CONDITIONS OF DEPOSITION OF TWO BRACHIOPOD BEDS IN THE CARBONIFEROUS LIMESTONE AT BOLT EDGE, NEAR SPARROWPIT, DERBYSHIRE

by

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Summary

Two brachiopod beds from the Carboniferous Limestone at Bolt Edge, Derbyshire, are described. Tracings of the positions of shells suggest that they were built up into cross-bedding structures. These probably indicate that there were currents flowing from the shallow water of the shelf region to the deeper water of the basin.

Introduction

On the Buxton to Sparrowpit road (A 623) lies Bolt Edge Quarry (SK 088798), in the Carboniferous Limestone just north-east of the Ebbing and Flowing Well. This quarry has been used for dumping rubbish from the Ferodo Works at Chapel-en-le-Frith for about ten years now, so it was thought to be worthwhile to record some observations made before the evidence was obliterated.

This quarry was excavated on the edge of the Carboniferous Limestone massif in the Monsal Dale Beds (H.M. Geological Survey. Sheet 99, Chapel-en-le-Frith), which are D_2 in age; the unconformity with the Edale Shales lies just on the other side of the main road to the north-west. The position of the quarry corresponds with the postulated position of the edge of the shelf region, where shallow water is believed to have given way to deeper water of the basin to the north-west (Hudson & Cotton, 1945).

Barnes & Holroyd (1896) recorded small pebbles and fish teeth from this quarry and believed they accumulated on a sea beach similar to the one they envisaged at Castleton.

Jackson (1908), "from the quarry near the Ebbing and Flowing well", found many fish teeth which were very rolled and abraded. These he identified mainly as Psephodus magnus (M'Coy). He also believed they were thrown up on an old sea-beach.

These theories of the presence of a sea beach are not now generally accepted; it is thought instead that the beach-like deposits and comminuted debris are the result of nighly turbulent water action (Sadler, 1964a, discussing the "Beach Beds" at Castleton, where a submarine channel is described) or represent a marginal facies, such as the fore-reef as described by Wolfenden (1958).

Stratigraphy

The quarry at Bolt Edge showed three distinct types of lithology. At the top were 20 feet of massive fine-grained limestones, which were calcarenitic in part and contained finely comminuted white shell debris. In thin section, these upper beds showed many rounded shell fragments, numerous well-rounded crinoid ossicles, rounded limestone "pebbles" and occasional foraminifera, indicating they were probably laid down in fairly turbulent water.

Intercalated between these calcarenitic limestones and the beds below were thin, black, shaly lenticles from which the fish teeth were obtained.

Below these shaly beds was a more massive, dark-grey, fine-grained limestone with pockets of crinoid debris, overturned colonies of the Rugose coral Lithostrotion, and very many Gigantoproductid brachiopods. Thin sections of this massive limestone showed numerous brachiopod fragments (many of which were aligned parallel with the bedding), as well as crinoid ossicles and occasional bryozoan fragments. This Gigantoproductus bed was about two feet thick and dipped at 10 degrees towards the north-west. The large brachiopod shells and coral colonies could not be extracted because of the lithology of the limestone, so tracings of them were made straight from the rock face (see Sadler, 1964b, for the method of taking tracings from the Cyrtina septosa Band). Thus a true record of the positions of the shells was made from the north face of the quarry. From these tracings, which were taken over a horizontal distance of 46 feet along a dip section, it was possible to get an overall picture of the distribution and disarticulation of 154 Gigantoproductids. It was found that 97% had their concave sides uppermost and only 3% had their convex sides uppermost. 75% of the shells were disarticulated.

Conditions of Deposition

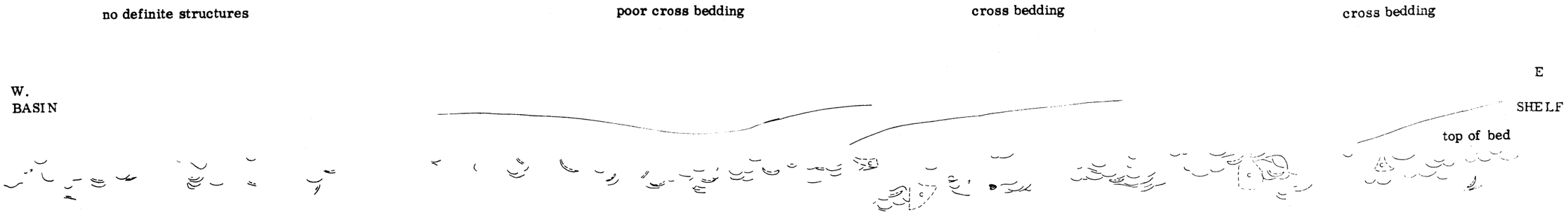
This assemblage of fossils is undoubtedly a death assemblage, the shells having been transported to these positions by moving water and the coral colonies overturned.

The most interesting feature noted from the positions of the shells was their alignment in the form of cross-bedding, the dip of which varies from 5 to 12 degrees; the angle decreases towards the north-west, where the structures become very much less well-defined, although the shells are still grouped in clusters (see diagram). It is thought that these cross-bedding structures were formed by currents flowing from the shallow water of the shelf to the deeper water of the basin. There appears to be an absence of reef and fore-reef beds (Wolfenden, 1958), although a small knoll reef is indicated towards the southern end of the quarry (Geological Survey, Sheet 99). There is no available evidence of a submarine channel similar to that described near Castleton (Sadler, 1964a). Possibly the currents were set up by the tidal ebb and flow between the shelf and the basin.

Four colonies of Lithostrotion (three overturned and one lying on its side) were found amongst the brachiopod debris which was aligned into the cross-bedding structures, giving further evidence of turbulent water.

The high percentage (75%) of Gigantoproductid shells in the apparently unstable position, that is with the concave side uppermost, is thought to have been due to the fact that these large saucer-like shells became embedded in the limy mud on the sea-floor and therefore became more stable than is normal for shells with their concave side uppermost.

Three feet above this Gigantoproductus bed was a four-inch band containing smaller brachiopod shells (probably Dictyclostus) and small crinoid fragments. Two-thirds of the shells were disarticulated and 50% had their convex side uppermost. They were built up into a single small cross-bedding structure.



Text-fig. 1.

Diagram to show the actual positions of the brachiopod shells and coral colonies in the Gigantoproductus bed. Above the section of the bed are suggested lines of the cross-bedding structures.

Key — Articulated shells are shown with two valves, one being represented by a dotted line. Coral colonies are shown by an approximate cone shape with a C in the middle.

Scale: — Horizontal and vertical 1 inch represents 3 feet.

General Conclusions

These observations are all considered to point to turbulent water conditions occurring on the margin between the shallow water of the shelf and the deeper water of the basin. It is thought that the ebbing and flowing tides over this margin probably set up currents, some of which brought the large Gigantoproductus shells from the shelf region and deposited them on the edge of the basin. At times these currents were confined to submarine channels cutting through the reef (Sadler, 1964a), but at Bolt Edge it is believed that there was no reef wall present and there is no evidence available of any submarine channel. The dip of the beds is thought to be a depositional one, such as was described at Castleton (Wolfenden, 1958), but not nearly so steep. The tidal currents piled the shells into cross-bedding structures, the dip of which decreases towards the basin.

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References

BARNES, J. & HOLROYD, W.F. 1896. On the occurrence of a sea-beach at Castleton, Derbyshire, of Carboniferous Limestone age. Trans. Manchr. Geol. Soc., Vol.25, pp.119-132.

HUDSON, R.G.S. & COTTON, G. 1945. The Lower Carboniferous in a boring at Alport, Derbyshire. Proc. Yorks. Geol. Soc., Vol. 25, pp.254-330.

JACKSON, J.W. 1908. Carboniferous Fish-remains in North Derbyshire. Geol. Mag., Vol.5, pp. 309-310.

SADLER, H.E. 1964a. The origin of the 'Beach Beds' in the Lower Carboniferous of Castleton, Derbyshire. Geol. Mag., Vol.101, pp. 360-372, 4 figs.

1964b. Conditions of sedimentation of the Cyrtina septosa Band in the Lower Carboniferous of Derbyshire. Mercian Geol., Vol.1, pp.15-22, 1 fig.

WOLFENDEN, E.B. 1958. The paleoecology of the Carboniferous reef-complex and shelf limestones in North-West Derbyshire, England. Bull. Geol. Soc.Amer., Vol. 69, pp.871-898, 12 figs.

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