
Pindale Quarry, Derbyshire

[SK 159 823]

Introduction

The Pindale Quarry GCR site [SK 159 823] is a disused quarry 1 km to the east of Castleton (Figure 7.14)a. The exposed section straddles the boundary between the Bee Low Limestones (Asbian) and the Monsal Dale Limestones (Brigantian). It provides an almost perpendicular section through the northern margin of the Derbyshire Platform. Its historical importance lies in the relationships displayed between shelf and shelf-margin limestones which provided critical evidence in reconciling the macrofaunal biostratigraphical schemes of basin and platform carbonate successions. The succession includes numerous erosional surfaces and macrofaunal bands in which solitary and colonial corals are common. An exceptional example of the geometry and internal structure of a large-scale sedimentary structure is also exposed. The succession was first described as part of a stratigraphical study of the Castleton area by Shirley and Horsfield (1940). Eden *et al.* (1964) and Stevenson and Gaunt (1971) determined the stratigraphical relationships between the limestones in shelf and slope settings by fine-scale mapping and correlation that was supported by a detailed biostratigraphical study. More recent work at the site includes the detailed sedimentological work by Gawthorpe and Gutteridge (1990) and the micropalaeontological investigations conducted by White (1992).

Description

At the base of the succession and occupying the valley floor is the Pindale Tuff (Fearnside and Templeman, 1932; Shirley and Horsfield, 1940; Eden *et al.*, 1964). This unit is no longer exposed, but scattered pieces can be found on the path approaching the site from the north. Above this, approximately 22 m of late Asbian-early Brigantian limestones are exposed (Figure 7.14)b. The D₁–D₂ (Asbian–Brigantian) boundary is taken at the Lower Girvanella Band (= the 'Girvanella-bed' of Jackson, 1941b) — a concentration of microbial oncoids, some 10 m below the top of quarry face, which is truncated by one of a number of low-angle erosion surfaces that cut down-section towards the shelf margin (Eden *et al.*, 1964). Some of these erosion surfaces are associated with palaeokarstic features (Gawthorpe and Gutteridge, 1990). The characteristic Asbian corals *Dibunophyllum bourtonense*, *Caninia* cf. *densa* and *Palaeosmilia murchisoni* and the brachiopod *Davidsonina septosa* have been found in limestones below the Lower Girvanella Band. Typical Brigantian fossils including *Dibunophyllum bipartitum* and *Diphyphyllum* cf. *lateseptatum* occur immediately below the Upper Girvanella Band (Eden *et al.*, 1964). Comprehensive lists of the fossils recorded from this section are provided by Eden *et al.* (1964) and Stevenson and Gaunt (1971).

The succession consists mainly of grainstone and packstone with subordinate wackestone; the limestones are dominated by highly abraded and disarticulated bioclasts, comprising mainly crinoids and brachiopods. Several macrofaunal beds occur containing rolled and abraded brachiopods, microbial oncoids, solitary and colonial corals. These beds tend to be laterally discontinuous and rest on scoured or winnowed surfaces. The limestones are mainly flat-bedded; however, at the north-east end of the quarry, coarse bioclastic and intra-clastic limestones show an abrupt increase in dip to the north that reflects sedimentary drape over the carbonate platform margin. A wedge-shaped interval 130 m long by 20 m thick showing both shelf- and basinward-dipping foresets of large-scale cross-stratification occurs below the Lower Girvanella Band (Gawthorpe and Gutteridge, 1990). This large-scale sedimentary structure developed on a bedding plane that shows evidence of emergence, including palaeokarst and calcrete textures. The bedform shows a two-stage development of vertical aggradation, followed by progradation towards the shelf margin ((Figure 7.14)c).

Interpretation

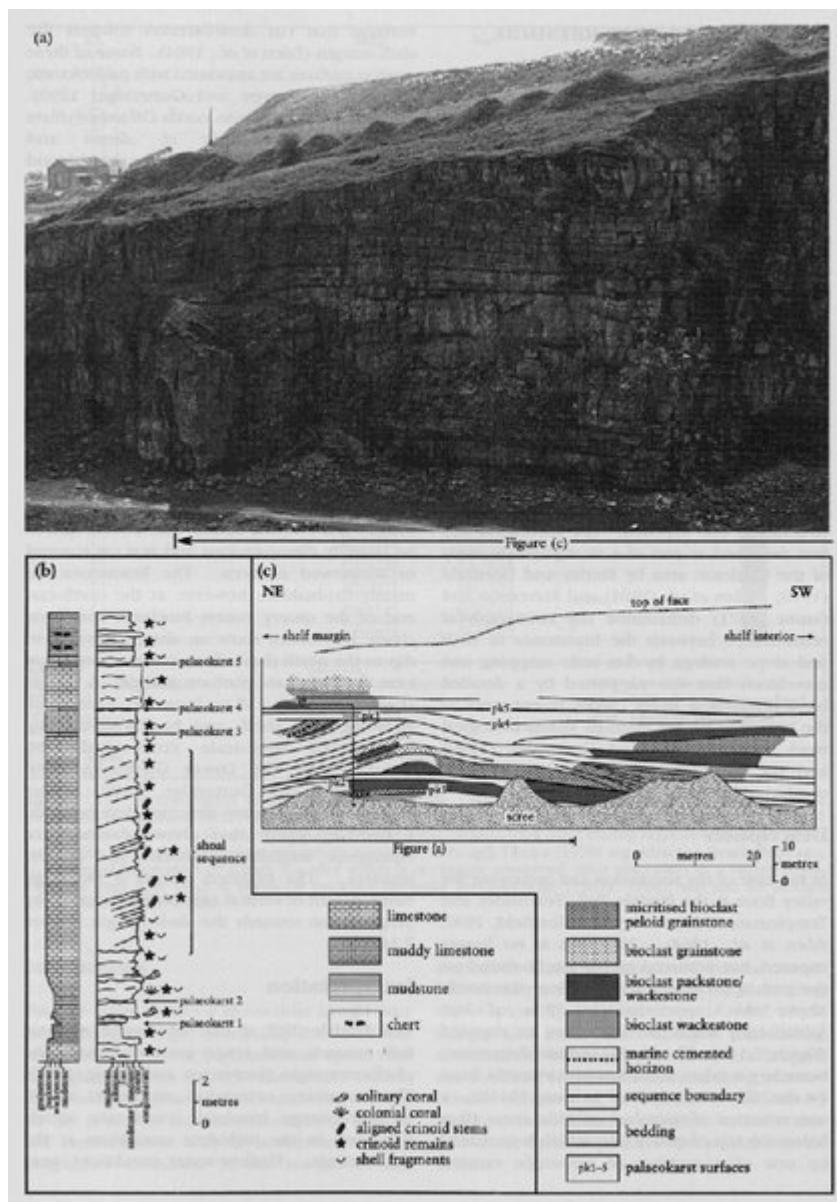
The Pindale Tuff is one of several volcanic tuff mounds and vents associated with the platform margin (Stevenson and Gaunt, 1971). The remaining succession represents a belt of high-energy bioclastic carbonate shoals deposited in the turbulent conditions at the shelf margin. Shallow-water conditions were punctuated by periods of subaerial exposure

during sea-level lowstands. A large-scale sedimentary bedform developed as the shelf margin was flooded. Initially this feature developed by vertical accretion but subsequently it prograded laterally until it spilled over the shelf margin. The macrofaunal developments and beds with microbial oncoids appear to rest on scoured or winnowed surfaces in the troughs of these large-scale bedforms. This suggests that not all of the macrofaunal bands and erosion surfaces are of regional stratigraphical significance as previously suggested by Shirley and Horsfield (1940), Eden *et al.* (1964) and Stevenson and Gaunt (1971); the majority may only be of local sedimentological significance.

Conclusions

The succession at Pindale Quarry demonstrates the nature of the northern margin of the Derbyshire carbonate platform during late Asbian to early Brigantian times. In contrast with the Asbian margin seen in Cave Dale and around Winnats Pass (see Castleton GCR site report, this chapter), the shelf margin at this site was characterized by the development of a bioclastic carbonate shoal complex deposited in high-energy conditions close to the platform edge. Carbonate sediment was largely transported off shelf and a drape over the shelf break can be seen at the north-eastern end of the quarry

References



(Figure 7.14) (a) General view of the large-scale carbonate sand-body (lower centre) in the Bee Low Limestones (Asbian) at the Pindale Quarry GCR site, near Castleton. The dip of the overlying thinly bedded Monsal Dale Limestones (Brigantian) at the top of the face increases to the north-east (left) as they drape the platform margin. The height of the

face is approximately 25 m. (Photo: P.J. Cossey.) (b) Sedimentary log of the Pindale succession. The shoal sequence refers to the large-scale carbonate sand-body illustrated in (a). The Asbian–Brigantian boundary is taken at the second palaeokarstic surface overlying the carbonate sand-body (see Eden et al., 1964). (c) Detailed sketch section of the lower part of Pindale illustrating the geometry of beds and limestone microfacies associated with the large-scale bedform in the Bee Low Limestones (Asbian). Note that blank areas of the section are those from which no microfacies data are currently available. The dashed line between asterisks marks the line of the logged section illustrated in (b). After Gawthorpe and Gutteridge (1990).