Part 3 Subsequent formations and phenomena

((Plate 34))

((Plate 23))

The geology of Anglesey. Volume 2

Memoirs of the Geological Survey.

By Edward Greenly.

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Chapter 12. The Baron Hill and Careg-Onen rocks and the Cambrian Period

Introductory

At Baron Hill, Careg-onen, Mynydd Llwydiarth, Holland Arms, and Trefdraeth, all of which localities are south of Lat. 53° 20′, are eight little outliers of ancient rocks, whose importance is quite out of proportion to their size. For they are later than the Mona Complex, and yet 'appear to be Pre-Ordovician, supplying us thus with stepping-stones across a vast chronological interval. In the last division of the chapter will be found some evidence as to the condition of Anglesey during the Cambrian period.

The Baron Hill rocks

From the Suspension Bridge to near Beaumaris, Anglesey overlooks the Strait in a steep and richly wooded feature, precipitous in places, and about 300 feet in height. At Gallows Point this feature leaves the Strait and turns northward, and just where this occurs its face is composed, for a space of 650 yards, not of the schists of the Mona Complex, but of an inclined outlier of ancient stratified rocks that rest upon them. Nearly all the exposures are in Baron Hill Park, and it will therefore be convenient for the purposes of this work to refer to them as the Baron Hill Rocks. The best sections are those in the drive, but there are others along the top of the wood, and in the Llandegfan road. They are quite different in structure from the adjacent Gwna schists and identical in character with the volcanic group of Bangor.

Petrology

There are two principal types: green, brown-crusted rocks, too poor in quartz even to the naked eye to be called grits, usually rather coarse, very tough and massive; and hard mudstones, dull green or blackish in colour, in which a fine parallel bedding is sometimes to be seen. The fragments in the first type are often a quarter to half an inch and at one place nine inches in diameter: and are partly sub-angular, partly rounded. These fragments consist almost entirely of various felspars, and of rhyolitic and andesitic lavas. Among the acid lavas are fragments of a purple felsite like that of Bangor, some showing fine wavy fluidal structure, while one of them was found by Prof. Bonney to be still glassy. The

andesitic rocks have typical trachytic texture, being 'crowded with elongated crystallites of felspar', and many are vesicular. The matrix is a dust in which minute lath-felspars can sometimes be seen, but often reconstructed and chloritised. In many parts the rocks are darkened with secondary iron-ores. To this it may now be added (E9794) [SH 599 757], (E6066) [SH 60 75], (E10915), (E10916) [SH 59 76], (E10917) [SH 59 76] that many of the felspars are sodium varieties near to albite, but that some have a higher refractive index and may be nearer to andesine. Also that some of the trachytic, fragments are true variolites, and are undoubtedly derived from the Gwna spilites.

The rocks are thus ashy grits and volcanic muds, but they are in part epiclastic, and contain a few fragments of old schists. Their felsitic and andesitic materials are therefore to be regarded as contemporaneous, their spilitic materials as derived from the Mona Complex, though they (and also the old schists) may have been detached, not by sub-aerial waste, but by volcanic explosions.

About a quarter of the outlier is composed of the ashy grits, of which five principal bands have been traced upon the six-inch map.

Tectonic relations

The beds throughout this outlier dip steadily a few degrees west of north at angles varying from 30° to 90°, the average being high; so that the thickness, measured from these dips, would not be less than 1,000 feet. The strike, therefore, is almost directly at the western margin of the outlier (as well as at the strike of the adjacent schists); and if this structure be considered in relation to the form of the ground, it becomes evident that the outlier cannot be resting undisturbed upon the schists. The relations, however, cannot be explained by normal faulting. The trend of the zones in the Mona Complex, as well- as that of the features, show clearly that no fault of the required magnitude traverses them towards the south-south-west, nor is there any evidence whatever along the coast of such a rupture. The northern boundary is almost certainly faulted, for the adjacent Gwna zones end off against a line of springs, in continuity with which is a deep hollow in the hill-face. Unless, therefore, the beds are rapidly folded in boat-shaped isoclines pitching down the hill they cannot be resting upon their natural base. But were that the case, the massive gritty- tuff of the southern end would bend round and continue ' along the western margin, which it does not do. It results that the outlier must be riding upon a thrust-plane that has an inclination at. this point to the east-north-east a little greater than the average slope of the ground, that is to -say of about 18°. This, which may be called the Baron Hill Thrust-plane, may be of considerable importance, for there is evidence that it is of considerable persistence. The hill-face (away from the outlier) must be of the nature really of a ' bare sole', and it persists as a strong sinuous feature for about two miles to the north until, west of Bryn-celyn, it is cut obliquely by a Post-Carboniferous fault-line. Along the Strait it may be thrown down somewhat by the Garth Ferry fault.

The beds riding upon the Baron Hill thrust-plane have been subjected to movement of the kind that might be expected above such a surface, as may be seen from (Figure 189), (Figure 190), which are the third and fourth sections along Baron Hill drive, counting from the south-western edge of the outlier. But these give no idea of the degree to which the fine banded mud-stones have been fractured. This is shown in (Figure 191), taken from a spot beneath a minor thrust about half way down the cliff. Along this minor thrust-plane, moreover, is a seam of mylonite up to a quarter of an inch thick.<ref>Those who visit the place may be requested to abstain from hammerin$_g$ the section at the point X.</ref> The same phenomenon is seen in several places.

Age of the rocks

Between the rocks below and above thy' Baron Hill thrust-plane there is certainly a very strong contrast in metamorphic condition, the Baron Hill Beds having, in spite of the mylonising just described, no cleavage or foliation whatever, whereas the Gwna rocks upon which they rest, though not highly crystalline, are thoroughly foliated. To this may now be added the fact that in a slide taken from a little to the north of the archway over the Llandegfan road the gritty tuff contains a rudely triangular fragment of a fine, wavy, clastic schist that may very well have been derived from the adjacent Complex. It is true that spilitic fragments do occur in some of the members of that Complex (p. 166), but those beds are associated with and affected by the same metamorphism as the Gwna spilites, which very lavas, passing into chloritic schists, form an integral part of the Mona Complex immediately below the Baron Hill thrust-plane. There seems no reason to doubt that the Baron Hill tuffs are posterior to the whole of that metamorphism.<ref>That the Baron Hill

thrust-plane drives higher beds upon lower presents no difficulty. Slices of beds, piled up by minor thrusts, are occasionally driven over beds of lower horizons upon major thrust-planes in the North-west Highlands.</ref>

That the volcanic group of Bangor, of which this is a fragment, is at any rate not of later date than Cambrian is generally admitted, and now finds confirmation in the fact that no trace of such rocks can be found on or above the zone of *Didymograptus extensus,* which is well defined along the Menai Strait. Within some half a mile of one of their Bangor outcrops, that zone (see chapter 14) rests directly upon the Mona Complex, leaving us to infer that it transgresses them with a sharp unconformity. They are certainly far below the Penrhyn purple slates, and consequently, if Cambrian at all, must be very low down in that series. The zone of *Olenellus,* it is well to recall, has never yet been identified in North Wales, and may be represented in part by volcanic rocks. But whether the Baron Hill and Bangor Series be Cambrian or a late Pre-Cambrian formation is a problem that is not likely to be solved until the tracts between the Menai and the mountains have been mapped in detail and with precision, and their finer Pre-Ordovician beds have been searched for fossils.

The Careg-Onen Beds

At four places along the southern side of Red Wharf Bay there are small strips and patches of old sedimentary rocks that rest unconformably upon the Mona Complex, and whose relations to the Ordovician shales are such, as to suggest that they do not belong to that system.

The localities are:

1. A strip in the sea-cliff, 200 yards in length, at Careg-onen cove, north-west of Bwrdd Arthur

2, 3. Two little outliers, 100 and 34 yards in length respectively, resting on the steep north slope of Mynydd Llwydiarth, just above Coch-y-mieri

4. A strip about a third of a mile in length, on the same slopes rather further west.

The rocks include grits, mudstones, slates, and ironstone. Nearly all the sediments are very hard and flinty.

Petrology

The grits are for the most part hard greywackes, some dark and coarse as in the western strip, others lighter and finer as at Coch-y-mieri. That of Careg-onen is full of clastic mica. Some of those at Coch-y-mieri have impersistent seams of dark shale and are rather muddy. These contain many rounded masses, about a quarter of an inch long, of fine mudstone like that interbedded with the grits, which are probably 'galls' of contemporaneous erosion. At the western strip there is a band of conglomerate, with well-rounded pebbles as much as an inch in length, of a quartz-felsite with good rhyolitic structure. The coarser grits of the base contain fragments of the local schists, of quartzite, and quartz-mosaic, with small bits of lavas of spilitic aspect. The clastic felspars are allied to albite, such as is common in the Mona Complex. ***The mudstones*** are of olive to pale sea-green tints. Where unaltered they are finely gritty, but elsewhere very fine, and at Coch-y-mieri have been converted, by a basic sill that is nearly concealed, into faintly spotted spilosite full of brightly polarising microliths that lie in all directions. ***The slates*** — None of the sediments just described, though intensely indurated, are cleaved, but at Careg-onen most of the mudstone is now a well-cleaved, hard, pale sea-green slate. In it, here and there, are bands of dark nodules, arid a few oolitic grains, sheared along the cleavage. Bedding is indistinct and can be made out in a few places only, at which it is seen to be rather sharply folded (Figure 192), and where minute micas lie across the cleavage, they are bent. The cleavage itself is for the most part straight (though traversed by a few thrusts, as in (Figure 192)), is smooth, and almost vertical; it is the dominant structure, and these folded planes are only seen if sought for. The old bedding is welded, and the slates have become unusually hard. ***The ironstone*** of Careg-onen appears to be a micaceous mudstone that has been impregnated with haematite; but this ferrification has been irregular and partial. The rock is gritty in parts. No oolitic grains have been seen, and it is quite different from the Ordovician ironstones.<ref>The slides of the Careg-onen rocks are (E9791) [SH 581 819], (E9792) [SH 581 819], (E9793) [SH 581 819], (E9799), (E9813) [SH 581 819], (E9814) [SH 581 819], (E9815) [SH 581 819], (E9816) [SH 581 819], (E9817) [SH

551 798], (E9818) [SH 551 798], (E9819) [SH 544 795], (E9820) [SH 546 795], (E9821) [SH 544 795], (E9833) [SH 551 798], (E9834) [SH 551 798], (E9835) [SH 551 798], (E9836) [SH 551 798].</ref>

Palaeontology

In six out of sixteen slides (E9791) [SH 581 819], (E9813) [SH 581 819], (E9816) [SH 581 819], (E9820) [SH 546 795], (E9821) [SH 544 795], (E9836) [SH 551 798], cut from these sediments, there are sections of sponge-spicules (Figure 193). All are in grits, and only one-third of the grits were barren. They occur both at Careg-onen, Coch-y-mieri, and in the western strip, and in each case at the base of the series. Of those in the thin micaceous grit of Careg-onen Dr. G. J. Hinde wrote in 1896 The rounded bodies in the slide are undoubtedly sections of sponge-spicules, which are cut through, some at right angles, others obliquely, and very rarely in the direction of their length. The dark spot in the centre of most of them is the axial canal of the spicule, now filled with some dark mineral. In some cases the spicules have been squeezed out of shape. They are from .07 to .26 millimetre in thickness. I cannot say to what group of siliceous sponges they may have belonged, for only these sections are to be seen. They are now of micro-crystalline (?) silica of the same character as is usual with sponge remains in Palaeozoic rocks. They seem to be fairly numerous in the rock'. Of those frogs Coch-y-mieri and the west, he wrote in 1907 The sections contain sponge-spicules of the same character as those in the slide (Careg-onen) which I examined in 1896, and there is every probability that they belong to the same series'. In that from Coch-y-mieri spicules are more abundant than in the original slide, and not only do they confirm what was noted concerning their sponge characters, but some of them clearly show that they belong to the hexactinellid group of siliceous sponges. Several examples of four-rayed forms are present and traces of their axial canals are preserved. They are all imperfect but their characters are distinct. No conclusion as to the age of the rock can, however, be made from these spicules, for they are very common forms. It may be stated, however, that the earliest known sponges, those from the Menevian beds in South Wales, belong to the same group'. Whatever, then, be the real age of the beds, it is clear from these interesting organisms that those of the three localities can all be safely placed do one and the same horizon. No other fossils have been found. The Careg-onen slates and the western mudstones have been searched by Mr. J. M. Muir for two days, but without success.

Structure and relations

The sea-cliffs of Careg-onen are remarkable for the double (or rather, it will appear, even triple) unconformity so clearly to be seen. in them (Figure 194) and (Plate 26)B. Towards the west end of the beach the pale green slates, emerging from beneath rather crumbly dark shales of Ordovician age, give rise at once to a vertical wall of cliff that attains to some 15 or 20 feet in height. The top of this cliff (Figure 194) is a sharply marked feature, and over it the shales pass at moderate angles. About half way along, the folded bedding can be seen, and near the western end (at x in (Figure 194)) corrugated Gwna Green-schist of the Mona Complex rises suddenly from beneath the slates in a very sharp anticline (Figure 195), and then again on some gentler undulations before rising *en masse* at the west wall of the cove, where it is driven a little eastward over the slates. The spiculiferous grit first discovered and submitted to Dr. Hinde occurs close to the base at the sharp anticline. It varies from three to four inches in thickness, but is very much pinched and broken as shown in (Figure 196) and (Figure 197). West of the stream the slates (here not much cleaved) undulate above the Gwna schists, and at their base is a muddy breccia with fragments of schist, and also the ironstone, both of which contain sponge-spicules.

A section of the larger outlier at Coch-y-mieri is given in (Figure 198). At the base is a rather coarse, shaly, grit with galls' and fragments of Penmynydd mica-schist, and in this are the hexactinellid sponges described above. Then follow finer grits, then compact grits, then a bed with rolled mudstone fragments, then the spotted hornfels, and finally a rather coarser grit with fragments of compact rocks. The smaller outlier is less well exposed, but consists of grits with the same general dip. From the high dips it is clear that the outliers must either rest upofi a disruption-plane or be sharp synclinal infolds.

The western strip is more complex. The annexed section (Figure 199) illustrates its probable structure. Olive-green mud-stones overlie hard grits with sponge-spicules, and these rest unconformably upon the Penmynydd mica-schists. At the southwest end of the strip the base (which seems unfaulted) is at a high angle. Towards the north-east it is at a low angle, but the series is bounded by a fault. In the middle of the strip, the two south-eastern faults coalesce, cutting out the grit and bringing the mudstones against the Mona Complex. But there appear to be pebbly grits within the mudstones.

Geological age

That these rocks are of later date than the metamorphism of the Mona Complex is abundantly evident. Powerfully as they are folded, they are not in the least affected either by the foliation or by the extreme and involved contortions of the schists, which are truncated against them. Fragments of those schists occur in their lowest member. And at the three localities they rest upon three different members of the Complex, the Gwna Beds and two different parts of the Penmynydd Zone.

Their relations to the Ordovician rocks present more difficulty. In 1896 it was supposed that the junction at Careg-onen was the true base of the Ordovician resting unconformably upon them, and stress was laid upon the view that the Ordovician shales, although so fine, were unaffected by any cleavage. Fresh evidence, however, has been obtained since then. By means of a rope the junction was explored at the cliff's brow, and some excavation done along it. Not only is the surface slickensided, but the shales rest upon it obliquely and are even contorted in places. Also, a little to the east along the beach, these, shales have been opened out a good deal in the works connected with the Mersey Dock Board's quarry, and it has been found that there is a feeble cleavage in them after all. Finally, it appears that the lower zones of the Ordovician are missing. The local fossils are somewhat ambiguous (Chapter 14, 'Llangoed Area'), but certainly not lower than the zone of *Didymograptus bifidus,* and unlikely to be lower than the Glenkiln; yet at Pen-yr-allt, only a mile away (*loc. cit.*), the zone of *Didymograptus extensus* is present. Evidently several zones of the Ordovician are cut out by thrusting at a lower angle than the dip, and the surface of the green slates must be regarded as a thrust-plane.

On the other hand, the Careg-onen Beds, both slates and mudstones, are very much more compacted and indurated than any of the Ordovician rocks for many miles around. Dr. Hinde also considers that the only sponge-spicules yet found in the Ordovician of Anglesey (Chapters 13, 14, (Figure 200)), which are in the Glenkiln beds, are distinct as a whole from those that occur here. And finally there is this important consideration. If these rocks be Ordovician at all, they are certainly basement beds, and as such cannot be higher than the zone of *D. extensus.* Now the lithological types of fine sediment in the several graptolitic zones are very persistent (Chapter 13); and nowhere in the Arenig Beds of the Island has anything been found that in the least resembles the pale sea-green and olive-green hard slates and mudstones of this series. It remains, therefore, extremely improbable that these beds belong to the Ordovician. And if so, then their extremely limited distribution beneath that system, together with their greatly superior cleavage and induration, show that the relations must be unconformable. Can they be correlated with anything?

To whatever formation they belong, they are its basement beds, and as the base of the Baron Hill Beds has not yet been seen either at Baron Hill or Bangor, they may possibly belong to that series. But the Bangor series is highly volcanic, whereas the Careg-onen Beds, though containing derived volcanic fragments, are essentially sedimentary.

Since this chapter was written, however, light has been thrown upon their age from another direction. Mr. Nicholas<ref>See the last division of this chapter.</ref> has shown that, at St. Tudwal's, there is a strong unconformity between the Ordovician and Cambrian systems. He also describes the Harlech rocks of that tract as containing beds of pale-green and often 'cherty ' mudstone that may sometimes be termed 'hälleflinta', words that certainly recall the rocks of Careg-onen. No sponges are yet recorded from St. Tudwal's, but those of Careg-onen are consistent with a very low position in the Cambrian system. The Careg-onen Beds, therefore, parted by unconformities both from the Ordovician and the Mona Complex, may possibly be Cambrian.<ref>If Cambrian, their sponges must be considerably older than the Menevian ones alluded to above by Dr. Hinde.</ref>

If they belong neither to. that system nor to the Bangor Series, then they must be survivors of some late Pre-Cambrian formation that has not been recognised elsewhere.

In conclusion, they are certainly far later than the Mona Complex, and must be Pre-Ordovician. But the question as to whether they be Cambrian or Pre-Cambrian must await further research upon the Bangor series and upon the base of the Cambrian throughout North Wales.

Bwlch-gwyn Felsite

At Bwlch-gwyn, Holland Arms, are two small masses of quartz-felsite, the larger of which, close to the house on its north side, is about 100 yards in length, and forms a high rocky knob. The smaller one, about 220 yards to the east, is surrounded by the Penmynydd schists of the Mona Complex, and its relations are not exposed. The larger one lies between the schists and the Ordovician rocks, and is evidently cut off by a fault at its northern end. On its south-east side it is seen in contact with mica-schist, which is baked, and loses its fissility, the felsite being undeformed. On the west, sandstones and sandy shales, containing brachiopods and corals, that lie at the base of the Arenig Beds (Chapter 14) rest against the felsite with a dip of 60°. The surface of the felsite is hummocky, the beds are unbroken, and there is no sign either of a fault, or of the least contact alteration. This felsite is therefore later than the Mona Complex, and Pre-Ordovician. It is a typical rhyolitic felsite, with phenocrysts of hypidiomorphic quartz, and of rather stout albite (E9854) [SH 483 730], in a fine devitrified matrix with beautiful fluidal structure. The rock is different in many ways from the sills and dykes described in Chapter 16; but the fluidal structure and fine crypto-crystalline mosaic of the matrix recall the quartz-felsite of Llanberis. It may therefore be assigned, with much probability, to early Cambrian or late Pre-Cambrian time.

Trefdraeth Conglomerate

About a third of a mile west-north-west of Trefdraeth Church is a knob of conglomerate, some 30 yards in length. Most of the pebbles are about jtn inch long, but some of them exceed three inches. The majority are of Gwna quartzite, and of various quartz-felsites, but there are also Gwna Green-schists of local type, jaspers, and granite of the Complex, with fine laminated grits, and unknown black chert-like rocks. The matrix is green, and evidently derived from the waste of local volcanic rocks. It is powerfully sheared, and some of the pebbles deformed, though the harder ones retain their rounded shape. The planes of shearing are in the same general direction as the foliation of the Complex, but some of the pebbles of schist lie with their divisional planes across those of the matrix. This conglomerate is therefore later than the Complex, but its junctions with the adjacent schist and quartzite are not exposed. Its matrix, though so sheared, is less reconstructed than those rocks, but much more deformed than any Ordovician rocks of that portion of the Island. It recalls the Llanberis conglomerate both in condition and contents, but may belong either to the Cambrian or to the Careg-onen Beds.

Chronology of the outliers

Whether the four rock-groups described above are all of the same date is very doubtful; it is indeed very improbable. The Careg-onen rocks and the Trefdraeth conglomerate may be Cambrian: the Baron Hill rocks' and the Bwlch-gwyn felsite may be somewhat older. But however this be, it is evident that all of them are fragments of formations that bridge, or partly bridge, the great gap of time between the Mona Complex and the Ordovician. There can be no doubt also that these formations must once have been extensive, and that the reduction of them to these tiny fragments is the work of the powerful and prolonged erosion that ushers in the Ordovician system in this region.

The Careg-onen, Trefdraeth, and Baron Hill rocks have been doubtfully coloured and lettered as Cambrian upon the one-inch map. But the Bwlch-gwyn Felsite has been coloured vermilion for the sake of visibility.

The Cambrian Period in Anglesey

There has long been a serious gap in our knowledge of the early history of Anglesey, no reliable information having been available concerning its condition during the Cambrian Period. No rocks of unimpeachable Cambrian age have, indeed, been discovered in the Island. Some recent researches on another part of North Wales, however, are now throwing a flood of light upon the subject.<ref>Their results have had to be made use of in the earlier parts of this chapter, and in Chapter 9.</ref>

The relations of the Cambrian and Ordovician systems in Carnarvonshire

When Ramsay put forward his far-reaching theory (see p. 15) first of overlap and then of erosive unconformity at the base of the Arenig Beds, he was deterred from carrying his views to their legitimate conclusion by the following

considerations. First, no discordance of dip was perceptible on the mountain-flanks of north Carnarvonshire. In the second place, believing as he did that the Harlech-Penrhyn (which appears to be the Paradoxidian) division of the Cambrian system was represented in the Mona Complex, there remained only the upper (*i.e.* Olenian) division to be overstepped. And, as no Tremadoc beds could be identified on those mountains, the thickness to be overstepped between the mountains and the Menai was reduced, for him, to little if any more than that of the attenuated Lingula flags of the Ogwen. For many years, therefore, the degree of unconformity which it seemed necessary to postulate remained but a moderate One; the more so as Tremadoc beds were for a while supposed to exist in Anglesey.

As soon, however, as the fragments that had been referred (always with some hesitation) to the Tremadoc form *Neseuretus ramseyensis* were found (see p. 16, and Chapters 13, 14) to belong to the Arenig species *Calymene tristani,* all fossil evidence for the presence of Cambrian rocks disappeared from Anglesey. When, further, the zonal investigation of the Ordovician of the Island (see Chapters 9, 8) demonstrated that it reposed immediately upon the Mona Complex with a great unconformity, and when the correlation of that Complex with the lower divisions of the Cambrian could no longer (see Chapter 9 and pp. 425–6) be sustained, the hiatus between Cambrian and Ordovician in North Wales assumed of necessity much more serious proportions. For, with the disappearance of Cambrian rocks from Anglesey, no escape remained open from the conclusion that the whole of the North Carnarvonshire development of that system is overstepped between the Bethesda foothills and the Menai Strait.

Unfortunately, the definition of the zonal horizons between the Lingula flags and the Bala beds on the northern slopes of Snowdon and the Ogwen mountains leaves much to be desired. But not long after the Anglesey researches just mentioned, it was shown by Mr. T. C. Nicholas (see pp. 15, 35) that, about St. Tudwal's in the Lleyn, the base of the zone of *Didymograptus extensus* rests upon the Cambrian rocks with an unconformity so pronounced that no less than 6,000 feet of beds are transgressed in a few miles, the discordance itself being visible in a cliff-section. Here then, there was revealed a stratigraphical break amply sufficient to account for the total disappearance, in so short a space, of the Cambrian of the Ogwen sections.

The Cambrian rocks of Anglesey

Such being the case, it became evident at once that Cambrian rocks might have existed upon Anglesey after all; and Mr. Nicholas accordingly proceeds to urge that their long-discussed absence from that island was likely to be due, not to mere overlap or attenuation, but to prolonged Sub-Arenig denudation. Cambrian fragments have not as yet, it is true, been identified in the Ordovician conglomerates of the Island; but it must be remembered that their parent rocks had not, in Ordovician times, undergone the gigantic pressure of the Post-Silurian movements, so that they would not possess the survival-power of the tough greywackes and slates that compose the formation as it is presented to us to-day.

If, however, the evidence from St. Tudwal's be applied to North Carnarvonshire, we can proceed a step further. Along the Ogwen, where neither the Tremadoc beds nor the zone of *Olenellus* have been identified, the Cambrian series has nevertheless a thickness' of 5,000 feet. It approaches. to within less than three miles of the Menai Strait, where it is completely overstepped, the base of the zone of *Didymograptus extensus* resting directly on the Mona Complex. This phenomenon, as well as the disappearance of the Tremadoc Beds, must now be ascribed to the same unconformity as that which, at St. Tudwal's, presents to us a visible discordance of dip. That no such discordance of dip is perceptible between the two systems in the Ogwen section must mean that the Cambrian Beds were (*cf.* p. 219, and Chapter 14) locally horizontal in Ordovician times. From the direct reposal of the Extensus zone upon the Mona Complex, we can discern that Anglesey was the site of a broad Cambrian anticline of Pre-Ordovician date. If we suppose that the horizontal floor of one of its complementary synclines lay where the junction of the two systems emerges in the Carnarvonshire mountains, the swift change from concordant dips to rapid overstep receives an explanation.

With such complete unconformity at St. Tudwal's, and such an overstep across the Ogwen-Aethwy interval, no doubt can remain that a considerable' mass of Cambrian rocks must once have rested upon the surface of the Mona Complex in Anglesey.

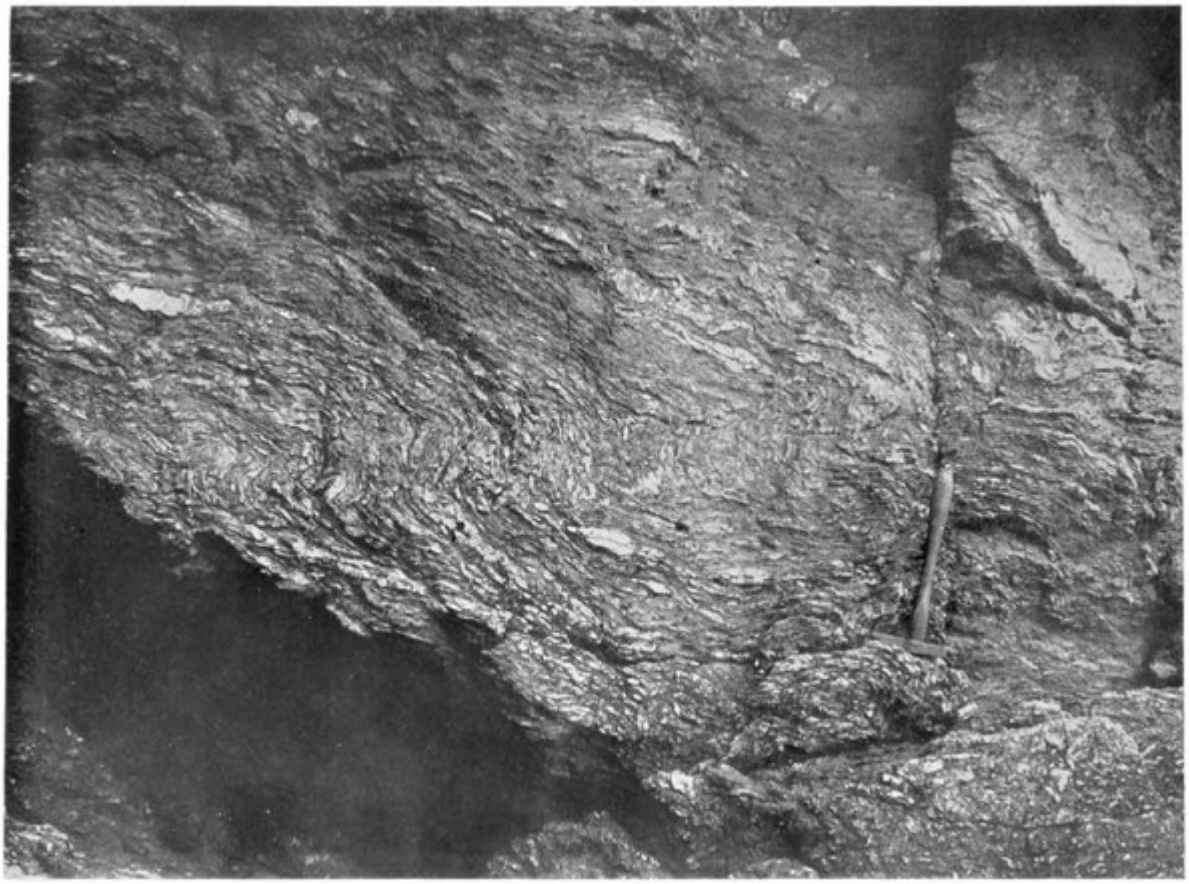
They have vanished. Yet it is not quite beyond our power to form a general mental picture both of their zonal horizons and their nature. The zones of *Olenus* and *Paradoxides* must both have been present. The zone of *Olenus* could hardly

fail to be represented by the missing Tremadoc Beds, as well as by the dark-grey shales, 'and the sandy flags with *Lingulella dttvisii,* of the Ogwen mountains. The zone of *Paradoxides* (if we are right in referring the Penrhyn slates with *Conocoryphe viola* to that horizon) contains, not only massive grits that may have thinned out somewhat, but pelitic sheets hundreds of feet in thickness, which must have persisted far to the north-west over the site of Anglesey. That the zone of *Olenellus,* not yet identified in North Wales but so widespread in the British Isles, was totally absent, is difficult to believe. A suggestion has been thrown out that it may be locally represented by the volcanic group of Bangor'. Even, however, if that prove to be Pre-Cambrian, there may still be room for the zone below the purple quarry-slates. Its fossils should be looked for in the thin bands of slate that alternate with the St. Ann's and adjacent grits, which are far below the green beds with. *Conocoryphe viola.*

These Cambrian zones, even if attenuating, must have still maintained an aggregate thickness of three or four thousand feet far over Anglesey. But in the course of even the earlier stages of the Ordovician erosion they were swept away, leaving at the most a few little isolated infolds, it may even be not a wrack, behind.

Whether the tiny fragments of Baron Hill and Careg-onen be survivors of the vanished Cambrian deposits of Anglesey has already been discussed in this chapter.

(Plate 34) Cleavage and bedding in Cornstones and Mudstones of the Old Red series. Porth-y-mor.



(Plate 23) Folding of Autoclastic Melange. Menai Strait.

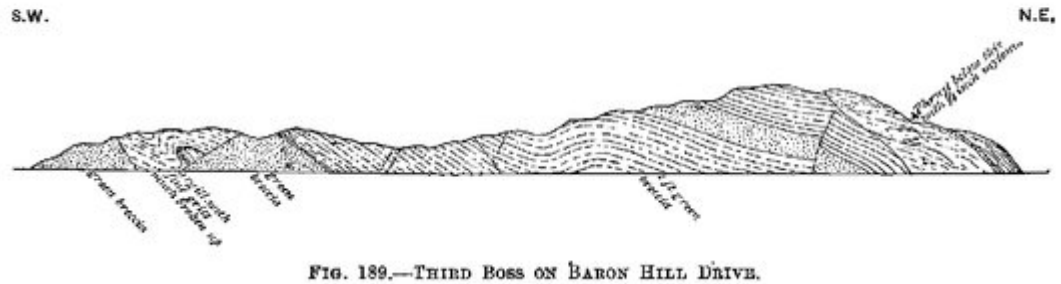


FIG. 189.—THIRD BOSS ON BARON HILL DRIVE.

(Figure 189) Third boss on Baron Hill Drive. Scale: one inch = 50 feet.

FIG. 190.—FOURTH BOSS ON BARON HILL DRIVE.
Scale: One inch = 50 feet.

(Figure 190) Fourth boss on Baron Hill Drive. Scale: one inch = 50 feet.

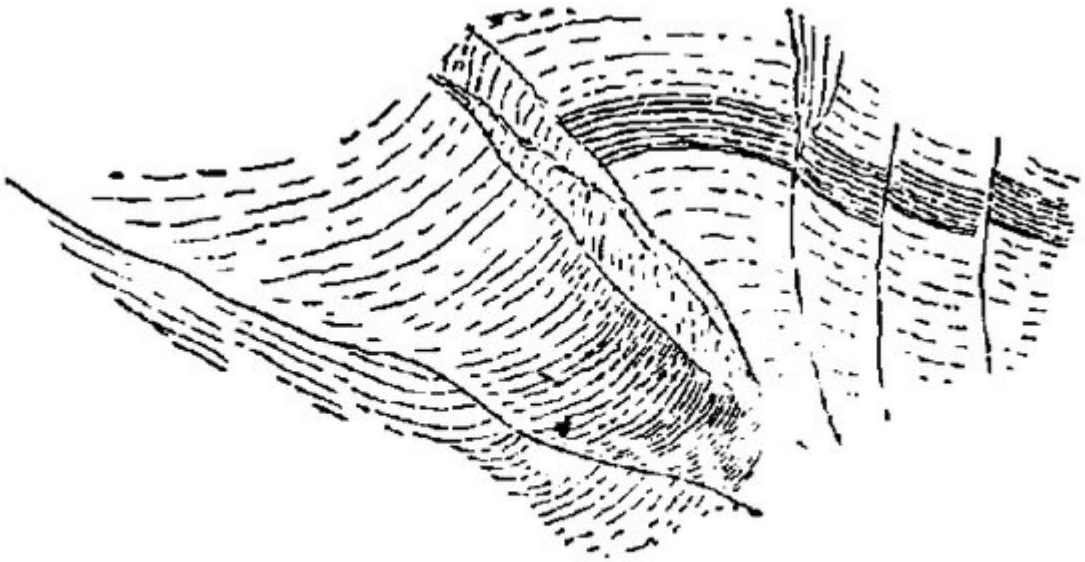


FIG. 191.

FACE OF CLIFF.

(Figure 191) Face of cliff. Two and three-quarter inches below the thrust shown under x in (Figure 189) Natural size.

FIG. 192.

BEDDING AND CLEAVAGE ON CAREG-ONEN BEACH.

(Figure 192) Bedding and cleavage on Careg-onen beach.

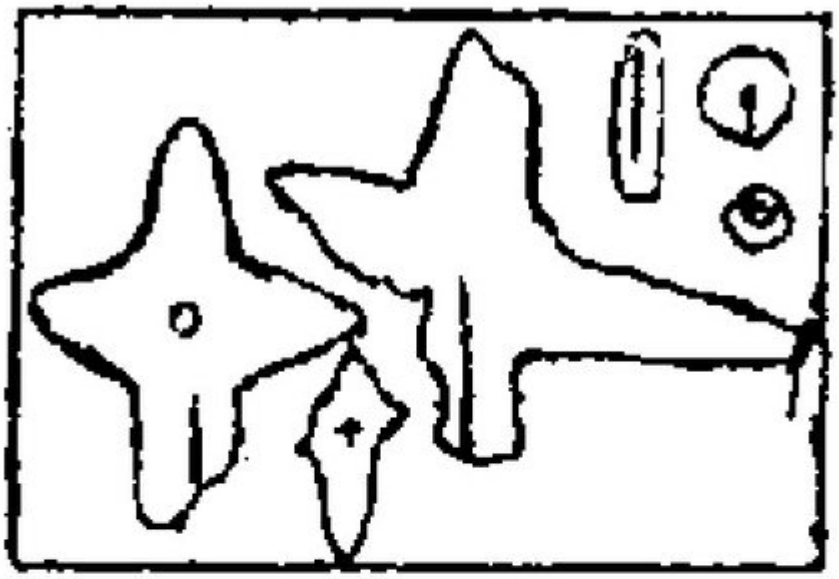


FIG. 193.

SPICULES OF THE CAREG-ONEN BEDS.

(Figure 193) Spicules of the Careg-onen Beds. Simple forms from Careg-onen. Hexactinellid from Coch-y-mieri. × 12.

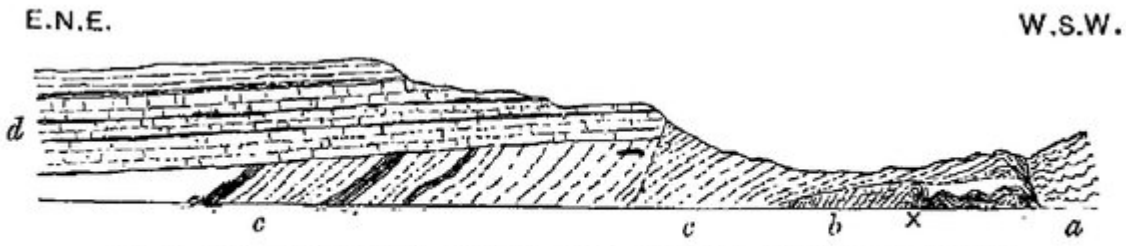


FIG. 194.—SECTION ALONG THE CLIFFS AT CAREG-ONEN.

Scale: One inch = 440 feet.

(Figure 194) Section along the cliffs at Careg-onen. Scale: one inch = 440 feet. Gwna Green-schist (a); Careg-onen Beds (b); Ordovician Shales (c); Carboniferous Limestone (d).

The Skerries. From near Carmel Head.

Careg-onen Cliffs.
Mona Complex, Careg-onen Beds, Ordovician Shales, and Carboniferous Limestone.
Height seen = about 330 feet.

(Plate 26) The Skerries. From near Carmel Head. 26a Careg-onen Cliffs. Mona Complex, Careg-onen Beds, Ordovician Shales, and Carboniferous Limestone [Note.—The crags in the foreground are composed of the Careg-onen Beds, ex where to 1¾ to 2 and one eigth inches from right hand edge of view) the sharp anticline of G Green-schist (Figure 194), (Figure 195) rises from under them.].

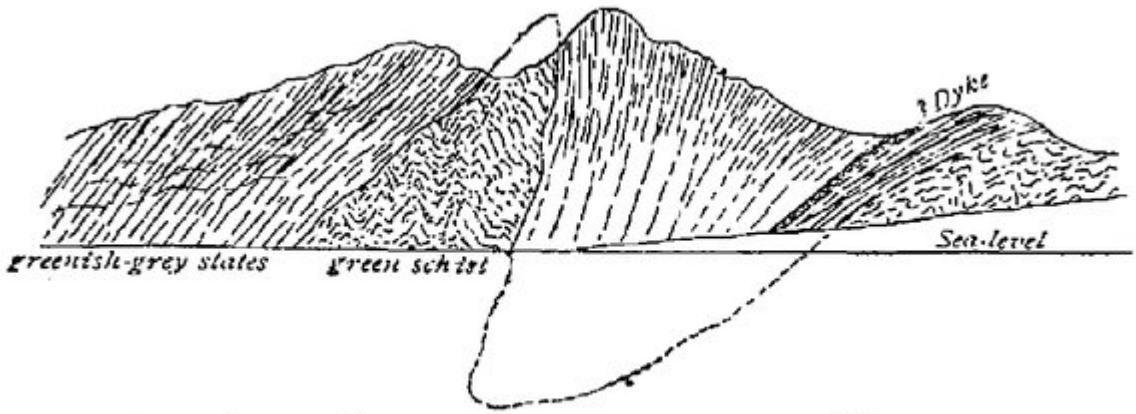


FIG. 195.—THE ANTICLINE AT X IN FIG. 194.

(Figure 195) The anticline at × in (Figure 194) [Section along the cliffs at Careg-onen]

FIG. 196.

(Figure 196) Detail of (Figure 195). [Section along the cliffs at Careg-onen]

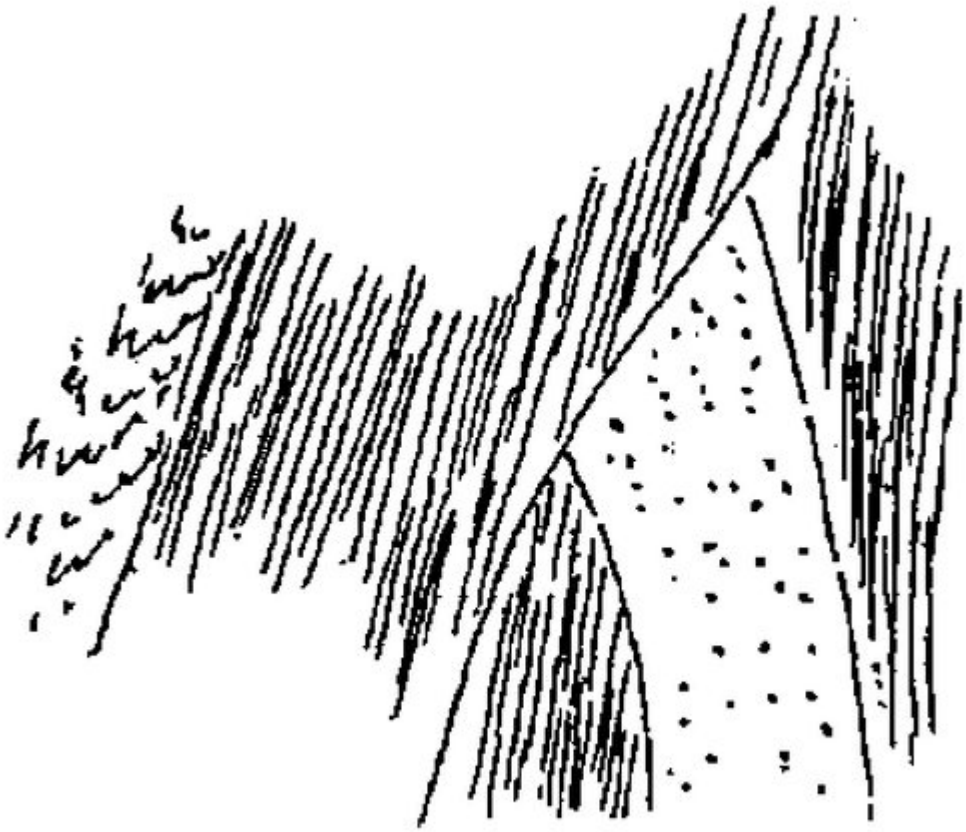


FIG. 197.

(Figure 197) Detail of (Figure 195). [Section along the cliffs at Careg-onen]

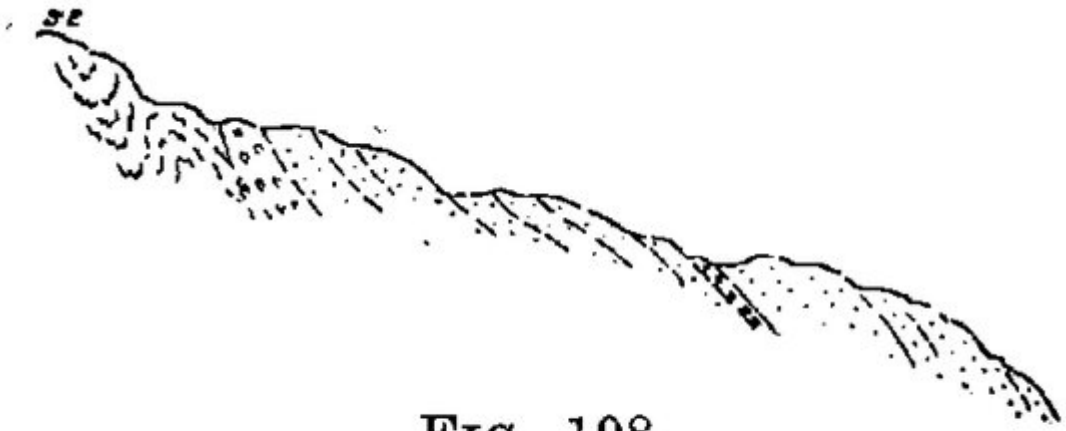


FIG. 198.

SKETCH SECTION OF CAREG-ONEN BEDS AT COCH-Y-MIERI.

(Figure 198) Sketch section of Careg-onen beds at Coch-y-mieri.

FIG. 199.

SKETCH SECTION.

(Figure 199) Sketch section. About a quarter of a mile south-west of Ty-mawr. M = Penmynydd Schists. a = Careg-onen Beds. b = Ordovician Shales.

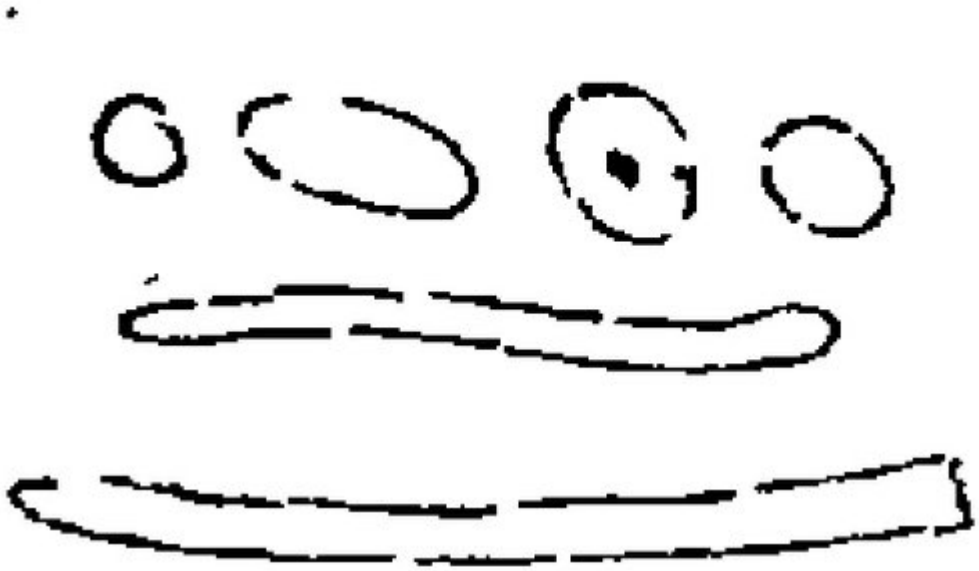


FIG. 200.

SPICULES OF GLENKILN CHERT,

(Figure 200) Spicules of Glenkiln Chert, Porth wen. × 12.