SOME STRATIGRAPHICAL BREAKS IN THE DINANTIAN MASSIF FACIES IN NORTH DERBYSHIRE

by

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This short article describes some of the stratigraphical breaks in the Dinantian limestones of the Wye Valley area of North Derbyshire, which were demonstrated to members of the East Midlands Geological Society in the course of a field excursion on June 6th, 1970, led by the author. Particular attention is paid to those exposures which have not previously been described in any detail.

Apart from two major lava flows and several tuff bands within the Dibunophyllum zone, and lenses and layers of chert in the higher part of that zone, and some argillaceous shales at the top, the Dinantian sequence is an entirely calcareous one. The exposed sequence, from the lowest beds at Woo Dale, 5 km. (3 miles) to the east of Buxton, to the highest beds in the Headstone railway cutting at Little Longstone, shows a total thickness of about 500 m. (1,600 ft.) (Cope, 1933, p.128). To this can be added almost 300 m. (900 ft.) of limestones, often extensively dolomitized, which were encountered in the Woodale boring (Cope, 1948), and which lie beneath the lowest beds exposed at Woo Dale.

The limestones display a wide range of textural and gross lithological characters from biosparites to calcilutites, as well as of colour. The latter seems to depend very largely upon the amount of carbon present, and insoluble residues show little evidence of the influx of terrigenous material, though fragments of land plants have been found at several horizons. Beds vary in thickness from a few inches, typical of the higher part of the succession to scores of feet especially in the Chee Tor Beds which make up the basal part of the Lower Dibunophyllum zone. Some of these massive beds are of considerable areal extent with little change in thickness. A large part of the massively-bedded limestones consists of small detrital fragments of crinoids and brachiopods denoting widespread but possibly quite gentle current action. Sadler (1964, p.20) has given evidence for the action of more powerful currents in certain areas, at the horizon of the *Davidsonina septosa* band, near the top of the Chee Tor Beds. The thick beds of calcilutite which characterize the upper part of the Woo Dale Beds (S_2 zone) appear to be largely chemical precipitates with little or no evidence of current action, though within these beds there are some horizons at which the limestone is roughly laminated, and is full of fragments of a dichotomously-branched plant stem with prominent mid-ribs. At other horizons, there is evidence of deposition under calm and stable conditions so that corals appear to be still in their growth positions.

All the limestones within the sequence appear to have been deposited at depths within which rugose corals could live. In those beds rare in corals, such as the Woo Dale Beds and the thin limestones with chert of the Monsal Dale Beds (higher part of D_2 zone), there is positive evidence of extremely shallow-water conditions in the sporadic occurrence of thin layers of coal or coaly shale at a few horizons.

There are some exposures which give evidence of pauses in deposition or rather unusual conditions of deposition, and these are briefly described in stratigraphical order.

1. Woo Dale Beds (S_2 Zone)

The Woo Dale Beds (formerly Daviesiella Beds) are so named because they crop out in the core of the pericline and are reasonably well exposed near Woo Dale, east of Buxton.

There is a total exposed thickness of about 100 m. (300 ft.). These limestone are mainly well-bedded grey or dark grey microsparites, in which *Davidsonina carbonaria* (M'Coy) has

been found in several localities. They are frequently dolomitized especially near the base of the section. The upper part consists of thickly-bedded calcilutites with minor microsparites, carrying the large brachiopod *Daviesiella llangollensis* (Dav.).

The upper part of the Woo Dale Beds is well exposed in the railway cutting on the north side of the Devonshire Arms, a little over a mile east of Buxton. Here, the calcilutites are not as dominant at this horizon as they are, for example, at the confluence of Great Rocks Dale and Wye Dale.

In this exposure (SK 803726), the bedding is highly irregular. One thick bed is loaded with specimens of *D. llangollensis*, some of which give evidence of fracture or abrasion prior to lithification. There is no suggestion of any preferred orientation of the shells in the sediment, which must have been laid down rapidly under turbulent conditions. The upper surface of this bed is irregular, pene-contemporaneously eroded, and is succeeded by wedge-bedded limestones which also contain *D. llangollensis*.

2. Chee Tor Beds (D_1 Zone)

The Chee Tor Beds [called the Chee Tor Rock by Sibly (1908) on account of the splendid exposure of these limestones at Chee Tor, 7 km. (4 miles) east of Buxton] show thicknesses between 100 and 130 m. (300-400 ft.). The limestones are almost exclusively sparites and micrites showing a $CaCO_3$ percentage of more than 98, and sometimes as high as 99%. The finest section presently existing is on the west side of Great Rocks Dale in the Tunstead Quarry of Imperial Chemical Industries Ltd. The immensely massive beds in the topmost 65 m (200 ft.) of this group contain four well marked clay bands. The clays are blue to grey in colour when unweathered, and frequently contain disseminated crystals of pyrite. The thickest bed shows almost 0·6 m. (2 ft.) of clay resting upon a highly irregular surface. When such a surface is bared, during quarrying operations, it is seen to contain innumerable potholes into which the clay descends, an appearance which suggests sub-aerial weathering. Whether or not it becomes necessary to postulate uplift prior to the formation of each clay band, such horizons undoubtedly mark major interruptions in the otherwise fairly tranquil deposition of the Chee Tor Beds. Each is a typical disconformity (Cope, 1939, p.61).

3. Miller's Dale Beds (D_1 Zone)

The Chee Tor Beds are surmounted, in the full succession, by the Lower Lava Flow of Miller's Dale; this lava can be examined along Miller's Dale near Raven's Tor (SK 150732), and in an easterly direction it is last seen in a small exposure by the mill-leat to the east of Litton Mill. This lava is succeeded by the Miller's Dale Beds which show a thickness of about 40 m. (125 ft.) in Miller's Dale. These beds consist of light-grey limestones frequently shelly and generally thickly-bedded or massive.

In general, the Miller's Dale Beds show evidence of fairly continuous deposition with winnowing of crinoid and brachiopod fragments by current action.

In Blackwell (Sandy) Dale (SK 132727) to the south of Miller's Dale there is a major break in the general parallelism of the beds. The dale has been cut through a large dome-like mass of limestones in which the dips are at considerable variance with those in the succeeding limestones (see Fig.1). The dome-like mass consists of light grey micrite and calcilutite having a discrete upper surface which, by its pitted nature, gives evidence of a certain amount of penecontemporaneous solution. This mass shows a rude but distinct bedding concentric with this upper dome-like surface; the limestones of which it is composed contain productids, some of giganteid type, and scattered corals including *Palaeosmilia murchisoni* (Ed. & H.). The succeeding beds show, adjacent to the northern side of the dome, a dip of about 9°N. There is some wedge-bedding and successive beds show overlapping relationships as they abut against the surface of the dome. They are mainly well-bedded micrites with abundant crinoid ossicles, echinoid plates, and productids. The limestones in the cliffs at the summit of this section dip eastwards at a low angle and, therefore, appear to be horizontal in the illustration. This clearly brings out the tendency for the beds abutting on to the dome to thin gradually as they approach it.

The dome-like mass is interpreted as a patch-reef, and it is evident that it stood up as a discrete mass, and was chemically weathered on the surface, before finally being buried by later deposits.

4. The D_1-D_2 Junction

On palaeontological grounds the D_1-D_2 junction in the Miller's Dale area has been placed at the top of the Miller's Dale Beds and base of the succeeding Station Quarry Beds (Cope, 1937, p.192). This junction coincides with a well-marked disconformity which can be examined in several good exposures.

The fascinating section in the railway cutting just outside the eastern portal of the now abandoned Litton Tunnel (SK 167727) is now readily accessible. A sketch of this exposure made many years ago (Cope, 1933, p.132) shows a cross-section of a wide channel cut into the upper part of the Miller's Dale Beds; the channel-fill consists of rather dark grey limestones with scattered chert nodules (Station Quarry Beds). The top of the Station Quarry Beds is marked by a thin band of clay which has been proved to be on the horizon of the Upper Miller's Dale Lava (Cope, 1937, p.185). The base of the chanel-fill is a deposit of pebbles of dark grey limestone in a crumbly, calcareous, and pyritous matrix. The pebbles vary in size up to about 0·01 m. in diameter, and are frequently pyritous. Their form leaves no doubt whatsoever that the limestones from which they were derived were fully lithified at the time, and that they had undergone some transport.

Another good section showing similar erosion phenomena, lies within the goodsyard area of the now abandoned Miller's Dale Station (SK 138732). This exposure, which affords a cross-section of a channel in the upper part of the Miller's Dale Beds has been known for many years, but there does not appear to be any permanent record of it. This is regrettable as the exposure is now largely overgrown with willows, the roots of which have considerably disturbed the soft shaly channel-fill.

Upon entering the former goods-yard, the D_1-D_2 junction is readily visible towards the top of the cliff on the north side. Throughout most of the section the lower Miller's Dale Beds are separated from the Higher Station Quarry Beds by a thin sale parting. About 150 m. east of the road, this shale suddenly expands to fill an erosion hollow, probably a channel, in the Miller's Dale Beds. The cross-section of the channel is like an inverted bell in shape, about 3 m. (9 ft.) in maximum depth, and rather more at the greatest diameter (fig. 2). The basal beds of the Station Quarry Beds thicken and sag slightly over the channel, the result of compaction of the fill. A solitary crushed specimen of *Gigantella* cf. *giganteus* (Martin) was found in the lowest bed. Lying in the bottom of the channel is a waterworn boulder of limestone, lithologically similar to the adjacent light-grey limestones of the Miller's Dale Beds. The greatest diameter of this boulder appears to be about 1·5 m. (4 ft.). Standing on the limestone bed of the channel, this boulder is covered and surrounded by soft grey shale containing a saucer-shaped 0·1 m (4 in.) layer of dark grey micrite with pyrite about 0·6 m (2 ft.) below the base of the Station Quarry Beds. The shale above this limestone layer is blue-grey in colour and is packed with segrations of pyrite cubes and small pebble-like fragments of pyritized dark grey calcilutite; it is almost unfossiliferous. The shale below the limestone band is grey and argillaceous, containing plant remains, fish scales, bivalves, gastropods, and brachiopods. All the fossils are crushed or broken, and it is difficult to retrieve anything more closely determinable from this now weathered and disturbed mass of shale.

There can be little doubt, in the light of these and other exposures, that the area of deposition underwent uplift in late D_1/early D_2 time, and that the Miller's Dale limestones were channelled by streams which brought in terrigenous material from non-calcareous terrains outside.

5. The Upper Miller's Dale Lava Flow

The Upper Lava of the Miller's Dale area attains a maximum thickness of slightly over 30 m. (100 ft.) around Knot Low and on Priestcliffe Lees, in Miller's Dale. It diminishes in thickness in all directions, but most rapidly towards the east and south-east.

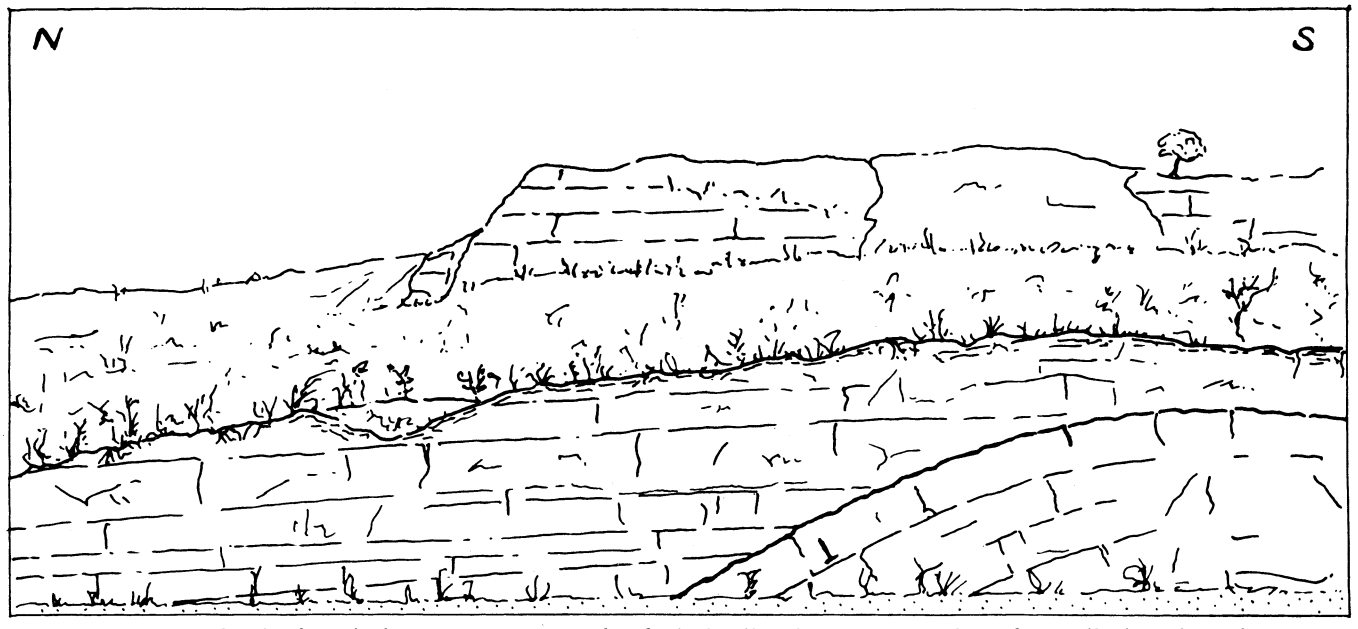

Figure 1. Sketch of roadside section on east side of Blackwell Dale showing patch reef in Miller's Dale Beds (approximate scale noted by hammer on bedding plane in patch reef on right).

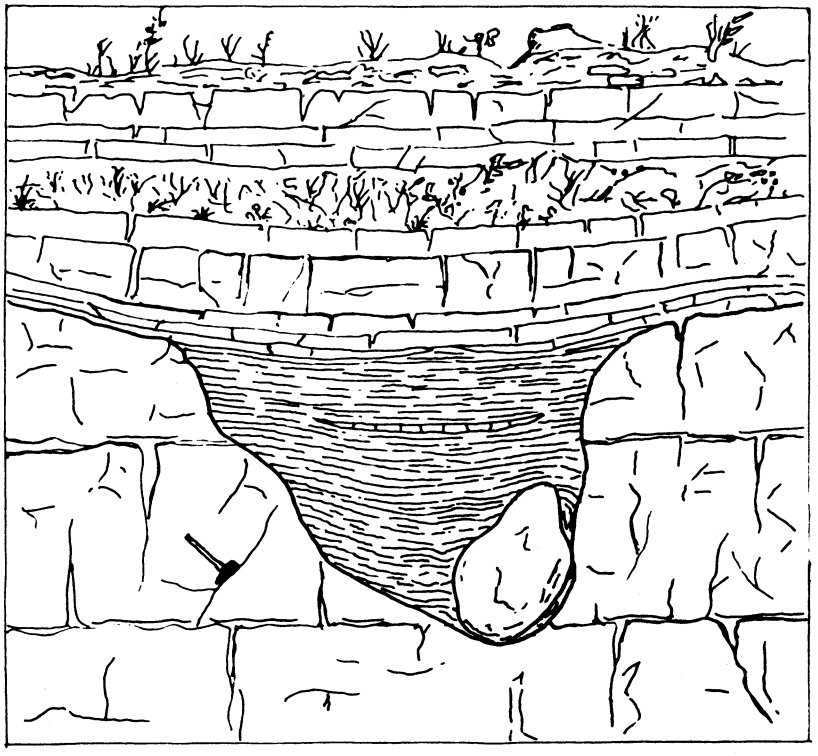

Figure 2. Idealized sketch of exposure showing channel cut in Miller's Dale Beds, Miller's Dale Station Goodsyard (abandoned).

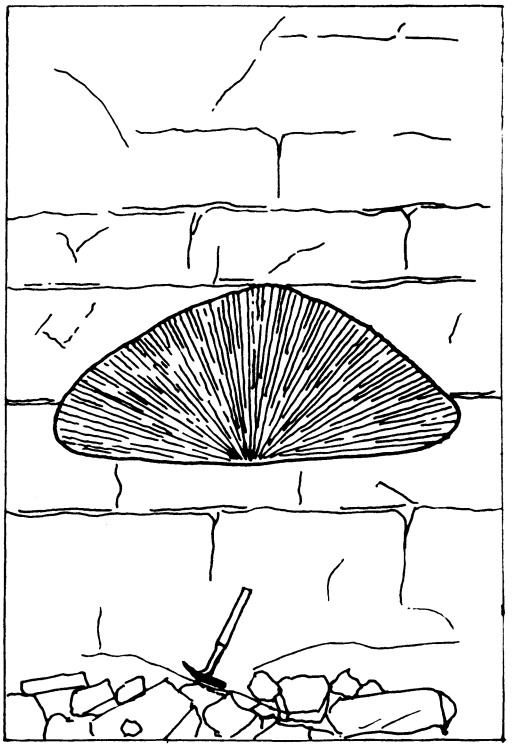

Figure 3. Section through corallum of *Lithostrotion portlocki*, Priestcliffe Beds, Miller's Dale Quarry.

The abandoned railway-cutting south of Tongue End in Miller's Dale shows the flow thinning rapidly to the east (Cope, 1933, p. 137), and at the western portal of Litton Tunnel it has been demonstrated that, beyond the area of its development, the lava is represented by a thin bed of clay, formerly a tuff (Cope, 1937, p.185). The slope of the lava front is surprisingly steep, showing a gradient of about 1 in 3, and in view of the presence of waterworn fragments of basaltic lava in the overlying limestone, immediately adjacent to the lava front, some erosion of the front might be reasonably assumed. In a temporary exposure near Taddington (Cope, 1937, p.187), now no longer available, flow-units in the lava showed a dip of 35^{o}, and were approximately parallel to the sloping front of the flow where it was dying out. It would seem, therefore, that though erosion of the front of the flow may have occurred such erosion did not necessarily lead to a steepening of the front.

Wherever the front of the flow is visible, as in Miller's Dale, it is noticeable that the succeeding limestones are irregularly bedded, and are banked against the lava front.

It seems highly probable that the flow was extruded into the sea and it may well have been entirely submarine. Certainly, whenever the normal top of the flow is seen it is remarkably smooth suggesting marine planation rather than sub-aerial erosion. Deposition of calcareous sediments does not appear to have been resumed over much of the area of the flow until a considerable thickness had accumulated against the lava front.

6. Priestcliffe Beds (D_2 Zone)

The limestones normally succeeding the Upper Lava are the Priestcliffe Beds (Cope, 1933, p.134). They are well exposed in the insecure face of the abandoned Miller's Dale Quarry (SK 142731). A few feet above the lava-limestone junction in this quarry, a complete colony of *Lithostrotion portlocki* Ed. & H., in the growth position is exposed in section. The corallum is 0·75 m. (2 ft. 6 in.) in diameter and shows a maximum height of 0·5 m. (15 in.) (see Fig. 3). A bedding plane in the enclosing limestones makes a trace around the corallum about 0·05 m. (2 in.) above its greatest diameter. The upper surface of the corallum shows no features which might suggest erosion. All the relationships point to rapid sedimentation, with the bedding plane representing a very ephemeral break.

7. White Cliff Coral Band (D_2 Zone)

One of the finest sections of the White Cliff Coral Band which lies in the upper Monsal Dale Beds has existed until recently in a small quarry about 140 m. (150 yds.) WSW of the Crossdale Head Mine, on the west side of Castlegate Lane, Great Longstone. This section has now been deteriorating for some years as the quarry is being used for the tipping of rubbish, and it seems likely to become useless for study purposes within the next few years. This coral band shows a lower part with colonial corals such as *Syringopora* sp. and *Lithostrotion junceum* (Flem.), and an upper portion with large clisiophyllid corals. The latter appear to be lying prostrate, giving the appearance of being broken. Closer examination, however, shows that not only is there a distinctly preferred orientation of the simple coralla, but that the latter are bent almost parallel to the substratum, suggesting currents coming from a north-easterly direction. The almost prostrate position of the large coralla seems to indicate a very slow rate of deposition on the surface of the reef.

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References

COPE, F.W. 1933. The Lower Carboniferous succession in the Wye Valley Region of North Derbyshire. Journ. Manch. Geol. Assoc., vol.1, pp.125-145.

1937. Some features in the D_1-D_2 Limestones of the Miller's Dale Region, Derbyshire. Proc. Yorks. Geol. Soc., vol.23, pp.178-195.

1939. The Mid-Visean (S_2-D_1) succession in North Derbyshire and North-West England. Proc. Yorks. Geol. Soc., vol.24, pp.60-66.

1948. Boring at Woo Dale. Abstr. Proc. Geol. Soc. Lond., p.24.

SADLER, H. 1964. Conditions of sedimentation of the *Cyrtina Septosa* Band in the Lower Carboniferous of Derbyshire. Mercian Geologist, vol.1, pp.15-22.

SIBLY, T.F. 1908. The faunal succession in the Carboniferous Limestone (Upper Avonian) of the Midland Area. Quart. Journ. Geol. Soc. Lond., vol.64, pp.37-53.

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