

obviously quite distinct from any of the foregoing, but which are not sufficiently well preserved to admit of description. They consist of thin plates, from half to three-fourths of an inch in thickness, which had nearly an upright position, and have calices, all of which are oblique. They were found in the neighbourhood of Evesham.

DESCRIPTION OF PLATE VII.

- FIG. 1. *Heterastræa Etheridgei*, a horizontal section a little below the calice, showing the imperfect union of the corallites, fissiparity in progress in two corallites, and one corallite which has resulted from gemmation. Magnified three diameters.
- „ 2. „ *Etheridgei*, a vertical section showing the dissepiments and the edges of the septa. Magnified three diameters.
- „ 3. „ *Eveshami*, a portion of the type specimen showing a calice which has been developed from a bud, and still retains a more or less circular outline. Magnified two diameters.
- „ 4. „ *Fromenteli*, a portion of the specimen figured by Prof. Duncan, exhibiting, in close proximity, both gemmation and fissiparity. Magnified two diameters.
- „ 5 & 6. „ *Tomesi*, portions having calices resulting from both gemmation and fissiparous division. Magnified two diameters.
- „ 7. „ *regularis*, some calices magnified two diameters.
- „ 8. „ *Stricklandi*, some calices of a specimen from Evesham, having both gemmation and fissiparous division. Magnified two diameters.
- „ 9. „ *endothecata*, a portion of the type specimen, showing fissiparous division in progress. Magnified two diameters.

III.—ON SOME EFFECTS OF PRESSURE ON THE DEVONIAN SEDIMENTARY ROCKS OF NORTH DEVON.¹

By J. E. MARR, M.A., F.G.S.

DURING Professor Hughes' annual geological excursion, which was last Easter conducted to Ilfracombe, I was much struck with certain structures exhibited by the ordinary Devonian sediments, and some of these are, I think, worthy of a short notice. Most of them are exhibited on the beach close to Ilfracombe, at the bathing place, where there is also seen the folded grit band rendered classical through Dr. Sorby's writings.

The rocks here consist of cleaved argillaceous deposits interstratified with thin grits and limestones, and the latter have been folded amongst the former in a most remarkable manner. The changes which take place are illustrated in Fig. 1. The first stage is the production of a series of sigmoidal folds having the middle limb replaced by a thrust-plane. This is well shown in the case of two limestone bands just above a small cave on the shore, at the bathing place. A further development is shown in Fig. 1a, and the result of this is the formation of a series of "eyes" of limestone, which vary in length from a fraction of an inch to several feet, according to the magnitude of the folds. As the smaller folds are merely the convoluted portions of larger ones, the "eyes" get pulled out along the thrust-planes, replacing the middle limbs of the larger folds, as shown in Fig. 1b. In this way, the central portions of these larger folds

¹ Read at the Manchester Meeting of the British Association.

present the appearance shown in Fig. 1c, where we find a series of lengthened "eyes," forming flattened lenticular patches interbanded with the normal cleaved argillaceous material. By these simple changes we have produced a rock having all the mechanical characters of a schist, but consisting of alternating lenticular patches of limestone and clay-slate, and presenting the apparent false-bedding which is also seen in true schists. The apparent dip of the rocks is here entirely fallacious, and is due to the pulling out of the limestone "eyes," so as to have their longer axes parallel with the general strike of the cleavage planes. In many cases the cores of the larger folds have the "eyes" compressed together to form an irregular nodular mass, in which the separate "eyes" can be some-

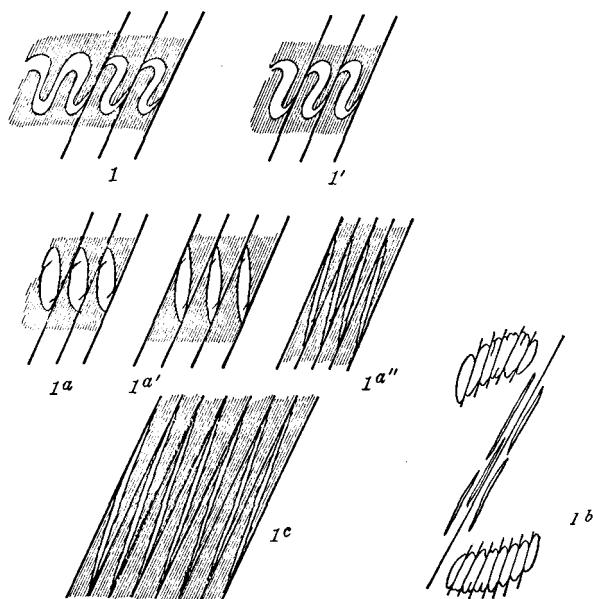


FIG. 1 1'. Transition from ordinary overfolds to the stage 1a.

„ 1a. As in text.

„ 1a' 1a''. Transition from 1a to 1c as produced along the fault plane in 1b.

„ 1b 1c. As in text.

times with difficulty determined, but at other times the lines of demarcation are wholly obliterated. In these masses, the crinoid joints of which the limestones are largely composed are affected in the way described by Dr. Sorby in his Presidential Address to the Geological Society (Q.J.G.S. vol. xxxv. p. 89), and in some cases are seen converted into a number of irregular polygons. Along the planes where the limestone "eyes" have been dragged out, we find that the crinoid stems are separated in a way similar to that figured by Heim in the case of a Belemnite (*Mechanismus der Gebirgsbildung*, pl. xv. fig. 6), and the spaces separating the different joints are then filled with crystalline calcite.

The changes occurring in the case of the thin grit bands are generally similar to those described above; but here we find also that the particles are compressed, and there appears to have been a slight mineral rearrangement. The grits are nevertheless easily distinguishable as such even to the naked eye.

The rocks at the bathing place are furthermore traversed by quartz veins, some of which were formed before the principal folding of the rocks, and in this case, the veins are affected in the same way as the thin bands of limestone. Fig. 2 shows the foldings of such a quartz vein, as seen close to the Tunnels at the

FIG. 2.



bathing place. Here two quartz veins occur parallel with two thin bands of limestone, and are folded like the limestone, showing that the veins were formed along the bedding planes, before the latter were affected by the folding. At this spot, both limestone and folded quartz veins suddenly disappear against a large divisional plane to the right, and a few feet to the right of this plane a series of quartz veins run parallel with the cleavage planes. It is possible that the latter veins were produced by the mechanical rearrangement of the folded veins along the thrust plane of a large fold, but it is not easy to prove this, as in the case of the limestones, and the rectilinear veins may have been formed in their present condition by segregation. Upon a flat surface of rock to the south of this place, quartz veins are seen formed into "eyes," and these "eyes" in places have been almost certainly dragged out. In such cases we have the incipient formation of a schistose rock composed of alternating lenticular masses of argillaceous material, limestone and quartz. Precisely similar phenomena may be seen at Hagginton Beach and elsewhere, and indeed the whole coast offers excellent examples of the formation of these schistose structures in ordinary sediments, where all the mechanical peculiarities of a true schist are visible, without any great change in the chemical composition of the individual constituents of the rock.

At Hagginton Beach a mass of limestone occurs, which has been pulled out so as to form a series of elliptical nodules occurring in the same line. Here we find the junction of limestone "eyes" without any folding of the particular mass of limestone in which the "eyes" occur. A flattening of these "eyes" would cause the formation of lenticular masses of limestone of a similar character to those described as occurring at the bathing place; nevertheless the mode of formation of the "eyes" is quite different in the two cases.

Some of the smaller "eyes" seen in a cliff just north of Hagginton Beach are composed of masses of coral. The elliptical shape of the

"eyes" does not appear to be due to the original growth of the coral, for the sides of the nodules are seen to consist of sections of the coral. This may be owing to chemical solution of some parts of the limestone, but appeared to me to be caused by the actual shearing off of a portion of the coral. This supposition requires confirmation, and it is probable that a fuller examination of the district will yield the requisite evidence.

The structures seen in these North Devon rocks remind one of those described by Dr. Bonney as occurring at Tor Cross in S. Devon (Q.J.G.S. vol. xl. p. 1). He brings forward proof to show that in that region "there is no valid evidence of a passage from schist to slate." The occurrence of rocks in North Devon having all the mechanical structures of true schists, without possessing their peculiar chemical composition, bears out this conclusion. In connection with this, it is of interest to notice that whereas in South Devon, where phyllites are found associated with normal schists, the sedimentary rocks are largely penetrated by igneous intrusions, this is not the case in North Devon, where such intrusions are very rare. One mass of quartz felsite, which has been described by Dr. Bonney (GEOL. MAG. 1878, p. 207), does occur at Bittadon, and he states that it is "affected slightly by cleavage." It was therefore intruded prior to the last earth-movements of this area. In some parts of the rock there is a parallelism of the alteration products which have been developed along the line of cleavage, but unfortunately the portion of the rock which has undergone the greatest amount of cleavage is so decomposed that no specimen could be obtained sufficiently firm for slicing. The apparent absence of schistosity in this rock can be however accounted for on the supposition that at the place where it is exposed, the mass forms an "eye" which has not undergone any great change. It would be of interest to know if this rock is exposed elsewhere, and if so, under what conditions it is there found.

I am indebted to Mr. E. J. Garwood, B.A., F.G.S., for the use of photographs displaying many of the structures which I have described above.

IV.—NOTES ON THE GEOLOGY OF MYNYDD MAWR AND THE NANTLE VALLEY.

By ALFRED HARKER, M.A., F.G.S.,

Fellow of St. John's College, Cambridge.

MYNYDD MAWR, about three miles west of Snowdon, is an abrupt rounded hill, 2300 feet high, separating the valleys of Nantlle and Cwellyn. A reference to the maps of the Geological Survey (75 N.E. and N.W.) shows it to be due to an isolated boss of "intrusive hornblende-porphry" in the form of a rounded parallelogram, a mile and a half in its longest diagonal. Dr. Hicks¹ has mapped this patch as Pre-Cambrian, and included it in his Arvonian system; but apart from its position, breaking

¹ Q.J.G.S. vol. xxxv. p. 297, 1879.