 1968), but mainly from underground workings or temporary exposures; the Doe Lea site is one of the few to provide permanent outcrop and diversity of assemblage (see also Eyemore Railway Cutting — Chapter 7). In Scotland, where it is known as the Skipsey's Marine Band, there are a number of exposures, but they have less diverse assemblages (Currie *et al.,* 1937; Bless and Winkler Prins, 1972).

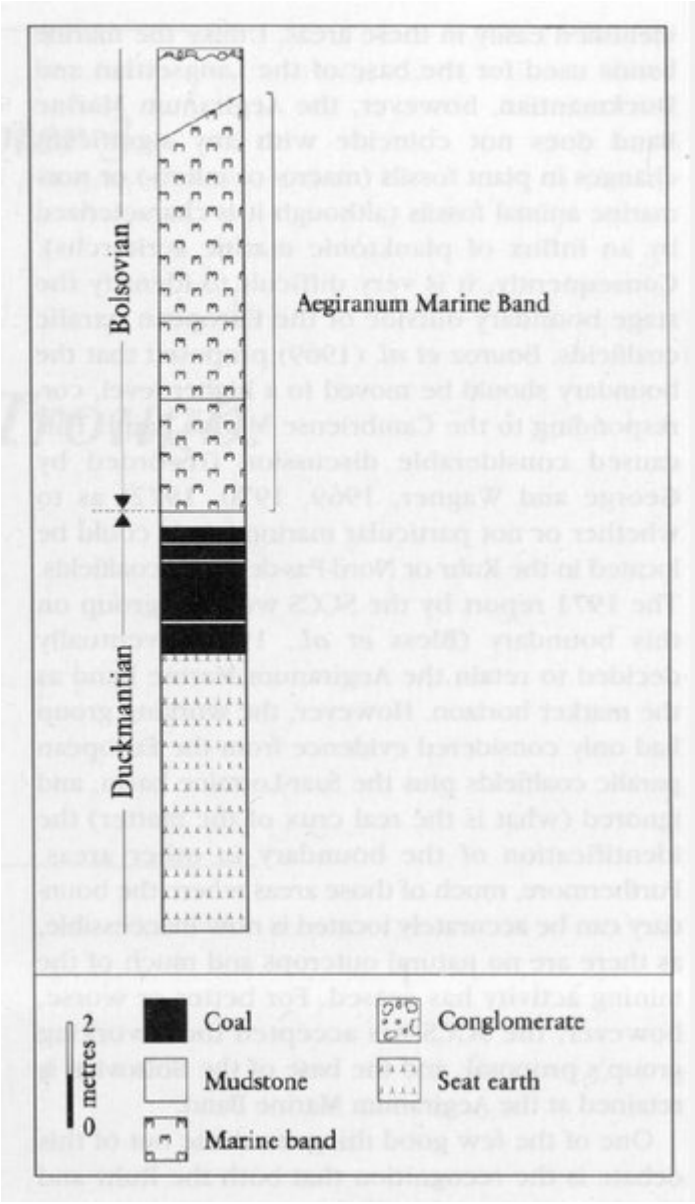
In northern Europe, this marine band is widely known in the paralic coalfields between the Pas-de-Calais and the Ruhr (Bless and Winkler Prins, 1972), although always in underground or temporary workings. Unlike the Vanderbeckei Marine Band, however, it has not yet been identified further east in Poland (Musia *et al.,* 1983). The hope that similar

assemblages might be identifiable in the fully marine sequences in Russia (Bless *et al.,* 1972) has not been fulfilled (see Wagner and Bowman, 1983 for an account of some of the problems involved).

Conclusion

Doe Lea is an internationally recognized standard for defining a time plane, 311 million years before the present, and marking the start of the Bolsovian Age.

References



(Figure 2.12) Log of section at Doe Lea. Based on Owens et al. (1985, fig. 4).