Penton Linns, Dumfries and Galloway–Cumbria

[NY 431 772]–[NY 437 774]

Introduction

Situated to the south-east of Langholm on the border between England and Scotland, the gorge at Penton Linns, Liddel Water [NY 431 772]–[NY 437 774] provides one of the finest inland sections of the Upper Liddesdale Group (Brigantian) in the Northumberland Trough. The section is also renowned for the high quality of the preservation of its crinoid faunas. Peach and Horne (1903) included some information on the site in their account of the structure of the Canonbie Coalfield. The Langholm and Bewcastle memoirs (Lumsden *et al.,* 1967; Day, 1970) include details of the section and Monro (in Stone, 1996) has written an excursion guide to the locality. The site is most accessible from its northern side.

Description

At Penton Linns, the Liddel Water has eroded a course across an asymmetrical anticlinal structure and exposed an excellent, fault-bounded section containing 130 m of strata belonging to the central part of the Upper Liddesdale Group. The succession, which is of 'Yoredale' type, extends from the Penton Limestone at the base, to the sandstones overlying the Harelawhill Limestone at the top. A simplified log of the exposed section, based on information in Lumsden *et al.* (1967) and Day (1970), is presented in (Figure 3.33). Extensive faunal records from the section are also recorded by Day (1970). In the core of the anticline the upper parts (6.7 m) of the Penton Limestone are exposed as beds of limestone with calcareous shale partings. The limestone contains patches of *Girvanella,* and near its top, Zoophycos*, Gigantoproductus* and large solitary corals (including *Aulophyllum pachyendothecum, Clisiophyllum* and *Dibunophyllum bipartitum*) occur. Gastropods, bivalves and colonial corals (*Siphonodendron junceum, Diphyphyllum* cf *lateseptatum*) are also found in this unit. The clastic parts of this cycle (12.8 m) consist of mudstones passing up into siltstones, silty sandstone and a rooty sandstone capped by a thin coal seam (0.07 m).

Above this, 1.5 m of calcareous shale with gigantoproductids and broken shell fragments pass up into the poorly fossiliferous Bridge Limestone (3.7 m), which contains large crinoid stem fragments, corals (*S. pauciradiale*)*, Zoophycos* and some brachiopods and bivalves. From the interval between the Penton Limestone and Bridge Limestone, Day (1970) also recorded *Dibunophyllum* c.f. *bourtonense.* The calcareous shales overlying the Bridge Limestone (2.0 m) are rich in brachiopods, bryozoans and bivalves. These are overlain by a thick sandstone (9.6 m) which passes up into a rooty seatearth with a thin coal seam (0.05 m) on top. Above this, a calcareous sandstone (1.8 m) with roots and a few fossils has been interpreted as a decalcified limestone. This interpretation is based upon the correlation of strata from the nearby Archerbeck Borehole where a limestone is present at this level (Lumsden *et al.,* 1967). A thin (3.0 m) sequence of mudstones and sandstones occurs between this sandstone and the Rhynchonellid Sandstone, another rooty sandstone, containing brachiopod fragments in which the eponymous form is particularly well represented. This is immediately overlain by the crinoidal, dolomitic Linns Limestone (4.3 m), which has a red-stained iron-rich upper surface. The clastic components of this cyclothem are mudstones, sandstones and seatearths (5.8 m) with three thin coal seams (the Kilnholm Coals).

The Tombstone Limestone, which is the marine unit of the next cycle, consists of sparsely crinoidal and bioclastic limestone beds with shale partings. The limestone gets its name from the well-developed jointing pattern which divides the posts up into rectangular slabs. The overlying shales with ironstone nodules (7.0 m) contain a prolific fauna of brachiopods, bivalves and gastropods, and both Lumsden *et al.,* (1967) and Day (1970) have drawn attention to the presence here of the stratigraphically useful bivalve *Posidonia becheri.* The mudstones pass up into a sandstone (3.7 m). Above this, a thin (1.2 m), unnamed limestone with a red-stained upper surface contains *S. pauciradiale.* The overlying shales contain an abundant and diverse fauna including *Microcyathus cyclostomus, Edmondia pentonensis, Posidonia becheri* and *Beyrichoceratoides truncatum?* (Lumsden *et al.,* 1967; Day, 1970). These shales (1.7 m) are overlain by sandstones and siltstones (8.2 m) with three thin coal seams. Resting on these beds are the mudstones (1.4 m) that

underlie the Gastropod Limestone.

The Gastropod Limestone (5.1 m) is bedded with calcareous shale partings. It contains a fauna of crinoid columnals, brachiopods, molluscs and trilobites but its most characteristic feature, from which it gets its name, is a bed at the top of the unit which is rich in poorly preserved pleurotomariid gastropods (Lumsden *et al.,* 1967). Sandstones, in places rooty and capped by a thin coal seam (4.6 m), lie between the Gastropod Limestone and the Harelawhill Limestone. This latter limestone is the thickest limestone in the sequence (9.6 m). Faunas from it include gastropods, bivalves and trepostomous bryozoans. It also includes a thick (1.0 m) calcareous shale parting, with productoid and spiriferoid brachiopods, and large crinoid columnals, 1.3 m above the base. Towards the top of the limestone there are several bands of chert nodules. Colonies of *S. funceum in* the limestone are the highest records for this species in the local sequence. The roof shales (1.0 m) of the limestone are rich in productoid and spiriferoid brachiopods, but also contain crinoids, trilobites, bivalves, gastropods and cephalopods (Peach and Horne, 1903; Lumsden *et al.,* 1967). It was in these shales that Wright (1924, 1936) collected a large number of more-or-less complete crinoids and, probably also, the type material of the gastropod *Euphemites pentonensis* (Weir, 1931). The shales pass up into siltstones and silty mudstones with ironstone nodules (17.1 m) which include, about 3 m above their base, a 1.5 m limestone band with patches of *Saccaminopsis fusulinaformis.* Marine fossils are also common in the shales immediately above the limestone. The section is completed by a thick, fine-grained sandstone (7.3 m). Further details of the fauna from beds above the Harelawhill Limestone are reported by Day (1970).

Interpretation

The Penton Linns section provides a vital exposure of a sequence through part of the Upper Liddesdale Group (Brigantian), which is otherwise poorly exposed and best known from the nearby Archerbeck Borehole. Correlations by Day (1970) have equated the Penton Limestone, Bridge Limestone, Linns Limestone, Tombstone Limestone, Gastropod Limestone and Harelaw-hill Limestone with, respectively, the Greengate Well Limestone, Jew Limestone, Tyne Bottom Limestone, Single Post (= Lower and Upper Bath-House Wood) Limestone, Scar Limestone and 5 Yard Limestone recorded elsewhere. However, some of these correlations appear to be contradicted by work in other areas (see Tipalt Burn site report, this chapter, and (Figure 3.5), (Figure 3.18) and (Figure 3.30) for further details). The cyclicity developed in the Upper Liddesdale Group provides evidence of rapid palaeogeographical changes with marine conditions, in which calcareous shales and limestones were deposited, alternating with delta-front and delta-top conditions, in which coarsening-upward terrigenous clastic units were deposited. These are often capped by rooty seatearth or ganister beds and thin coal seams, which represent fossil soils.

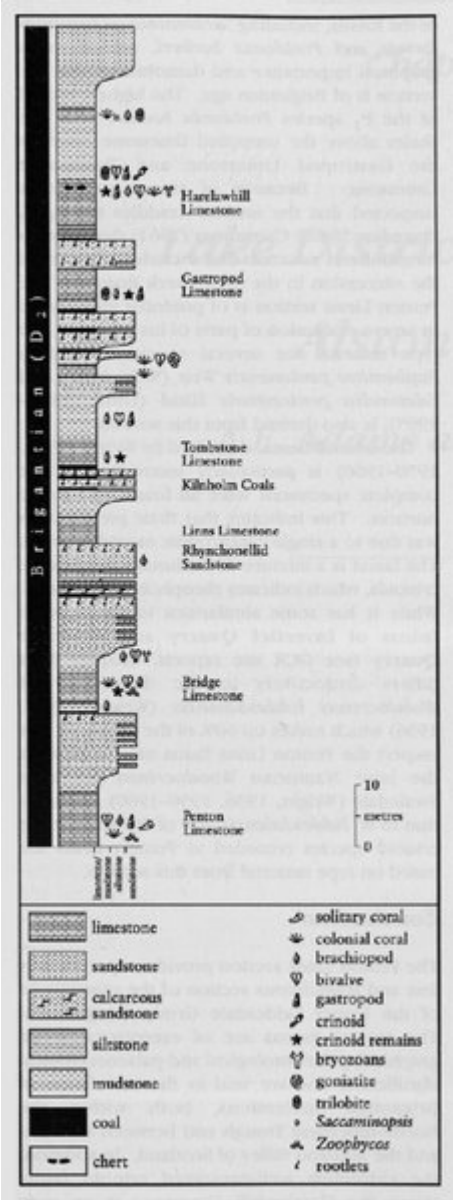
The different marine horizons have a variable and sometimes distinctive fossil content. Some of the fossils, including *Saccaminopsis fusulinaformis* and *Posidonia becheri,* are of stratigraphical importance and demonstrate that the section is of Brigantian age. The highest record of the P_1 species *Posidonia becheri* is in the shales above the unnamed limestone between the Gastropod Limestone and Tombstone Limestone. Because of this record It is suspected that the section straddles the P_1–P_2 boundary. Since Cummings (1961) developed a foraminiferal zonation that included this part of the succession in the Archerbeck Borehole, the Penton Linns section is of potential importance in any re-evaluation of parts of his scheme. The type material for several species, including *Euphemites pentonensis* Weir (Weir, 1931) and *Edmondia pentonensis* Hind (Hind, 18961905), is also derived from this section.

The crinoid fauna, described by Wright (1924, 1950–1960) is particularly interesting as the complete specimens were all found at a single horizon. This indicates that their preservation was due to a single catastrophic mortality event. The fauna is a mixture of inadunate and flexible crinoids, which indicates rheophobic tendencies. While it has some similarities to the Scottish faunas of Invertiel Quarry and Roscobie Quarry (see GCR site reports, Chapter 2) it differs distinctively in the dominance of *Woodocrinus liddesdalensis* (Wright, 1924, 1936) which makes up 60% of the fauna. In this respect the Penton Linns fauna most resembles the later Namurian *Woodocrinus fauna* of Swaledale (Wright, 1936, 1950–1960). In addition to *W. liddesdalensis,* five of the other seven crinoid species recorded at Penton Linns are based on type material from this section.

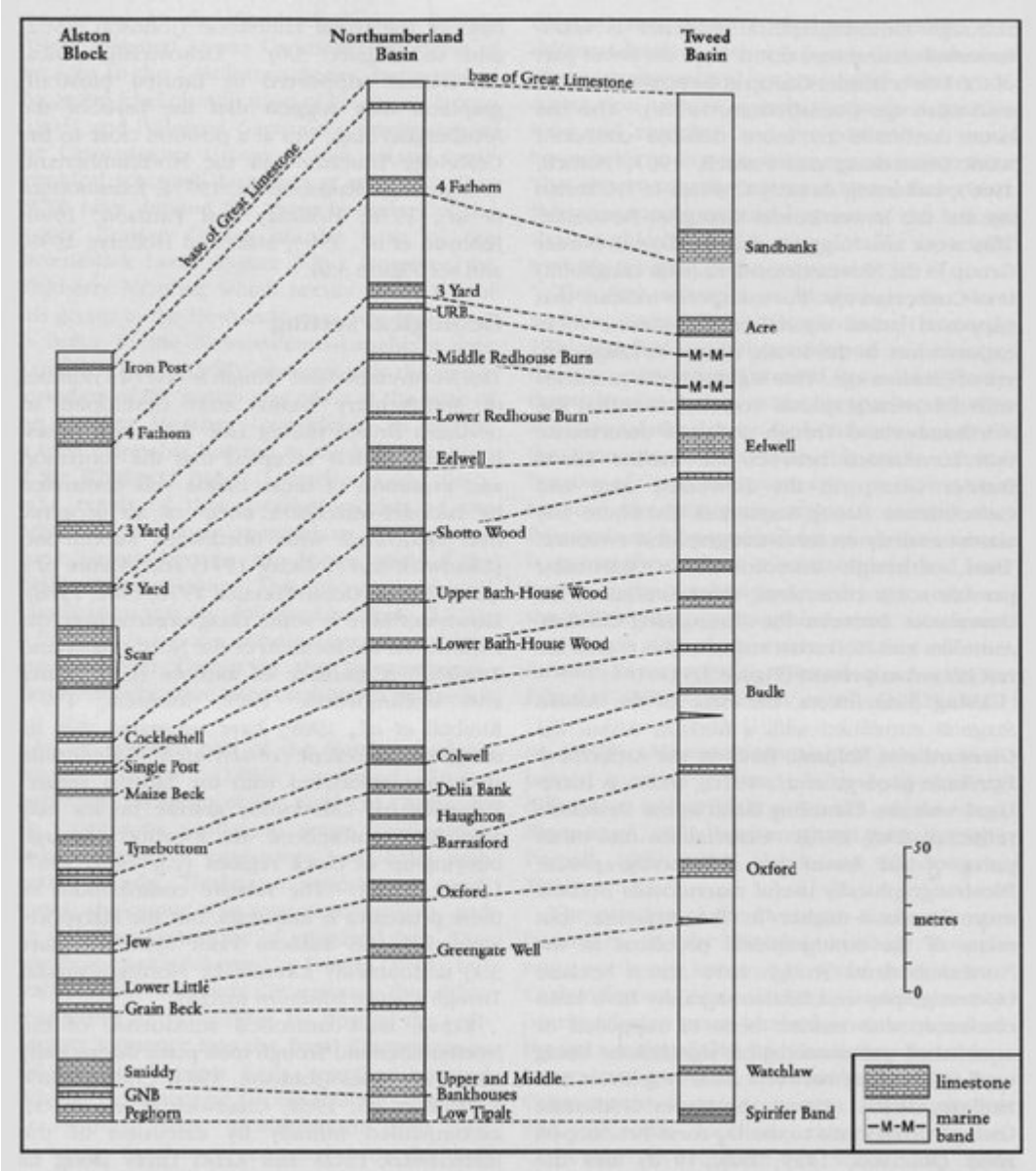
Conclusions

The Penton Linns section provides a particularly fine and fossiliferous section of the central part of the Upper Liddesdale Group (Brigantian). The marine faunas are of exceptional stratigraphical, palaeontological and palaeoecological significance and are vital in the correlation of Brigantian successions, both within the Northumberland Trough and between this area and the Midland Valley of Scotland. In addition, the extremely well-preserved crinoid fauna above the Harelawhill Limestone is an early occurrence of the *Woodocrinus* fauna, and arguably one of the finest examples of its kind in northern England.

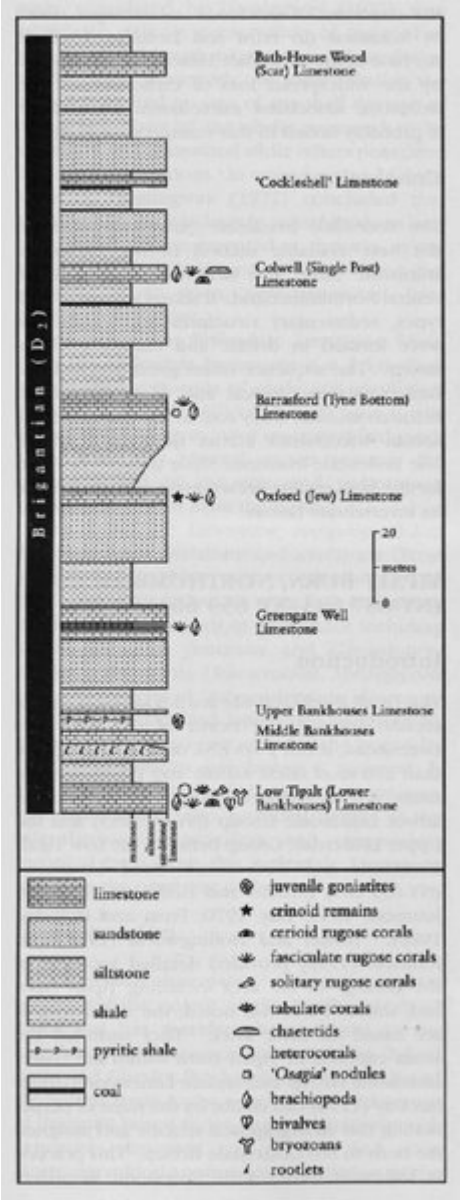
References



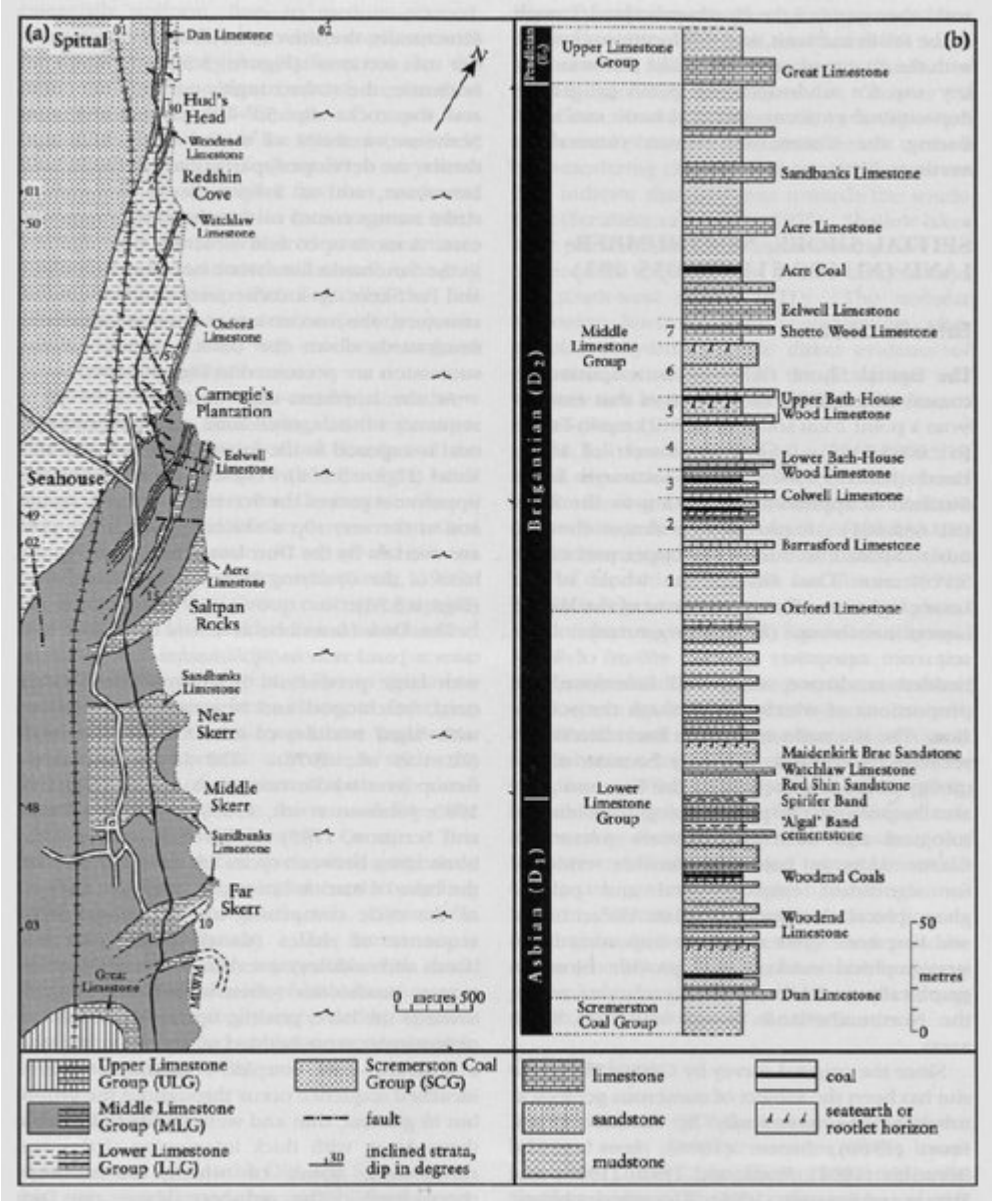
(Figure 3.33) Simplified stratigraphical log of the Upper Liddesdale Group (Brigantian) succession at the Penton Linns GCR site, near Langholm. Based on information in Lumsden et al. (1967) and Day (1970).



(Figure 3.5) Stratigraphy of the Upper Liddesdale Group (Brigantian, D_2) limestones from the Alston Block to the Northumberland Basin and the Tweed Basin. (GNB — Girvanella Nodular Bed; URB — Upper Redhouse Burn.) After Frost and Holiday (1980).



(Figure 3.18) Section of the Upper Liddesdale Group (Brigantian) succession in Tipalt Burn. After information in Johnson (1959). Limestone names follow the nomenclature used by Day (1970) and Frost and Holliday (1980), while the names in parentheses are those used by Trotter and Hollingworth (1932) and Johnson (1959). See text for discussion of the problems associated with the naming and correlation of these limestone marker beds.



(Figure 3.30) (a) Simplified geological map and (b) section of Lower Carboniferous Lower Limestone Group to Middle Limestone Group strata exposed at the Spittal Shore GCR site, Berwick-upon-Tweed (details of the Scremerston Coal Group and Upper Limestone Group omitted). After Turner and Scrutton (1995), with additional section details from Frost (1969) and Reynolds (1992). Numbers in (b) relate to cyclothemic sedimentary cycles identified in the Middle Limestone Group beds by Reynolds (1992).