Trowbarrow Quarry, Lancashire

[SD 480 758]

Introduction

Trowbarrow Quarry near Silverdale [SD 480 758] is one of the most spectacular exposures of Carboniferous Limestone in northern England. Over 150 m of rock is exposed, including the whole of the Urswick Limestone (Asbian) and the base of the overlying Gleaston Formation (Brigantian). The diversity of limestone lithologies, including features indicative of subaerial exposure, are beautifully displayed.

The site is also well known for its abundant fauna and flora, including a particularly rich microfossil assemblage. Elements of the site geology were first recorded by Garwood (1913). More recent work of significance includes the sedimentological work of Horbury (1987, 1989) and the biostratigraphical studies of Strank (1981) and Athersuch and Strank (1989).

Description

The succession at Trowbarrow is affected by the Silverdale Disturbance and bedding is close to vertical throughout the quarry (Figure 4.11). Garwood (1913) recognized that the exposure mostly lay in the D_1 Zone and appears to have interpreted the succession as younging to the west. Biostratigraphical and sedimentological evidence (Strank, 1981; Horbury, 1987; Athersuch and Strank, 1989) has since confirmed that the succession youngs eastwards. The quarry displays a complete section of the late Asbian Upper Urswick Limestone and the base of the Brigantian Gleaston Formation. The early Asbian Lower Urswick Limestone, including the Woodbine Shale, is less well exposed.

As with all other Asbian shelf limestone successions in Britain, the Trowbarrow sequence is punctuated by emergent surfaces and palaeosol clays. This, together with the repeated occurrence of limestone lithologies defines a marked cyclicity. The most important sedimentological work on the Urswick Limestone, including the section at Trowbarrow, is that of Horbury (1987, 1989) and a summary log based on his work is reproduced in (Figure 4.12). Two major carbonate facies dominate the succession. These comprise bedded, rubbly weathering, argillaceous wackestones and packstones, and thickly bedded, pale-coloured grainstones. 'Pseudobrecciation' (colour mottling) is present at some levels in both facies.

The argillaceous wackestones and packstones frequently contain fossils interpreted as being preserved with little disturbance, including colonial and solitary rugose corals, *Syringopora,* productoid brachiopods and *Straparollus.* Microfossils visible in thin-section include foraminifera, sponge spicules, *Saccaminopsis,* bryozoans, and algae such as *Coelosporella, Stacheoides, Kamaena* and *Kamaenella.* The rubbly appearance sometimes evident results from the weathering of *Thalassinoides* burrows (Horbury, 1987, 1989).

There are few macrofossils in life position in the grainstones, the exceptions being a few colonial corals and local concentrations of brachiopods such as *Davidsonina septosa.* In thin-section there is an abundant microbiota visible, dominated by *Kamaenella,* but *Koninckopora, Ungdarella* and foraminifera are also common. Peloids with some ooids and intraclasts make up the remaining grains.

These two carbonate facies, arranged in couplets, make up the bulk of the visible section (Figure 4.12), but other carbonate lithologies are present. These include thin porcellanous limestones (carbonate mudstones) and stromatolites.

Non-carbonate facies comprise terrigenous clastic mudstones. These include calcareous shales, the most important of which is the 4 m-thick Woodbine Shale close to the top of the Lower Urswick Limestone (Figure 4.12). Garwood (1913) recorded a rich fauna of corals, brachiopods, bivalves, gastropods and nautiloids from this shale and noted that many specimens were compressed. Other terrigenous clastic mudstones include variegated clays which are found overlying

palaeokarstic surfaces. These have been identified as K-bentonites by Horbury (1987, 1989).

Microfossils from the Urswick Limestone at Trowbarrow have been extensively studied for stratigraphical and palaeoecological purposes. Strank (1981) studied foraminifera, and Athersuch and Strank (1989) studied foraminifera and conodonts. They established that the early Asbian–late Asbian boundary lies just above the top of the Woodbine Shale. Strank (1981) provided an extensive list of the foraminifera encountered and noted that, of all the late Asbian sections she had studied, the section at Trowbarrow had the most abundant foraminiferal fauna. Further work on the palaeoecology of Urswick Limestone microbiotas here has been undertaken by Adams *et al.* (1992), White (1992) and Horbury and Adams (1996).

Interpretation

Horbury (1989) interpreted the argillaceous wackestone and packstone facies as a deep-water platform deposit that formed at least below fair-weather wave-base; the grainstone facies as a shallow subtidal to intertidal shoal deposit; and the carbonate mudstones and stromatolites as forming in low-energy intertidal and supratidal environments. The particularly rich and typical Asbian faunas and floras in the sequence (Garwood, 1913; Athersuch and Strank, 1989) may reflect close proximity to the Asbian shelf margin, with a freer exchange of sea water from shallow shelf to open sea, than at localities in the interior of the Lake District carbonate platform.

In common with other shelf sequences of Asbian and early Brigantian age, the succession at Trowbarrow is strongly cyclic, with episodes of subaerial exposure resulting in karstification of limestones beneath palaeosol clays of volcanic origin. The completeness of the Asbian succession at Trowbarrow means that it is particularly valuable for studying how cycle style varies vertically and in comparison with other areas. Horbury (1989) interpreted the succession in terms of the interplay of tectonically controlled shoaling cycles up to 20 m thick, caused by platform down-faulting, and emergence relating to smaller-scale glacio-eustatic cyclicity.

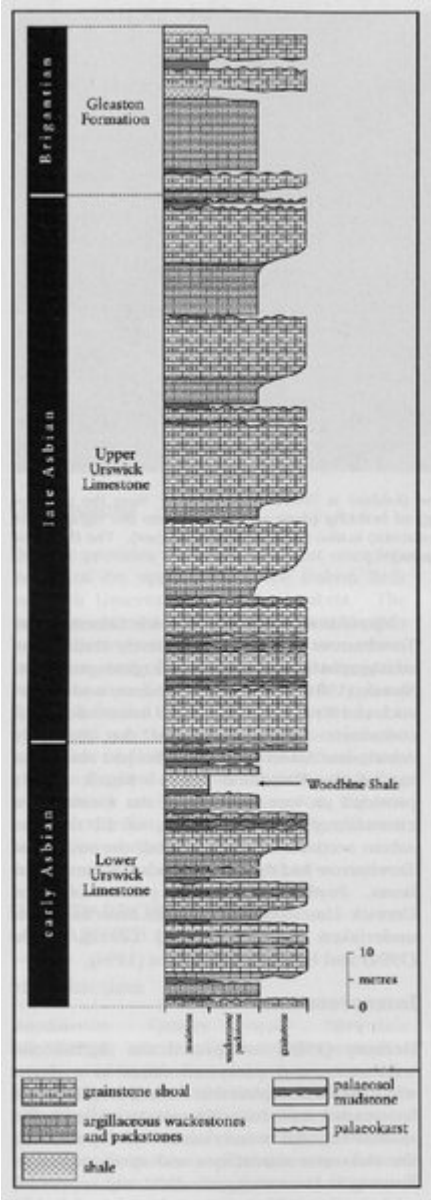
Both the early Asbian and late Asbian strata show an upward increase in the volume of the argillaceous wackestones and packstones (Figure 4.12), indicating that overall the platform was submerged to progressively increasing water depths during each of the two episodes, probably reflecting increased rates of subsidence (Horbury, 1989). The early Asbian–late Asbian boundary is characterized by several phases of emergence, and Horbury (1989) suggested that this resulted from several eustatic cycles operating at a time of little net subsidence.

Conclusions

Trowbarrow is one of the most important shelf limestone localities in northern England. The Asbian Urswick Limestone is exposed in its entirety and the carbonate facies are exceptionally well displayed, together with features indicative of periodic emergence. The site provides valuable evidence of the styles and causes of cyclicity in the Urswick Limestone and contains a rich biota in which the abundant foraminiferal fauna is particularly notable. The effects of the Silverdale Disturbance are also well seen in the quarry.

References

(Figure 4.11) Section of the Upper Urswick Limestone (Asbian) at Trowbarrow Quarry. Note the pseudo-brecciated appearance (possible bioturbation mottling) of bedding plane surfaces seen to the right of the illustration. The younging direction ('way up' of the sequence) is also to the right (to the east). The height of the quarry face is approximately 20 m. (Photo: A.B. Adams.)



(Figure 4.12) Simplified sedimentary log of the Urswick Limestone (Asbian) at Trowbarrow Quarry illustrating the distribution of the principal lithofacies and emergent surfaces. Note that the base of this section also marks the top of the underlying Park Limestone. After Horbury and Adams (1989).