Chapter 25 The Red Measures

Introduction

In two parts of Anglesey there occur certain bright red beds that are later than the Carboniferous rocks to which they are adjacent. These districts are the Malldraeth Coal-field (Figure 302) and the Strait-side by the Ferry, just opposite Carnarvon. Exposures are poor and few; but, as the rocks are undoubtedly the latest remaining sediments in the Island, and even in the western part of North Wales altogether, they are of no small interest. The Ferry beds are exposed along the shore. Those in the Coal-field were, when Ramsay discovered them, only to be seen on the mine spoil-banks, but there are now shallow sections on the railway at Holland Arms, and a small one at Llangaffo. The best section of all was on the new branch railway close to the station, but this was visible for only a few months in 1908, and is now completely turfed over. A suite of 11 specimens from it, however, is preserved in the museum of the Geological Survey. Records, also, of 14 coal-borings that pass through these rocks have been obtained; and new evidence from the contents of the rocks themselves is now available. Finally, the question of their age cannot be fully discussed without reference to the sections at Llanfair-is-gaer on the other side of the Strait, and a short account of these will therefore be given.

Petrology

1. Ferry Beds — These are almost wholly red mudstones and marls with some pale grey-green mottling and banding. Bedding is not conspicuous, but there are a few bands with small pebbles.

2. Malldraeth Valley Beds — These are much more varied. The most important is a massive, soft, red sandstone, rather coarse in texture, interbedded with more flaggy red sandstones having definite micaceous partings, among which are some yellowish-white ones. The massive beds are often pebbly, sometimes quite a conglomerate, with pebbles as much as two inches in length. Mottled red and grey-green marls and soft blue-grey shales form a large part of the series, and there is also a yellowish dolomitic breccia containing fragments of a fine limestone and triangular, sharp-edged, pieces of chert.

3. Mainland — There is a series of beautifully banded red and green marls with pebbly beds like those at Foel Ferry, and a great conglomerate with a red matrix, full of pebbles up to eight inches in length.

4. Microscopical ingredients — Dr. H. H. Thomas, who has made a special study of the minerals of the English Trias, has kindly furnished the following report.

He examined, microscopically, the heavy residues from 13 specimens, which may be arranged thus:

C. Two from the south cutting at Holland Arms, one from the north cutting, one from a shallow pit just east of the north cutting, and one from the Ferry.

B. Five from the Berw Pools Pits, 'Colliery, disused'.

A. Three from Morfa-mawr Pits.

Zircon, rutile, and brown tourmaline occur throughout, anatase and brookite more sparingly. In some, especially a micaceous manly sandstone in Group B, tourmaline is extremely common, but the blue variety is rather rare. Anatase is well represented as colourless and steel-blue plates and double pyramids, particularly in a pale, speckled, red sandstone in Group B, and as yellow tables in the flaggy micaceous beds of Group C. The most interesting point is that those from Group C are all of one type, differing from the other rocks chiefly in containing an abundance of detrital garnet. This mineral is either absent from or but feebly represented in the others. It will be observed that four of these are all from one horizon, that this is the highest known in the district, and that the specimen from the Ferry beds is /identical in character. None contain staurolite, a mineral very prevalent throughout the Triassic rocks of England that lie above the Lower Mottled Sandstone.

5. A slight secondary change has taken place. Not uncommonly the blocks of red sandstone, especially the massive type from the old shafts, glisten brilliantly in the sun; and this can be seen with a hand-lens to be due to secondary enlargements of quartz with well-developed crystal facets, a well-known feature of some of the later Red Rocks of England.

6. Pebbles — Those in the Ferry beds consist of quartzites, cherts, and a red porphyritic rock with a granular matrix. Pebbles of this last (E10565), (Plate 28), Fig. 5 are found in enormous numbers in the Llanfair-is-gaer conglomerate, and small ones abound in the pebbly bands between the marls at the Brickworks. Its granular body consists of small but rather broad and stumpy albites, closely studded with rectangular and hypopolygonal crystals of quartz. The porphyritic felspar is also albite, and there are a few phenocrysts of quartz. Twinning is rather rare both in phenocrysts and matrix. The albite phenocrysts contain inclusions of the quartz, and both generations of quartz have suffered some resorption. The albites are rather decomposed, and are also stained with haematite. This rock has never been discovered *in situ,* but seems to belong to the older Palaeozoic suite. Other varieties of it exist in the Llanfair-is-gaer conglomerate, which would reward investigation, and throw light on its affinities. It is allied to the Quartz-Keratophyres. In the Malldraeth Valley beds pebbles are more varied as well as more abundant than in the Ferry beds. Their character may be gathered from the following analysis. of a collection of 120:

Fine hard dark grits	66
Keratophyres and felsites	19
Quartzites	13
Unknown sandstones	13
Vein quartz	1
Limestone	1
Cherts	7
	120

Though stained, their original colour often survives in the interior of the pebbles. The fine dark grits are quite recognisable; they are thin-bedded and flaggy, with occasional partings of dark micaceous shale, and are, without doubt, derived from the Ordovician rocks.

The quartzites must be from the Mona Complex, though there is a notable absence of any other rock from that. They may have been washed out of Ordovician or Carboniferous conglomerates. The rarity of vein quartz is remarkable. Four of the cherts have been sliced, and examined by Dr. G. J. Hinde. They are pale yellowish rocks, with some small rhombs of a carbonate, and many organic fragments, which in two cases (E10550) [SH 455 715]–(E10551) [SH 455 715], include remains of polyzoa (Figure 304), but no sponge spicules. In one of these the broken surface showed part of the column of a small crinoid.

The igneous rocks were, with a few felsites, chiefly fragments (E10553) [SH 455 715] of the very same keratophyre as that which occurs in the Ferry beds and in the Llanfair-is-gaer conglomerate. The cherts can hardly be anything but Carboniferous, and lithologically they resemble those of the Posidonomya Zone. Only one Pre-Carboniferous chert (other than the jaspers of the Mona Complex) is known in the Island, that of the Glenkiln beds of the north: it is far away, and is quite different in petrological characters and fossil contents.

The most remarkable feature of the pebbles, however, is their form and surface. They are seldom well rolled, but have re-entering curves and concavities; and some are sub-angular, some even sub-triangular in form, with tolerably sharp edges. Many are pitted and dimpled, and on the edges of those of flaggy grit the, fine bedding is etched out, thin hard seams projecting sharply. Finally, the whole surface of the hard keratophyre and chert pebbles has a peculiar low polish that passes even into the little pits and dimples, though it is rather stronger on the convexities. Now this is not the kind of surface imparted by water-rolling or ice-rubbing; but is, in point after point, that now well-known to be produced by blowing sand<ref>By a curious local coincidence, this process can be seen in action only a few miles away, among the dunes of Newborough (Chapter 32).</ref>: it is the characteristic desert 'polish'.

Unity of the Red Measures

It will be seen that these four tracts of red beds have several well-marked characters in common. They are as a whole much less indurated than the Carboniferous Limestone or coal-bearing series: they have a persistently strong red colour, with green mottling or banding. The Malldraeth Valley beds and the Ferry beds have five heavy minerals in common, and the latter are further linked with those of Holland Arms by their garnet. Their pebbles may be compared from the following table:

Griffith's Crossing	**Llanfair-is-gaer**	**Ferry**	**Malldraeth**
Keratophyre	Keratophyre	Keratophyre	Keratophyre
Quartzite	Quartzite	Quartzite	Quartzite
Felsite			Felsite
		Chert	Chert
			Black grits
			Sandstone
			Limestone
			Vein-quartz

Finally, the physical condition of the pebbles is the same in all four cases. No doubt can remain, therefore (as there is no stratigraphical reason for separating them), that all four belong to one and the same formation.

Succession

The mineral contents of the Ferry beds is the same as that found at Holland Arms, and as it is clear from the Berw mining records that the Ferry beds themselves do not exist in this district, they must be placed immediately above the Holland Arms beds. Below those must be placed the beds of Morfa-mawr, and at the base the Llanfair-is-gaer conglomerate. Allowance being made for the rapid changes of character that may be expected in a series of this kind, it would seem that all the divisions are represented in the Llangaffo deep boring (see Chapter 24). The succession may therefore be stated thus:

Ferry Marls

Holland Arms Sandstones

Morfa-mawr Pebbly Sandstones

Keratophyre Conglomerate

Thickness

Information as to dip is scanty. The, high dips in the Holland Arms cuttings are certainly quite local and due to disturbance. Ramsay in his section draws these rocks dipping at 10°–15° to the south-east. In both the borings to the south of the railway the Red Rocks are stated to be horizontal. The thickness at Berw may therefore be taken at about 300 feet. The dip at Foel Ferry is about 5°, and at the Brickworks about the same, so that protraction across the Strait gives a thickness of some 450 feet, but there is reason to think that the marls are faulted down against the conglomerate. In the Llangaffo deep boring there is the surprising thickness of 700 feet. Even if a low dip of 4° or 5° was overlooked the result would hardly be affected, for the position is about 400 yards from the boundary fault, which would thus bring in more beds and counterbalance the error. The formation is therefore of much greater magnitude than was supposed by its discoverer, Ramsay.

Relations of the series

The base of the Ferry beds is not seen: they are adjacent to and dip away from the D2a zone of the Carboniferous Limestone. Doubtless they are faulted some 500 feet in any case, but unless the whole of the Upper Carboniferous is cut out by a fault of some 2,000 feet, the base of the series must rest unconformably upon the limestone, which in that district, moreover, is frequently iron-stained. Nor is the base exposed at Llanfair-is-gaer, though the conglomerate has

the aspect of a basement formation. The Carboniferous Limestone is faulted against and thrust over it. In the Malldraeth Valley, where the Red Series rests upon the Coal Measures, there can be no doubt that it does so unconformably. In the first place, Ramsay estimated from the mine sections that its dip was some 10° lower than that of the Coal Measures. This is now confirmed by the new 'borings near Llangaffo, where it is said that the Red beds rest horizontally upon Coal Measures dipping at about 8° or 9°. Next, it is said that certain coal-seams are known to crop up against their base at Berw (Figure 302). In the third place, they are said to be unaffected by Tome of the minor faults, which may account for the fact that, in the section of the Berw Mine, the three-foot and four-foot coals are missing on the north side of the tangential fault (Chapter 35) (though that does cut the Red beds to some extent<ref>The fact that a dyke fails to pierce them can no longer be appealed to; as the railway section shows that they are traversed by the two Holland Arms dykes; and similar dykes cut and alter the Llanfair-is-gaer conglomerate.</ref>). In the fourth place: at Berw their base rests on beds about 50 or 60 feet higher than the three-foot coal, but at Morfa-mawr it is only about the same distance above the seven-foot six-inch coal, which is at least 300 feet and probably some 600 feet lower down.

The pebble contents of the rocks points to the same conclusion. It is quite different from that of the Lower Carboniferous conglomerates of the district, the pebbles in which are chiefly vein-quartz and jasper, and are, well, sometimes very well rolled. In this, as well as in the nature of the matrix, the rock differs from everything in the Limestone series, and must have been accumulated under new conditions. Dr. Strahan remarked that the Llanfair-is-gaer conglomerate is evidently no mere passing episode, but belongs to the type of deposit that is apt to usher in a new series altogether. Besides which, the chert pebbles must be regarded as derived from the Carboniferous Limestone itself.

The unconformity, therefore, would appear to be one of importance. The Carboniferous rocks must have been exposed to erosion at least as far down as the cherts of the Posidonomya Zone. But the Sub-Carboniferous floor itself would seem to have been laid bare, for the pebbles of Ordovician grit have not the smooth forms that second rolling imparts to pebbles washed out of pre-existing conglomerates.

Geological age

The aspect of some of the beds is certainly reminiscent of the Keuper Marls of England; but the petrological evidence is not in favour of even the Ferry beds being placed any higher than the Lower Mottled Sandstone of the English Bunter. Yet a series containing such a thick mass of banded marl cannot be placed actually with that sandstone; and Dr. Thomas, from the microscopic evidence alone, hesitates to. so place it. Now, many years ago, Ramsay recognised in the Malldraeth Valley beds a strong resemblance to the Red beds of the Denbighshire Coal-field, then called Permian, but now regarded as belonging to the Coal Measures, though uncon-formable to the productive measures; and in this view Dr. Strahan, who has examined the sections, concurs. The series, near Wrexham, contains thin seams of coal, and it is stated by Ramsay that similar thin seams have been found in the red beds near Carnarvon. A specimen of *Calamites suckowi* Brongn. was found in the red sandstone of one of the old spoil-banks at Holland Arms by Mr. Griffith J. Williams, and has now been named by Dr. Kidston.

The evidence, therefore, considered in all its bearings, points to the correlation of these Red beds of Anglesey with that group of Upper, unproductive, Coal Measures that has lately been found to exist over so large a space of the English Midlands.

Conclusion

In this part of North Wales the formation must be assigned a thickness of more than 700 feet; and the unconformity at its base appears to be considerable. The rocks undergoing denudation were almost entirely Carboniferous and Ordovician, together with a keratophyre that has not been seen *in situ;* and throughout a great part of the period the climatic conditions were those of a desert.

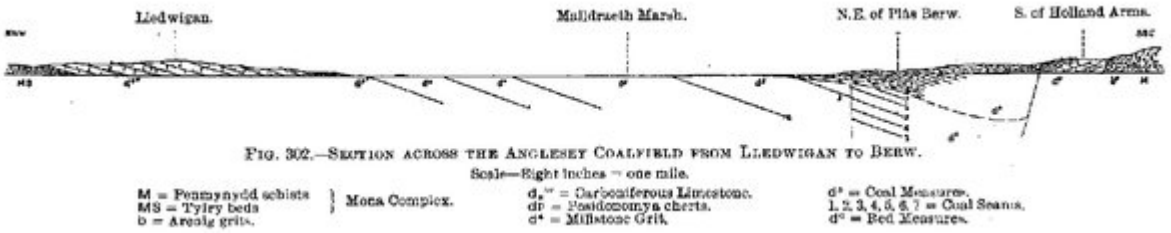
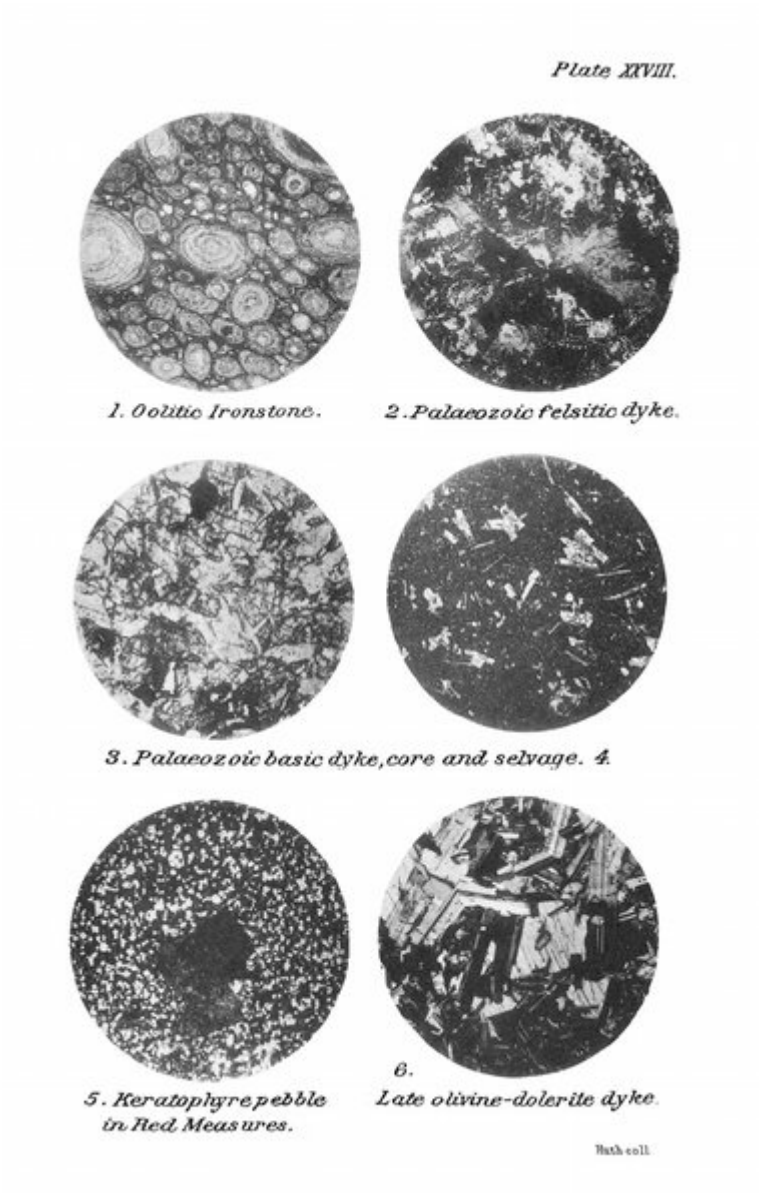


FIG. 302.—SECTION ACROSS THE ANGLESEY COALFIELD FROM LLEDWIGAN TO BERW.

Scale—Eight inches = one mile.

(Figure 302) section across the Anglesey coalfield from Lledwigan to Berw. Scale eight inches = one mile. M = Penmynydd Schists, Mona Complex MS = Tyfry Beds Mona Complex d2■ = Carboniferous Limestone. dp = Posidonomya Cherts. d4 = Millstone Grit d5 = Coal Measures. 1, 2, 3, 4, 5, 6, 7 = Coal Seams. d6 = Red Measures.



(Plate 28) Microphotographs of rocks later than the Mona Complex. 1. Oolitic Ironstone. 2. Palaeozoic Felsite Dyke. 3, 4. Palaeozoic Basic Dyke. 5. Keratophyre Pebble in Red Measures. 6. Late Olivine-Dolerite Dyke. See Appendix 3.

FIG. 304.
POLYZOON FROM PEBBLE IN RED MEASURES. × 12.

(Figure 304) Polyzoon from pebble in Red Measures. × 12.