Elliscales Quarry, Cumbria

[SD 224 747]

Introduction

The Elliscales Quarry GCR site is a disused quarry [SD 224 747], 1 km north-west of Dalton-in-Furness, which offers a unique exposure of patch reefs within the Arundian (C_2) succession. Although Adams (1984) followed Rose and Dunham (1977) in regarding these reefs as part of the Red Hill Oolite, recent work by Johnson *et al.* (2001) considered them part of their newly defined Dalton Formation (= Dalton Beds of this chapter), and it is the latter view which is followed in the present account. Highly fossiliferous carbonate buildups at Elliscales Quarry provide rare evidence of particular significance in understanding the construction of organic frameworks in Lower Carboniferous reef systems. Accounts of the geology have been presented by Garwood (1913), Nicholas (1968) and Rose and Dunham (1977), but this report is based mainly on the sedimentological work of Adams (1984) who considered the anatomy and development of the Elliscales reefs in detail.

Description

Adams (1984) described the bedded facies adjacent to the Elliscales reefs as finely bioclastic peloidal packstones with some grainstones, and the reefs as pale-weathering masses of unbedded, mottled and fossiliferous fine-grained limestones with vertical walls and dome-shaped tops. Two prominent reefs are exposed on the north and west faces of the quarry (Figure 4.8), while smaller developments of reef limestone are recorded from the quarry floor (Adams, 1984). The reefs are up to 5 m in width, 15 m in height and 25 m or more in length. A few thin tongues of reef material extend into the inter-reef beds, and contacts between the two facies are generally sharp. In places, however, textures and contacts are obscured by dolomitization and haematization.

Frame-building organisms in the reef facies include *Syringopora* (tabulate coral), solenoporoid algae, the problematic *Aphralysia* and a few microbial thrombolites and stromatolites. Typically these organisms are found in their life position and as delicate upward-branching attached or encrusting growth forms. The more erect of these growth forms most probably acted as baffles to gentle currents carrying suspended sediment in a fairly low-energy environment (Adams, 1984). Within the reefs a strong ecological zonation is evident, with *Syringopora* at the base, passing up into a *Syringopora–Aphralysia*–thrombolite association in the middle, and a solenoporoid alga–*Aphralysia*–thrombolite association at the top (Figure 4.9). The upward replacement of *Syringopora* by the more robust branches of solenoporoid algae is attributed to increased energy levels and light penetration as a result of shallowing. Reef growth is thought to have been initiated by the attachment of *Syringopora* to a partially lithified substrate. Although Adams (1984) followed Be■ka (1981) in assigning *Aphralysia* to the Foraminifera, its systematic position remains uncertain (R. Riding, pers. comm., 1999).

Other fixed forms recognized as contributing to the development of the reef framework and assisting in the binding and trapping of fine-grained sediment include fenestelloid, fistuliporoid and branching bryozoans (the most common group), tuberitinid foraminifera, spirorbid worms, rhodophyte algae (ungdarellids), cyanobacteria (*Girvanella*) and other micro-problematica (*Garwoodia*). Additional forms identified by Adams (1984) as less-significant elements of the reef core include the brachiopods (*Cleiothyridina* cf. *glabristria, Stenoscisma isorhyncha, Schizophoria* and *Derbyia*), corals (*Michelinia megastoma, Caninia ciliata, Clisiophyllum ingletonense, Palaeosmilia murchisoni* and *Koninckophyllum praecursor*) (Garwood, 1913; Rose and Dunham, 1977), 'coiled nautiloids or goniatites' (Nicholas, 1968), echinoids, crinoids, ostracodes, endothyrid and tetrataxid foraminifera, calcispheres, the ?cyanobacterium *Renalcis* (Adams, 1983) and *?Uraloporella* (Adams, 1984), an organism of uncertain biological affinity.

Interpretation

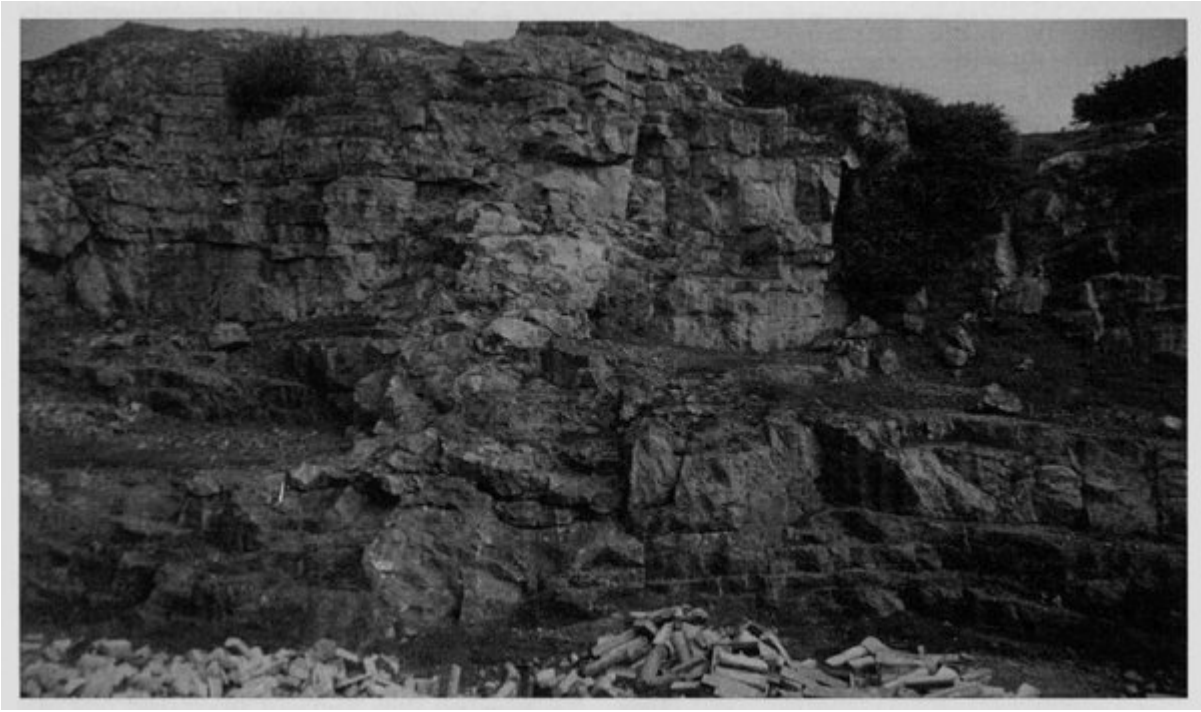
Adams (1984) was the first to determine that the Elliscales reefs were ecologically zoned biogenic structures built by sessile organisms that encrusted one another to produce a rigid and wave-resistant organic framework. The presence of abraded grain calcarenites and lithified blocks of the reef framework in talus bands on the reef flanks confirmed that the developments were at least partially cemented and resistant to occasional periods of turbulence (Adams, 1984). The gentle arching of limestone beds over the tops of the reefs Indicates that reef elevation above the sea floor during growth must have been minimal (Nicholas, 1968; Adams, 1984). The greater quantity of 'carbonate mud' noted adjacent to the reefs than in other areas is attributed to the sheltering effect provided by the presence of the reefs, despite their low elevation (Nicholas, 1968).

Although similar but much smaller reefs occur in the Martin Limestone at Marton Quarry, 3 km north-east of Elliscales, their distribution over the Lake District Block may not be confined to the Furness district as previously envisaged (Adams, 1984) since blocks of strikingly similar reef material also occur at Meathop to the east. However, attempts to account for their development in a regional palaeogeographical context have been hampered by poor exposure of Arundian successions in the area. Originally, Nicholas (1968) suggested that the reefs developed on the back of an embryonic fold structure, the 'High Haume Anticline', but regional thickness trends for formations within the Arundian succession conflict with this view (Rose and Dunham, 1977; Adams, 1984). Further speculation by Nicholas (1968) that the reefs developed in a shelf-margin setting was rejected by Adams (1984) who, in consideration of Lower Carboniferous isopach data for northern England presented by George (1958), suggested that any shelf edge, if present, would have had a north-east--south-west trend and been located some kilometres to the south-east of the present site. Following this view, Adams (1984) considered the buildups as 'patch reefs' that developed on a shelf area, and that their north-south elongation was the product of gentle (possibly tidal) current movements oblique to the shelf margin. Reef growth was rapid in response to high sedimentation rates as the shelf subsided.

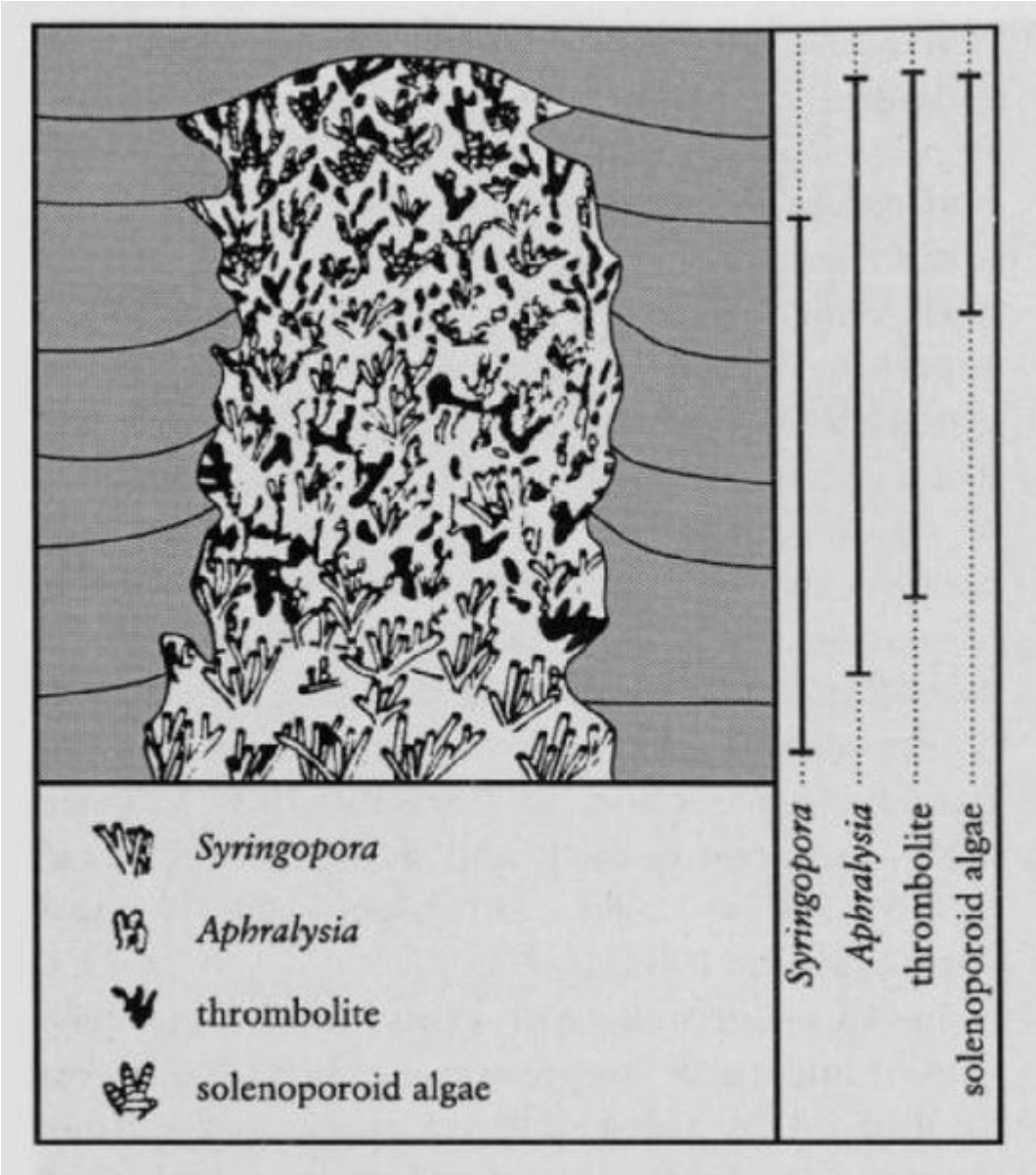
Conclusions

The reefs at Elliscales Quarry contain an ecologically diverse fauna and flora that is unique within the Arundian successions of south Cumbria. The exceptional preservation of frame-building organisms (chiefly lime-secreting algae, coral and other micro-organisms) make this one of the most Important sites in Britain for understanding the organic evolution of Lower Carboniferous reef systems. At no other site in north-west England can the organic framework to an ancient reef of this particular type be so clearly demonstrated.

References



(Figure 4.8) The north face of Elliscales Quarry showing the near-vertical walls of an unbedded reef limestone mass (centre) surrounded by dolomitized beds within the Arundian succession. The vertical height of the reefs is approximately 10 m. (Photo: A.E. Adams.)



(Figure 4.9) Schematic section of the reef illustrated in (Figure 4.8) showing the ecological succession of frame-building organisms in the reef core. The vertical height is approximately 10 m. Organisms not drawn to scale. After Adams (1984).