

---

## Chapter 14 Detail of the Ordovician rocks

### The Menai Fragments

The shales of the Carnarvonshire side between the bridges are well exposed along 100 yards or so of shore to the south of the Church islet. At the west end of the section the base of the Carboniferous conglomerate can be seen resting upon them unconformably, and they are reddened for several feet below it. Where unstained, they are clean blue-black micaceous shale of Arenig type, quite free from cleavage. Their graptolites are undistorted, single extensiform stipes reaching two inches in length. They have yielded [Af. 3702–25]:

The forms marked \* were collected by Miss Elles, and are in the Sedgwick Museum at Cambridge.

*Didymograptus extensus* (Hall)

*Didymograptus gibberulus* Nich. \*

*Didymograptus nicholsoni* Lapw. \*

*Didymograptus nitidus* (Hall)

*Didymograptus cf. uniformis* E.&W. \*

*Tetragraptus serra* Brongn. \*

*Tetragraptus amii* Lapw. \*

*Lingulella* sp.

*Caryocaris wrighti* Salter

*Caryocaris* sp.

Trilobite (indet.)

which indicate the lower part of the zone of *Did. extensus*. Their base is not seen, even at spring-tide ebb.

Pebbles from the Glacial gravels of Ty'n-y-caeau have yielded [Af. 168–97, 302]:

*Didymograptus bifidus* (Hall)

*Didymograptus extensus* (Hall)

*Didymograptus hirundo* Salter

*Lingula?* [or *Lingulella?*]

*Æglina binodosa* Salter<ref>Recorded by Mr. Edwards and Prof. Ainsworth Davis, Lpl. G.S., 1906.</ref>

*Caryocaris marri?* Hicks

*Caryocaris wrighti* Salter

which must have come from the bed of the Strait to the north-east. All three zones must therefore be developed in that direction, and outcrop somewhere upon the sea-floor.

The Anglesey shore at Garth Ferry is composed, for three-eighths of a mile, of grits ([E6067](#)) [SH 576 738], ([E9837](#)) [SH 577 739]–([E9838](#)) [SH 577 739] and shale, forming cliffs 10 or 20 feet in height, brought against the Mona Complex by a strong fault that runs along close behind, and keeps on appearing in the cliff. No fossils have yet been found, but some shale (often concealed by shingle) which rests on the grits a few yards to the south-west of the Inn is of thoroughly Arenig type. The most conspicuous rock is a massive white grit, in which, beyond the Inn, are thin partings of shale. To the south-west, there are also darker, thin-bedded grits. The whole group is much faulted and shattered, and the boundary fault is for some distance a steep overthrust. But in many places the junction is obscured by excessive quartz-veining. At a little outlying 'buttress' of grit, 570 yards south-west of the Inn, the massive grit is to be seen resting on the schists; and it contains fragments of jasper, quartzose schist, and Gwna Green-schist. It is therefore a basal grit, and must underlie the shale of the shore between the bridges. The Garth Ferry shale may thus be expected to yield fossils of lower horizon still.

## The Llangoed area

All the southern parts of this are laden with heavy glacial drifts, but there are good sections on the hill-top at Bryn-celyn and on the coast at Careg-onen, with some small ones between. Neither base nor top of the series is visible, for, as has been shown in Chapter 12, the plane upon which it rests at Careg-onen is a thrust that cuts out several zones. In the ironstone quarry on the south side of the Bryn-celyn road at a place 50 yards west of the '216' level, the following fossils were obtained [Af. 26–79]:

*Climacograptus* sp.

*Dendrograptid*

*Didymograptus amplus* *E.&W.*

*Didymograptus murchisoni* (*Beck*)

*Didymograptus murchisoni* *var. geminus* (*His.*)

*Diplograptus* (*Glyptograptus*) *dentatus* (*Brongn.*)

The *Didymograpti* are abundant, but are preserved, for the most part, not in shale, but in muddy felspar grits. Greenish micaceous shale appears in the lanes a little to the east. West of this, in the deep ravine [Af. 160, 3743], *Didymograptus gibberulus* Nich., and an obscure crustacean were obtained in dark mudstones, indicating that the Extensus zone rises close to the junction with the Mona Complex. A boring for water has lately been made about 500 yards east-south-east of Wern, at a house called on the six-inch maps Plâs-yn-llangoed, in the Carboniferous Limestone at a spot 60–100 feet above the base. It passed through the limestone into dark shales. In the upper parts of these were found, at a depth of 140–190 feet [Af. 3745–62]:

*Climacograptus antiquus?* *Lapw.*

*Cryptograptus tricornis?* (*Carr.*)

*Glossograptus* sp.

*Mesograptus foliaceus* *Murch.*

*Paterula?* *balcletchiensis* (*Dan.*)

*Conularia?*

thus indicating the zone of *Glyptograptus teretiusculus*. The boring then passed into darker shales, associated with which<ref>It was said to be at the bottom, but this is merely from local information, and seems unlikely. The progress of

the boring was not watched by a geologist, and only one short core was obtained by the present writer.</ref>, some 300 feet from the surface, was pisolitic ironstone dipping, so far as can be seen from the core, at moderate angles. In these lower shales were obtained [Af. 3525–37]:

*Didymograptus amplus* E.&W.

*Didymograptus murchisoni* (Beck)

*Diplograptus* (*Orthograptus*) *calcaratus* Lapw., var. *priscus* E.&W.

*Diplograptus* (*Amplexograptus*) *coelatus* (Lapw.)

*Acrotreta* cf. *nicholsoni* Dav.

*Paterula?* *balcletchiensis* (Dav.)

The graptolites are large and in beautiful preservation. The discovery thus proves the extension eastwards of the two zones beneath the Carboniferous Limestone, and shows that the beds are not inverted.

Shale of Ordovician type is visible at Glan-yr-afon, and at a few places in the narrow belt south of Bwrdd Arthur, with debris of pisolitic ironstone., On the coast at Careg-onen, the general relations are shown in (Figure 194) and (Plate 26)B. A considerable thickness of beds appears to be exposed, but there are many planes of movement, though little cleavage. Grey shales of doubtful type dip under similar beds which have received a purple-red staining beneath the Carboniferous Limestone. In the red shales were found [M. 756, 3011–17] *Dicranograptus rectus* Hopk., and *Diplograptus* (*Glyptograptus*) *teretiusculus* (His.), var. *euglyphus* Lapw., so that these must be assigned to at least a high position in the zone of *Nem. gracilis*, if not to the zone of *Clim. peltifer*. The grey shales, 50 yards to the west, and behind a little hut, yielded [Af. 2294–3010, 3641–61]:

*Climacograptus antiquus?* Lamr.

*Climacograptus scharenbergi* Lapin.

*Climacograptus* sp.

*Orthis* sp.

*Plectambonites?*

*Ctenodonta transversa* (Portl.)

*Ampyx nasutus* Dalm.

*Ogygia?* [or *Asaphus*]

The evidence is, therefore, apparently conflicting — the only case of such conflict in the island. Miss Elles writes that the graptolites are characteristic Glenkiln forms, while Mr. Lake writes: The *Ampyx* is clearly the same as the form which occurs fairly frequently in the Bifidus shales of South Wales, and not, so far as I know, at any higher horizon'. Mr. Muir writes (May, 1913):

'There is no doubt whatever that the trilobites and graptolites came from the same bed, for I got them in one case at least on the same slab, and there is no possibility of a fault or thrust-plane'. The graptolites on that slab, however, were not well-preserved, and Miss Elles's list was made from the others, which leaves it open to appeal to thrusting as an explanation of the discrepancy. From the development of the Extensus zone only a short distance away (p. 432 and below), it is evident that the base of the system is cut out at Careg-onen. Dr. Teall has lately drawn my attention to a paper by Arnold Heim<ref>Ueber rezente und fossile Rutschungen und deren lithologische Bedeutung. *Neues Jahrb.*,

1908, vol ii., p. 137., describing recent slips of alluvial deposits on a slope not exceeding 4° or 5°, by which not only are certain beds cut out, but older have been brought to overlie later ones. Possibly slips of this kind may account for the apparent faunal overlaps' that seem to be met with occasionally.

**The Llanddona Outlier** — At Pen-yr-allt, Llanddona, some six feet of dark shale of Arenig type, and unclesaved, is seen to rest directly on the Gwna Green-schist in the farm lane and yard, at varying angles. This little outlier has yielded [Af. 3737–38] fragments of simple-celled Dichograptids, and *Caryocaris wrighti* Salter, so that the Extensus zone is present here, without, apparently, any basal grit, for there seems to be no slide-plane.

The position of the Pisolitic ironstone ([E9795](#)) [SH 602 796] and analyses) remains to be considered. The old quarry at Bryn-celyn has lately been enlarged, and two small shafts made in its floor, from which it appears that the ironstone must be about 15 20 feet in thickness. The felspar-grits ([E9796](#)) [SH 602 796] with *Did. murchisoni* dip as if to pass under the ironstone, and contain a few grains of oolite in their 'lower' beds; but at the north end they are driven over it. No fossils have been found in the ironstone itself, but shale on a heap that seems to have come from the southern shaft (of a different type from that which is associated with the ironstone) contains large specimens of *Did. murchisoni*. It is therefore possible that the ironstone may not be on that horizon, and that the zone of *Glyptograptus teretiusculus* may have been cut out by the thrust-plane. On the whole, however, it appears doubtful whether the ironstone is on one horizon, even within the limits of the quarry, and in the boring at Plâs-yn-llangoed it seems to be close to the Murchisoni shales.

## The strips along the Berw Faults

In the first of these, at Llanddona, two small exposures only, both of dark shale, have been found, one at Tan-y-gwreiddyn, the other under a hedge 200 yards to the east-north-east. The line has, therefore, been drawn from the features. On the drift-covered slopes are many blocks of dark shale, mudstone, and pisolitic ironstone, so that there can be no doubt of the existence of a tract of Ordovician rocks. One of these mudstone blocks, from about 233 yards north of Ty'n-y-pistill, yielded [Af. 164] *Cryptograptus tricornis* (Carr.) var. *schäferi* Lapw., so that the zone of *Nemagraptus gracilis* is probably represented.

The existence of the strips that run through Pentraeth is inferred altogether from the evidence of drifts and features. Along the slopes between the village and the sea, debris of dark shale of Ordovician type is plentiful, and the gently undulating surface, bounded by strong features, indicates that some formation different from either the Mona Complex or the Carboniferous Limestone occupies this tract. But the limestone of Pentraeth Mill seems to be wedged into the midst of it. The strip along the Vale of Ceint was, at the time of the surveying, discovered from natural bosses by the riverside; but a much better section has since been exposed on the railway, east of Ty-coch, in blue-black and grey micaceous shale and mudstone, with some grits, and calcareous concretions three feet wide. The beds, which appear to be vertical, are much disturbed and slickensided, and the shale across the river is contorted. The shale on the railway has yielded [Af. 3221–29] *Lingula cf. brevis* Portl.

The long strip that runs from the north side of Mynydd Llwydiarth as far as Bwlch-gwyn is composed entirely of dark shale with a few thin grits. There is a persistent high dip, which appears to be generally a cleavage; but at Rhyd-yr-arian and Bwlch-gwyn the dominant divisional planes must be bedding. The dips are to the north-west, but no basal grit emerges, and by the farm-yard of the Dragon Farm, Penmynydd, shale is seen resting directly upon the mica-schist of the Mona Complex at an angle of 35–45°, apparently undisturbed. The north-western boundary is the main Berw fault; and the south-eastern, though frequently curved, and at moderate angles, is in all probability a plane of movement also, though not of any great displacement, and very likely pre-Carboniferous. It is shifted several times by cross-faults, one of which has given rise to the line of crag along the south-west end of Mynydd Llwydiarth. At Bwlch-gwyn, hard flaggy grits with shale partings dip off the old quartz-felsite. The rocks are fairly exposed all along the steep hill-brows, being very bare on the back of Mynydd Llwydiarth, where their smooth cultivated surface contrasts very sharply with that of the rugged schists. Deep ravines have been cut in them at this place ([E9882](#)) [SH 539 794], at Tyfry Stream and at Rhyd-yr-arian; and there are also good sections on the roadsides near Dyffryn and Cefn-poeth. The shale is contorted and strikes N.W–S.E. east of Plâs Penmynydd, but this may be due to the drag along the Berw faults. Wherever the shale is in good condition, as in the ravines, especially that of Rhyd-yr-arian, it is of decidedly Arenig or 'bifidus' types, with some dark

muddy grits.

At Rhyd-yr-arian have been obtained [Af. 3699–700] *Didymograptus hirundo* Salter, and *Orthis* cf. *proava* Salter; at Bwlch-gwyn, close to the quartz-felsite [Af. 211–38] *Palaeocyclus* sp., *Petraia* sp., *Orthis* cf. *proava* Salter, and *Orthis* sp. Dr. Matley remarks that the specimens of *Orthis* cf. *proava* from this district are all much smaller than the *Orthis proava* found in the Principal Area. It is evident that the whole of the beds in this long strip must be assigned to the Arenig and Llanvirn series; that their upper parts are likely to be in the Bifidus zone; and that, as the *D. hirundo* beds at Rhyd-yr-arian ravine (which are a little to the north-west of the farmyard) must be some way from the base, the zone of *D. extensus*, so well developed on the Strait, may be expected to be present.

The Ordovician rocks are cut out at Bwlch-gwyn, and where they re-appear, the strip has become very narrow (Figure 302), and is composed entirely of dark, hard grits, sometimes with muddy partings, sometimes very massive, as at Holland Arms. East of the cross-roads by the Inn, the junction with the Mona Complex is seen to be a curved fault or slide-plane; and in the lane south of the Inn, dark vertical grit strikes at the boundary. At the farmyard under the woods, due east of the station, *Orthis* cf. *proava* Salter [Af. 203–5] was obtained.

The last of the strips leaves the great Berw fault near Tai-hirion, and wedges out among the schists, into which it was probably dropped by Pre-Carboniferous faults. (See also Chapter 23 for further evidence of this.) Its rocks are well exposed, and are hard, dark-greenish grits or greywackes ([E9883](#)) [SH 457 705], rather massive, yet evenly bedded, and with partings of finer, muddy, grit. No cleavage is perceptible. To the north-east of Tai-hirion their upper surfaces weather into saucer-like hollows between the joints. Along the foot of the slope dark shale of Arenig type rests upon them. The best section in the grits is where Glan-morfa farm-lane leaves the Bryn-y-fedwen lane: and at this place were found [Af. 302234] *Favosites fibrosus* (Goldf.), Crinoidal columnals and *Orthis* cf. *proava* Salter. Ramsay also records from this tract *Asaphus Powisi*, *Calymene brevicapitata*, and *Phacops apiculatus*, but the specimens cannot now be traced.

From the thickness of the grits, which is about 325 feet, it is probable that, in this tract, the base nearly emerges on the south-east side. At Glan-morfa the shale has been slightly corrugated in such a way as to curiously simulate the pleurae of large trilobites like *Ogygia*.

## The Llangwyllog area

Except about Bwlch-y-fen and at Llangwyllog Church, where the base emerges; and on the north-east, where the Old Red Sandstone passes uncomfortably across it, this tract must be enclosed entirely by faults and slides. It also appears, from the trend of the features, that some of the faults are shifted by later faults, but the boundaries are almost everywhere obscure. Nearly the whole of the area is occupied by dark shales, with a persistent vertical cleavage, not strong enough, however, to distort the fossils at all severely. At the base there is about 180 feet of massive, hard, white grit ([E9977](#)) [SH 419 788] like that of Garth Ferry. The best exposures of this grit are at the farm south of the road at Bwlch-y-fen, where it contains dark shaly streaks and is succeeded by thin-bedded grits. It is seen at intervals, broken by faults, as far as Tyddyn, and it appears again at Llangwyllog Church (Figure 201).

At Bodwrog Farm, with an easterly dip of 45°, and faulted on its eastern side, is a narrow strip of conglomerate, which must be regarded as an outlier from the basal grit of Bwlch-y-fen.. Close to its north-east end the actual base is exposed, resting on oxidised mica-schist.

Two types of shale have been recognised: the dark grey, micaceous Arenig type, and the dead-black type of the *Nemagraptus gracilis* zone. The first appears to form the country as a whole, the second occurs along with the pisolitic ironstone at Ty'n-yr-onen, and in some other areas to the north-east (which are indicated, approximately, upon the map), the largest being at the far end at Capel-coch. Distinct bedding is not often seen.

The lowest horizon identified has been found in Tyddyn farmyard, where a small variety of *Didymograptus hitidus* (Hall) [Af. 1650–53], regarded by Miss Elles as low down in the zone, was obtained in the shale. The spot is only 27 yards from the basal grit, but there is faulting. The grit is let down and some of its middle beds cut out. These faults are doubtless ancillary to a larger one, dropping the two missing zones against it. The shaly films in its upper bed near Bwlch-y-fen

have yielded graptolitic debris and should be further searched. Beds in the railway cutting west of Llangwylog Church yielded *Diplograptus* (*Glyptograptus*) *dentatus* (Brongn.) [Af. 159], and may, therefore, be assigned to the Arenig, which agrees, again, with their position, a short distance above the basal grit. South of the church Prof. Hughes recorded *Trinucleus murchisoni* and *Æglina major*, which are probably now in the Sedgwick Museum, Cambridge, and *Æ. major* Salter is figured in *Mem. Geol. Surv*, Decade 7, pl. 10, fig. 9 (1853), from Glan-y-gors, but the exact spot cannot now be ascertained, nor is it known whether that form ranges above the Bifidus zone.

The two succeeding zones have not been identified, but the upper Glenkiln has been found, well developed, at four places. About 320 yards west-south-west of Capel-coch Windmill have been obtained [Af. 1–11, 86–158]:

*Climacograptus antiquus* Lapw.

*Climacograptus bicornis* (Hall)

*Climacograptus brevis* E.&W.

*Climacograptus scharenbergi* Lapw.

*Climacograptus c.f. scharenbergi* Lapw.

*Climacograptus* sp.

*Cryptograptus tricornis* (Carr.)

*Dicellograptus sextans* (Hall), var. *exilis*? E.&W.

*Didymograptus superstes*? Lapw.

*Diplograptus* (*Glyptograptus*) *teretiusculus* (His.), var. *euglyphus* Lapw.

*Nemagraptus explanatus* (Lapw.), var. *pertenuis* (Lapw.)

*Lingula* sp.

*Orbiculoidea elongata*? (Portl.)

an assemblage clearly indicating the upper part of the zone of *Nem. gracilis*, if not, Miss Elles suggests, slightly above it, in the zone of *Clim. peltifer*. The other fossils are as follows. In the roadside quarry, Glan-y-gors [Af. 3581–603]:

*Climacograptus antiquus* Lapw.

*Climacograptus brevis* E.&W.

*Climacograptus c.f. brevis* E.&W.

*Climacograptus scharenbergi* Lapw.

*Dicellograptus sextans* (Hall)

*Diplograptus* (*Orthograptus*) *calcaratus*, var. *acutus* E.&W.

*Lasiograptus* (*Hallograptus*) *mucronatus* (Hall), var. *bi-mucronatus* (Nish..)

*Paterula*? *balcletchiensis* (Dav.)

At a quarry 550 yards east of Glan-y-gors:

*Climacograptus antiquus* Lapw.

*Climacograptus brevis* E.&W.

*Climacograptus* sp.

The oolitic ironstone ([E10061](#)) [SH 433 793] is exposed about 270 yards north-east of Ty'n-yr-onen; and is about seven feet thick, with shale of the dead-black *Nem. gracilis*' type above and below. Just above it were obtained [Af. 3523–4, 3542–66]:

*Climacograptus antiquus* Lapw

*Climacograptus brevis* E.&W.

*Climacograptus scharenbergi* Lapw.

*Dicellograptus sextans* (Hall)

*Diplograptus* (Orthograptus) *calcaratus* Lapw., *var. acutus* E.&W.

It is evident that these faunas differ but slightly from one another, and that all of them are to be assigned to the zone of *Nem. gracilis*.

From them, in spite of the aspect of monotonous obscurity which the district presents at first sight, the general nature of its structure becomes apparent. It must consist of some four (perhaps more) infolds of the zone of *Nem. gracilis*, caught in a folded tract of Arenig, Llanvirn, and (presumably) Lower Glenkiln shales. At a quarry 360 yards east-south-east of Llangwyllog Church folding upon vertical axes can be seen, which is in harmony with the nearly vertical dip of the cleavage. The base emerges in two places on the western margin, but the eastern side is faulted throughout, so that the general structure must be somewhat as in (Figure 201). In other parts the western side is also faulted. The strike of the cleavage, however, is not parallel to the axis of the district, but runs W.S.W.–E.N.E., crossing it obliquely, and this agrees with the fact that the infolds are not (so far as can be made out) in line with one another, but overlap *en échelon*. The tract must, therefore, have been originally folded along vertical axes trending W.S.W.–E.N.E., and afterwards let in among the Mona Complex by a system of faults running from south-west to north-east. As these faults do not pass up into the Old Red Sandstone, they must be assigned to the later part of the great Post-Silurian earth-movements.

## The Principal Area

This (Folding-Plate 11) will be considered in the following order:-

1. The south-western wing and south-eastern margin from sea to sea.
2. The western margin.
3. The country about Llanerchymedd.
4. The country to the north-east of Llanerchymedd.
5. Llanbabo and the Cors-y-bol country.
6. The northern margin.

### 1. The South-Western Wing and South-Eastern Margin

The south-western wing is occupied by conglomerate from side to side, but five inliers of gneiss and two infolded outliers of shale show that the great syncline, deep as it is, must be complex. It shallows to the south-west, for on the outer islets at Rhosneigr the Mona Complex rises. One of the best sections is at Llyn Maelog, where a number of escarp Mental ridges look down upon the lake. Massive grits ([E9952](#)) [SH 330 737] alternate with coarse conglomerate, in which are a great variety of pebbles ([E9873](#)) [SH 326 733], generally well rolled, rocks from the middle region of the Mona Complex

predominating, so that the drift of the mat Trials was evidently from the east. The rocks of Holyhead have not been recognised with certainty in the conglomerates anywhere. *Orthis proava* Salter [Af. 200–2] is abundant in some of the grits along the lake side. All round the low coast of Rhosneigr there are excellent sections (especially at low water) of the overlying shales of the outlier, a typical 'alternating series', the black shale being full of bands of fine grit ([E9891](#)) [SH 317 727], for the most part about an inch or two in thickness. The shale within the infold is cleaved and wonderfully crumpled (see Chapter 18, (Figure 261), (Figure 262), (Figure 263), (Figure 273), (Figure 274)). On all the south-western reefs the folds pitch to the north-east, but towards the Crigyll they begin to pitch to the south-west, consistently with the rise of the end of the boat-shaped infold, which brings up the conglomerate on the north-east. But the fold is broken, not only by the faults that bring the shales of Braich-yr-Osedd against the conglomerate, and the conglomerate against the schists close by; there is evidence that the shales are bounded by a much greater one, probably a steep overthrust, near the Crigyll. The conglomerates of the Tywyn Trewan strike at the outlier, and a water-boring near Ty'n-y-morfa, intended to reach the conglomerate, was abandoned, still in shale, at 600 feet, revealing at once the unexpected depth of the infold, and that there is not room for a symmetrical rise towards the west. Had it been symmetrical the conglomerate would have been entered long before; it must be an isocline plunging downwards to a plane of rupture. Towards the north end of the shore section, a third of a mile from the Crigyll's mouth, the shales yielded ill-preserved specimens of *Didymograptus nicholsoni* Lapw. and *Acrotreta?* [Af. 1387–91], Arenig or Llanvirn forms which leave the exact position of the beds uncertain. A zonal form here is much to be desired, for as the place is close to the cross-axis of the infold, the depth of shale below must be at least as great as at the boring, so that, the precise horizon known, an estimate of zonal thicknesses in the Arenig series would be possible.

The actual base of the conglomerate can be studied on the top of a boss 500 yards west of Bodenog, where a thin patch of pebbly grit rests directly upon an uneven surface of granite. The granite is reddened in a manner quite unlike its present-day mode of weathering, so that what we see here is the Sub-Ordovician decomposition.

Between the dunes of the Tywyn Trewan are the 'giant' boulder-beds (Plate 27) described on p. 405. At a spot some 500 yards south-west of Trewan Sands Crossing the boulders are finely weathered-out, but the largest, which are of gneiss, are on a knob 500 yards to the north-west of this, where they have been rubbed away flush with the general surface and are not conspicuous. At Harlech the pebbles are seldom an inch in length, and most of them are green-mica-schists of the New Harbour group (of the dull variety found close by), with many of the bedded jaspers. The pebbly grits ([E6064](#)) [SH 337 749] are often so full of green volcanic fragments as to look like tuffs ([E1547](#)) [SH 38 67], but those fragments are from the Mona Complex. Between the boulder-beds among the dunes are well-defined bands of pebbly grit, which give north-easterly dips clearly. These indicate a thickness of some 3,000 feet for the conglomerate, which is astonishing, but as thicknesses measured near Treiorwerth are on a similar scale, this does not seem to be due to deceptive repetition, especially as the Treiorwerth dips are north-westerly. The syncline probably coincides with a Pre-Ordovician hollow filled with conglomerate. About Llyn Traffwll bedding has been largely obliterated by a rude cleavage, and as the dips are towards the boundary, that is probably an overthrust.

**Llyn Traffwll Complex**— For about 300 yards along the western shore of this lake, south of Hen-blâs, is a perplexing group of rocks (Figure 202) E8449, ([E8453](#)) [SH 321 770], ([E8454](#)) [SH 321 770], ([E8455](#)) [SH 321 770], ([E8459](#)) [SH 321 770], ([E8460](#)) [SH 321 770], ([E8461](#)) [SH 321 770], ([E8462](#)) [SH 321 770], ([E8463](#)) [SH 321 770], ([E8464](#)) [SH 321 770], ([E8465](#)) [SH 321 770], ([E8466](#)) [SH 321 770], ([E10654](#)) [SH 321 769], ([E10655](#)) [SH 321 769], ([E10656](#)) [SH 321 769], ([E10657](#)) [SH 321 769] well exposed in rocky ground. It consists of conglomerate and grit with two inliers of gneiss, the northern one containing a band of granite, the southern containing two strips of amphibolite (p. 325). Along the western side is a sill of partly schistose diabase (Chap. 17). The group is close to the western margin of the Ordovician area, and a thin skin of mica-schist adheres at one place to the outer side of the diabase. But between the northern inlier and the lake, the grit, being an arkose of the gneiss, resembles it, and the line is difficult to draw. The structure does not appear cataclastic, and the doubtful material is probably a beach-breccia, adhering to the surface of the old land. On the eastern side of the southern inlier is also some very gneiss-like conglomerate, some of it basic-looking, which may be of the same nature. There are also very curious sections at the south end of the ridge of diabase. A strip of gritty, flinty rock, which may be the remains of either Ordovician grit or gritty mica-schist, wedges in between the diabase (here very schistose) and the gneiss. Finally, on the eastern side of the ridge's end, where the diabase wraps partly round the gneiss, most of which is acid, another basic rock appears. This is an amphibolite, is coarse, and quite unlike the diabase,



there somewhat fine. Yet it includes a number of irregular fragments of granitoid rock, an inch or two in length, as if caught up, and strangely enough, some of a still coarser amphibolite. We seem to be dealing with the effects of the intrusion of a basic sill along the sides of an ancient inlier, itself partly composed of basic rocks of different ages; and with a kinship of composition between the conglomerate and the gneiss, from which it was in part derived; the whole obscured by deformation both of the gneiss, the conglomerate, and the sill, as well as by the thrusting movements along the western margin.

In the country about Bryngwran such dips as are perceptible suggest that the inliers of gneiss are the cores of isoclinal folds. The infolded outlier of shale is poorly exposed, but has the same character as that of Rhosneigr, and is crumpled. The conglomerate is now becoming finer, tending to pass into pebbly grit, and films of shale appear upon the bedding-planes. The following fossils have been obtained from the pebbly grits between Bryngwran and Treiorwerth. At the roadside an eighth of a mile north-west of Ty-hen were obtained [Af. 1337–53, 1402–13]:

*Orthis proava* Salter

*Rafinesquina* cf. *llandeiloensis* (Dav.)

*Calymene parvifrons* Salter

*Calymene tristani* Brongn.

*Calymene* sp.

*Ogygia selwyni* Salter

*Ogygia* sp.

*Orthis proava* Salter [Af.1454–8] was also found at two other places close to Ty-hen, and at the Smithy, Bryngwran. By the bend of the stream south-east of Ffynnon-y-mâb, in a coarse grey shaly film between the grits, were found [Af. 1426–48]:

? *Tetragraptus headi* (Hall)

*Leptaena rhomboidalis* (Wilck.)

*Orthis proava* Salter

*Orthis* (*Hebertella*) *vespertilio* J. de C. Sow.

*Rafinesquina* sp.

the *Dichograptid* stipes being 4½ inches in length. The dips in this district are clear, and indicate that the thickness of the pebbly grits is 2,500–2,700 feet. The *Tetragraptus* films are some 1,200 feet down in the grit, far below the shales, which have yielded the *Extensus* fauna not far off (p. 445). Probably, therefore, we see here the oldest graptolitic fauna of Anglesey. But the trilobites and brachiopods of Ty-hen are close to the base, hundreds of feet further down. The basal grits are now poorly exposed until we come to Tre-riffri, whence to Prys-owen they overlook the gneissic tract in a well-marked escarpment about 50 feet in height, and have thinned to only some 350 feet. Low down in this escarpment, by the lane-side between Bryn-clyd and Prys-owen, were obtained [Af. 12, 14, 789, 844–60]:

*Orthis proava* Salter

*Orthis* sp.

*Rafinesquina*?

*Ogygia selwyni* Salter

Ogygia sp.

an Extensus-zone fauna like that of Ty-hen. *Orthis proava* Salter is very abundant, and in beautiful preservation.

The base now turns round (probably faulted a little in obscure ground) into the great bay south of Llanerchyrnedd, and a good escarpment is developed again at Mynydd-mwyn-mawr, north-east of which is a section in hard grits with beds of conglomerate. The interior of the bay is filled with shale of Arenig type, rapidly alternating with fine grits. Its eastern side is considered to be faulted, because the basement beds do not appear and the shales dip at the boundary.

Conglomerate appears again on the roadside north of the Windmill, the pebbles being for the most part of local types. On the parish boundary, just where it leaves the road, the actual base is exposed. Beyond Bachau the sandy basement group disappears, and it is inferred that a thrust is beginning to develop, but the ground is obscure. At Tre-wyn, however, shale and hornfels are seen to be severely crushed against each other. A strong feature begins to appear as soon as the Bodafon moor schist and the quartzite come. against the shales, and at the great crags of quartzite it is even undercut. Here there is a clear section (Figure 154), (Figure 156) across a powerful northward 'thrust, that will be called the Bodafon thrust-plane, which cuts out the base all the way from Bachau. The Bodafon thrust-plane, turning eastward, is then overstepped by the Old Red Sandstone. In the valley, by Bodafon-isaf, conglomerate ([E10059](#)) [SH 479 891], ([E6065](#)) [SH 472 869], rising, probably, on an isocline, dips towards black shale, in which at the streamlet about 130 yards to the south of City Dulas bridge, were found [Af. 1132–8]:

*Didymograptus acutidens* E.&W.

*Didymograptus bifidus?* (Hall)

*Didymograptus deflexus?* E.&W.

*Acrotreta* sp.

indicating the zone of *D. bifidus*, though the presence of *D. deflexus* (lately known only in the Lake District) suggests a low position in that zone.

## 2. The Western Margin

Shale first appears at the farm. by the roadside near Tre-angharad, but the ground is obscure as far as the high bare land between Treiorwerth and Presaddfed, on which an alternating group' like that of Rhosneigr is abundantly exposed, and shows rapid folding. Beds of muddy breccia begin to come in, and are exposed at many places to the east, as far as Clwch, while similar deposits evidently occupy much of the rapidly widening tract to the west of the conglomerate. At Presaddfed the boundary (shifted by a small fault) is well marked, black mudstones full of sub-angular fragments of fine green schist being "exposed about 10 yards from the Mona Complex. But by the side of Llyn Llywenan, although it is certain that there is a sudden shift, the lines are quite conjectural. Similar gritty mudstones, and shale with thin grits, are seen at intervals near the boundary as far as Bodynolwyn-hir, where bands of conglomerate come in, indicating that the beds are just above the basement group, and a few paces to the north of the farmyards, were obtained [M. 1354–66]

*Dendrograptus* sp.

*Didymograptus deflexus?* E.&W.

*Didymograptus* sp. ['extensiform' type]

*Orthis proava* Salter

*Æglina* sp.

showing that the base is still in the zone of *Did. extensus*, and that the usual trilobites and brachiopods accompany the graptolites.

These beds appear to be wedged down into the basement grits, but without any large fault, for across the road, and thence to the river Alaw, the conglomerates and grits contain many films 'of shale (of Arenig type). These are often broken up into 'galls', and as they are enclosed in uncles and unbroken grit, it is evident that some contemporaneous erosion was going on. Massive pebbly grits expand eastwards to the opposite shore of Cors y Bol, and on them rests a faulted outlier of shale, full of sandy beds, and even of muddy conglomerate. In the upper part of the shales, at the farm north-east of Caergwili, were found [Af. 947–62]:

*Didymograptus bifidus* (Hall)

*Didymograptus nicholsoni* Lapw.

*Didymograptus cf. patulus* (Hall)

*Didymograptus stabilis* E.&W.

*Didymograptus* sp.

*Lingula* sp.

a Bifidus-zone assemblage, but unusually rich in extensiform types. This is the first record of the zone on the opening out of the great syncline, and it certainly seems very near the base. But the dips indicate some 500 feet of shale below it, and we have also seen that some of the Extensus zone has been, locally, removed by contemporaneous erosion.

A great development of conglomerate ([E8457](#) [SH 369 858], [E8470](#) [SH 369 858], [E10397](#) [SH 371 852] follows, which forms rugged escarpments near Bôd-Deiniol, where it is about 1,000 feet thick. About half-way down in it, *Orthis cf. proava* Salter [Af. 1077–81] was obtained in the interbedded grits, just above the beds with galls of shale. Pebbles of gneiss and granite occur in the lower beds, but are rare at the top, where Gwna quartzite and New Harbour mica-schist are dominant. The curious flat pebbles of the latter are best seen on the upper dip slopes of the Bôd-Deiniol ridge. They contain all their ancient structures, even the late minute cross-corrugation. There are also many pebbles of a singular black quartzite, first noticed here, and at that time not known *in situ*, but found afterwards among the disturbed Gwna schists at Llanbadrig (see pp. 80, 309). These Gwna pebbles must have come from the buried tract of Cors y Bol, so that there was a westerly drift of material in this district also in Ordovician times. The conglomerates pass up into grits interbedded with shale, of which they also contain 'galls'. The whole of this great mass of conglomerate disappears near Brwynog. Where it passes below Fferatn-uchaf the Bifidus zone is very near it, but as the Extensus zone rises again only a mile to the north-east, the conglomerate must still be referred to that zone. There is no change in the horizon of the base of the system.

Hence to Llanrhyddlad there is little to record but cleaved shale, though that is abundantly exposed on the high ground. About 300 yards east-north-east of Ucheldref-uchaf the ironstone is, very poorly, seen. But at Bron-heulog, a few yards from the boundary, *Acrotreta* sp. and *Lingula brevis* Portl. [Af. 1449–53] were found; and a quarter of a mile north of east from Ucheldref-uchaf, close to the ironstone (so that there must be movement) [Af. 1465–73]:

*Didymograptus bifidus* (Hall)

*Didymograptus* sp. ['extensiform' type]

*Diplograptus* (*Amplexograptus*) *confertus* Lapw.

*Diplograptus* (*Glyptograptus*) *dentatus* Brongn.

which, taken together, indicate that the Bifidus zone is brought against the boundary. The disappearance of the conglomerate must, therefore, be taken to be due to faulting. At Bron-heulog, however, there is a winding escarpmental feature, which then dies down, and the line, straightening, runs on through rather obscure country to Rhyd-wyn, where it is well marked, dark shale abutting upon a reef-like ridge of silicified schist. On the road from Rhyd-wyn to Craig-y-gwynt there is a cutting through the junction, which is clearly a fault, both rocks being crushed. This fault bends with

extraordinary sharpness near the Garn, where a basic sill runs along it, but it is not possible at present to interpret the structure at this point. Arenig and Glenkiln beds, (see pp. 462, 465), are wedged in between the Garn and the boundary faults, but strike across the interval.

The western margin, therefore, is divisible into three parts. In the middle of it the base rests, unbroken, upon the Mona Complex; to the north of Brwynog and south of Llanfrisant it is faulted. The southern fault is inferred from the inclination of the overfolds to be an overthrust. The northern fault is seen, at Yr-ogo-goch (Figure 203), to be a steep slide.

### 3. The country about Llanerchymedd

This is the district of the small inliers, no less than 14 being known, 12 of gneiss, two of other schists, and three of pebbly grit. About two miles to the south-west of the inlier country, at a place about 680 yards east-north-east of Chwaen-wen, micaceous shale yielded *Didymograptus extensus?* (Hall) [Af. 1425], so that the great syncline is probably still filled with the lowest zones. Between the inliers, the shales have yielded zonal forms in several places. Black shale between thin muddy grits in a quarry 750 yards southeast of Meindir, and 490 yards north-east of Treian, yielded [Af. 4182–6]? *Dendrograptid*, *Dictyonema* sp., and *Didymograptus extensus* (Hall) [prox. end], indicating the zone of *Did. extensus*. The position is immediately above the basal' grit that wraps round one of the gneissic inliers. Black shale by the streamlet, 200 yards to the west of Treian, contained [Af. 874–89, 1335–6]:

*Didymograptus hirundo* Salter

*Didymograptus nitidus* (Hall)

*Æglina binodosa* Salter

*Æglina c.f. binodosa* Salter

*Æglina* sp.

*Trinucleus gibbsi?* Salter [or *T. sedgwicki?* Salter]

and similar shale, in the streamlet about an eighth of a mile west of Llwydiarth Esgob [Af. 3601–11]:

*Dictyonema* sp.

*Didymograptus cf. nitidus* (Hall)

*Didymograptus* sp. ['extensiform' type]

*Diplograptus* (*Glyptograptus*) *dentatus* (Brongn.)

indicating; in both cases, the zone of *Did. hirundo*.

The other fossils are from the basal grit on the flanks of the inliers. On the west side of Bryn Gwallen, a little plateau of pebbly grit that rises to the 300-foot contour, overlooks the largest inlier, and the base is laid bare, gneiss rising about 12 feet up into the escarpment, in which have been obtained [Af. 261, 820–6]: *Orthis proava* Salter, *Ampyx* cf. *domatus* (Ang.), and *Ogygia selwyni* Salter. Also, labelled 'Bryngwallen' in the collection of the late Mr. James Hughes, of Llanerchymedd, now in the University College of North Wales, and preserved in grit of the same type, were *Ogygia selwyni* Salter and *Calymene*, cf. *tristani* Brongn. These were the first specimens of *C. tristani* found in Britain elsewhere than on the southern coast, and were presented to the museums in Cambridge and at Jermyn Street. The same collection, and also that of Mr. Thomas Prichard of Llwydiarth Esgob, contains, in grit of the same type (locality merely 'near Llanerchymedd'), *Orthis testudinaria* Balm., *Calymene parvifrons* Salter, and *Ogygia selwyni* Salter; and Dr. Callaway obtained the same three species, apparently from the margin of the inlier to the north of Treian. He kindly lent the fossils for re-examination.

From the old quarry by the roadside, 400 yards north of Bryn Gwallen, were obtained [Af. 827–43]:

Crinoidal remains

*Orthis proava* Salter

*Calymene parvifrons* Salter

*Ogygia selwyni* Salter

*Ogygia* sp.

From a grit-quarry a few yards west of Chwaen-bach, on the north flank of that inlier [Af. 866–73]:

Crinoidal remains

Ptilodictya?

*Orthis cf. alata* J. de C. Sow.

*Orthis proava* Salter [in walls, reported to be from here]

*Æglina binodosa* Salter

*Æglina* sp.

From pebbly but muddy grits at Ceidio farm (base not seen) were obtained [M. 861–5]: *Orthis cf. proava* Salter, *Strophomena* sp. and a Hyolithid.

Thus, in the infolds between these inliers, the shale is nowhere found to rise above the zone of *Did. hirundo*, and that which rests immediately upon the basal grit is in the zone of *Did. extensus*, while the pebbly basal grits themselves that rest upon the inliers contain the same trilobite fauna as that which is elsewhere found in the Extensus zone. The inliers are therefore not islands rising in the Arenig sea, but the cores of anticlines which bring up the true base. They must be often broken, for the grits have seldom been traced all round them. The north-westerly dips, which are persistent almost everywhere, indicate that the folds are isoclinal, and the frequent absence of the grits on the southern side shows that the isoclines are overthrust (Folding-Plate 11). The total absence of grit about several is probably due merely to imperfect exposure combined with faulting. That the large tract of Bryn Gwallen really is an inlier is shown by the presence of grit immediately to the south of it, on the west of the alluvium; but as this grit dips northward it is evidently nipped in between the inlier and the great gneissic tract. A small patch of grit, still dipping northward, remains upon the inlier near its southern end.

The trilobite-grit around the inliers is usually massive, weathering a whitish brown, and with bands of pebbles, chiefly gneiss, hornfels, and quartzite, and on those east of the railway, a fine siliceous mica-schist. At Ceidio the gritty black mudstones are well developed, but the types alternate rapidly and the line is uncertain. Above the basal grit comes an alternating series of black shale and thin grits like that of Rhosneigr, the shales being seldom free from sandy matter for many yards together. A fine section of them is exposed in the ravine at Nantanog.

Consistently with the low horizons indicated by the graptolites, inliers emerge at intervals all across the district, so that the great fold must here be comparatively shallow. The most remote is a small boss of granite 250 yards west of Chwaen-goch; and next, at Chwaen-goch itself, an uprise of gneiss with conglomerate wrapping round its north-western side, but thrust over shale on the east. Then follow the inliers already described, and then the massive grits of Llanerchymedd station (Figure 240), which rise eastward among shales and are (beyond the fault) followed by broken grit and shale on to which they were probably driven. Last of all is the great inlier of Foel Hill (Figure 204). Fine mica-schist with quartzites rises from beneath conglomerate and hard pebbly grit, the actual base being exposed at the west and east ends of the inlier, and at a little scarp 110 yards east of the summit of the hill. But shale appears within the

conglomerate near the hill-top, so that this must be an infold, and the conglomerate of the summit and north slopes a second anticline. Along the- southern escarpments conglomerate and shale again dip under the inlier of schist, beyond which two more anticlines are indicated by small emergences of conglomerate and hornfels to the east. All the dips are northerly. The form of the schistose inlier, moreover, indicates that the principal anticline is compound. These great isoclines are the advance waves of the general impulse from the north. Just beyond Llwydiarth Esgob begin the opposing isoclines (Figure 205)–(Figure 206), coming from beneath the Bodafon thrust-plane,

#### 4. The country to the north-east of Llanerchymedd

This district is essentially one of the zone of *Didymograptus bifidus*. Its fauna first appears at a cutting on the railway west of Cae-mawr, just where it crosses the river Alaw, which has yielded [Af. 1127–31]:

*Diplograptus (Glyptograptus) dentatus (Brongn.)*

*Glossograptus?*

*Lasingraptus (Hallograptus) mucronatus (Hall), var. inutilis (Hall)*

At Cae-mawr, on the east side of the road, blue-black micaceous shale has yielded [M. 890–909, 1082–96]:

*Didymograptus artus E.&W.*

*Didymograptus bifidus (Hall)*

*Didymograptus murchisoni (Beck), var. geminus (His.)*

*Didymograptus nanus Lapw.*

*Didymograptus stabilis E.&W.*

*Diplograptus (Glyptograptus) dentatus (Brongn.)*

*Lingula cf. brevis Portl.*

suggesting perhaps the upper part of the zone. Mr. Macconochie remarks that the graptolites are 'good and abundant'. Thence eastwards the beds are usually rather hard and flaggy, with fine sandy bands among shale of the usual kind; but there are so many basic sills that the hardening is probably slight contact-alteration.

In beds of this kind, on the north bank of the Afon Goch, south-east of Tyddyn-bach, a little quarry is perhaps the best exposure of the Bifidus zone in Anglesey. It has yielded [Af. 253–60, 910–42]:

*Climacograptus scharenbergi Lapw.*

*Cryptograptus? antennarius (Hall)*

*Dendrograptus sp.*

*Dichograptid*

*Didymograptus affinis? Nich.*

*Didymograptus artus E.&W.*

*Didymograptus bifidus (Hall)*

*Didymograptus nicholsoni Lopw.*

*Didymograptus cf. patulus* (Hall)

*Diplograptus* (*Glyptograptus*) *dentatus* (Brongn.)

*Diplograptus* (*Glyptograptus*) *dentatus* var. *appendiculatus* Ellen

*Glossograptus acanthus* E.&W.

*Trichograptus*?

*Lingula c.f. brevis* Portl.

and 250 yards downstream from that place [Af. 943–6], *Didymograptus bifidus* (Hall) [highest mut.], and *Diplograptus* (*Glypto-graptus*) *dentatus* (Brongn.) There is no cleavage, and the graptolites are beautifully preserved. An anticline rises to the south, and on its other side, 110 yards west by south from Llandyfydog Church, were obtained [Af. 1105–18]:

*Didymograptus acutidens* E.&W.

*Didymograptus bifidus* (Hall)

*Didymograptus gracilis* Törnq.

*Didymograptus hirundo* Salter

*Diplograptus* (*Orthograptus*) *calcaratus* Lapw., var. *priscus* E.&W.

*Diplograptus* (*Amplexograptus*) *confertus*? Lapw.

*Diplograptus* (*Glyptograptus*) *dentatus* (Brongn.)

*Lasiograptus* (*Halograptus*) *mucronatus* (Hall), var. *inutilis* (Hall)

and at a cottage 140 yards north by east from the Church [Af. 1119–26], *Didymograptus bifidus* (Hall), *Diplograptus* (*Glyptograptus*) *dentatus* (Brongn.), and *Glossograptus acanthus* E.&W. It is therefore probable that undulations of the Bifidus zone occupy most of this area, and that the zone is of considerable thickness.

At the sharp bend in the stream east of Llwydiarth Esgob (Figure 205)–(Figure 206) the folded beds are an alternating group like that of Rhos-neigr. But there must be a deep infold between the Deri anticline and the Bodafon thrust-plane, for the oolitic ironstone was worked at Llandyfydog Mill (Melin Esgob of six-inch map) in 1870. The workings were then filled in, but Mr. Thomas Prichard, of Llwydiarth Esgob, has kindly procured specimens, and furnished an analysis (p. 407) made at that time. Except a massive grit, whose horizon is uncertain, by the sill north of Gaer, little but flaggy shale is now seen in the obscure country as far as the Deri inlier.

At the western end of this, about 160 feet of conglomerate, rising from beneath gritty shale, rests upon the Mona Complex. A few yards west of the Pensarn road the base is visible. This conglomerate cannot be traced far, and the rest of the boundaries of the inlier are very obscure. But as the few exposures are all shale and have northerly dips both in the Deri water and at City Dulas, it is probable that the conglomerate is cut out, and that the anticline is isoclinal, overthrust on the south.

Nothing but dark shale, generally with thin grits, is visible over the broad slopes between this and the Nebo inlier, but exposures are few and poor except in the wooded ravines of Coch-willan and Llanwenllwyfo Church. In the upper waters of the latter, near Tyddyn-igion, they are still rapidly overfolded from the north, but between this and the Nebo road, two small inliers of gneiss, close to exposures of shale, appear, probably upon overthrust anticlines. Then a considerable strip of massive grit rises near Nebo and rests upon the Nebo gneisses. The rapid folds must therefore be pitching westwards, and bringing up the base; thrusts, however, cutting out the basal grit before it rises finally unbroken. In the

large quarry about 830 yards east-south-east of Nebo some 30 feet of grit ([E10281](#)) [SH 473 900] dips gently westward off the gneiss and passes under shale, so that here the base is clear. But it is immediately faulted against shale at the south-west' end of the quarry, and just to the northwest of the streamlet it dips north and north-east, with shale again beneath it, so that the whole strip must be inverted except for about 170 yards. But this properly belongs to a discussion of the boundary (see Chapter 18).

The shores of Traeth Dulas are obscure, but a fine section is seen along the quarter of a mile of coast between the nook of Dulas Bay and the gneissic inlier, towards which the beds dip. In the nook, at the bathing house by the end, of the long plantation, are black shales, which have yielded [Af. 1297–316] *Didymograptus murchisoni* Beck, *Diplograptus* (*Glyptograptus*) *teretiusculus?* (His.) and *Trinucleus gibbsi* Salter, indicating the zone of *Did. murchisoni*. Banded flags, micaceous and sandy ([E10275](#)) [SH 489 897], with fine mudstone bands, then come on, and at the base of a projecting sill of diabase, 170 yards from the bathing house, these have yielded [Af. 265–76] *Didymograptus bifidus* (Hall) and *Diplograptus* (*Glyptograptus*) *dentatus* (Brongn.), so that the northerly dip is on the limb of an inverted infold, upon which the Bifidus zone has risen. Thin grits now appear, and a good 'alternating group' occupies the remainder of the section. There are a few thrusts, and some overfolding near the end, at which is the curious steep overthrust shown in (Figure 264)–(Figure 265) but the beds are not much disrupted. There must therefore be a thickness of some 500–600 feet of beds below the top of the zone of *Did. bifidus*. Yet the basal grit is quite cut out, with an unknown thickness of shale above it, leaving plenty of room for the lower zones, above the emergences of the base at Pen-y-graig-wen and Nebo. A good deal of the broad infold of Llanwenllwyfo may be occupied by the Murchisoni shales, but no sign has been seen of any of the higher zones.

## 5. Llanbabo and the Cors-y-bol country

This is the district of the deep infolds which take in the higher zones. Indications are known of six, but in three only have the higher faunas been decisively obtained. These are all at Llanbabo — one at the church, one at Fferam-uchaf, and one between the church and Bôd-Deiniol. They may be called the 'Church', the 'Fferam', and the 'Lane' infolds (the last from the position of its only good exposure at an angle in a lane). The complete succession is not found in any one of them. Before describing them it will be well to consider the nature of the surrounding country. At Llanbabo, some 60.0 yards north of the church ((Figure 211), b<sup>e</sup>), black micaceous shales with thin grits are well exposed by the roadside. They have yielded [Af. 1097–1104] *Didymograptus* cf. *deflexus* E.&W., and are placed by Miss Elles in the zone of *Did. extensus*. They must rise on an isoclinal anticline, and the conglomerate must be immediately below. Similar shale is seen 180 yards east of Fferam-uchaf on the north side of the road, and on the south side conglomerate rises from beneath it. The two succeeding Bifidus faunas have been found at three places. In black shale with thin grits at a well on the west side of the road, by the turning west of Fferam uchaf, occurred [Af. 1392–1401]:

*Didymograptus bifidus* (Hall)

*Didymograptus hirundo* Salter

*Orthis* cf. *proava* Salter

*Orthis* sp.

*Paterula?* *balcletchiensis* (Dav.)

At a spot 190 yards east-south-east of Fferam-uchaf, in similar beds, were found [Af. 1049–60]:

*Didymograptus bifidus?* (Hall)

*Didymograptus hirundo?* Salter

*Lingula* sp.

*Trinucleus?*



A shale that outcrops in the road half a mile to the south-south-west of Llanbabo Church yielded [Af. 3612–14] *Didymograptus artus* E.&W. It appears, therefore, that the country surrounding the three infolds consists in the main of Upper Arenig and Lower Llanvirn shales, with one anticline bringing up the zone of *Did. extensus*. To the north of Fferam-uchaf is a good deal of a dirty yellowish shale which Mr. Macconochie had not recognised in any of the zones.

The Fferam infold (Figure 207)–(Figure 208) will be considered first. Strictly outside its limits, being to the south of the Bifidus shales on the east side of the road, 250 yards west-south-west of Fferam-uchaf, gritty shale yielded [Af. 1367–81, 1414–21, 1459–64]:

Coral

*Didymograptus murchisoni* (Beck) [well preserved]

*Orthis cf. proava* Salter

*Orthis* (*Dalmanella*) *testudinaria* Dalm.

*Trematis*?

*Æglina* sp.

*Placoparia* sp.

*Trinucleus gibbsi* Salter in a thin 'flinty' band sp.

*Trinucleus* sp. in a thin 'flinty' band sp.

showing that the Murchisoni zone duly follows that of *D. bifidus*, taken in on a small subsidiary infold. These beds have not been found in the main infold, and must be cut out. So must, apparently, be the zone of *Glypt. teretiusculus*. But on the north side of the road, west of the farmyards, about 20 feet of well-bedded gritty ironstone appears, and can be traced for about 350 yards, becoming however, then, a ferruginous grit, with small fragments of schists. Upon this rests a very dark shale or mudstone, which at the farmyard has yielded [Af. 1382–6]:

*Dicellograptus sextans* (Hall)

Diplograptid ['Glenkiln' type]

*Nemagraptus gracilis* (Hall)

Grits, but not ferruginous, appear to the east of the house, and above them, about 270 yards east of the house, black shale like that of the farmyard, has yielded [Af. 1033–48]:

*Climacograptus antiquus* Lapw.

*Climacograptus scharenbergi* Lapw.

*Climacograptus* sp.

*Dicellograptus sextans* (Hall)

*Dicranograptus nicholsoni* Hopk.

*Didynaograptus superstes* Lapw.

*Diplograptus* (*Orthograptus*) *calcaratus* Lapw., var. *acutus* E.&W.

*Diplograptus (Glyptograptus) teretiusculus (His.)*

*Diplograptus (Glyptograptus) teretiusculus var. euglyphus Lapw.*

*Lasiograptus (Hallograptus) mucronatus (Hall), var. bi-mucronatus (Nich.)*

*Nemagraptus gracilis (Hall)*

*Nemagraptus sp.*

The zone of *Nemagraptus gracilis* is, therefore, strongly developed here.

The Lane infold will be considered next. One exposure only is now to be seen in it. This is a small quarry (Fig. 209), at a right angle in a lane 650 yards south-south-west from Llanbabo Church. About 15 feet of finely gritty ironstone ([E9938](#)) [SH 383 747] are seen, evenly but rather massively bedded. Upon this are two feet of passage beds, and then black shale like that of the Fferam infold, which has been quarried rather low, so that the most richly fossiliferous parts are only accessible in dry weather. This has yielded [Af. 963–98, 1422–4]:

*Climacograptus antiquus Lapw.*

*Climacograptus bicornis (Hall)*

*Climacograptus brevis? E.&W.*

*Climacograptus scharenbergi Lapw.*

*Cryptograptus tricornis (Carr.)*

*Dicellograptus intortus Lapw.*

*Dicellograptus patulosus Lapw.*

*Dicellograptus sextans (Hall) sp.*

*Dicellograptus sp,*

*Dicranograptus nicholsoni Hopk.*

*Dicranograptus rectus Hopk.*

*Didymograptus superstes Lapw*

*Diplograptus (Orthograptus) calcaratus Lapw., var acutus E.&W.*

*Diplograptus(Glyptograptus) teretiusculus (His)*

*Lasiograptus (Hallograptus) mucronatus (Hall) var. bi-mucronatus (Nich.)*

*Nemagraptus gracilis (Hall)*

*Nemagraptus sp,*

and is the best exposure of the zone of *Nem. gracilis* in Anglesey. Mr. Macconochie remarks that here and in the Fferam infold, the shale is of the same type, and the graptolites in the same state of preservation as in the Moffat-Melrose anticline in Scotland.

At a spot near this Dr. Callaway obtained, in 1884, the graptolites that will now be quoted, which he kindly lent for examination by Miss Elles. But on the six-inch maps published in 1888 no exposure is shown that corresponds to his description, nor could any be found by the writer or the Survey collectors. Mr. Muir, however, obtained information from the farmer, in 1911, that an old quarry had been filled up at a spot 150 yards north-north-west of the right-angle in the lane, and found some debris- of shale of the same type as that in the streamlet by the church (see below): This, therefore, appears to be Dr. Callaway's locality. He (Dr. Callaway) obtained the important collection [Af. 4187–217], kindly presented to the Geological Survey by his niece, Miss K. Saunders:

*Climacograptus bicornis* (Hall)

*Climacograptus scharenbergi* Lapw.

*Dicellograptus morrisoni*

*Dicranograptus ramosus* (Hall)

*Diplograptus* (*Orthograptus*) *truncatus* Lapw., var. *intermedius* E.&W.

undoubted Hartfell forms, and a characteristic assemblage of the zone of *Dicran. clingani*. Nothing more is yet known of the Lane infold, but excavations may reveal the other zones, and possibly the one above this.

In the 'Church' infold (Figure 210) (Figure 211)), the lowest zone exposed is seen in the streamlet, about 120 yards south by west from the church, where black shale with thin sandy seams yielded a fine development of the typical Murchisoni ' assemblage [Af. 999–1012, 3506]:

*Didymograptus euodus?* Lapw.

*Didymograptus murchisoni* Beck

*Didymograptus murchisoni* var. *geminus*.(His.)

*Lingula* cf. *granulata* Phill.

Just below the road, 100 yards south-west of the church, is a quarry traversed by a strike fault. On the south side is a massive grit, broken and confused. On the north side is a good section in dark (but not sooty-black) shales, alternating with rather coarse grits.

The shales have yielded [Af. 709–18, 758–77, 1013–32, 1061–72]:

*Climacograptus scharenbergi* Lapw.

*Cryptograptus tricornis* (Carr.), var. *schäferi* Lapw.

*Dicellograptus divaricatus* (Hall)

*Dicellograptus patulosus* Lapw.

*Dicellograptus sextans* Hall

*Dicranograptus* cf. *brevicaulis* E.&W.

*Dicranograptus* sp.

*Diplograptus* (*Orthograptus*) *calcaratus* Lapw., var. *vulgatus* E.&W.

*Diplograptus* (*Mesograptus*) *multidens* E.&W., var. *compactus* E.&W.

Diplograptus (*Amplexograptus*) *per-excavatus* Lapw.

Diplograptus (*Glyptograptus*) *teretiusculus* (His.)

Glossograptus *armatus* Nick.

Lasiograptus (*Hallograptus*) *mucronatus* (Hall), *var bi-mucronatus* (Nick.)

Leptograptid

Lingula sp. nov.,

a fauna regarded now by Miss Elles as being high up in the zone of *Nem. gracilis*, probably above the sooty-black shales.

About 400 yards to the north-east of the church, and north of Glan-y-gors, there is a quarry in folded black shale with some thin grits, locally ferrified. The shale has yielded a rather poorly preserved Diplograptid [Af. 1290–4] considered by Miss Elles to be *Climacograptus* cf. *wilsoni* Lapw., thus apparently indicating the first zone of the Harden beds. This important exposure should be further searched. The streamlet from the little ravine comes down under the churchyard wall and then along the hedge; and 50 yards from the church, about south-south-east, some thin grits are exposed in its bed, with a little black shale, smooth and clean, which yielded [Af. 1073–6; 1264–89]:

*Climacograptus bicornis* (Hall)

*Climacograptus caudatus* Lapw.

*Climacograptus minimus* (Carr.)

*Dicellograptus morrisoni* Hopk.

*Dicellograptus* sp.

Diplograptus (*Orthograptus*) *calcaratus* Lapw., *var. basilicus* Lapw.

Diplograptus (*Orthograptus*) *calcaratus* Lapw., *var. vulgatus* E.&W.

Lingula sp. nov.

a characteristic assemblage of the zone of *Dicran. clingani*: linked by two forms with the collection made by Dr. Callaway from the Lane infold, and, adds Miss Elles, 'preserved in the same type of shale'. Four zones, therefore, are represented in this important infold. Rapid folding is visible in the ravine to the north-west, and by the roadside on the hill north-east of the church. But the infolds cannot be unruptured. The Church infold (Figure 211) must be overthrust on the north-west, for shale of Arenig type comes on at once, and the Extensus beds are only 250 yards away. Internally, one slip-fault is visible in the large quarry, and it is certain that the Hartfell beds, inverted, must have slipped down against the Glenkiln. The Glenkiln zones do not continue round the Hartfell on the east up to the overthrust, for shale of Arenig type occurs at Tyddyn-bach. The Fferam infold (Figure 208) is evidently slipped on the south, cutting out at least the Murchisoni zone, and the conglomerate must be thrust on to it from the north. Nothing can be made out about the structure of the Lane infold. These infolds are strangely near to the western margin, which must be due to the great boundary slide, here evidently leaving the base and coming against the Murchisoni nip at Fferam-uchaf.

In the quarry and ravine south of Pen-padrig thin grits, folded sharply, alternate with dark shale, and here a cleavage appears again. By the alluvium at Penbol the ironstone is seen, but rather decomposed. Thin seams of ironstone 80 yards west of the railway at Glasgraig-fawr, are mere local ferrifications in shale of Arenig type. East of this, and 'up the slopes of Rhos-y-bol, shales are exposed in many places, but their horizon is not known.

The islet in the alluvium at the eastern end of Cors y Bol consists of conglomerate with pebbles up to six inches long, and calcareous nests. The pebbles are of Gwna quartzite, green-schist, and limestone, with many of gneiss and granite. There are short beds and 'wisps' of shale, which is of Arenig type. It is evidently the basal conglomerate, rising on an anticline.

Less than a mile to the south, however, in the valley to the east of Gwredog, a new quarry by the streamlet has exposed 7 or 8 feet of massive oolitic ironstone under shale of the *Nemagraptus* 'type, but no fossils could be found. To the north-east of this, at Pwll-coch-isaf, the ironstone was worked about 30 years ago and was seen by Prof. Hughes, but is not now exposed. In the farmyard, black shale with thin mudstones of the 'sooty-black' type characteristic of the zone of *Nem. gracilis* yields 3726–7? *Climacograptus scharenbergi* Lapw. Deep synclinal infolds must therefore run along both sides of the 'Islet' anticline.

## 6. The Northern Margin and Parys Mountain

The phenomena at the Carmel Head and Nebo thrust-planes (Plate 31) and (Figure 264) (Figure 265), (Figure 270), (Figure 271), (Figure 272) are described in Chapter 18.

About 270 yards east-south-east of Cefn-du-mawr, Llanfairnyng-hornwy, is a small boss of mica-schist like that of the Garn inlier: and about 300 yards south-west of Bod-hedd is a three-foot band of the same, highly brecciated, and lying in gritty shale. Neither of these are boulders, and they are not easy to interpret. Possibly the first may be an outlier from the Garn thrust-plane; and the second -be due to a thrust and slip that have developed on the strike of the anticline of Craig-y-gwynt. The broken beds immediately below the Carmel Head thrust-plane at the roadside, east of Bod-hedd, are muddy grit and conglomerate ([E10967](#)) [SH 334 898], so that the beds are probably inverted and the base about to rise. This is confirmed by finding, at the old slate quarry of Llyn Llygeirian, west of Llanfflewin Church, [Af. 794, 1474–77]: *Diplograptus (Glyptograptus) dentatus* (Brongn.) a form common in the zone of *Did. bifidus*. Beyond the Geirian fault a narrow band of conglomerate, which may be a continuation of that of Bod-hedd, rises in the shales close to the thrust-plane, probably on an anticline whose eastern end is overridden by the thrust. Gritty shales of cherty aspect ([E10998](#)) [SH 324 904] are exposed near the Ucheldref road, and there are beds of angular conglomerate in Gwaen-ydog ravine lying between shale that resembles that of the neighbouring *Extensus* beds of Llanbaba. Nothing but shale of unknown horizon, well exposed at Garnedd Smithy and in the railway at Rhosgoch, is then seen for three miles. But, close to the thrust-plane, in a quarry by the road from Four Crosses to Bodewryd, smooth black shale yielded [Af. 1139–43] *Cryptograptus tricornis* (Carr.). Similar shale is well exposed as far as Bryn-goleu, where it contains little fragments of green schist unlike that of the Amlwch beds just across the thrust. At a small shaft 100 yards north of Bryn-goleu, it yielded [Af. 1144–9]:

*Cryptograptus tricornis* (Carr.)

*Dicellograptus*?

Diplograptidae

*Leptograptus*?

The two faunas indicate Lower Glenkiln or Upper Llanvirn, and the lithology is that of the lower of the two. Shale which Mr. Muir thought to be of 'Bifidus' type is well exposed in the ravine to the east.

Before considering the valley between Bryn-goleu and Parys Mountain it will be well, however, to pass across to that hill itself. The Silurian shales within the felsite infold and on the southern side are described in Chapter 15. Skirting the northern margin of the felsite is a zone, about 200 yards wide, of dull grey shale, which has a greenish tinge in places. It graduates down into the green shales themselves ([E11266](#)) [SH 440 906], which, with an outcrop some 300 yards in width (possibly due to repetition), occupy the northern dip-slope. They contain a few dark seams, and thin grey films are frequent in them. Near the foot of the steep slope they are succeeded by dark shales' with only a few green films, in which, at intervals of six, or eight inches, are thin hard mudstones, rather darker than the shale, dipping at about 80°, and crossed at an acute angle by the cleavage. They can hardly extend along the strike for a quarter of a mile. None of these

beds, though well exposed, and repeatedly searched by Mr. J. O. Hughes, by the writer, and by the Survey Collectors, have yielded any fossils. They are the beds that have been provisionally correlated (Chapter 13) with the Barren Mudstones of the Scottish Hartfell group. Not even their most northerly beds resemble the shales of the zone of *Dicran. clingani*, SO that the Lower Hartfell beds are probably over-ridden by the Carmel Head thrust-plane.

Returning now to the valley between Bryn-goleu and the mountain, it will be seen that a shift of the outcrop of the great thrust plane shows that a fault with a moderate upthrow to the east must run along this valley just beyond the ravine. On the other side of it was obtained the interesting fauna that raises the perplexing structural questions which were postponed for discussion to the present paragraph. The fossils were obtained from the refuse heaps of three old mine-shafts. The first and most important may be found as follows: Where the road from Trysglwyn meets the road that goes over Parys Mountain to Ainlwch, a level '370' is given on the map, and 133 yards from this, in the direction 'of Rhos-y-bol, a footpath going westward leaves the road. Close to this footpath, about 60 yards along it, there is an old shaft, which, from a small (unnamed) chapel just across the stream: that runs off the mountain, may be called the Chapel Shaft'. It is hardly more than 10 yards from the base of the Parys Mountain felsite. Black shale from it yielded [Af. 1156–82, 3500–3]:

*Azygnograptus*?

*Climacograptus* sp.

*Didymograptus acutidens*? E.&W.[or *Leptograptid. stipe*?]

*Didymograptus* sp. ['*extensiform*' group]

*Diplograptus* (*Glyptograptus*) *dentatus* (*Brongn.*)

*Glossograptus armatus* *Nich.*

*Phyllograptus angustifolius* *Hall*

*Phyllograptus cf. typus* *Hall*

*Caryocaris* sp.

*Placoparia*?

That from a shaft 150 yards to the north-west yielded [Af. 1150–5, 1183–8]:

*Didymograptus bifidus* (*Hall*)

*Didymograptus patulus* (*Hall*)

*Didymograptus stabilis* *E.&W.*

*Lasiograptus* (*Hallograptus*) *mucronatus* (*Hall*), *var. inutilis* (*Hall*)

*Phyllograptus cf. typus* *Hall*

That from a shaft, 30 yards further to the north-west [Af. 1189–1204]:

*Dicellograptus moffatensis* (*Carr.*)

*Dicellograptus* sp.

*Didymograptus acutidens* *E. d W.*

*Diplograptus (Glyptograptus) dentatus (Brongn.)*

Miss Elles refers these shales to the base of the zone of *Did. bifidus*, and her remarks on the fauna have been given on p. 415.

In relation to the country on the western side of the valley, the presence of this horizon presents no difficulty; for, Lower G-lenkiln or Upper Llanvirn beds being present there, the fault might be expected to bring up the lower part of the Bifidus zone. In relation to the Parys Mountain infold, however, its presence is extremely perplexing, for it is found close to the base of the felsite, just where the highest Hartfell zones would naturally be expected to plunge beneath the Llandovery. The difficulty may, to begin with, be somewhat alleviated by remembering that the fossils were obtained from the tops of refuse-heaps, which must, accordingly, have come from the bottoms of the shafts. The Chapel Shaft is 130 feet deep, so that its bottom is lower than the valley floor along which the fault runs. The *Phyllograptus* beds may therefore have no outcrop at all, and are, in any case, 130 feet below the base of the felsite. The positions of the zones are, nevertheless, anomalous, and the difficulty is twofold. From the occurrence of the ironstone at Penbol, the country thence to Parys Mountain might have been expected to consist of an infold of Upper Glenkiln and of Hartfell beds deepening north-eastwards to pitch under the Llandovery shales: instead of which we find Lower Llanvirn shales rising. And in the second place, the proximity of the *Phyllograptus* beds to the base of the Llandovery calls for explanation. It is evident that serious disruptions underlie the Parys Mountain infold.

The first difficulty may be met by supposing that the beds from Rhosgoch to the Chapel shaft rise on the western side of a thrust with a westward inclination (let it be called the Chapel' thrust) which, emerging from beneath the Carmel Head thrust-plane somewhere to the north of Parys Mountain, rims south-west, and, curving to the south, pushes the *Phyllograptus* beds south-eastward over the higher zones. It is, however, extremely difficult to find a satisfactory line for such a thrust; and moreover, the persistent inward dips all round the curve at Rhwnc are the opposite to such as would be produced at it. In the farmyard at Rhwnc, where the base of the felsite is exposed (Figure 212), it is thrust over the shale, and the thrust (which may be called the Rhwnc thrust-plane) is evidently powerful, but is at low angles (10°–15°), and from the north-east. On the other hand, Mr. Fanning Evans, the manager of the mines, states that the lodes worked from the Chapel and adjacent shafts have a dip to the west, which must have been determined by pre-existing (see Chapters 19, 35) structural planes, such as the overthrust here postulated; and this is remarkable confirmatory evidence of its reality. If, however, we suppose that the Chapel thrust has no outcrop, all the facts known can be reconciled. Now the Rhwnc thrust is higher, and must therefore be the later of the two. It is suggested, therefore, that after the production of the deep infold, an oblique movement arose, interrupting it, and ending in the production of the Chapel thrust. But that, at a later stage, the whole of the upper part of the Parys infold, carrying with it the Llandovery shales, the felsite, and the barren green shales, was cut away and driven, at a lower angle than the pitch, a considerable distance to the south and west along the Rhwnc thrust-plane, overriding the Chapel thrust-plane, and bringing the felsite on to the zone of *Did. bifidus* (Figure 213). For the Rhwnc thrust-plane it is possible to find a line, and this is indicated on the one-inch map. It follows the felsite for about 300 yards from Rhwnc, but elsewhere has had, in default of fossil evidence, to be drawn partly by the character of the shale and partly by feature, meeting the Carmel Head thrust-plane at the Llaethdy road. To that great rupture it is, indeed, to be regarded as a precursor. The Parys Mountain and adjacent folds belong (Chapter 18) to an early stage of the great southward impulses, and by reason of their great vertical amplitude and the rigidity of their 'hard-packed' rocks, they offered considerable resistance to the great final impulse, accounting for the steeper inclination, in their neighbourhood, of the Carmel Head thrust-plane. But the strain of that impulse must have been enormous. Accordingly, before it finally prevailed, a great slice of the deep infold gave way and was driven forward upon the major thrust-plane of Rhwnc. The impulse was to the south, but the high dips in the infold, and the presence of the Nebo anticline, were an obstacle. The more moderate upward inclination of the pitch was an easier path, and the south-westerly direction actually taken is the resultant of the two.

This hypothesis has a further advantage: it helps to explain the narrowness of the belt of shale between Parys Mountain and the Nebo inlier, where the highest zone of all actually abuts upon the gneiss. Had this to be ascribed entirely to the Gwchiaid slide, the displacement on that plane would have to be of enormous magnitude at Trysglwyn, quite incredible in view of its disappearance to the south-west without producing any perceptible effects. The position of the Tarannon shales by the roadside north-west of Trysglwyn shows that the Rhwnc thrust-plane laps round the Nebo inlier and is faulted down against its end. These shales were therefore driven across the whole width of that part of the gneissic inlier;

and it is possible to ascribe credible dimensions to the Gwichiaid slide, which must be nearly overlapped by, or more probably cut, the Rhwnc thrust-plane, thus accounting for the narrowness of the strip of shale. A section through the central parts of Parys Mountain is given in (Figure 214). The Rhwnc thrust-plane cannot be followed any further.

Along the Nebo thrust-plane evidence is very scanty until Nebo is reached, where (see pp. 450–1) the thrust passes locally into over-folding, and even dies out altogether for a short distance. Different parts of an overfold have probably been brought into line by cross faulting. Thrusting, probably at high angles, is resumed immediately, and the basal grit cut out, reappearing for a short distance near Plâs-uchaf. Thence to the road the line is well defined, but after that it is drawn by springs and features to the remarkable overthrust (see (Figure 264)–(Figure 265)) opposite Ynys y Carcharorion.

## Mynydd-y-garn to Carmel Head

The extreme end of the Principal Area will be considered in connexion with the isolated tract of Carmel Head, because the latter would be unintelligible without it. No zonal fossils have been obtained beyond Bonw farm, and no fossils at all beyond Mynydd-y-garn; even the bedding is often obliterated, so that the district is one of the most obscure in the island in spite of the abundance of exposures.

The base emerges on the Garn inlier (Folding-Plate 9), the summit and eastern shoulder of the hill being composed of a massive conglomerate ([E11061](#)) [SH 319 908]–([E11062](#)) [SH 318 907] which dips, on the eastern shoulder, under grits that contain seams of shale, and these under shale of Arenig type. At the summit the precise position of the base can hardly be made out owing to the shearing, but on the eastern escarpments the conglomerate creeps across all the three zones of the Complex that emerge in the inlier. The pebbles are chiefly of Gwna quartzite and fine siliceous grit like that of the torn Gwna beds of Trwyn Crewyn, with Gwna limestone, Church Bay tuff, mica-schist like that of the inlier, gneiss and granite, some of the two last being eight inches long. The inlier is bounded on the west by a large fault, and on the east side of this fault a little upfold of schist shows that there is a slide along part of the northern boundary. This slide dies out eastward, but there must be a roll upwards of the conglomerate before it dips finally under the shales.

Fossils [M. 1491–1507] have been obtained from three places in the Garn conglomerate and grit, most of them from a limestone lump about 300 yards east-south-east of the summit, only the *Orthis* being found at the other two. They are:

Crinoidal ossicles

*Orthis cf. proava* Salter

*Orthis* (*Dalmanella*) *cf. testudinaria* Dalm.

*Parastrophia*, *aemula?* (Dav.)

By the roadside at Craig-y-gwynt, in an upfold of grit (Figure 215), were obtained [Af. 1508–12] a crinoidal ossicle and *Orthis cf. proava* Salter. The above are not zonal forms, but in shale west-south-west of Craig-y-gwynt was found [Af. 1478] *Diplograptus* (*Glyptograptus*) *dentatus* (Brongn.), and at Bonw farm [Af. 151314] *Didymograptus sp.* [extensiform type] and *Orthis cf. proava* Salter. It is therefore certain that in the shales overlying this conglomerate zones as low as that of *Did. bilidus*, probably as low as that of *Did. extensus*, are present, and that the conglomerate itself is of Arenig age and on the same general horizon as those at the base of the Principal Area three miles to the south-east.

From the Garn to Carmel Head (see section and map, Folding-Plates 10, 13) almost all is dark shale, powerfully, sometimes doubly, cleaved. But along the margins of the great Ordovician infolds, thrust and slipped as they are, strips of pebbly grit survive; and to the south-east of the Beacons a folded inlier of conglomerate rises through the shales. These beds must be on, or not far from, the horizon of the Garn conglomerate, so that the greater part of the shales of these barren tracts may be assigned to the Arenig. The shales have been re-examined in many parts of the district, and found to be of Arenig type in every case.

The local details of special interest, beginning on the south side of the Garn, are as follows. A somewhat obscure group of rather fine grits, rapidly interfolded with the shales (Figure 215) appears at Craig-y-gwynt. In default of zonal evidence,



it may be regarded as the upper part of the basal grits, rising on a steep and complex anticline, overdriven slightly from the north. Shaly conglomerate again rises by the roadside, 180 yards to the north. Then comes the Garn thrust-plane (Folding-Plate 9), at which is a zone of disturbance about 13 yards in width. This is well exposed at an escarpment 320 yards to the north-west of Craig-y-gwynt, and also on the floor of the farmyards at Cefn-du, apparently an infolded outlier of the zone surrounded by shale. At the escarpment (which is the best exposure), Green-mica-schist of the inlier is driven over the dark shales at angles of about  $40^{\circ}$ . The schist retains its ancient folding, but this is broken up and brecciated. Between it and the main body of the shale is a zone about four feet thick of minor thrusting, composed of long overlapping wedges or lenticles of schist and shale. To the west, the Garn thrust-plane, curving round, is cut off at the fault; to the east, it is lost in a tract of uniform dark shales.

From the north side of the Garn a tract of shale with interrupted borders of pebbly grit ([E10355](#)) [SH 305 914] runs westwards to the sea. A junction is exposed east of Handy, but whether thrust is not certain. On the coast at Yr-ogo-goch the relations shown in (Figure 203) are seen on the side of a cave. But in the cave the shale creeps rapidly round the shoulder of the buttress of schistose tuff, and curves up to the fault of the upper part of the cliff. The junction is a shearing slip along the cleavage, bifurcating downwards, but with a sort of 'hitch' not easy to interpret. In Porth y Bribys is a fine section in dark shale, considered by Mr. Macconochie to be of a somewhat unusual kind. It appears to be a variety of the micaceous Arenig type, but the bedding is remarkably obscure, a steep cleavage being almost the only structure visible. A grit near the north cliff, however, reveals undulation at low angles, overfolded from the north. Beyond the basic sill about 50 feet of pale grit are seen, a good deal sheared, and easily confused with those of the Gwna schists. The Ordovician grit, nevertheless, contains fragments of the fine Gwna grits, which are driven over it at an angle of about  $60^{\circ}$ . The junction is exposed on the brow north of the cove, and may be called the Crewyn thrust-plane (Folding-Plate 10), but what thickness of the grit is cut out cannot be determined.

The next Ordovician tract wedges out before reaching the sea. A junction is to be seen in Hendy farm-lane, which appears to be a slip along the cleavage, but is obscured by silicification. Between Hendy and the sea the lines are such as would be produced along a double or triple infold, slipped and overthrust. But there is again silicification, and it must be admitted that the sheared felspathic grits of the Ordovician are very difficult to separate from those of the felsitic Fydlyn schists. Nowhere in the Island have the boundaries between the Ordovician and the Mona Complex been found so difficult to lay down with satisfaction as at this place.

On the spur between the coves at Porth-yr-hwch, a felsitic Fydlyn tuff of the Mona Complex rises on a slide from below dark shale, which is well seen in the northern chasm, where the slide is perfectly exposed. Over it, in the same chasm, the gneissoid granite of the Complex is driven southwards on the powerful Hwch thrust-plane, which, running inland, bounds the gneissic tract upon the south (Figure 130). The average angle of thrust is about  $30^{\circ}$ , but bends over to as low as  $18^{\circ}$ , allowing the shale to re-appear on the cliff that overlooks the southern chasm. At the top of the northern chasm the actual plane (here shifted slightly by later planes at lower angles) is exposed, though poorly. The gneiss riding on it is heavily mylonised.

About half way to Porth Padrig is a good conglomerate, well exposed above the track leading from Mynachdy to the old mines. Long narrow bays of shale run into it, and strips of shale seem to rest upon it, so that it must be regarded as a crumpled anticline of the basement beds. The pebbles reach three inches in length, and include quartz, quartzite, and fine siliceous grit; but it is curious that here, close to the gneissic inlier, very few of gneiss or granite have been seen, though they are abundant on the Garn. This anomaly suggests that the Gader gneiss has been transported a considerable distance along the Hwch thrust-plane, and that the Garn pebbles do not come from it at all, but from buried or destroyed gneiss lying to the north of the Garn inlier. The Garn conglomerate itself lies directly upon Gwna beds, and there seems no room for any gneiss. The inlier, however, is riding upon the Garn thrust-plane, and is therefore *sans racine*. That thrust is evidently powerful, and must have considerable horizontal overdrive. So the gneiss that yielded the Garn pebbles is probably situated, where 'autochthonous', in some infold of inverted Mona rocks now concealed beneath the great *nappe de recouvrement* brought forward on the Carmel Head thrust-plane. The Gader conglomerate becomes very sheared and silicified on its northern side, as well as in the adjacent strip beyond the track, simulating the Gwna grits. The Hwch thrust-plane is cut off by a large steep slide which, carrying a vein, bounds the gneissic tract upon the north, and is well seen upon the western coast, where it cuts older slips that are at lower angles. Sixty yards to the north is another large thrust, at an angle of  $34^{\circ}$ , but wholly in shale with minor thrusts adjacent. All these cut the cleavage. The

structures in the shale along the cliffs of Carmel Head are described in Chapter 18.

We now come to the Carmel Head thrust-plane (Plate 31), (Folding-Plate 10), (Folding-Plate 13). The structures at the great section are described and figured in Chapter 18. On the eastern- shore, however, it should be noted that, where the thrust-plane, broken by several small faults, skirts the coast, four small 'windows' revealing the underlying shale will be found in the lower parts of the cliffs. It cannot be traced across the sea-weed-grown floor of Porth yr Ebol (as the cove a quarter of a mile south-east of Carmel Head is called on the .0004 and six-inch maps) and must be suddenly shifted by a normal, brecciating fault, with a downthrow to the north, which is seen in the cliff on the other side, to the south of which the great thrust-plane rises a few yards, and, turning round, passes along the face of the cliff ([E11008](#)) [SH 301 928]–([E11009](#)) [SH 299 930]]. It is then again shifted eastwards by another fault, which can be seen in the next cove, along whose floor it runs, disappearing beneath the drumlin; beyond which it is traceable again towards Mynachdy lane. Shale is visible beyond it on the outer ebb-reefs of the cove, but these are densely overgrown with sea-weed, and whether the shale is a faulted inlier from below the great thrust, or an extension of the Glenkiln shales of Porth Padrig, has not been- determined.

Finally, about 700 yards south-east of Bonw, are two exposures of the pisolitic ironstone. They are associated with the usual heavy blue-black shale, grits appearing above and below. The beds lie in a normal synclinal fold, pitching against the Garn fault. The ironstone [[E10352](#)] [SH 318 897], ([E11079](#)) [SH 319 897], and analysis] is, next to that of Llangoed, the most beautiful iron-oolite in Anglesey. The following fossils have been obtained [Af. 1479–90, 1515–22, and Dr. Matley's collection]:

*Didymograptus indentus* (*Hall*)

*Diplograptus* (*Amplexograptus*) *perexcavatus?* *Lapw.*

(*Glyptograptus*) *teretiusculus* (*His.*)

*Lingula* or *Siphonotreta?*

*Acrotreta* sp.

chiefly from the stale. They indicate the zone of *Glypto. teretiusculus*, so that the ironstone is slightly below the horizon at which it is found at Llanbabo, but a little higher than at Llangoed. At Bwlch (six-inch map) near the ironstone, Dr. Matley obtained a *Leptograptus*, probably but not certainly on the south-western side of the Garn fault.

## **Mynydd Eilian**

Fossils have been obtained. as follows: Porth-y-Gwichiad, about 80 yards north of the streamlet [Af. 1317–24], *Placoparia* sp., indicating shales of upper Arenig age; the same shore, about 35 yards further north [Af. 1325–34]:

*Climacograptus scharenbergi* *Lapw.*

*Climacograptus* sp.

*Diplograptus* (*Glyptograptus*) *teretiusculus* (*His.*) [broad var.]

*Diplograptus* (*Glyptograptus*) *teretiusculus* var. *euglyphus* *Lapw.*

indicating beds near the junction of the Glenkiln and Hartfell groups: Coast at the old slate quarries, about 260 yards south of the Carmel Head thrust-plane [Af. 3627–40], *Diplograptus* (*Glyptograptus*) *teretiusculus* (*His.*), indicating the zone. of *teretiusculus*.

But all the upper parts of Mynydd Eilian, and thence to the coast at Trwyn-du, are composed of dull greenish grey, barren, gritty shales, which Messrs, Muir and Macconochie agree with the writer in correlating with those of Parys

Mountain that are conjecturally referred to the Upper Hartfell. Coarse conglomerates and grits, with some shale of Arenig type, appear close to Porth-y-cowgl and at Fresh Water Bay. Such is the zonal evidence. From it a section (Figure 216) (which is really generalised, by combining sections along several parallel lines) has been constructed. But it must be understood as merely a suggestion, and owing to the general destruction of bedding the dips are quite conjectural.

A few local notes are all that need be added. Beginning at the south end of the coast-line, the dark shales are of good Arenig type. They contain lumps and strips of fine dark limestone and grit, and the strike both of bedding and cleavage is much disturbed. The cliffs of Porth-y-Gwichiad are composed of dark shales which, where the higher zone has been identified, show the bedding better than any in the district, and the banded Lower Hartfell shale of Llanbabo may very well be represented in these cliffs. Thrusts, later than the cleavage, and some of them at very low angles (Figure 267), (Figure 268) are numerous, so that there is no difficulty in understanding the juxtaposition of the two fossiliferous horizons. At Trwyn-du the grey-green shales come on, but after passing Ogo-fawr these give place to gritty shale with thin dark mudstones, beyond which come the Fresh Water conglomerates, with pebbles of gneiss, granite, quartzite, and Gwna phyllite, some of which reach a foot in diameter. The dynamical effects produced in this and in the conglomerate further north are described in Chapter 18. Then follow the dark slates of the old quarries, ushered in by a large thrust which breaks the cleavage. These dark slates, whose lower parts are of Arenig type, contain thin grits, now much cut up. Finally come the dark shale, grit, and conglomerate (E8469) [SH 482 927] over which the Amlwch schists are driven on the Carmel Head thrust-plane. They resemble the Fresh Water conglomerates, but boulders of Gwna limestone are present as well as the other types.

Passing inland, the sandy beds are not so coarse, being chiefly felspathic and rather muddy grit, which is well seen at and smith of Pant-y-groes. The boundaries are generalised. The summit of Mynydd Eilian is composed of the grey-green shales, with occasional gritty bands, which present a fine escarpment to the south-east. The bedding is destroyed, the shale is pencilly ' from double cleavage, and there is much contact alteration. At the west end of Llaneilian alluvium, 133 yards west of the '132' level, is a conglomerate full of blocks of phyllite, quartzite, and limestone from the Gwna beds, some of which are a foot in length. The phyllite and quartzite are evidently derived from the Corwas anticline, and doubtless the limestones were removed from the same area.

With the Eilian area may be placed six little strips of dark shale, four inland, two on the coast, that, without any basal grit, rest upon the Nebo gneisses. The one about 300 yards north-west of Plâs-uchaf is at the foot of an escarpment along whose brow is gneiss, evidently overthrust. On the shore at the stream's mouth that comes down from Llanwenllwyfo old Church, the relations are exposed, and the shale is of Arenig type. No slide-plane has been detected on the south, beneath the shale, but the gneiss is thrust over from the north. It would seem, therefore, that the basal grit has thinned out altogether, as appears to be the case also (see p. 434) at Llanddona.

## The Northern Wedges

**The Succession** — In the tract between Cemaes and Bull Bays, called here the Gynfor district, the Ordovician rocks are, on the great sea-cliffs and rugged hill-tops, better exposed than anywhere else in Anglesey. In Gynfor, eight wedges of them are let into the Mona Complex, here consisting chiefly of the Gwna beds with their conspicuous quartzite, very slightly altered. Another wedge occurs at Porth Padrig, Mynachdy. All are of the nature of deep infolds, ruptured by many slips and overthrusts.

The succession in Gynfor, compiled from the evidence of all the wedges, is as follows:

	Feet
Black shale (top not seen)	40
Oolitic ironstone	20
Banded sandy shales with black chert	150
Pale conglomerates and grits, about	300
Purple conglomerate	180
	690

and at Mynachdy:

Dark shale with thin grits.

Dark shale with mudstone and some grits.

Black shale with lenticular beds of breccia and limestone.

Conglomerate (confused).

The purple conglomerate, the cherty shales, and the limestone are unknown elsewhere in Anglesey.

The black shales are of the same 'sooty' character as those of the Nemagraptus zone to the south of the Carmel Head thrust-plane, but the ironstone is paler,, more calcareous, and less oolitic. The group underlying it consists of rapid alternations of dark shale and fine sandstone. They are apt to have a cherty cement, and there are bands of clean black chert with sponge-spicules (Figure 200). The pale psammitic group varies a good deal, being sometimes grey, but often greenish; sometimes a pebbly grit, sometimes a coarse conglomerate with great boulders of quartzite. The purple conglomerate is always cleaved or sheared, but for many miles there are boulders in the glacial drifts of an undeformed conglomerate that resembles it both in character and contents. Thin seams of purple shale occur in it which, when highly sheared, simulate the purple phyllites of the Amlwch beds. Indeed, the anamorphic state of the purple conglomerate at Porth Wen, and its absence at Ogof Gynfor and other places, tempt one sometimes to wonder whether it belong after all to the Mona Complex; but its junction with the pale conglomerate east of Hell's Mouth, the occasional purple seams in the latter, the urrsheared boulders just described, and (above all) the total absence of any such rock in the Mona Complex away from the base of the Nemagraptus beds, negative this.

### **Fossils of Gynfor**

The fossil-lists from the Gynfor wedges will be given here all together, for, as the lithological zones are quite easy to recognise, it is not necessary to quote the fossils in order to interpret each particular locality. To Dr. Matley's lists are added those collected by Prof. T. McK. Hughes, Mr. J. Owen Hughes (which are those with registered 'Af'. numbers), and the writer.

From the pale basal grits were obtained:

At top of cliff, south side of Ogof Gynfor [Dr. Matley's collection]:

*Orthis vespertilio* *J. de C. Sow.*

*Orthis* (*Dalmanella*) *testudinaria* *Dalm.*

*Orthis confinis?* *Salter*

*Orthis proava* *Salter*

*Orthis* ?or *Zygospira* sp. [small, with simple ribs]

*Strophomena* *cf. imbrex*, *var. semiglobosina* *Dav.*

'*Rhynchonella*' sp. [or *Orthis?*, large, with very strong ribs]

'*Rhynchonella*' sp.

Crinoid columnal

Trilobite

(A similar assemblage was found on the cliffs west of Llanlliana cove, near the purple conglomerate.)

About 100 yards east of Ogof Gynfor [Dr. Matley's collection]:

*Orthis vespertilio* *J. de C. Sow.*

*Orthis* sp. [? or *Zygospira*]

'*Rhynchonella*' sp.

*Cf. Ctenodonta*

At 120 yards north of Ogof Gynfor [Dr. Matley's collection]:

*Lingula cf. tenuigranulata* *McCoy*

Graig Wen tramway [By Prof. Hughes, and now in Sedgwick Museum, Camb.]:

*Orthis bailyana* *Dav.*

*Orthis cf. confinis* *Salter*

*Orthis proava* *Salter*

On Pant-y-gaseg Hill [Dr. Matley's collection]:

*Orthis proava* *Salter*

From the cherty shales:

At Porth Wen Bay (By E. G.) ([E10516](#)) [SH 408 946]:

Sponge-spicules, in chert (some simple and rod-like, some cylindrical or fusiform. None hexactinellid. *G. J. Hinde*)

At Dinas Cynfor:

Crinoidal columnals.

At Ogof (or Ogo) Gynfor (usually pronounced Ogo Gunvor) (for exact position see p. 477, and (Figure 220)) in the cherty shales just above the basal conglomerate [Af. 3507–22]:

*Callograptus* sp.

*Cryptograptus tricornis* (*Carr.*)

*Dendrograptid*

*Desmograptus* sp.

*Dicellograptus intortus* *Lapw.*

*Dicellograptus sextans* (*Hall*)

*Diplograptus* (*Glyptograptus*) *teretiusculus* (*His.*), *var. euglyphus* *Lapw.*

*Lasiograptus* (*Hallograptus*) *mucronatus* (*Hall*), *var. bi-mucronatus* (*Nich.*)

*Petalograptus?* *phylloides* *E.&W.*

Ptilograptus sp.

From the black shales (above the ironstone):

At Penterfyn [Af. 754–5, and Dr. Matley's collection]:

Didymograptus sp.

Dicellograptus intortus *Lapw.*

Dicranograptus nicholsoni *Hopk.*

Dicranograptus ramosus *Hall*

Dicranograptus rectus *Hopk.*

Diplograptus teretiusculus (*His.* or *var. euglyphus Lapw.*

Climacograptus scharenbergi *Lapw.*

Cryptograptus tricornis *Hall*

Nemagraptus gracilis *Hall*

Lingula brevis *Portl.*

In the Vicarage grounds above Llanbadrig Cove [Dr. Matley's collection]:

Acrotreta sp.

Paterula balcletchiensis *Dav.*

Siphonotreta?

Llanbadrig Cove, 300 yards south of church [Af. 735–53, and Dr. Matley's collection]:

Didymograptus superstes *Lapw.*

Dicellograptus sextans *Hall*

Dicellograptus, sp.

Dicranograptus nicholsoni *Hopk.*

Climacograptus brevis *E.&W.*

Climacograptus scharenbergi *Lapw.*

Diplograptus euglyphus *Lapw.*

Cryptograptus?

Glossograptus sp.

Lasiograptus (Halograptus) mucronatus (*Hall*)

Leptograptus sp.

## Nemagraptus gracilis

The graptolites of Penterfyn and Llanbadrig are characteristic assemblages of the upper parts of the zone of *Nemagraptus gracilis*, those [Af. 3507–22] from the cherty shales of Ogof Gynfor indicate its lower parts, possibly the passage beds from the underlying zone. The brachiopod-fauna from the conglomerates immediately beneath has three species in common with that of the conglomerates that underlie the shales of the zone of *Did. extensus*, a remarkable persistence.

**Relation to the Mona Complex** — The base is actually exposed on Pant-y-gaseg Hill, at Graig Wen, at Hell's Mouth, on both sides of Dinas Cynfor, and at Ogof Gynfor; and is easily traceable in many other places. The general absence of a visible discordance suggests a doubt as to the existence of an unconformity: but its reality can be demonstrated from the following considerations. Throughout most of the area, the base of the Ordovician rests upon the Gwna quartzite; but on Pant-y-gaseg Hill and some other places it rests upon the Gwna grits and phyllites. On the north side of that hill (see below) it must rest upon, or have cut very nearly down to the tuffs of the Skerries Group. The bed resting upon the Mona rocks is not always the same: sometimes it is the pale, sometimes the purple conglomerate. Both conglomerates contain abundant boulders and pebbles of the quartzite, and also of the Gwna phyllites, in some of which the ancient planes of movement can be found, and these planes may sometimes be seen, even within a cleaved conglomerate, to lie parallel, not to its cleavage, but to its bedding. Pebbles of the Gwna jaspers are frequent in the purple conglomerate. In other parts of Anglesey conglomerates that lie below the zone of *Did. extensus* rest upon the Gwna beds and contain abundant pebbles of them, and that in much more altered condition than they are here. Finally, at the cliff's foot on the north side of the entrance to Ogof Gynfor ((Plate 29), and (Figure 221)) there is even in this district, a very strong discordance. Coarse conglomerate, full of boulders of the quartzite, rests upon upturned edges of flaggy quartzites that alternate with bands of phyllite. The base, though cut by a small slip, is not a plane of movement. It is irregular, and the conglomerate adheres to the eroded surfaces of quartzite.

From the fact that the conglomerate does for the most part rest upon the quartzite, it must be concluded that the Gwna rocks happened, in Ordovician times, to be so disposed in this district that their quartzite lay sufficiently horizontal to form the surface for a space of about a mile and a half from east to west. ((Figure 97).) But that surface must have already been unevenly eroded, for the restricted outcrops of the purple conglomerate, in spite of its thickness of 180 feet, point to rapid local overlaps. Dr. Matley has remarked that where the width of outcrop of the quartzite increases that of this conglomerate decreases, the united width of the two being fairly constant. From this it may be inferred that the purple conglomerate filled old eroded hollows in the quartzite-surface, and the pale conglomerate was then spread out upon a floor thus evened up.

## The Gynfor Sections

Beginning at the east these are as follows:

**1. Pant-y-gaseg Hill** is skirted all along its northern side by a narrow tract of pale grit ([E10959](#)) [SH 408 946] and conglomerate, from beneath which a little purple conglomerate emerges in three places; resting upon Gwna phyllites with many small quartzites, and steeply overthrust on the north by the massive green tuffs (among which, however, a strip of conglomerate is let in a few yards away, indicating a Pre-Ordovician date for the thrust, shown in (Figure 95), which drives the Skerries rocks on to the Gwna Beds). The conglomerate can be seen at one place to rest undisturbed upon, and to partly wrap round, a boss of quartzite. It contains enormous blocks of the same rock, one of which, irregular in form, is six feet in length. At the old mine shaft there is much debris of dark shale or phyllite, suggesting that the *Nemagraptus* shales may lie below, and that the conglomerate is really thrust over them.

**2. Porth Wen Bay** — The eastern side at the 'n' of 'Wen', called Porth Pridd on the six-inch maps. — This important locality supplies the key to the succession. All the conglomerate is, however, cut out by a very clean-cut fault, north of which is about 20 feet of coarse grit. The south cove is occupied by the spiculiferous cherty ([E10516](#)) [SH 408 946] (Figure 200) and banded group, which are finely exposed. These then rise into a great sharp spur, 100 feet in height, which parts the coves. To its northern wall clings the pale ironstone ([E10517](#)) [SH 408 946] upon which rest about 40 feet of black shale, the beds being nearly vertical. So far the rocks are not broken up, but in the north cove, which is

occupied for the most part by the black shale, there is more confusion than can be shown in any figure, thin grits and ironstone being carded in and in with the shales. The steep thrust (Figure 95) upon which the Gwna grits are driven over is not a single plane, but is interrupted, high up the cliff, by oblique shifts which cause inosculation of the two series for several yards.

**3. Torllwyn.** Except at Porth Wen works, where all the rocks are deeply decomposed, the conglomerates (E11004) [SH 401 946], repeated on the headland, are finely exposed on the great cliffs all round this area, and hardly less so on the high ridge between Graig Wen and Hell's Mouth. At the stack on the shore north of the works the purple conglomerate (E10514) [SH 408 940] contains blocks of quartzite more than two feet long, and this is also the best section in which to study its deformation and schistosity (Chapter 18). Pebbly green grits follow, with bands of coarse conglomerate, containing boulders three feet long, chiefly quartzite, but with some of pale quartzose schists. The dynamical structures are interesting here; the strike of the cleavage, also, which is east and west, being oblique to that of the bedding. The finer beds are wonderfully ruptured along this cleavage. On the north cliffs of Torllwyn purple beds appear for a few yards, and then a little of the Gwna phyllites with a small quartzite and limestone. Though ruptured, it is evident that the base is rising, here. As we turn round the headland the grits contain pebbles of greenish schists as well as quartzite, and one of gneiss was seen at the summit of Torllwyn (which is 260 feet in height). The cove at the 'r' of 'Torllwyn' (Porth Adfan of the six-inch map) presents a perplexing section. In its recess the purple conglomerate, here largely phyllite, is driven over a few feet of disturbed cherty shales, from beneath which the green grits rise. But along the foot of the southern cliffs is a low ridge of the Gwna phyllites with two little quartzites. To construct a consistent section is almost impossible, but it is clear that the base has risen here and then been torn out more than once., Pale pebbly grits follow to the west, and then, just before Hell's Mouth is reached, the purple conglomerate rises, unfaulted, in a magnificent sea cliff, resting at an angle of 60° upon the quartzite. Thence one may walk on it along the high ridge, broken by three small faults, as far as Graig Wen. It is but little sheared, and the characters of the deposit may be better studied here than anywhere. The staining is, capricious, but often penetrates the pebbles. These include schistose Gwna grit and phyllite whose deformation is independent of that of the conglomerate, for side by side with them are unshattered pebbles of the same size and shape. There are also many pebbles of scarlet Gwna jasper. On the western boss of Graig Wen a little outlier of conglomerate appears to be an infold in the quartzite; of which, however, it contains a lenticular mass. The section in the quarry at the eastern end of Graig Wen is perplexing. The quartzite, now rapidly thinning, contains, and even overlies, strips of purple phyllite of the type that belongs to the conglomerate, which appears to have been driven into it along slide-planes. A green phyllite which is also present may belong to the Gwna group. The uprise of the base at Porth Adfan and on Torllwyn indicates that the repetition in this area is not due to simple faulting, but to isoclinal folding on the large scale with ruptured anticlines (Figure 217), the pale conglomerate being doubled on itself in two deep infolds and its thickness greatly exaggerated. The confusion at Porth Adfan may be interpreted as an attempt to insert an extra syncline and anticline between the two large infolds.

**4. Dinas Cynfor.** This 'noble headland' (often called Llanlliana Head) 200 feet in height, the most northerly point of Anglesey, seems to be a continuation of the southern infold of Torllwyn. Yet it is remarkable that the Hell's Mouth fault, although a down-throw to the west sufficient to bring in the remaining four Ordovician infolds, produces little hardly any displacement of the base. The high dips at Hell's Mouth are not a sufficient explanation of this, which must be due to the disposition of the already broken Ordovician wedges at the time of the faulting (p. 219). Along its landward escarpment the purple conglomerate, still resting upon quartzite, rises vertically. It is grandly seen in both cliffs, and about 200 yards from the east cliff the junction, with a little quartzite breccia beneath the conglomerate, is exposed in a shallow section. The syncline takes in a good many feet of the cherty shales, which here contain a massive bed of grit near the north point. The fold is broken by two faults, which diverge westwards, and between them it is compound, with a subsidiary anticlinal roll that pitches eastwards, throwing the shales off southwards near the western end. Small trough faults that are seen on the cliff overlooking Porth Llanlliana emerge towards the north as mere joint-planes. (Figure 218) is a section, drawn from a boat, along the range of cliff that faces the north-west.

**5. Glochog.** This tract extends from Porth Llanlliana to the next headland, known locally as Glochog, though there is no room for the name on the one-inch map. Near its eastern end the base is seen a little inland, pale conglomerate resting on the Gwna phyllites, against which, in the cliff, it is then faulted down. About 70 yards to the west, however, purple conglomerate and shale rise on a broken anticline in the lower part of the cliff, which is the most westerly appearance of



that bed. The tract is slightly faulted, but probably for a short distance only, on the south. Its western cliffs display grand sections of massive grits and coarse conglomerate, containing enormous blocks of quartzite. At the headland, and also at a strong feature about 200 yards -east of it, there are overthrusts, between which, upon some broken bluffs, the cherty shales appear, repeated in a manner which shows that they are 'climbing up' in a succession of minor folds, until the conglomerate rises finally from beneath them at the top (Figure 219).

**6. Pen-terfyn.** The inland tract lying to the south-east of this house (which stands between the 'd' and 'r' of 'Llanbadrig ') appears to consist chiefly of the black shale, but it is poorly exposed and its relations are obscure. About 210 yards to the south of Pen-terfyn, two small isolated outliers of conglomerate rest upon a boss of quartzite, and at the roadside farm a patch of the cherty shales dips off a boss of conglomerate. At Pen-terfyn itself the tract suddenly narrows, and the ironstone and Nemagraptus shale is exposed in a little quarry about 100 yards to the north-west. The section is as follows (after Matley):

	Feet
Ironstone <a href="#">(E11011)</a> [SH 437 898] with partings of graptolitic shale	17
Black shale	2
Blue sandy shale	2

The tract is evidently bounded entirely by thrusts and slips.

**7. Llanbadrig Cove, south of the Church.** (Porth Padrig of the six-inch map.) The same is the case with this tract. It also consists almost entirely of the black shales, but ironstone [\(E10971\)](#) [SH 375 945] rises between them and the Gwna beds on the foreshore; and a little conglomerate clings to the quartzite for about half of the distance between the sea and the fork of the road (appearing also again just to the east). The only point of general interest is the exposure of the black shales upon the coast, which contain abundant graptolites.

**8. Ogof Gynfor.** Inland, this tract is rather obscure. But it is perhaps the most illuminating of all, because of the magnificent section across its whole width, displayed in the deep chasm of Ogof Gynfor and the cliffs to the north of that, 100 or more feet in height. This was first figured by Blake, and afterwards by Dr. Matley, and (Figure 220) represents the results of three re-drawings of it by the present writer, approximately, but not exactly, in natural proportions, measurements being difficult to obtain, especially as the southern parts (from 'MG■' to 'b') are in the chasm, and have had to be brought artificially into line with the northern parts. The Ordovician beds present are the pale conglomerate and the cherty shales (here not very cherty). The graptolites obtained by Mr. J. O. Hughes from these shales came from between the two faults at x', a few feet above the conglomerate. The base of the conglomerate appears in three places, the middle one of which (just at the corner of the gulf) is that shown in (Plate 29) and (Figure 221) [\(E10952\)](#) [SH 378 948], [\(E10964\)](#) [SH 378 948], [\(E10965\)](#) [SH 378 948], [\(E10966\)](#) [SH 378 948]. Regarded as a whole, the section shows an infold, overthrust on the north, slipped on the south, and is a remarkable revelation of the structures developed in such infolds. The slips are, so far as can be seen, clean sharp cuts (not brecciating faults), usually not far from the direction of the cleavage, which, however, is feeble. In the midst are two ruptured anticlines of the Mona Complex, the larger of which forms the great north wall of the deep chasm, and is there chiefly composed of the gritty phyllites. In the ladder-like gap where the graptolites were found, the south fault is vertical, but the north one an overthrust, or rather two overthrusts, beneath which the ends of the beds of shale are crumpled and driven over. The minor thrusts in vertical beds at the north end are curious, and it should be noted that they are at lower angles than the major thrust bringing on the Gwna limestone, a reverse of the relation that is prevalent in the North-West Highlands. This section, and indeed most of those between it and Torllwyn, cannot be studied effectively except from a boat.

### **Porth Padrig, Mynachdy**

The inland exposures are few and poor. On the coast, at the cove at the north end of the section (called Porth-newydd on the six-inch maps), although the actual plane of junction is not exposed, the Mona schists dip northwards off da1k shales, and from their overhang it is evident that they are thrust over. This, which may be called the Mynachdy Thrust (Figure 222), (Figure 94), is regarded as superimposed upon the great Caerau thrust-plane. On the south cliff rises an alternating

group of black shale with thin grits, showing that the type of deposit so prevalent in the Arenig beds was repeated in the Glenkiln. They are more disturbed than would appear at first sight. West of them thin dark mudstones, rather nodular, are frequent. Then, just before turning round to Porth Padrig, strong beds, a foot or two thick, of angular conglomerate begin to appear, containing fragments of onartzite and some fine schistose rocks derived from the Mona Complex. In the northern inlet of Porth Padrig these conglomerates increase, and are certainly not cataclastic, for shale and laminated grit graduate into them. Then lenticular lumps of limestone develop in them, from a few inches to six feet thick, sometimes filling the whole width of the bed and displacing it (Figure 223). The bedding is undisturbed on the north wall of this inlet, but on the promontory between it and the south inlet there begins the extraordinary *mélange* described in Chapter 18.

The limestones have yielded [[\(E11012\)](#) [SH 305 927], [\(E11013\)](#) [SH 305 927], [\(E11014\)](#) [SH 305 927], [\(E11015\)](#) [SH 305 927], [\(E11016\)](#) [SH 305 927], [\(E11017\)](#) [SH 305 927], Af. 1586–1644]:

*Favosites fibrosus* (*Goldf.*)

*Solenopora compacta* *Bill.* [= *Tetradium peachi* *Nich. d Eth., jun.*]

Crinoidal columnals

*Monticulipora* sp.

*Prasopora grayae?* *Nich. & Eth., jun.*

*Camarella?* [*cf. Stricklandinia? balcletchiensis* (*Dav.*)]

*Leptaena rhomboidalis* (*Wilck.*)

*Lingula cf ovata* *McCoy*

*Orbiculoidea cf. perrugata* (*McCoy*)

*Orthis cf. proava* *Salter*

*Rafinesquina* sp.

Rhynchonellid

? *Maclurea matutina* (*Hall*) [operculum]

? *Maclurea logani* *Salter*, or *peachi* *Salter* [operculum]

*Maclurea?*

*Calymene?*

*Chasmops* sp.

*Illaenus caecus?* *Holm*<ref>Apparently identical with that from the Keisley limestone; but Holm's type rather imperfect.—  
P:L.</ref>

*Illaenus* sp.

The dark shales of the same cliff yielded [Af. 1524–80]:

*Climacograptus antiquus* *Lapw.*

*Climacograptus bicornis* (*Hall*)

Dendrograptid

Dicellograptus intortus *Lapw.*

Dicellograptus patulosus *Lapw.*

Dicellograptus sextans (*Hall*)

Dicranograptus sp.

Diplograptus (*Glyptograptus*) teretiusculus (*His.*), *var. euglyphus Lapw.*

Lasiograptus (*Hallograptus*) mucronatus (*Hall*), *var. bi-mucronatus Nigh.*

Nemagraptus gracilis (*Hall*)

Lingula sp.

Orbiculoidea?

And the dark shales and thin grits of Porth-newydd (as the cove at the north end of the coast section is called on the .0004 and six-inch maps) 150 yards to the north-east [Af. 1581–5, 1645–9]:

Climacograptus antiquus *Lapw.*

Climacograptus brevis? *E.&W.*

Dicellograptus sextans (*Hall*)

Orthis proava *Salter*

As the Porth Padrig fossils indicate the upper part of the zone of *Nem. gracilis*, there may possibly be an inversion, the Porth-newydd beds rising from beneath them on an overturn, and the base, all torn to pieces, brought up along the Porth Padrig slips (Figure 224) against the upper beds, as suggested in (Figure 222). On the other hand; as no limestones are known in the upper shales of Gynfor, and as the lower cherty shales are not seen here, there may be an ascending succession from Porth Padrig to Porth-newydd, bringing in higher beds not reached in Gynfor. The brachiopods of the limestone are those of the basement deposits which in Gynfor are psammitic and psephytic.

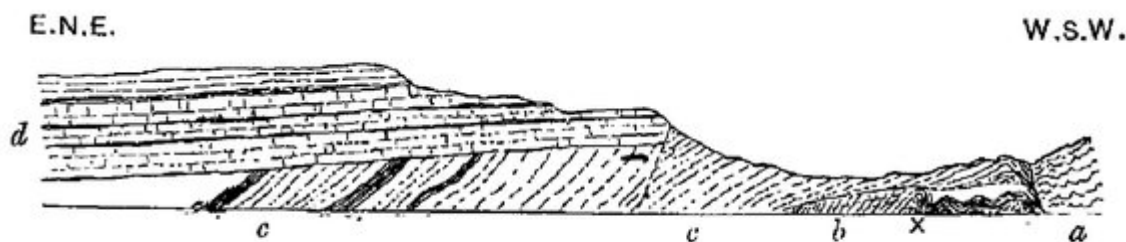


FIG. 194.—SECTION ALONG THE CLIFFS AT CAREG-ONEN.

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.

[Face page 26.]

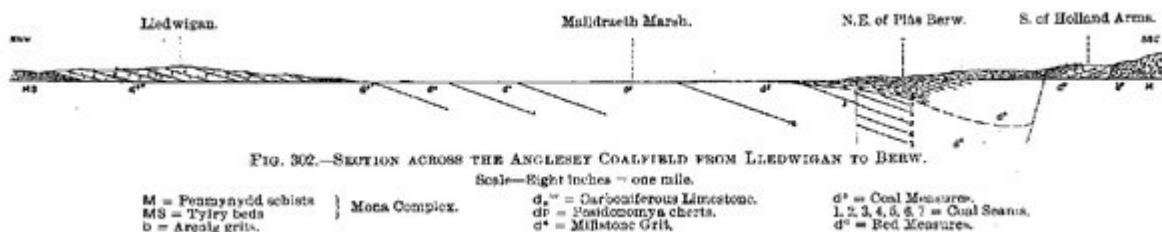


Careg-onen Cliffs.

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

[Face page 26.]

(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 1¼ to 2 and one eighth inches from right hand edge of view) the sharp anticline of G Green-schist (Figure 194), (Figure 195) rises from under them.].



(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.

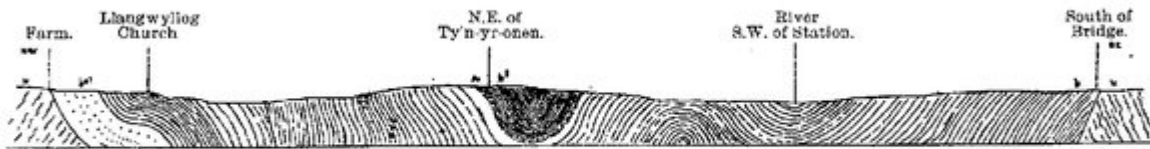


FIG. 201.—SECTION ACROSS THE ORDOVICIAN ROCKS OF LLANGWYLLLOG.

Scale—8 inches = 1 mile.

M = Penmynydd (Mona) Schists. b = Ordovician (undifferentiated).  
 be = Extensus Zone (with basal grit). Fe = Oolitic Ironstone. bg = Gracilis Zone.

(Figure 201) Section across the Ordovician rocks of Llangwyllog. Scale 8 inches = 1 mile. M = Penmynydd (Mona) Schists. b = Ordovician (Undifferentiated) be = Extensus Zone (With basal grit) Fe = Oolitic Ironstone. Bg = Gracilis Zone.



SECTION ACROSS THE PRINCIPAL ORDOVICIAN AREA FROM LLANOL TO PRYS-OWEN.

Scale 8 inches = 1 mile.

SE - Green Sandstone  
 M - Schists  
 b - Ordovician  
 be - Extensus Zone  
 Fe - Oolitic Ironstone  
 bg - Gracilis Zone

(Folding-Plate 11) Section across the Principal Ordovician Area from Llanol to Prys-Owen. Scale 8 inches = 1 mile.



FIG. 261.

(Figure 261) Folding, thrusting, and cleavage on the foreshore at Rhosneigr. Amplitudes about one foot.



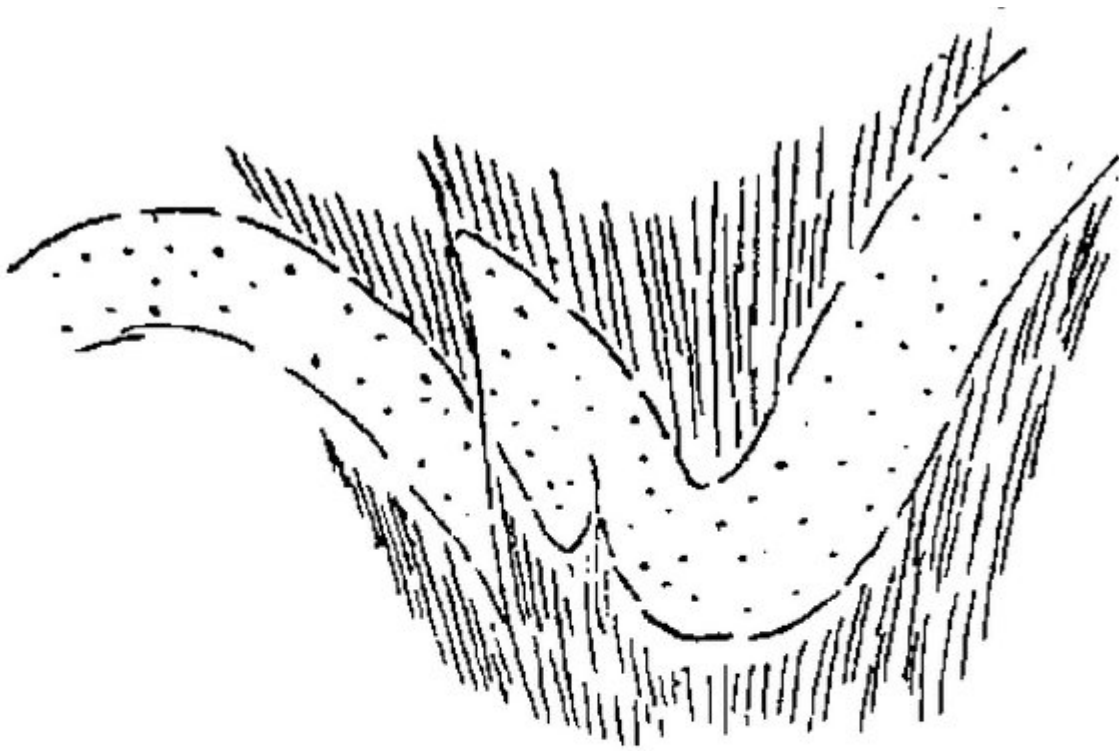
## FIG. 262.

*(Figure 262) Folding, thrusting, and cleavage on the foreshore at Rhosneigr. Amplitudes about one foot.*



## FIG. 263.

*(Figure 263) Folding, thrusting, and cleavage on the foreshore at Rhosneigr. Amplitudes about one foot.*



**FIG. 273.**

**FOLDING AND CLEAVAGE IN  
ARENIG SHALE WITH GRITS  
FROM 3 TO 12 INCHES THICK.**

**Foreshore at Rhosneigr.**

*(Figure 273) Folding and cleavage in Arenig Shale with Grits from 3 to 12 inches thick. Foreshore at Rhosneigr.*





FIG. 274.

SHREDDING OF  
ARENIG BEDS  
ALONG CLEAVAGE.

Rhosneigr Shore.

*(Figure 274) Shredding of Arenig Beds along cleavage. Rhosneigr Shore.*



*(Plate 27) Granitoid boulder from the Mona Complex in Arenig basement conglomerate. Tywyn Trewan.*

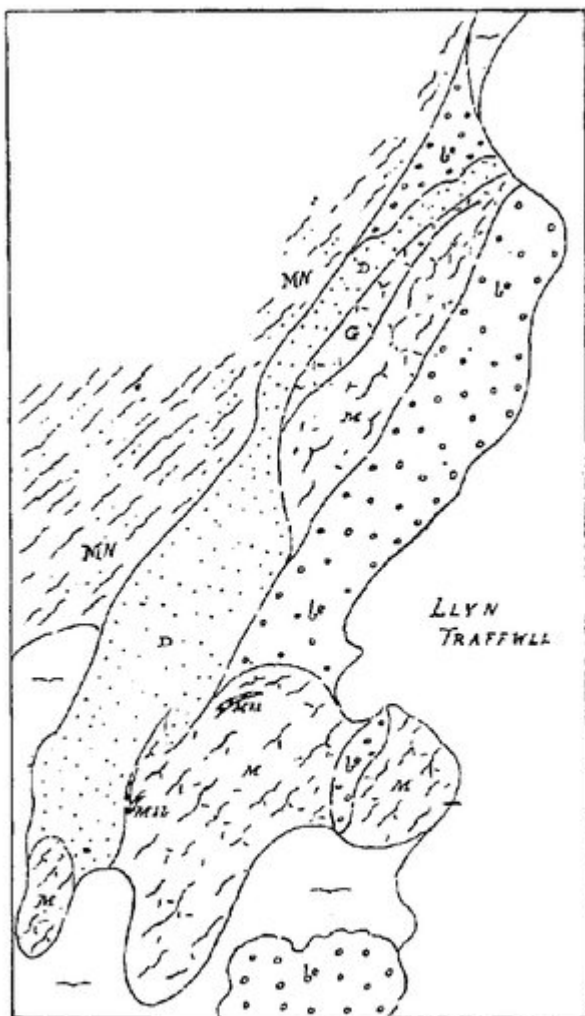


FIG. 202.—THE COMPLEX AT LLYN TRAFFWLL.

Scale .0004 or 1:2500.

M = Gneiss.      Mhb = Basic Gneiss.  
 G = Granite.    MN = New Harbour Beds.  
 be = Conglomerate of Extensus Zone.  
 D = Diabase.    [Alluvium symbol] = Lacustrine Alluvium.

(Figure 202) The complex at Llyn Traffwll. Scale .0004 or 1:2500. M = Gneiss. Mhb = Basic Gneiss. G = Granite. MN = New Harbour Beds. be = Conglomerate of Extensus Zone. D = Diabase. [Alluvium symbol] = Lacustrine Alluvium.

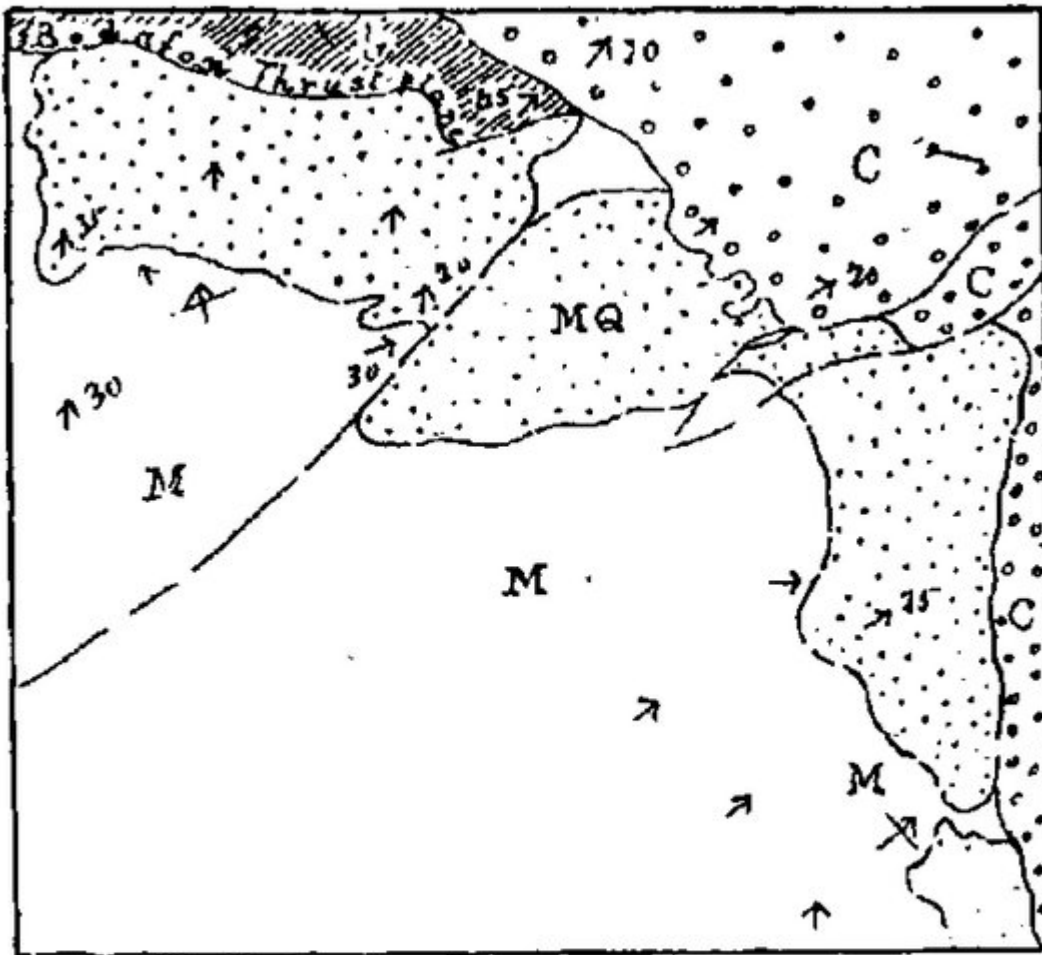


FIG. 154.

NORTHERN PARTS OF BODAFON MOOR.

(Figure 154) Northern parts of Bodafon Moor. From the six-inch maps. M = Bodafon Moor Schist. MQ = Bodafon Quartzite. b = Ordovician Shale. c = Old Red Sandstone.

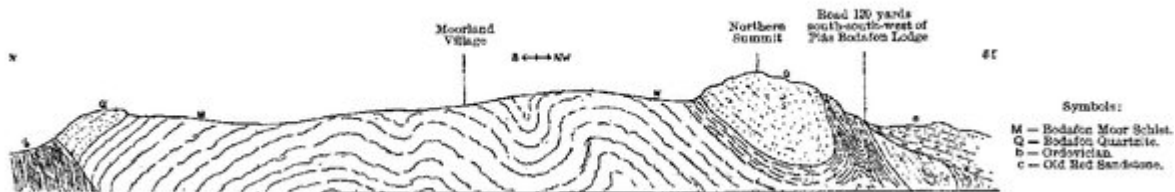
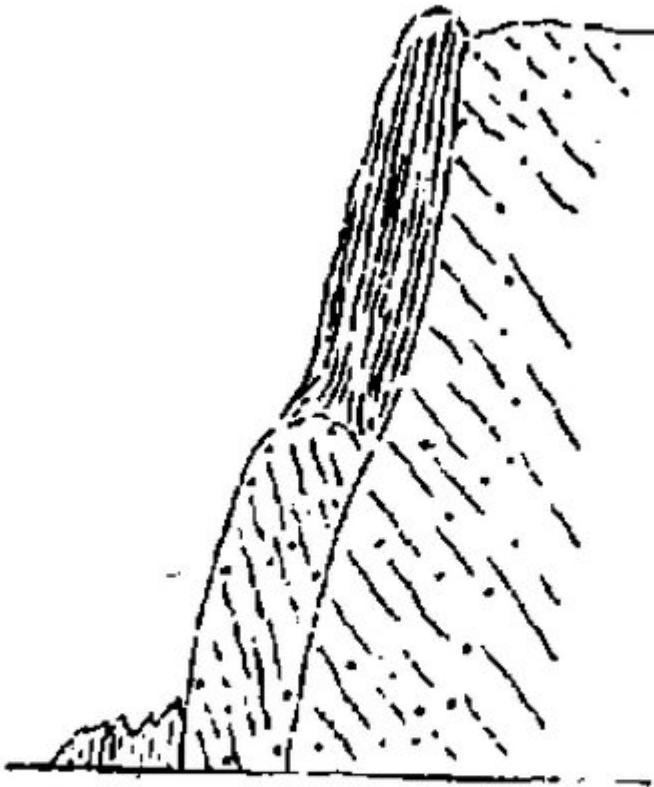


FIG. 156.—SECTION ACROSS BODAFON MOOR AND THE NORTHERN SUMMIT OF MYNYDD BODAFON.

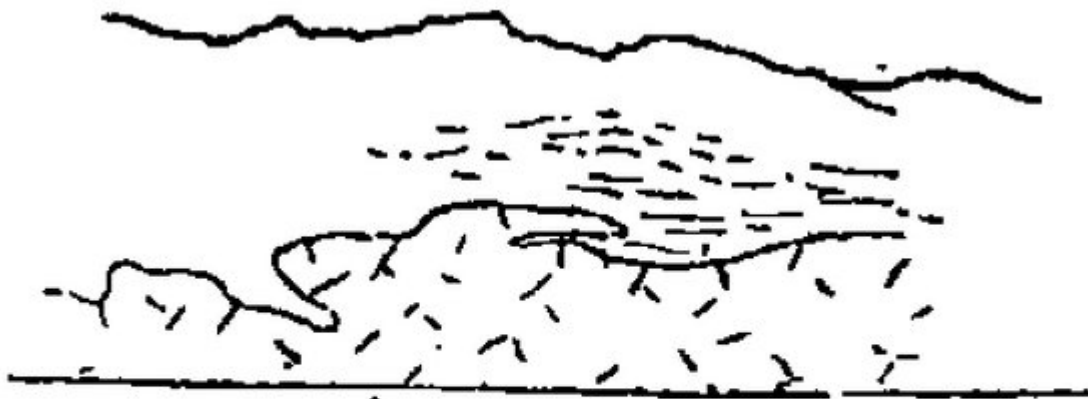
(Figure 156) Section across Bodafon Moor and the northern summit of Mynydd Bodafon. Scale: Eight inches = one mile. Symbols: M = Bodafon Moor Schist. Q = Bodafon Quartzite. b = Ordovician. c = Old Red Sandstone.



**FIG. 203.**

**THE RUPTURE AT  
YR-OGO-GOCH.**

*(Figure 203) The rupture at Yr-ogo-goch. Height about 100 feet.*



**FIG. 240.**

**FELSITE DYKE.**

(Figure 240) Felsite dyke. 270 yards west-north-west of Gwalchmai Inn.

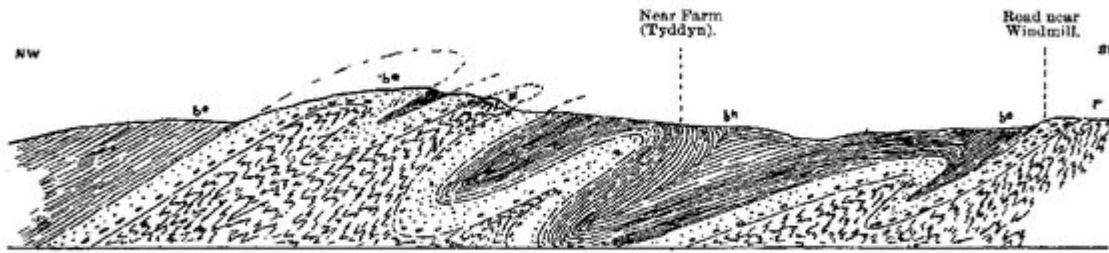


FIG. 204.—SECTION ACROSS FORT HILL, LLANERCHYMEDD.

Scale—12 inches = one mile.

M = Mica-schist } Mona Complex.      bh = Zone of *Did. hirundo*,  
 u = Hornfels      be = Zone of *Did. extensus* (with basal conglomerate).

(Figure 204) section across Foel Hill, Llanerchymedd. Scale-12 inches = one mile. M Mica-schist and u = Hornfels, Mona Complex. bh = Zone of *Did. hirundo*. be = Zone of *Did. extensus* (with basal conglomerate)



FIGS. 205, 206.—NORTH-WESTWARD FACING ISOCLINES IN ARENIG BEDS BELOW THE BODAFON THRUST-PLANE.

(Figure 205) North-westward facing isoclines in Arenig Beds below the Bodafon Thrust-plane. Height six feet and two feet. Bend in stream mile east of Llwydiarth Esgob.



FIGS. 205, 206.—NORTH-WESTWARD FACING ISOCLINES IN ARENIG BEDS BELOW THE BODAFON THRUST-PLANE.

(Figure 206) North-westward facing isoclines in Arenig Beds below the Bodafon Thrust-plane. Height six feet and two feet. Bend in stream mile east of Llwydiarth Esgob.



FIG. 264.—THE NEBO THRUST-PLANE ON THE COAST.

M = Gneiss.      b = Bifidus Shales.

Height: about 20 feet.

(Figure 264) The Nebo Thrust-plane on the coast. M = gneiss. b bifidus shales. Height: about 20 feet.

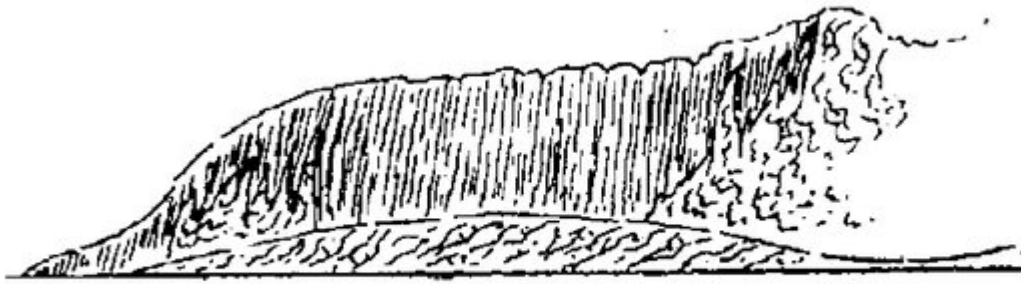


FIG. 265.—DETAIL OF FIG. 264.

(Figure 265) Detail of (Figure 264) Height: about one foot.

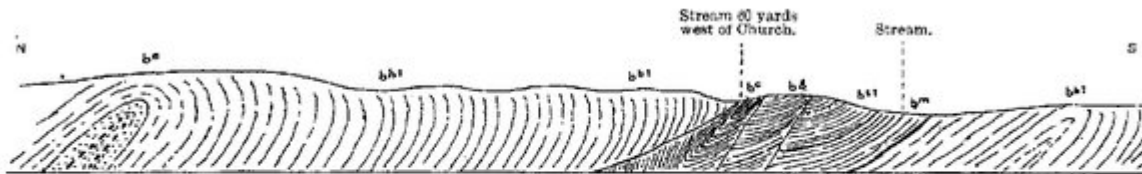


FIG. 211. SECTION ACROSS THE CHURCH INFOLD, LLANBABO.

Scale—12 inches = 1 mile.

bc = Zone of *Did. extensus* (with conglomerate). bb = Zone of *Did. hirtindo*. bb = Zone of *Did. bifidus*. bm = Zone of *Did. murchisoni*.  
 bt = Zone of *Glypt. teretiusculus*. bf = Zone of *Nem. gracilis*. bc = Zone of *Dicran. clingani*.

(Figure 211) Section across the Church Infold, Llanbabo. Scale-12 inches = 1 mile. Be = Zone of *did. extensus* (with conglomerate) bb = zone of *Did. hirtindo*. bb = Zone of *Did. bifidus*. bm = zone of *Did. murchisoni*. Bt = Zone of *Glypt. teretiusculus*. bg = Zone of *Nem. gracilis*. be = Zone of *Dicran. clingani*.

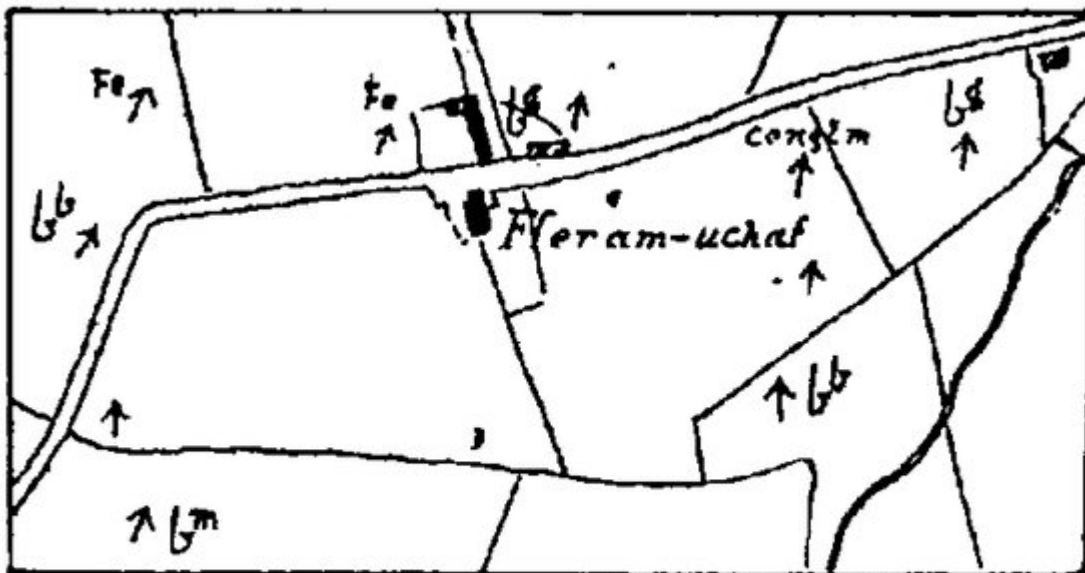


FIG. 207.—THE FFERAM INFOLD.

(Figure 207) The Fferam Infold. Six inches = one mile. Symbols as in (Figure 208) [MG = Gwna (Mona) Schists. Be = Zone Of *Did. extensus* (with basal conglomerate) Bb = Zone of *Did. bifidus*. bm = Zone of *Did. murchisoni*. Fe = Oolitic Ironstone. Bg = Zone Of *Nem. gracilis*.]

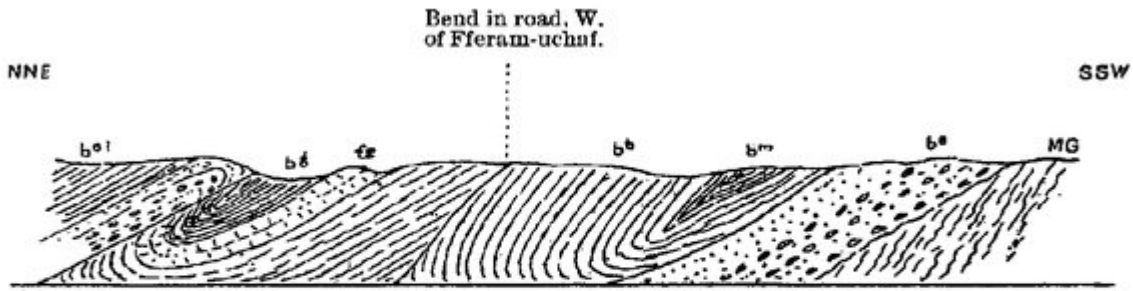


FIG. 208.—SECTION ACROSS THE FFERAM INFOLD, LLANBABO.

Scale—12 inches = one mile.

MG = Gwna (Mona) Schists.  
 b<sup>b</sup> = Zone of *Did. bifidus*.

b<sup>e</sup> = Zone of *Did. extensus* (with basal conglomerate).  
 b<sup>m</sup> = Zone of *Did. murchisoni*.  
 b<sup>g</sup> = Zone of *Nem. gracilis*.

Fe = Oolitic Ironstone.

(Figure 208) Section across the Fferam Infold, Llanbabo. Scale-12 inches = one mile. MG = Gwna (Mona) Schists. Be = Zone Of *Did. extensus* (with basal conglomerate) Bb = Zone of *Did. bifidus*. bm = Zone of *Did. murchisoni*. Fe = Oolitic Ironstone. Bg = Zone Of *Nem. gracilis*.

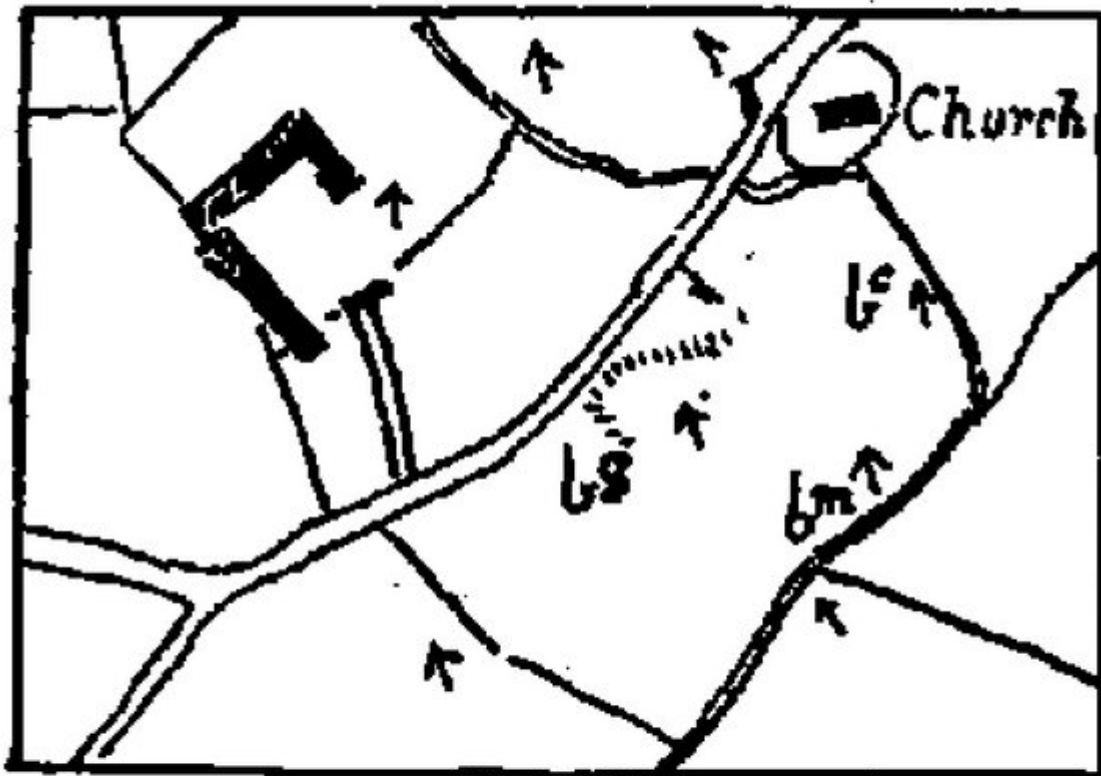
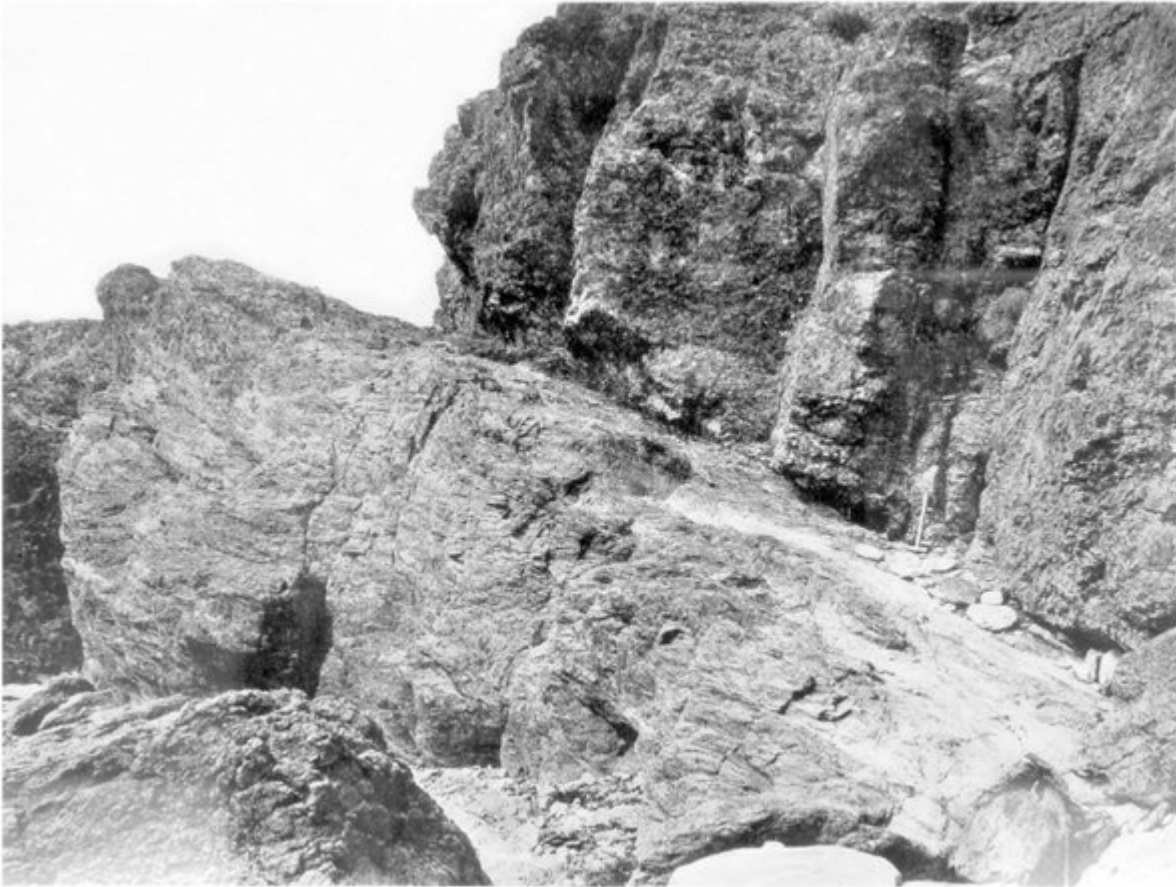


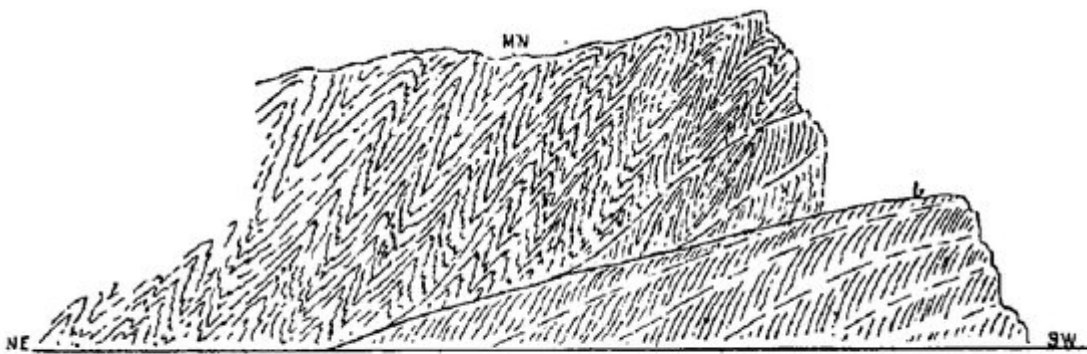
FIG. 210.—THE CHURCH INFOLD.

(Figure 210) The Church Infold. Six inches = 1 mile. Symbols as in (Figure 211) [Be = Zone of *did. extensus* (with conglomerate) bb = zone of *Did. hirtindo*. bb = Zone of *Did. bifidus*. bm = zone of *Did. murchisoni*. Bt = Zone of *Glypt. teretiusculus*. bg = Zone of *Nem. gracilis*. be = Zone of *Dicran. clingani*.]





(Plate 31) *The Carmel Head thrust-plane at Carmel Head. Frontispiece to Vol 2.*



**FIG. 270.—THE CARMEL HEAD THRUST-PLANE AT CARMEL HEAD.**

**MN = Amlwch Beds.      b = Cleaved Ordovician Shale.**

(Figure 270) *The Carmel Head Thrust-plane at Carmel Head. MN = Amlwch Beds. b = Cleaved Ordovician Shale.*



FIG. 271.

MINOR THRUSTS AT THE  
CARMEL HEAD THRUST-PLANE,  
CARMEL HEAD. .

Depth: about one foot.

CHT = The Main Thrust.

(Figure 271) Minor thrusts at the Carmel Head Thrust-plane, Carmel Head. Depth: about one foot. ChT = The Main Thrust.



FIG. 272.

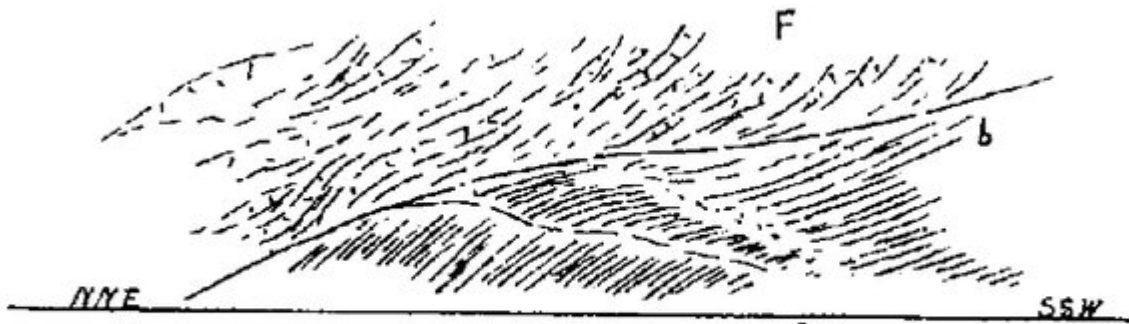
THE CARMEL HEAD THRUST-PLANE,  
147 yards south-west of  
LLANFAIRYNGHORNWY CHURCH.

Height: about eight feet.

MG = Gwna Beds.

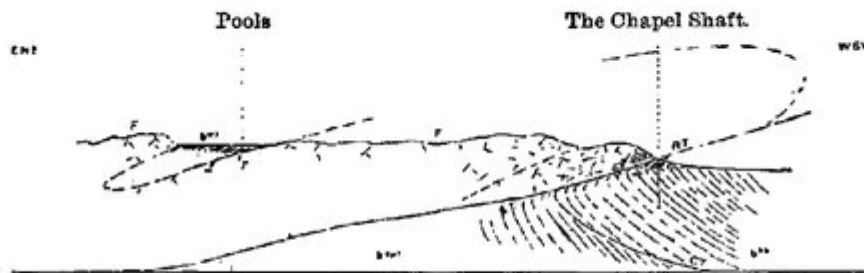
b = Ordovician Beds.

(Figure 272) The Carmel Head Thrust-plane, 147 yards south-west of Llanfairynghornwy Church. Height: about eight feet. MG = Gwna Beds. b = Ordovician Beds.



**FIG. 212.—THE RHWNC THRUST-PLANE AT RHWNC.**

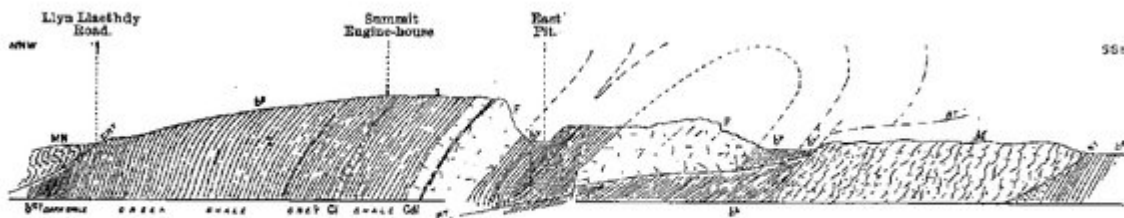
(Figure 212) The Rhwnc Thrust-plane at Rhwnc. Height about 10 feet. F = Sheared felsite. b = Arenig shales.



**FIG. 213.—SECTION THROUGH THE WEST END OF PARYS MOUNTAIN.**  
Scale—eight inches = one mile.

bhb = *Phyllograptus* and adjacent Shales.      bcp = Hartfell Shales.      bv = Llandovery Shales.  
F = Felsite.      CT = Chapel Thrust-plane.      RT = Rhwnc Thrust-plane.

(Figure 213) Section through the west end of Parys Mountain. Scale eight inches = one mile. bhb = *Phyllograptus* and adjacent Shales. bcp = Hartfell Shales. bv = Llandovery Shales. F = Felsite. CT = Chapel Thrust-plane. RT = Rhwnc Thrust-plane.



**FIG. 214.—SECTION THROUGH THE CENTRAL PARTS OF PARYS MOUNTAIN.**  
Scale—7.5 inches = one mile.

MN = Amlwch Beds } Mona Complex.      bb = Zone of *Did. bifidus*.      bv = Llandovery shales.      Cl = Charlotte's lode (on strike of North Discovery lode).      NT = Nebo Thrust-plane.  
M = Gneiss } Mona Complex.      bc = Zone of *Dicran. clingani*.      bv■ = Tarannon shales.      RT = Rhwnc Thrust-plane.  
be = Zone of *Did. extensus*.      bp = Parys Green shales.      F = Felsite.      Cdl = Carey-y-doll lode.      CHT = Carmel Head Thrust-plane.

(Figure 214) Section through the central parts of Parys Mountain. Scale 7.5 inches = one mile. MN = Amlwch Beds, Mona Complex, M=Gneiss, Mona Complex. be = Zone of *Did. extensus*. bb = Zone of *Did. bifidus*. bc = Zone of *Dicran. clingani*. bp = Parys Green shales. bv = Llandovery Shales. bv■ = Tarannon shales. F = Felsite. Cl = Charlotte's Lode (on strike of north discovery lode) Cdl = Carey-y-doll lode. NT = Nebo Thrust-plane. RT = Rhwnc Thrust-plane. CHT = Carmel Head Thrust-plane.

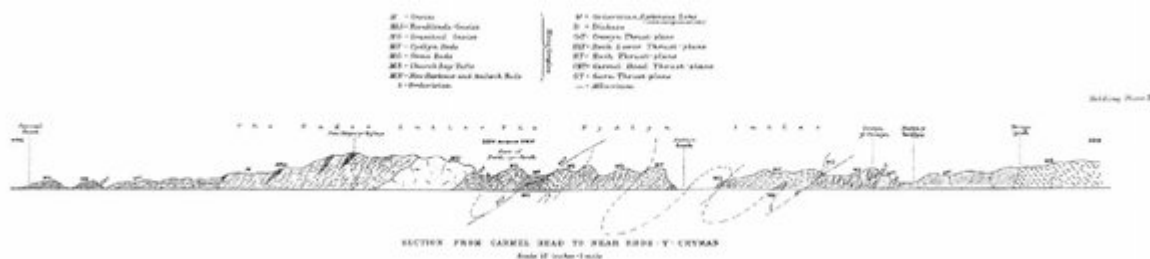


(Folding-Plate 9) Section through Mynydd-y-garn. Scale 12 inches = 1 mile.



**FIG. 215.**  
**THE CRAIG-Y-GWYNT ANTICLINES.**

(Figure 215) The Craig-y-gwynt Anticlines.

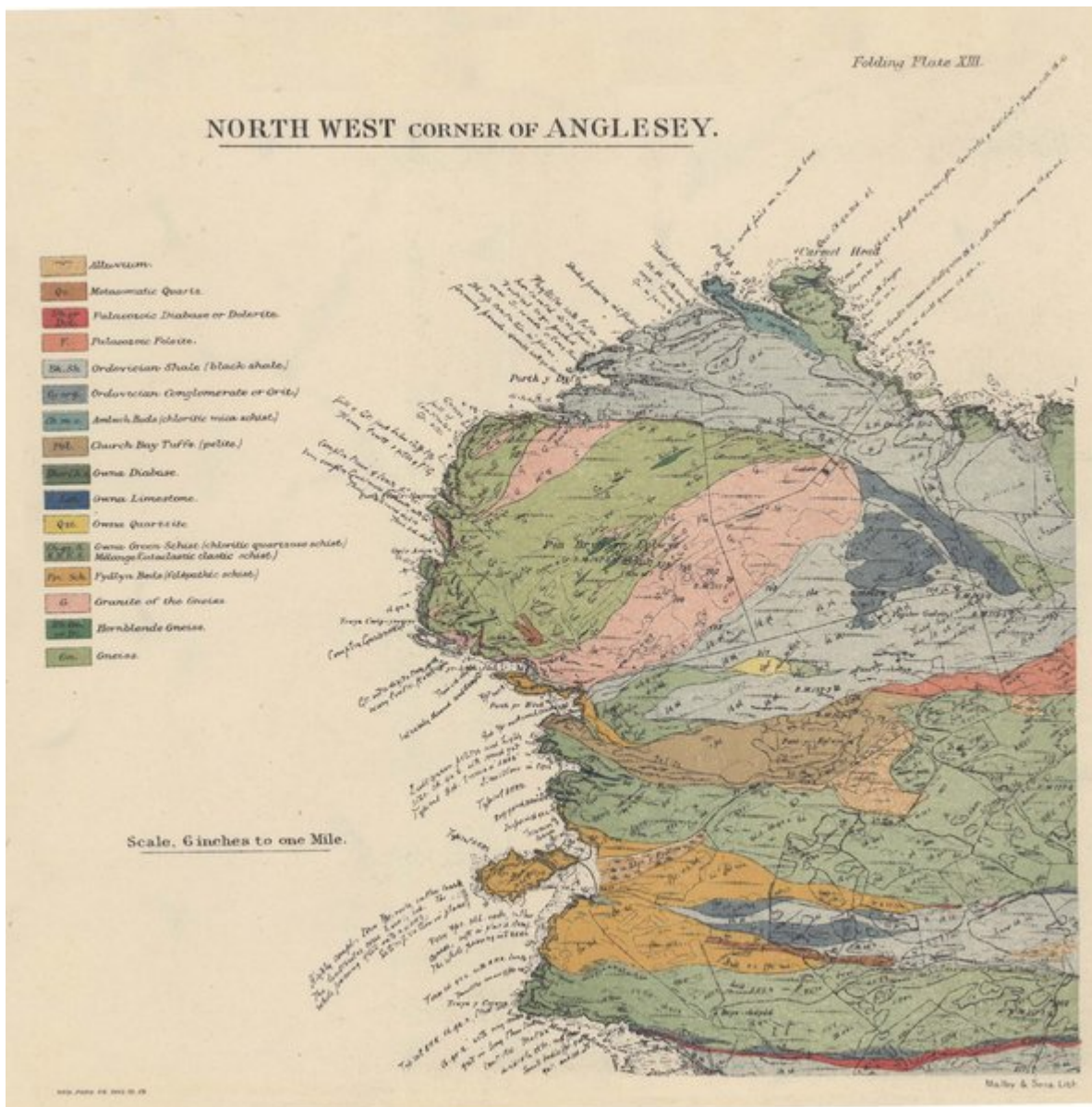


(Folding-Plate 10) Section from Carmel Head to near Rhos-y-Cryman. Scale 12 inches = 1 mile.

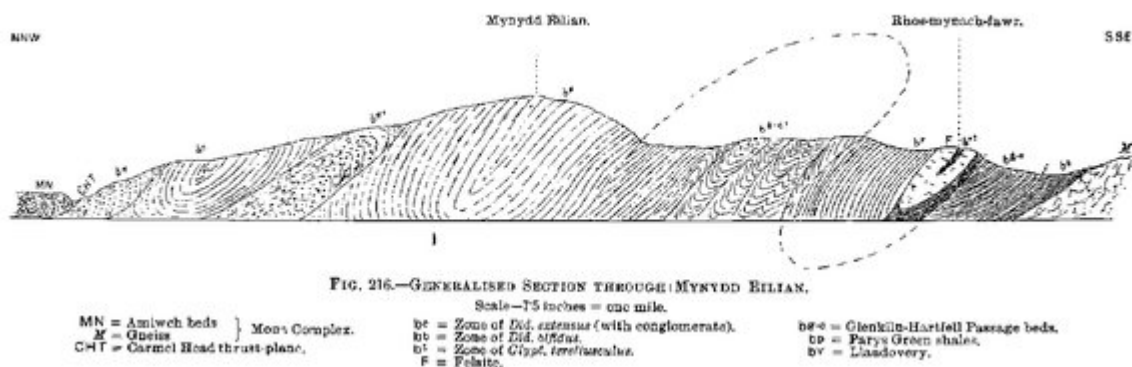


**FIG. 130.—SECTION ACROSS THE TWO COVES AT PORTH-YR-HWCH.**

(Figure 130) Section across the two coves at Porth-yr-hwch. M= granitoid gneiss. MF = Fydyln Beds. MG = Gwna Mélange, with limestone. b = Ordovician shale. Height at north end: about 200 feet



(Folding-Plate 13) The North-West corner of Anglesey. Reproduction of manuscript six-inch map.



(Figure 216) Generalised section through Mynydd Eilian. Scale—7 5 inches = one mile. MN = Amlwch Beds, Mona Complex. M=Gneiss, Mona Complex. CHT = Carmel Head Thrust-plane. be = Zone of *Did. extensus* (with conglomerate) Bb = Zone of *Did. bifidus*. bt = Zone of *Glypt. teretiusculus*. F = Felsite, bg-c = Glenkiln-Hartfell Passage beds. bp = part's green shales. by = Llandoverly.

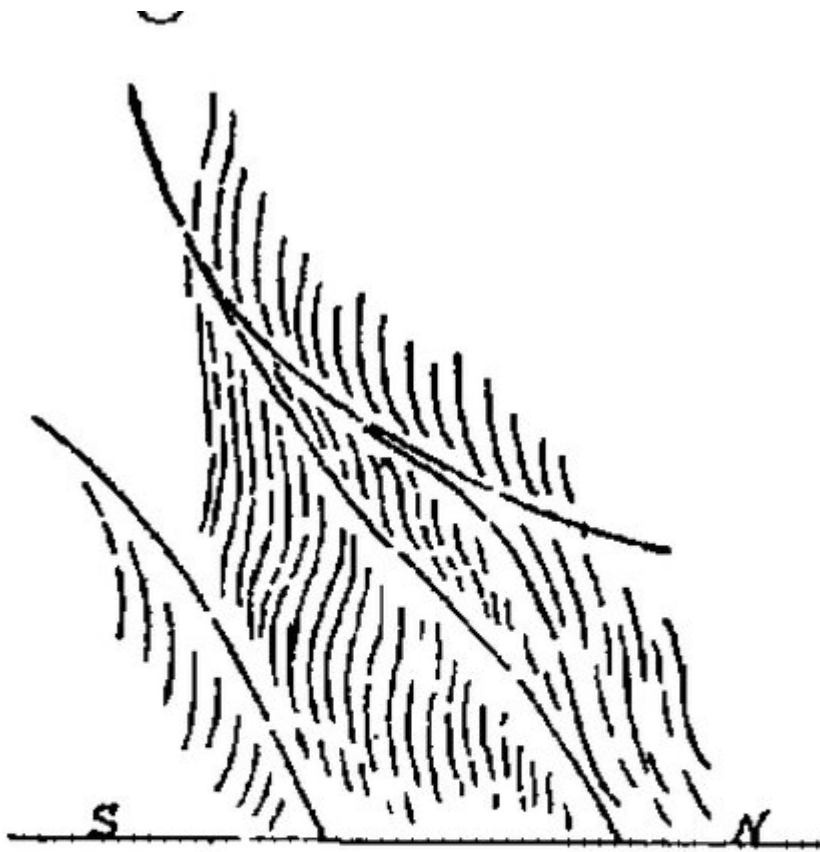


FIG. 267.

MINOR THRUSTS IN  
SHALE. PORTH Y  
GWICHAID BEACH.

*(Figure 267) Minor thrusts in shale. Porth y gwichaid beach. Height about 10 feet.*



**FIG. 268.**

**HORIZONTAL THRUST IN  
SHALE. NORTH CLIFF OF  
PORTH Y GWICHIAID.**

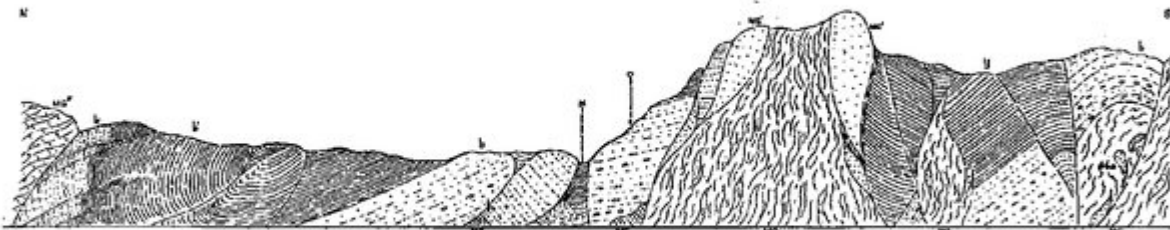
*(Figure 268) Horizontal thrust in shale. North cliff of Porth y gwichiaid. Height: about 10 feet.*



**FIG. 200.**

# SPICULES OF GLENKILN CHERT,

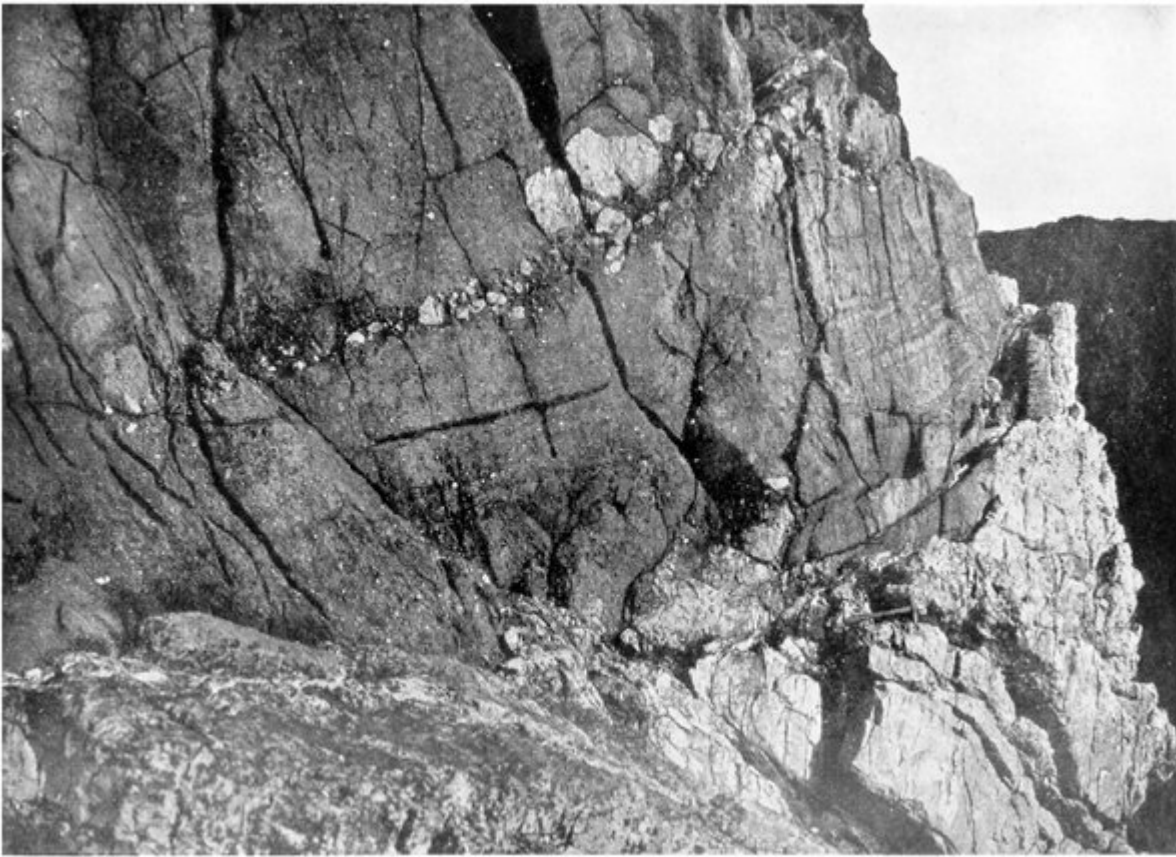
(Figure 200) Spicules of Glenkiln Chert, Porth wen.  $\times 12$ .



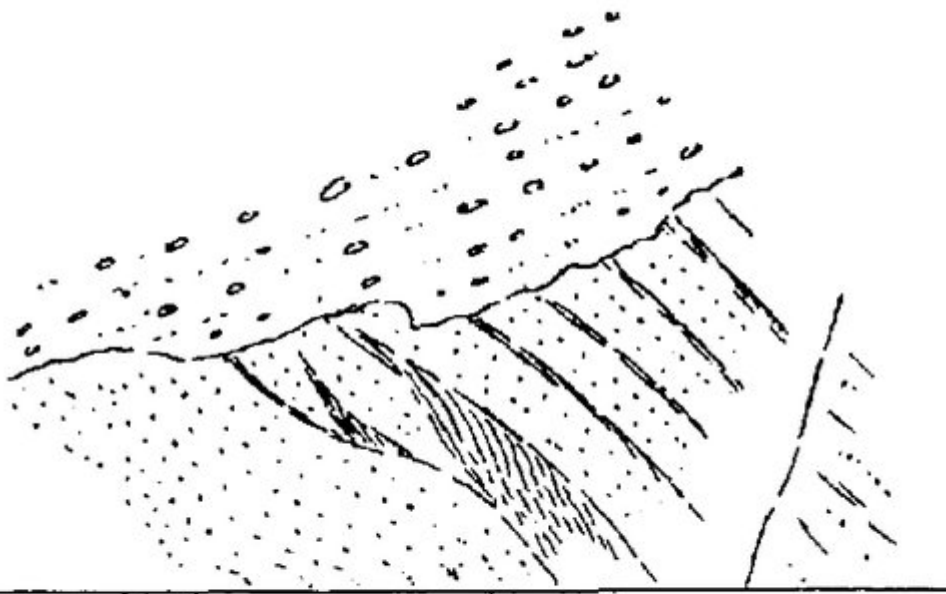
**FIG. 220.—CLIFF SECTION AT OGOF GYNFOR.**  
 Drawn from a boat, and brought to one plane. Scale about 65 feet = one inch.  
 MG = Gwna mélange. MG■ = Gwna quartzite. Mg■ = Gwna limestone. b = Glenkiln conglomerate. b' = Cherty shales.  
 Graptolites [a.f. 3507-22] obtained from base of shales below X. Unconformable base (see Plate XXIX and Fig. 221) well seen at cliff's foot below O.

(Figure 220) Cliff section at Ogof Gynfor. Drawn from a boat, and brought to one plane. Scale about 65 feet = one inch. MG = Gwna mélange. MG■ = Gwna quartzite. Mg■ = Gwna limestone. b = Glenkiln conglomerate. b■ = cherty shales. Graptolites [a.f. 3507-22] obtained from base of shales below X. Unconformable base (see (Plate 29) and (Figure 221)) well seen at cliff's foot below O.





*(Plate 29) Glenkiln conglomerate resting unconformably upon the Mona Complex. Ogo Gynfor.*



**FIG. 221.—THE UNCONFORMABLE JUNCTION  
OF PLATE XXIX.**

*(Figure 221) The unconformable junction of (Plate 29).*



FIG. 97.—DIAGRAM OF SUPPOSED ORIGINAL RELATIONS OF THE GLENKILN CONGLOMERATES TO THE MONA COMPLEX IN THE GYNFOR DISTRICT.

(Figure 97) Diagram of supposed original relations of Glenkiln Conglomerates to the Mona Complex in the Gynfor District, *b'*= Pale conglomerate. *b* = Purple conglomerate. MQ = Gwna Quartzite.



FIG. 95.—THE THRUST-PLANES AT TRWYN BYCHAN.

(Figure 95) The thrust-planes at Trwyn Bychan. Sketched from a boat. Cliffs about 100 feet in height. MS = Church Bay Tuffs. MG = Gwna Melange. *b* = Nemagraptus Shales.

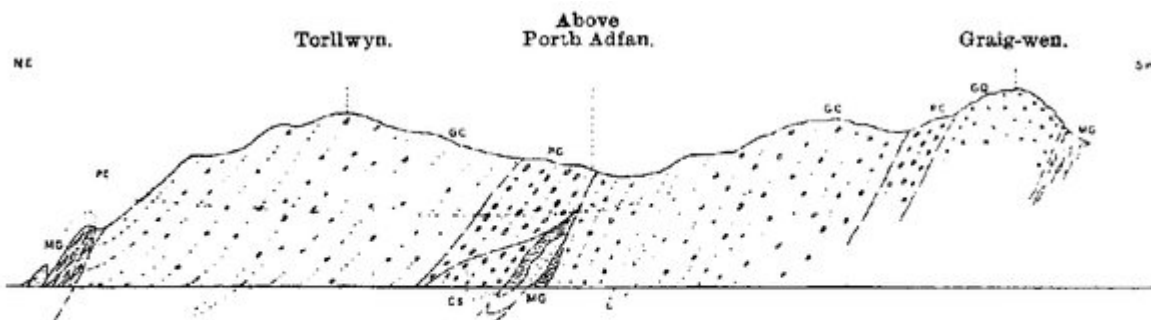


FIG. 217.—SECTION THROUGH TORLLWYN AND GRAIG-WEN.

Scale—16 inches = one mile.

MG = Gwna grit and phyllite	} Mona Complex.	CS = Cherty shales	} Glenkiln.
GQ = Gwna quartzite		GC = Grey conglomerate	
		PC = Purple conglomerate	

(Figure 217) Section through Torllwyn and Graig-wen. Scale-16 inches = one mile. MG = Gwna grit and phyllite, Mona Complex. GQ Gwna quartzite, Mona Complex. CS = Cherty Shales. Glenkiln. GC = Grey conglomerate, Glenkiln. PC =Purple conglomerate, Glenkiln.

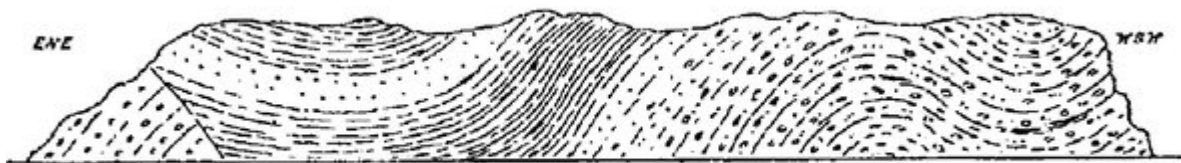


FIG. 218.—NORTH-WEST CLIFF OF LLANLLIANA HEAD.

(Figure 218) North-west cliff of Llanlliana Head. Sketched from a boat. Height about 100 feet. Glenkiln conglomerate and cherty shales.

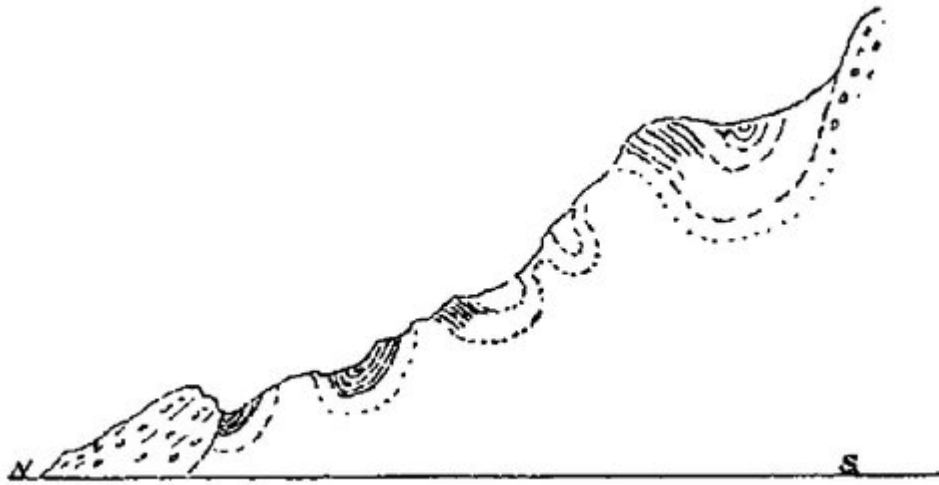


FIG. 219.—BLUFF ABOUT 200 FEET HIGH.

(Figure 219) Bluff about 200 feet high. About 200 yards east of Glochog. Glenkiln conglomerate and cherty shales.

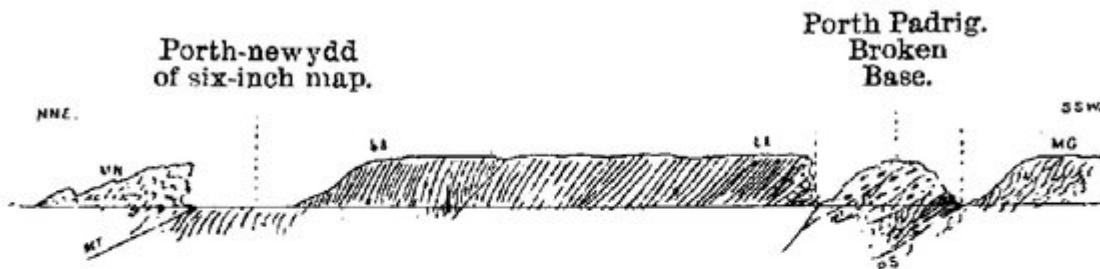


FIG. 222.—SECTION THROUGH THE ORDOVICIAN INFOLD OF MYNACHDY.

Scale—eight inches = one mile.

MN = Amlwch beds. MG = Gwna beds.  
 bg = Glenkiln shales, with limestone and conglomerate.  
 MT = Mynachdy thrust-plane. PS = Padrig slide.

(Figure 222) Section through the Ordovician Infold of Mynachdy. Scale eight inches = one mile. MN = Amlwch Beds. MG = Gwna Beds. bg = Glenkiln shales, with limestone and conglomerate. MT = Mynachdy Thrust-plane. PS = Padrig slide.

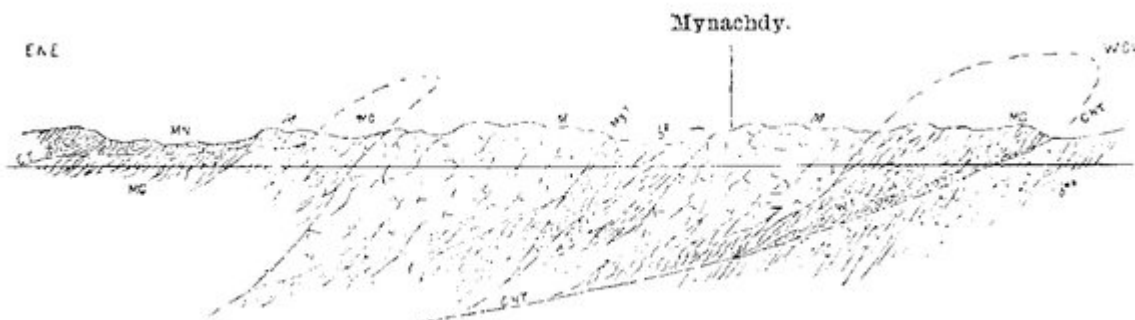
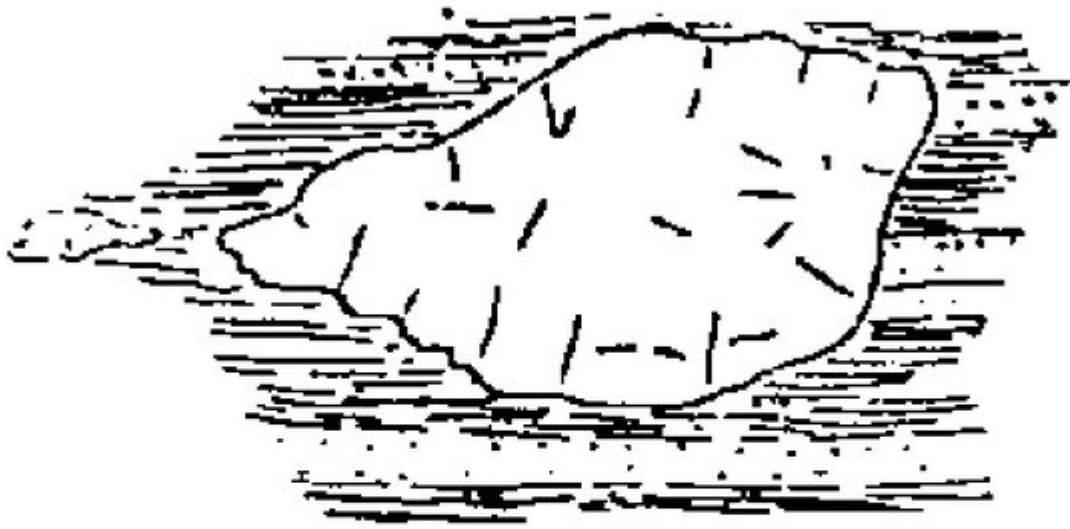


FIG. 94. SECTION AT MYNACHDY.

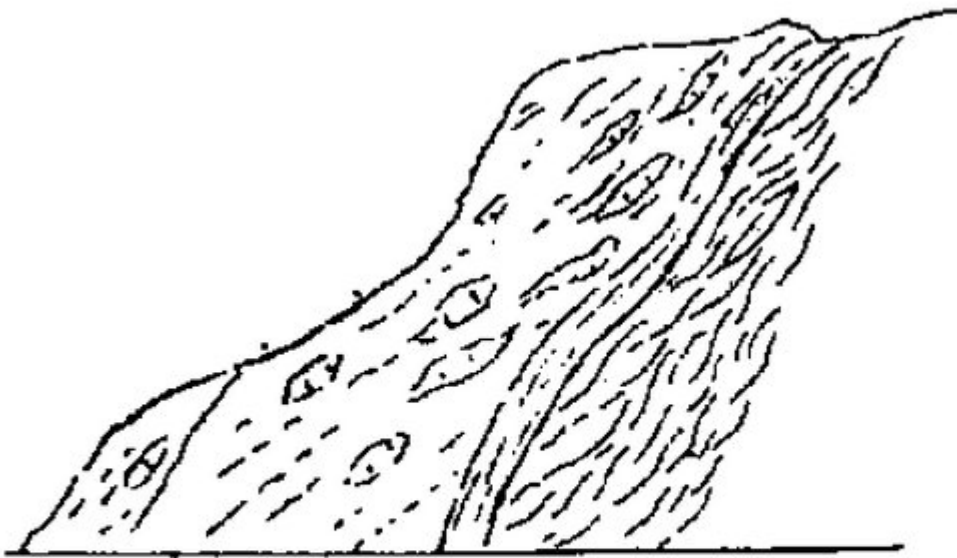
(Figure 94) Section at Mynachdy. Scale: Nine inches = one mile. MN = Amlwch Beds. MG = Gwna Beds. M = Gneiss. beb = Lower Ordovician Beds. be = Glenkiln Beds. CT = Caerau Thrust-plane. MyT Mynachdy Thrust-plane. WT = Wig Thrust-plane. CHT = Carmel Head Thrust-plane.



**FIG. 223.**

**SIX-FOOT LIMESTONE  
LUMP IN GRACILIS BEDS.**

*(Figure 223) Six-foot limestone lump in gracilis beds. North cliff of Porth Padrig.*



**FIG. 224.**

**THE PORTH PADRIG SLIDE.**

*(Figure 224) The Porth Padrig slide. Height about 30 feet.*