

the rocks become more and more foliated in appearance, then igneous material begins to show between the folia, and we come to half-igneous, half-metamorphic 'banded gneisses' at what we may take as the junction. Inside the igneous mass huge fragments of what was originally schist may often be seen, which by fusion and impregnation, in the absence of stirring movements, fully bear out Professor Cole's contention that "masses of quartz-diorite arise as products of admixture where granite intrudes into more basic masses."

Of course, normal contact rocks are seen where the old sedimentaries are invaded, but from what has been said on the question of relative age, it will be inferred that this is comparatively rare. I have nevertheless been able to record from time to time the presence of nearly all the characteristic contact minerals, like andalusite, fibrolite, kyanite, cordierite, etc., chiefly from 'Banded Ironstone' junctions. But the granite masses have kept as a rule well within bounds, and rarely break through their covering of the old Basement schists or those of igneous origin. But in the absence of actual invasion by a granite mass, it is fairly obvious whether or no the latter must be regarded as intrusive. The usual intense folding of the schists leaves little room for doubt as a rule, for rocks involved in movements which have left the granite undisturbed must necessarily be of greater age.

I am afraid some of the points discussed above may be regarded as of a rather obvious nature. My excuse for putting them into writing must be that they are seldom referred to in geological works and are almost persistently overlooked in dealing with the structure of metamorphic areas.

IV.—THE RIVER CEFNI IN ANGLESEY.

By EDWARD GREENLY, F.G.S.

MANY years ago, when discussing the origin of the Menai Straits, attention was drawn by Ramsay to the existence of several other valleys running in the same direction, north-east and south-west. Not only is this the case, however, but the valleys of the dominant system that traverses the plateau of Anglesey have the same trend, ridge and trough alternating with wonderful regularity, as far, at any rate, as Llanerchymedd, a distance of some 12 miles from the Straits.

Much less conspicuous, for the most part, though more numerous than at first sight appears, are certain valleys running at right angles to those of the dominant system, and therefore north-west and south-east. They may drain either to north-west or south-east. They are unlike those of the dominant system in almost every particular. Those are long and straight: these are short and sharply winding. Those are broad and relatively shallow, these narrow and relatively deep. Those are generally bounded by gently sloping sides, these by steep and even precipitous sides. Much the

largest is that through which the railway has been taken, just beyond the little market town of Llangefni.

The River Cefni is the name given to a very complicated system of streams, which, with all its branches, drains some 60 square miles of the interior of Anglesey. Entering the great hollow of the Malldraeth Marsh, which, as is well known, belongs to the dominant system, on its north-west side, at a point about a mile below Llangefni, the combined waters then turn round to the south-west, and find their way out to sea in Malldraeth Bay.

The Malldraeth Marsh is practically at sea-level, and until the year 1788¹ was flooded by the sea at spring tides. It was then reclaimed, and the river embanked and straightened for a distance of some six miles from its mouth; but the deserted meanders of the old river can be traced in many places as a series of stagnant, crescent-shaped pools along the alluvial plain.

Between the Marsh and Llangefni the river runs a little east of south in a comparatively open valley, chiefly cut in Carboniferous rocks. But at Llangefni it emerges, rather suddenly, from a ravine, which is excavated in schists and quartzites of the ancient complex, with a general N.E.-S.W. strike. This ravine extends for about $1\frac{1}{4}$ miles, almost exactly north-west, and is the most striking valley of the kind in the island. It is 140 feet deep at the wood's end by Pandy,² and in places less than 400 feet wide at the top, with precipitous and rocky sides, and it describes bold and sweeping curves in its course. In short, it is a perfectly typical water-cut valley, and differs in the most striking manner from the valleys of the dominant type.

But, at its upper end, instead of proceeding from an upland hollow in the same direction, we find that it issues, almost at right angles, from the side of a N.E.-S.W. valley of the dominant type, which extends for several miles to right and left of the exit.

Now this hollow, which may be called the Trefollwyn Valley, after a farmhouse in it near the railway, does not open out to the south-west like the Straits, the Malldraeth, and most others of the class. It is a closed oval basin, and its waters all converge to the head of the Cefni Ravine, and pass out that way at a point midway along its south-east side.

The further upper waters are very complex, and raise problems of their own, which cannot be dealt with in this paper, and which, indeed, I do not feel that I understand. But the anomalous system here described seems to throw some light on the relation of the two types of valley and their mode of origin. For the Trefollwyn Valley could not have been in existence when the Cefni Ravine was in course of excavation. Its south-west barrier, at Tai Mona, on the Holyhead Road, is less than 150 feet above sea-level,

¹ Information kindly supplied by Mr. Thomas Prichard, of Llwydiarth Esgob, Anglesey, from the records of the Drainage Commissioners.

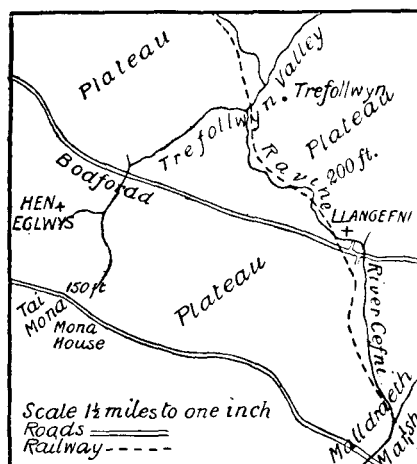
² I am indebted for this measurement to the kindness of Mr. Tobias Clegg, F.G.S., of Llangefni County School, who very ingeniously determined it by means of a kind of extemporized theodolite.

whereas the highest part of the plateau trenched by the Ravine is about 200 feet (see Map), so that the waters of a lake lying in the basin would have chosen the south-west exit and deepened that channel.

Nor can we postulate in this case an ice-dam such as those that have been appealed to with such striking success in Cleveland and other regions. There is not the smallest evidence of such a dam, the glaciation being steadily from north-east to south-west, with mere local variations of direction.

All the evidence goes to show that the Trefollwyn Valley is the later.

Now, nearly opposite to the exit at the Ravine's Head, a small stream enters the Trefollwyn Valley on its further side, after a course of about a mile from the north-west. It has no name on the maps, but the railway has been carried quite near to its south-west banks. It is cut in rock, not merely in drifts.



Sketch-map of part of course of River Cefni.

This channel is in the natural position for the apparently vanished upper portion of the Cefni. The fall would be slight, but there would be a fall, enough to make such a continuation possible, and ample if we allow for cutting back as well as cutting down of the lower part of the course. How, then, did it come to be so strikingly severed from its lower portion by the broad valley of Trefollwyn?

Admitting that 'subsequent' tributaries of the Cefni may have initiated that hollow, it is not easy to see how, with so short a course and so slight a fall, especially from the south-west (if, indeed, there was not a fall to the south-west, which seems much more likely), they could have produced one of such dimensions, for it is both deep¹ and broad.

¹ It is floored by alluvium, and its real bottom may even be below the level of the rock at the exit.

Nor does underground structure help us in any way. Though it is likely enough that there may be some fault or line of weakness along the hollow, there is certainly none of any importance.¹

Let us consider the relation of the two valley systems to the greatest of Post-Tertiary events, the Glacial Period. The valleys of the dominant system coincide, as is well known, with the general direction of glaciation, and contain abundance of Glacial Drift. They are either of Glacial age or older, and if we admit the possibility of glacial erosion, may have been produced by the ice, as was suggested by Ramsay, or, at any rate, deepened and enlarged by it.

The Ravine, lying directly across the path of the ice, cannot have been produced by it, and must be either Pre- or Post-Glacial. It must therefore be Pre-Glacial, as we have seen that it must be older than the Trefollwyn Valley. Confirmation of this is found in the presence in its bottom of Boulder-clay, undisturbed as far as I can see, at the south point of the great bend west of Pandy.

The Cefni, then, is a Pre-Glacial river.

If now we suppose that it received two small 'subsequent' tributaries from north-east and south-west, which met near the farmhouse of Trefollwyn, and that their combined hollows were deepened and greatly widened by glacial erosion to form the large valley of that name, we shall be able to understand the severance of the two portions of the Pre-Glacial Cefni, the production of the curious closed oval hollow, and the anomalous configuration and drainage of the present day.

Indeed, it seems probable that in Pre-Glacial Anglesey the drainage to north-west or south-east was much more continuous and systematic than it is now, and that the history of the present anomalous drainage cannot be understood without reference to the events of the Glacial Period.

A curious and very interesting consideration in connection with the ancient river Cefni is that, in the earlier stages of its history, far back in Pre-Glacial time, there must have been a fine waterfall close to where is now Llangefni Station. For, at that point, the river has cut through a lenticular band of very hard quartzite, about 100 feet thick, which is conspicuous from the Station, as of it are composed the white crags below the fir-trees just opposite. Resisting erosion much more strongly than the schist on either side of it, it gives rise, even now, to a rapid. In the early stages of erosion this rock, while freely allowing the river to cut *back* to it from below, must have retarded cutting *down* in its rear for a very long time: and consequently for long ages a fine cataract must have poured over a crag some 80 or 100 feet in height. Like Gray's flower in the famous Elegy, it came into being, and then dwindled gradually away, unwatched by any but the old wild beasts, and perhaps by some men almost as wild.

¹ A fault which partly coincides with the course of the Cefni between the town and the marsh does not pass into the Ravine, but somewhat to the eastward.