Dale Quarry, Derbyshire

[SK 283 542]

Introduction

The Dale Quarry GCR site [SK 283 542] is a disused, partly infilled quarry located immediately to the west of Wirksworth. The exposed succession includes the upper part of the Bee Low (Hoptonwood) Limestones and a complete section through the Monsal Dale (Matlock) Limestones and lower part of the Eyam (Cawdor) Limestones. Together with the other quarries in the Wirksworth area, Dale Quarry provides an unparalleled three-dimensional view of the evolution and lateral variation within the progradational carbonate platform margin that fringed the northern margin of the Widmerpool Gulf during late Dinantian times. The exposed section reveals limestones that were deposited on the platform margin slope and includes some spectacular examples of large-scale soft-sediment deformation. Aspects of the site geology were considered in regional stratigraphical studies by Shirley (1959) and Smith *et al.* (1967), but the most informative accounts are provided by Walkden (1982) and Gutteridge (2003). In the latter account, Gutteridge (2003) makes the case for re-exposing parts of the section recently obscured by infill.

Description

The Bee Low Limestones (25 m) comprise thickly bedded bioclastic peloidal grainstones and packstones with bedding planes marked by palaeokarstic surfaces overlain by thin volcanic-derived soils (Walkden, 1982). A typical late Asbian fauna including *Dibunophyllum bourtonenese, Siphonodendron pauciradiale* and *Palaeosmilia murchisoni* is present in these beds (Walkden, 1982).

The Asbian–Brigantian boundary is marked by a karstic surface probably with a few metres of Asbian strata missing. The Monsal Dale Limestones (30 m) and Eyam Limestones (3 m) consist of thinly bedded fine-grained bioclastic wackestones with shale partings (Figure 7.22). A few bioclastic packstones and grainstones (0.1–0.2 m thick) are also present; these have scoured bases and some show grading. Isolated lenses of coarse crinoidal grainstone up to 5 m thick and several tens of metres long also occur. These display large-scale southerly directed cross-stratification and are buried by the thinly bedded fine-grained bioclastic limestones. Soft-sediment deformation at various scales is common, including recumbent folds, small-scale flexures, imbricated thrusts and extensional slide planes (Figure 7.23). One of the latter cuts a crinoidal grainstone lens (now covered) demonstrating a vertical displacement of 15–20 m and a lateral displacement of 40–50 m. The direction of slumping indicates a southward-dipping palaeoslope.

The fauna consists of spinose productoids, rare zaphrentids and small rhynchonellid brachiopods. The contact between the Monsal Dale Limestones and the Eyam Limestones is inaccessible but appears to be an erosion surface (Walkden, 1982).

Interpretation

The Bee Low Limestones were deposited on a shallow carbonate shelf that was punctuated by emergent episodes when soils and palaeokarstic surfaces formed (Walkden, 1974, 1982; Vanstone, 1996). The boundary between the Bee Low Limestones and the Monsal Dale Limestones may represent a period of subaerial erosion; Shirley (1959) and Walkden (1982) recorded an unconformity at this level, and Walkden (1977) suggested that this surface marked an episode of subaerial erosion that is evident elsewhere on the carbonate platform at the Asbian–Brigantian boundary.

Shirley (1959), Smith *et al.* (1967) and Walkden (1970) recognized a major facies change in the Brigantian limestones, from cyclic limestones (with palaeokarstic surfaces) deposited in shallow shelf seas to the north, to a much thinner succession of thinly bedded argillaceous limestones (with no palaeokarstic surfaces) with a deeper-water fauna in the south. Walkden (1970, 1982), Oakman (1984) and Gutteridge (in unpublished work) interpreted this change as the

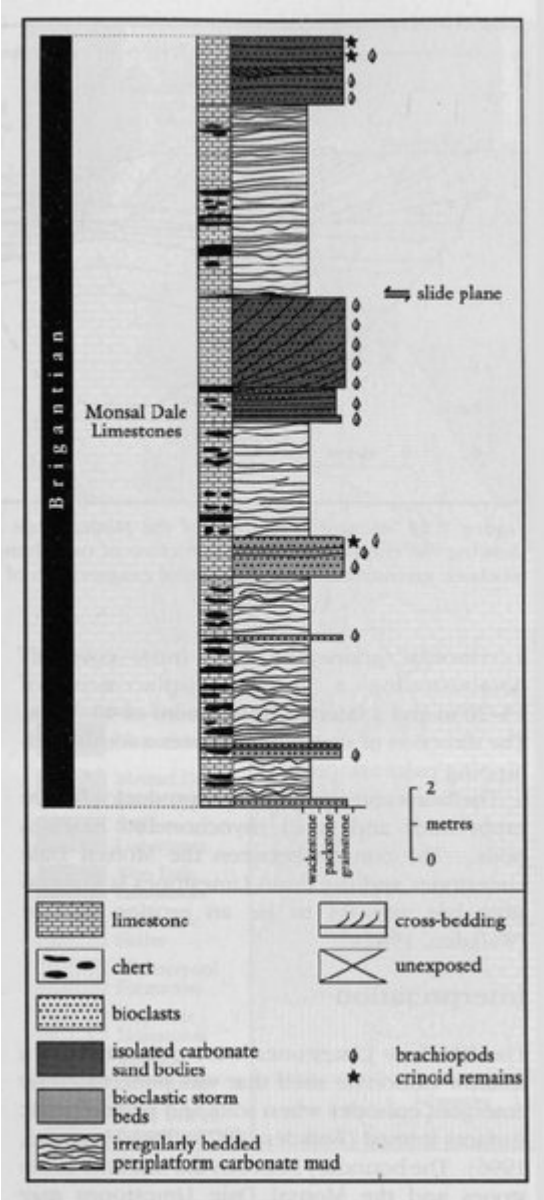
depositional record of the shelf-to-slope transition across the southern margin of the Derbyshire carbonate platform.

The Brigantian succession represents the unstable marginal slope of the carbonate platform. This is dominated by fine-grained carbonate sediment that was winnowed and transported off the shelf by storm and tidal currents and deposited below wave-base. The thin bioclastic beds represent occasional storm-deposited influxes of coarser material derived from higher-energy environments up the platform margin. Some storm beds were mixed with the surrounding fine-grained slope carbonates by bioturbation. Isolated megaripples of crinoidal grainstone migrated down the slope until they were starved of coarse bioclastic sediment and were buried by fine-grained slope carbonates. The platform margin slope was unstable and was affected by down-slope creep and major slumping. It is possible that some of the major slumps cut down to the level of the lithified Asbian platform carbonates. The nature of the contact between the Monsal Dale Limestones and the Eyam Limestones in Dale Quarry is not known but is also thought to be a subaerial erosion surface.

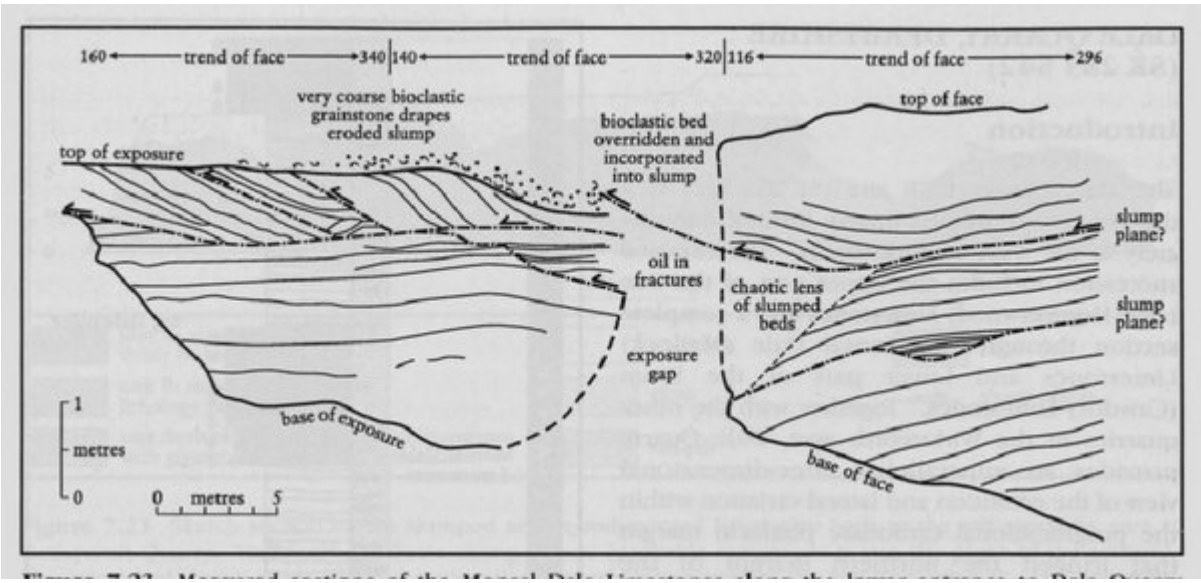
Conclusions

Dale Quarry is a key site for demonstrating the changing nature of the southern margin of the Derbyshire Platform during late Dinantian times. Asbian strata record a flat-topped carbonate shelf with shallowing-upwards cycles capped by emergence surfaces passing laterally into a narrow high-angle margin probably underlying Wirksworth. The transition from shelf carbonates to marginal slope carbonates stepped back some 1–2 km shelfward at the end of Asbian times such that the transitional area became broader and less steep. Subsequently, during Brigantian times, the platform margin built out progressively southwards into the Widmerpool Gulf by the off-shelf transport of shelf-derived carbonates and slumping.

References



(Figure 7.22) Sedimentary log of the section in the Monsal Dale Limestones (Brigantian) formerly seen at the Dale Quarry GCR site, Wirksworth. Parts of the section are now obscurred by infill (see Gutteridge, 2003).



(Figure 7.23) Measured sections of the Monsal Dale Limestones along the lower entrance to Dale Quarry showing the complex imbricate structure of two slump sheets. The slump is overlain erosively by a coarse bioclastic grainstone. Note the vertical exaggeration of the scale (x4). After Gutteridge (2003).