Graded bedding of the Harlech Dome

Kopstein, Franz Peter Henri Wallace

Publication date:
1954

ABSTRACT

The Cambrian geosynclinal sediments of the Harlech Dome, Wales, consist of an alternation of muddy sandstone beds (graywackes) and shale deposits. In many cases the former show grading. This was already mentioned by BAILEY (1930). Under grading one understands briefly the decrease of grain size in the same bed from the base towards the top.

KUENEN and MIGLIORINI (1950) and KUENEN alone in later papers describe graded beds and explain how turbidity currents form a mechanism that would be capable of causing grading.

Small scale cross bedding (mainly of ripple type) is comparatively common in the fine grained strata of the Harlech Dome. From the dip of the laminae a rough direction of supply of the material can be estimated. In our cases the source lay in the SW. If many measurements are available it appears possible to estimate the octant of the direction of supply. The comparative wide scatter in the orientation of the estimated current axes is caused by the current ripples. These latter never run strictly parallel to each other. Hence, they are not exactly perpendicular to the axis of the current at all points.

A more accurate method for estimating the direction of supply of the material is found in the orientation of the longest axes of the elongated pebbles (mainly quartz and feldspar). It appeared in the field that the macroscopic grains lay with their longest axes parallel to the axis of the current. The more distinct the grading in the bed is, the better the orientation mentioned tends to be; although in intercalated non-graded grit beds an orientation may also occur.

It appears that the mean of all estimated stage directions (of course only in stages were orientation occurs) is N. 8,2^{o} E., with a standard deviation of 5,5^{o}. The current, as we already know, came from the SW. For the Rhinog- and Barmouth Grits, stages in which grading is very frequent, the respective stage direction can be estimated more exactly than the value given above, because the respective standard deviations are smaller. In this case the stage direction is respectively N. 7,0^{o} E. and N. 9,3^{o} E. with standard deviations of 1,0^{o} and 1,3^{o}.

Further, it appears that within the two stages mentioned the hypothesis of equal station directions, for the separate stations must be rejected. Presumably this is the result of small local deviations in the direction of supply. However, no significant

differences occur between the six determined stage directions.

It further appears that the fine graded material, which has to be examined with aid of a strong lens or microscope, also shows orientation of the longest axes and that servicable determination can be obtained. It appears that proportionally more specimens occur (about 53%) which show either no or indistinct orientation. Also the result is less accurate, in comparison with the macroscopic observations. Still, the estimate of the current axis is more exact than that obtained from current bedding. So, the stage direction of the Rhinog Grits (determined microscopically) is N. 5,6^{O} E. with a standard deviation of 3,5^{O}. It is even possible to ascertain that the current direction remained constant during sedimentation of the material from the base to the top of the same bed. Only once an observation was made which shows an orientation of the elongated grains perpendicular to the estimated current axis. But that microscopic measurement belonged to a laminated fine grained top part of a graded bed.

With the method, described above, it is only possible to fix the axis of the current, but not its direction. However, it appears that the coarse pebbles (at the base of a graded bed e.g.) may slant downwards in the direction of the current. Hence, it is possible in the ideal case to determine from the pebbles not only the current axis but also its direction. In the fine grained material the dip of this imbrication is not predominantly downcurrent. Hence, no conclusion can be drawn concerning the direction.

Flow markings are also suitable for determining the current axis as well as its direction, because their orientation is parallel to the current axis while the upcurrent side is the deepest. The accuracy of the result is greater than that obtained from the current bedding. The mean of the seven estimated stage directions by this method is N. 6,1^{O} E. with a standard deviation of 3,4^{O}.

Internal deformation (e.g. convolute bedding) in the fine grained material is common. Distinct slumps are very rare.

There is plenty of evidence showing that only the lowest stage of the Cambrian, the Dolwen Grits (A), are shallow water deposits. In this stage on finds, amongst other things, that the irregular diagonal lamination is on a large scale and may run through the whole thickness of a bed. Also the directions of supply of the material vary greatly. Coarse gravel is scattered in the laminae, slightly accumulated at the base. Grading does not occur, nor are there shale deposits between the graywacke beds. The thickness of the layers is irregular. All these features indicate a shallow water environment.

In other stages these features are absent and, instead the following are encountered. Between the graded beds shale layers generally occur. Fossils are extremely rare. There is plenty of small scale current bedding. Any ripples occurring are always distinct current ripples. The source of the material is constant in the S.SW. Graded beds with all typical features, such as constant thickness, wide extent, flow markings, load casts, convolute bedding, shale inclusions, some slump structure, etc. are frequent in some of the stages and occur less often in the others. All these features point to deep water.

The bottom relief however, was presumably slightly less regular or the slope less pronounced during sedimentation of the Manganese Group (D), the Vigra- (J_1) and the Ffestiniog Flags (K). They contain fewer graded beds, while the cross bedding shows a greater diversity in the directions of supply.

The grain size, the thickness of the beds and the direction of the turbidity currents in the Southern part are practically the same as those in the Northern part of the Harlech Dome. Hence, it can be assumed that the deepest point of the geosyncline lay more to the N.NE., for otherwise the deposits would show a change in that direction, where the currents would tend to stagnate. Because the currents came from the S.SW. during the whole Cambrian (with the exception of the Dolwen Grits) the source - or in other words the Precambrian landmass which supplied the sediment - must also have lain in that direction.