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## Chapter 31 The detail of the drifts and glaciation

### Arrangement of the subject

The glacial deposits and phenomena cannot be expected to fall readily into sharply defined natural districts. The following arrangement, however, which will be found convenient, is in great measure natural. It is founded on the fact that the northern, eastern, and south-eastern margins are districts of glacial onset, where the Island was invaded by ice from without; while the middle and Holy isle are glacial districts of the lee, where the ice was passing off Anglesey to the south-west. The districts of onset bend round the lee-districts, enclosing them on three sides. No hard-and-fast line can, of course, be found between the two, but for purposes of description a useful parting-curve may be drawn through Llanrhyddlad, Llanifiwyn, Rhosgoch, the western ends of Parys Mountain, Pen-y-graig-wen, and Mynydd Bodafon, thence along the Carboniferous base-line as far as Cefn-iwrch, then across the alluvium of Bodeilio to the Ceint river, and finally along it and the Malldraeth to the western sea. The glaciation of the lee-countries is (with a few local exceptions) of the pure south-westerly type which we have found to be so characteristic of Anglesey. They are on the whole simpler, especially-in regard to the composition of their drifts, than are the onset-countries, which are more modified by external agencies; and had better be considered after them. The following sub-divisions are practicable, and will prevent the confusion arising from taking too large a district at one time.

### Districts of the Lee

#### *Holy Isle*

**North Central Country** (centring about Llantrisant) enclosed by the northern portion of the parting-curve, and a line drawn from Rhosneigr to Llanerchymedd.

**A South Central Country** (centring about Gwalchmai) enclosed by the Llanerchymedd–Rhosneigr line and the southern portion of the parting-curve.

### Districts of Onset

**The Northern Country**, lying outside the parting-curve, between Carmel Head and Bull Bay.

**The Eastern Margin**, lying outside the parting-curve. between Bull Bay and Red Wharf Bay.

**The Pennon Country** (really a wing of the Eastern Margin) lying to the east of a line from Llanddona to Beaumaris.

**The Menai Country**, lying between the Malldraeth–Red Wharf hollow, the Llanddona–Beaumaris line, and the Menai Strait.

In each case the surface and striation will be described before the drifts; coast also being taken before interior.

**Striae** — These have been generalised on the one-inch map. Those by the sea will be found where the point or the tail of the arrow touches the coast. Inland, the arrow-point is as near as is practicable to the spot, for placing the arrow-ring on the spot would often have confused the geological lines, especially those of small quartzites. Their exact positions can be found on the six-inch and .0004 maps, especially with the aid of a list that has been deposited in the office of the Geological Survey.

**Drift-sections** — There are great numbers inland that show from two to six feet of drift. If at any time these be needed for local purposes, they also can be found upon the six-inch and .0004 maps.

**Boulders** — Many of these also are noted on the six-inch and .0004 maps. Besides the slides here quoted, a suite ([E9325](#)) [SH 297 907], ([E9326](#)) [SH 463 935], ([E9327](#)) [SH 403 739], ([E9328](#)) [SH 333 750], ([E9329](#)) [SH 427 940], ([E9330](#)), ([E9331](#)) [SH 52 81], ([E9332](#)) [SH 297 760] has been cut from them.

The reader is requested to bear in mind that the details displayed in drift-sections are liable to somewhat rapid change: that delicate striae are subject to decay; and that boulders are often destroyed by man. The Anglesey Archeological Society, however, has undertaken to watch over the more notable boulders of the Island.

## Holy Isle

The glacial phenomena are simple, in spite of the length of coast and excellent exposures, because there was such a direct sweep of ice across the Isle from north-east to south-west. . Most of the country is remarkably bare and rugged, recalling often the scenery of the Lewisian Gneiss of Scotland. The boulder-clay is uniform in character, but the boulders are interesting, those from the northern Gwna quartzites mingling with those of the Holyhead quartzite.

### Surface and striation

The quartzite of Holyhead Mountain, the highest land in Anglesey, though bare of drift, retains glacial stria almost all over, so enduring is it. They are fine, but on the smooth ice-worn surfaces, often so polished as to shine in the sun, can be detected almost everywhere, especially towards sunset on a summer evening, when the light is getting low. The -crossing of the summit by them has been already noted (p. 697), one of the spots where they may be seen being a yard or two from the south cairn. The great crags along the North Stack fault have been ice-worn 50 feet below their brow, although they face south-west, and a vein-quartz on the north-west face of a ledge has been undercut several degrees. The brows of the great sea-cliffs from the Old Telegraph Station to the North Stack are rubbed and even polished, making the foothold very treacherous. Above the South Stack, close to the top of the steps, where the land suddenly falls, there is a deflection to south 10° west: and on the South Stack itself is a series running south-south-west close to the first building on the north side, but fanning out to south-west on the slope of the boss.

Inland, about Holyhead, striae can be found in many places on grits of the South Stack Series, but on the New Harbour Beds they are rare. Many strim cross the summit of Rhoscolyn Mountain, 200 feet above the sea, running about south-south-west with slight variations, and there are furrows, even on quartzite, about 40 yards north-west of the cairn. The singular deflection (No. 4) described on p. 698 is in the gap of the dyke, where the footpath crosses, south-east of Capel Gorllas. All over the Isle, the northeasterly pitch of the folded rocks lends itself readily to the production of pronounced onset-and-lee features, especially along the southern cliffs, the islets at Rhoscolyn Beacon being also striking examples.

### The Drifts

#### The Coast

***The Penrhos Gravels and Drumlin*** — Beginning at the Inner Harbour, Holyhead, and going east, we find that the coast shows four to six feet of boulder-clay on the smooth undulating ground about Llanfawr. Then at the east end of the bay, north-west of Penrhos, comes perhaps the most interesting drift in Holy Isle. Blown sand caps the little hill and sometimes obscures part of the section. At the north end there appears to be a rock rubble at the bottom, with a lower boulder-clay (but these are not very clear), a sand and gravel series, and an upper boulder-clay (not continuous along the whole section), which may (p. 705) perhaps be correlated with the red clay of the Eastern Margin. The sand and gravel is very irregularly bedded, but hardly tumultuous, and some of the stones appear to be faintly striated, as if washed out of boulder-clay. Towards the south end, the section shown in (Figure 328) was seen in November, 1904. Beautifully bedded sand is overlain by gravel, and that by the upper boulder-clay. Suddenly the gravel, much disturbed, is driven down into the sand, whose bedding becomes very sharply contorted, and in the middle of the down-driven gravel appears an oval section of boulder-clay about four feet by three feet. This is probably (p. 705) a 'leg' thrust out from the upper boulder-clay, its intrusion being the cause of the sharp disturbance. The boulder-clay then descends to sea-level.

East of this the low undulations of Penrhos Park reveal six to eight feet of boulder-clay, very tough and hard, in the cliff; and in the field behind the house, although the features were suggestive of gravel, nothing but boulder-clay was found in an excavation kindly made by Lord Sheffield to aid the surveying of the drifts. This result, it may be noted, shows that mounded features 'ought not to be relied on as evidence of gravels without some direct proof of their existence. This low

ground rises sharply into Gorsedd-y-Penrhyn, the surviving portion of a drumlin, with drift sections 50 feet in height, the rock floor scarcely rising above high-water mark. The drift is good hard grey boulder-clay, which becomes brownish higher up, full of striated and even polished stones. It has a banded structure (Figure 329) due to wavy seams of loam with small stones, but largely to bands of comparatively stoneless clay. The structures are not like bedding, but reminiscent of the celebrated shearing at Cromer, the seams ending off into boulder-clay.

***The shores of the Strait of Holy Isle*** are rocky, with very low land, largely alluvium, in the hollows, so that drift is rarely seen; but where the land is gently, undulating, boulder-clay, as usual, appears in the cliffs. At Four Mile Bridge there is a good section about 15 to 20 feet deep, and some five to eight feet of it is seen upon the Fadog promontory.

***Rhoscolyn to the South Stack*** — On the moor east of Borth Wen great boulders of dolerite are conspicuous, the Rhoscolyn dyke being close below them to the east. It is remarkable how suddenly, all over the Isle, these boulders appear immediately to the south-west of the dykes. Boulder-clay lies on the country close behind the cliffs of Rhoscolyn Head, and thickens into Borth Saint, a boss just to the east of which has some thrust into its crevices on the lee side. At the white arch known as Bwa-gwyn a little boulder-clay survives even on the arch itself. Along the cliff tops from Bwa-du to Borth Saint there are a great number of boulders of epidosite and of the coarse dolerite of the dykes, which must have been lifted, as these rocks do not reach the 50-foot contour in the direction of transport. The serpentines do not furnish many boulders. One of the best views of the great onset-and-lee features of Holyhead Mountain is to be had (Figure 339) from the high land of Rhoscolyn. Passing again on to the New Harbour Beds at Bwa-du, the land is low but very rocky, and yet the coast gives evidence that, in all probability, boulder-clay creeps along almost every little gap. At Casten, close to the house, there are many large boulders of coarse dolerite, evidently from the concealed dyke in the hollow close by, so that they must have been lifted. The uplift is only 10 or 20 feet, but as the distance is also very short, its angle is considerable. A boulder of the Porth Dafarch dyke may be seen in the foreground of (Plate 18). The high cliffs of the Llwyn-y-berth promontory are generally capped with three or four feet of boulder-clay, but in Porth Ruffydd it suddenly descends 50 feet into the hollow, and behaves in the same way at Henborth. The South Stack high moor appears to carry but little drift, for the head on the cliffs of Gigorth Bay seems to be really rubble that has slipped down the steep mountainous slopes above.

***Tuff-Boulders at the North Stack*** — Two or three boulders of the Church Bay Tuffs have been found, but only close to the North Stack, so that the north side of the mountain may safely be regarded as the limit of their stream. They are all of types known only between Porth Trwyn and Tre-fadog. The direction of transport across Holyhead Bay is therefore west-south-westward, which agrees with the striation at Llanfaethlu (Figure 325)–(Figure 326).

## **The Interior**

There are no good sections, the interest lying in the striations, the features, and the distribution of the drifts. A little boulder-clay lies in hollows even on the quartzite mountain, as may be seen where the path goes over the southern spur. Several other places yield evidence of boulder-clay resting in small hollows of the rock, or upon the nature of narrow strips of smooth land between high rock-knobs (Figure 317). The railway cuttings are obscure, but indicate as usual (pp. 736, 760–61) several feet of boulder-clay where the land is smooth and gently undulating; there are also a few eskers to the south and south-east of Llanfawr.

***Holyhead and Gwna Quartzites*** — On the South Stack moors are many large angular blocks of the Holyhead Quartzite, one, perched upon a rocky rising a little to the north-east of Foel, measuring nine by six by four feet. To the east and north-east of the Mountain, not a single boulder of its quartzite has been seen. Boulders of the Gwna quartzites from Llanfaethlu and the north are found all over the Isle, both within and without the zone of transport of that of Holyhead. They are not schistose but massive, of medium grain, much veined, and browned externally, with oxidation down the joints, a mode of weathering unlike that of the massive portions of the Holyhead Quartzite. The largest one that is known, which measures four by three by two feet, lies at a spot 180 yards southeast of the place where the great dyke of Holyhead is crossed by the Porth Dafarch road. Unlike those of local rocks, it is polished and striated, and has evidently had a journey of many miles.

***The Moraines*** — The mounds that are supposed to be moraines are at the following places:

1. Above the south-eastern upper quarry on the north-east side of the hill.
2. On the South Stack moors, east of Foel, just where the footpaths come down from the quartzite.
3. Above the sea-cliffs of Gigorth Bay, north of the lesser quartzite outlier.
4. About 270 yards to the west of the house north of Twr there is a hollow running down the mountain southwards, and in this is the most moraine-like of all these mounds.

## The North Central Country

This is the most heavily drift-laden of all the districts. Its principal points of interest are the shattering sections, its drumlins, and its boulders.

### Surface and striation

**The coast** is poor in striae, but makes up in interest from the torn surfaces worked up into boulder-clay. Many small exposures show that the same shattering is frequent inland also. At Felin-wen creek on the Strait of Holy Isle there is, at its north-end, an excellent section in shattered rock like that of Porth-delisc, with partly disrupted bands, passing into boulder-clay; while along the head of the creek, to the south-east, clay and even erratics are driven in among debris below large masses of rock that are scarcely out of place (p 701). Beyond the lane, there is the undercut shelf of (Figure 310), with a patch of hard boulder-clay (containing small erratics) remaining in place beneath its shelter; besides which we shall find an undercut striated surface as well as a south-easterly deflection outside the dam. At Penrhyn is fine shattering again, but not with much over-drag. Then comes the remarkable section in Porth-delisc (p. 701, (Figure 313), (Figure 314), shattering being found again at its north end with the rise of the rock. On the north cliff of Porth Trefadog, a thin zone of local angular breccia, with a rude parallel structure and a south-westerly turn-over, passes up into the boulder-clay. After this, though the Church Bay Tuffs are often decomposed, and striae rare, there is no notable shattering; nor does the surface display any striking phenomena till we come to the deep decomposition (p. 702) in Porth Swtan.

### Inland

Terminal curvature has been observed at Gwredog and Gwredog Church, Glan-y-gors, and Chwaen-goch, and is up-hill to the south-west at the last two places. Large furrows have been ploughed out even in hornblende-picrite, near the ravine of the Afon-goch. No striae have been obtained upon the summit of Foel Hill at Llanerchymedd; but upon that of Llanfaethlu Hill, at the pool 100 yards south-east of the Rectory, they are strong, with small furrows, going west 35° south, crossed by feeble ones going south, which indicate that the south-easterly striae at Llanfwrog (pp. 697, 708) must be regarded as a late and short-lived episode in the glaciation. The most striking glaciation in the district is that of the boss of grit and shale in the Station yard at Llanerehy-medd, which is finely modelled.

### The Drifts

#### The Coast

The first of the fine sections of the coast is between the Stanley Embankment and the Alaw's mouth, where the Foundry drum, some 70 feet high and more than half a mile long, rises from undulating spreads of drift 10 to 20 feet in thickness, whose base is at sea-level. All the drift is boulder-clay, with faint lines of differences 'of grain, and of larger stones, very gently inclined upwards to the south-west. The section shows no internal change of structure or material where the drift rises from the plain into the drumlins. Penial drum (Figure 321) is the most typical of all those dissected by the sea. It is about 75 or 80 feet in height with one of the peculiar sharp crests, oval in plan, resting upon low reefs, and the sea has cut right across it, with cliffs that reach the 50-foot contour. All is good blue boulder-clay, except a few small gravelly nests that graduate into the rest. Shell fragments have been found, but they are small and very rare. The remarkable sections of Porth-delisc are cut in a low undulating tract some 15 to 20 feet in height; and the little bay affords a section in boulder-clay as well as in the glacial breccia. The clay contains twisted lenticles of sand and gravel two or three feet thick. A large boulder of conglomerate, with nests of limestone, like that of the Garn, lies on the shore south of Trefadog.

It may have been first carried out to sea, and then brought here by the south-easterly ice-eddy indicated by the Llanfwrog stri. The drum, cut into at the cove north of Careg Fran, stands (*cf.* pp. 707, 740) over a narrow Pre-glacial hollow. The drift is thin from Crug-mor to Porth Swtan, where it thickens over the deep decomposition tract.

## The Interior

There are very few good inland sections, and the eastern parts are rather featureless, broad, gently undulating slopes that sweep down from the rocky hills. Probably there is eight or ten feet of drift upon them, for the cuttings on the railway reveal (pp. 736, 760–61) that depth or more upon the slopes of the Yule of Alaw near the Cors. Southward and westward these even slopes begin to rise into smooth hills that are very likely drumlins. The Brickworks at Llwydiarth-fawr afford almost the only really good section. About eight or nine feet of stiff, blue-black boulder-clay rests upon shattered shale. Most of it is very full of stones, but there are parts that are nearly stoneless, which again contain wandering vein-like stony portions.

**The Drumlins** — The form and drainage of Cars y Bol have been greatly modified by the drift. The narrows at the Foot Bridge are only 30 yards wide, and have been produced by a double drumlin placed almost across the valley. The marsh now drains out sideways into the Vale of Alaw, but the watershed at its south-west end at Llantrisant New Church is low and rockless, and the original exit was probably in this direction. Indeed the whole drainage of the drumlin country must have been completely altered. In that country, there being no good inland sections<ref>In Penrhiw drum, Bryngwran, three shafts, each about 24 feet deep, were sunk some years ago. The material brought up seemed to be wholly boulder-clay. They are now filled up.</ref>, the principal matters of interest are the forms and alignment of the drumlins themselves.

Their maximum development is along a great crescent whose eastern curve sweeps from Llanrhyddlad upper village through Llanddeusant and Llyn Llywenan to near Valley, inland of which they gradually become scantier. Some oval hills to the east appear to be of solid shale. From the driftless rock summit of Llanfaethlu, about 280 feet in height, one looks out, as from an island, over a billowy sea of smooth green hills. Llanfaethlu, indeed, were the drumlins removed, would be a much more conspicuous object than it is. They set in as soon as we leave the high bare land at Llanrhyddlad, and a feature of the first ones is a great difference in angle between their north-eastern and south-western slopes (Figure 323). Some that are close to the rocky ridge are elongated parallel to that, but most of them (Figure 324) are oval, and the south-westerly alignment of the major axis is very pronounced throughout the district, with few exceptions. Compound ones are rather rare; but there are some at Ednyfed and Bodfardden, south and east of Llanfaethlu, at the Cors y Bol narrows, and at Cleifiog Valley. The largest occur south of Llanfaethlu, Tre-Lywareh drum being nearly three-quarters of a mile in length, but none attain the size of the largest in the northern country. Where they are largest, they are also (as in the north) most closely crowded. In height, they are not far behind the northern drums, many, in the low country north of Valley, having a net height of quite 100 feet above the hollows. The large one by the Alaw's mouth is about 120 feet, and rises from drift only about six feet above the sea. Faintly terraced features are not uncommon, and are well marked alongside the Valley road, near Llanfachreth Bridge, also on Graianfryn and Tan-yr-allt drums (Figure 322). The tendency to steepen at the summit may be noted on those of Alaw's mouth; Llanfaehreth Bridge (which is a typical one in several ways and easy of access); Ty'n-Ilan, Llanllibio; Penial; Llanfwrog (north); Graianfryn; and others.

An exception to the north-east–south-west alignment must now be described. Corn-helyg drum, Llanfwrog, three-eighths of a mile in length and more than 100 feet high, lies with its major axis west-north-west—east-south-east. Even its peaked summit has the same alignment. There is nothing here in the features of the country to account for this. All around it the old land-surface is quite low, and it is itself the last high drumlin of the district. But that district is the one in which the south-easterly striae (p. 697) have been found. The exception, therefore, is evidently related to this deviation of the striae, and is no breach of the general law of the moulding of these drums. The relationship goes to confirm the view (suggested at Llanrhwydrys) that there was no appreciable relief of pressure. And, as the south-easterly strim seem (p. 731) to be later than the normal ones, drumlin-formation would appear to be a relatively late phenomenon of the accumulation of the boulder-clay.

## Boulders

To deal in detail with the boulders of this country would be a well-nigh endless task. Little more will be attempted here than to give localities for some particular boulders, and some local evidence for the statements made in the general description and on the chart (Figure 326). Parys Mountain boulders have been obtained by the bridge over the streamlet east of Glasgraig-fawr, and on the hill between Gwredog and Cors y Bel, also at Caergeiliog School. A boulder of Old Red cornstone has been found at Pen-llyn, Llyn Llywenan, showing that the stream fanned-out as usual; but some hornblende-picrites which occur at Treiorwerth, Bryn Edeyrn, and even Valley are beyond the main picrite stream, and must have come from the Cors y Bol intrusions. A boulder of the beautiful spherulitic dyke of Coeden is built into the north wall of the Llanddeusant road, at the sharp turn south of Llynon woods (Ash-tree lake). The Skerries Grits of Llanfechell appear along the road leading from Llanfaethlu to Upper Llanrhyddlad.

Coming to the Extra-Insular Erratics, the abundance of the *Posidonomya* cherts is really astonishing. They are scarcely less numerous on the western beaches than the northern, which could hardly be the case had they come across the Island, for they would have thinned out like the flints, the, red rocks, and the shells. We must suppose that their outcrop is extensive, and that they have been brought into Holyhead Bay by the south-easterly ice-eddy that produced the Llanfwrog striae and Corn-helyg drum. The Lakeland garnet-felsite boulder was obtained from the drift on the coast west-north-west of Plâs-y-glyn, and a small one of perlitic felsite ([E9332](#)) [SH 297 760] was found at Cymyran. Galloway granites occur at Llanfigael and many places, while at Llantrisant Rectory a block about a cubic yard in size is built into the wall at the steps below the garden. The great and chief one, in character as well as magnitude (p. 713) ([E5163](#)) [SH 383 835] (of which a piece about one by one by half a foot is preserved in the garden of the same rectory), lies in 13 fragments on the eastern side of the hedge that runs south-south-east from Gors-goch farm, some 200 yards from the house. At the house between Llynon Hall and Gronant a one-foot boulder of a beautifully fresh gabbro ([E10503](#)) [SH 331 850] is built into a wall. It may be referred with confidence to the Tertiary intrusions of the Western Isles of Scotland.

## The South Central Country

Except for the southerly deviation (p. 697, (Figure 325)) this country observes the normal very steadily, and its boulders are the most insular of any.

### Surface and striation

#### The Coast

Beginning at its southern end, we find that the Millstone Grit does not striate, but breaks into blocks which are dragged up into the boulder-clay in a south-westerly direction. Coming to the Mona Complex, onset-and-lee forms are finely developed, those about the Bodorgan Headlands being among the largest on the coast of Anglesey, while on the north side of Dinas Trefriw there is also furrowing on a grand scale. The spot where the miniature 'crag-and-tail' in solid rock (p. 699) can be seen is 150 yards north-west of Porth Cadwaladr, on a few square inches of ice-worn surface close to the margin of the boulder-clay. The north-western parts of the reefs of Careg-lydan are traversed by furrows, one of which, where coincident with a small crush, is undercut on the south-eastern side. The reefs at Rhosneigr show good onset-and-lee features, and the black shales are well striated near the Outflow from the lake.

#### Inland

At the old quarry by the roadside, 300 yards south-west of Bodorgan Front Lodge, there is again miniature solid 'crag-and-tail' as at Porth Cadwaladr; but thence, to the north-east, on the heights overlooking the Marsh, the striae are to be looked for chiefly on the quartzites. The great Engan spilites between Coron Lake, and Mona House give rise to some of the steepest and most mountain-like bosses in Anglesey, onset-and-lee forms being strongly developed near Mona House. The knobs of basic gneiss are also steep, and yet passages between them, only a few yards wide, are ice-worn, a feature well seen in a group north-north-west of Craig Allor, where moreover (p. 700), their major axes lie across the strike and along the direction of glaciation.

The great exception to the normal direction in this district is the tract, about 250 feet high, near Cefn-cwmmwd (p. 697) where the striae run from north to south, and the deviation can be traced down the hill to Llangristiolus Toll Gate, close to

the 50-foot contour. In all, some 15 such records have been obtained. At Nant-newydd there is complex cross-hatching; some striae on the north side of the farmyard running south, some even south-east, while at the quarries about quarter of a mile to the east, some run south, some west 10° south. The absence of escarpments in the Carboniferous Limestone along the Malldraeth may be due to this ice-movement from the north, for it could not fail to grind them down. At Lledwigan kiln the direction has become south-southwest, and at Cerrigceinwen south-south-west and south-west. This great deviation is not easy to account for, but may be due in some way to the movements of the lower portions of the ice in the deep Malldraeth hollow; though a small southerly group exists also at Rhos-meirch.

## **The Drifts**

### **The Coast**

Blue or brown boulder-clay (with a few gravels) is almost the only drift. Along the Malldraeth shore there is a good section in boulder-clay, and some is usually to be seen in the coves of the Bodorgan coast, but blown sand covers many of the sections. On the headland south-east of Porth Twyn-mawr there is boulder-clay in the hollows of a decomposing dyke. Porth Cwyfan has a fine section in 10 feet of boulder-clay, with lines of differentiation, and two trains of large stones. It is of unusual interest because of its relation to the Church Islet, which is discussed in Chapter 34. Drift is then thin until we approach the Cable Hut, where boulder-clay descends into a deep narrow cleft, which looks like a huller or broken-in cave, now open; and in Porth Trecastell about six feet can be seen, but it is doubtless thicker. The Porth Nobla section is a fine one, showing 15–20 feet of boulder-clay upon shattered mica-schist; beyond which it thins, only a few feet of it resting upon the ice-worn reefs of Careg Lydan and Rhosneigr.

### **Railway sections**

The long cuttings all go down into rock, especially those on either side of Bodorgan Station; in which, above the vertically cut walls there are sloping grass banks (p. 760) with depths of 15 to 20 feet from the surface. If any doubt remained as to whether these banks were really drift, it would have been dispelled by an opening made lately just above the crown of the arch of the western tunnel at Bodorgan, which revealed perfectly typical boulder-clay. There can be, indeed, very little rock above the tunnel, which goes to confirm a statement that the cutting between the tunnels was laid open by a fall of roof. The rock-surface in these cuttings is unusually even for Anglesey. Rhos-Badrig cutting is about 15 feet deep, no rock being seen, and short ones west of Ty-croes show six to 12 feet of drift, but the deep one at Llyn Maelog is all in rock. The cuttings on the Amlwch branch are less extensive. Those in the Cefni ravine are in rock, but seven feet of boulder-clay, rather reddish, and evidently, from the Ty-gwyn evidence (see below) the true upper division, appears on the smooth slopes towards Trefollwyn. Llangwyllog reveals a buried ridge of shale, for the drift thins to two feet at the station bridge. Shallow cuttings then show drift only, but at Cors-yr-eira bridge the depth is 12 feet and no rock seen, and about eight feet (above rock) at the next bridge near Mynydd-mwyn. Thus the evidence of the railway confirms the view (pp. 706, 761) that smooth land may be generally regarded as drift.

### **The rest of the Interior**

Isolated sections, though for the most part shallow, are numerous, quite enough to prove the boulder-clay to be as extensive as the coast and railway sections lead us to expect. At Ty-gwyn pit, Cefni Vale, some four feet of sand and gravel are seen under six feet of brown boulder-clay, only just reaching the surface. The false bedding runs up against the base of the boulder-clay, which is evidently (see above) the true upper division. In one place a tongue of gravel about six inches deep is (Figure 330) thrust down into fine sand. There are boulders of Bodafon quartzite and Old Red cornstone, also of mica-schist. Carboniferous sandstone is abundant, but limestone was not seen. The microscopic contents of this sand are found by Dr. H. H. Thomas to be the same as that of Ty'n-y-caeau (p. 757) but with rather less local material.

The boulder-clay is to be seen resting on or clinging to the flanks of knobs of rock at many places, sometimes packed into the crannies, as on the dyke 'northeast of Plâs Maelog (Figure 316), where it is also seen to fill a hollow about three feet deep on the top of a knob.

Often, even where no change of feature would have indicated it, boulder-clay is found to be creeping over the rock. About half a mile east of Rhytty, Ty-croes, a section four feet deep shows boulder-clay in a hollow on a boss (Figure 320); at Tai-moelion, near this, flat rock with boulder-clay in its hollows (at the pool) is evidently the summit of a nearly buried knob; and at an old quarry about a quarter of a mile south of Llyn Badrig, similar relations can be made out (Figure 319), while the brow of a long feature, east of Cefn-canol, Llangristiolus, just emerges, with drift on both the higher and lower ground (proved by drain-sections in 1905). Some of the smooth risings in the Coedana country, however, are probably drumlins. Near Pen-carnisiog, a new section shows rock shattered, and boulder-clay almost as hard as stone, rammed tight into every crevice. The boulder-clay rammed into the great dyke (Figure 315) is seen just below the main lane, 100 yards east of Plâs-bach farm lane.

## **Boulders**

Extra-insular erratics are not conspicuous, but on the shore at Traeth Lydan is one of Galloway granite five by three feet. More unusual is a block found at Cerig-engan ([E9327](#)) [SH 403 739] of thermally altered gabbro with partly granulitised pyroxenes and chlorite reconverted into biotite, which are characters of the Tertiary gabbros of Skye where invaded by the granophyres. The abundance of Carboniferous sandstone is remarkable (p. 709), but limestone also occurs, having been observed about Llanbeulan. At the lane-side by the 'Li' of Llangristiolus is a block of cornstone, probably taken from the main stream by the local southerly movement. Jasper (abundant near Bodorgan) has disappeared at Ty-croes. Dolerites are so plentiful that there must be many dykes concealed beneath the drift. The two great definite streams of hornblende-picrite and Bodafon quartzite with Old Red cornstone are delimited in a general way upon the chart (Figure 326). A stream that is enwrapped by these, but whose boulders are numerous and large, especially about Llanfaelog, comes from the basic gneisses of the Allor area.

The great picrite boulder shown in (Plate 45) is situated three-eighths of a mile east by south from Mynydd-inwyn-mawr and 50 yards west of the railway. Measuring fourteen by ten by eight feet and being 10 feet high, it is conspicuous to the traveller, and is perhaps the most striking glacial monument in Anglesey. It rests upon a little knob of shale, that is almost flush with the surface of the drift, and is traversed by several joints. North by east from it, and 80 yards from the line on the other side, is another, eighteen by nine by six feet, but not standing so high; while a third, five by nine by four feet, lies 320 yards to the north-north-west, on the same side of, and only about 20 yards from the railway. A similar boulder, now, unhappily, destroyed, is said to have stood outside the police-station at Llanerchymedd until about a quarter of a century ago. This group may have come from either Llandyfrydog or Mynydd Eilian.

At Glan-y-gors, Tycroes, the farmyard is floored by a jumble of dark mudstones and fine grits of Ordovician type, which cannot be regarded as an outlier in place, for there is no sign of the thick mass of conglomerate that lies at the base of the system not more than a mile away. No doubt they are to be explained, like the Carboniferous Limestone of Bryn-gwallen (Figure 327), as an ice-borne mass, now broken up. The spot is outside the zone of transport of the local Arenig shales, but it is within that of the picrites, along with which Ordovician material would be carried as far as it was able to survive, and a large frozen mass of grit and mudstone might hold together for a long distance.

## **The Northern Country**

This consists of two driftless ridges and a broad Pre-Glacial valley choked with drift. One of the ridges, which is considerably interrupted, runs along the sea-board. The other is a curve of lofty land that extends from Pen-bryn-yr-eglwys, past Mynydd y Garn, the Mynydd Mechell, and Parys Mountain, to Mynydd Eilian. As it is the natural rampart of the Northern Country, it may conveniently be termed the Northern Barrier, and as such is discussed in Chapter 34. The Northern Country is a physiographical unit, but for glacial purposes the parts that lie to the east of the meridian of Bull Bay village will be considered under the heading of the Eastern Margin, because their drifts belong, essentially, to that margin.

## **Surface and striation**

### **The Coast**



On the summit of Ynys y Fydlyn<ref>The striae mentioned in this paragraph will be found on (Folding-Plate 13).</ref> striae can be found upon the grits, and under the 'lee' of little escarpments about six inches high, which can hardly have been done by a floating but rigid agent. On the gneissose headland of Trwyn-yr-eryr, 200 feet above the sea, are furrows large enough for a man to lie down in, the largest known in Anglesey, while the southern face of the summit is undercut. Fine striation, emerging from the sea, may be seen on the shales at Carmel Head itself, the north-west point of Anglesey. Striae cross the summit of Pen-bryn-yr-eglwys, 260 feet in height, running in the same direction as on the low cliff of Carmel Head, three records having been obtained on quartz-aggregates in gneiss, a little to the north of the cairn. At the turning of the coast the change in the featurings is curiously marked, the last west-facing cliffs being undercut, the first north-facing cliffs being rounded-off.

East of Carmel Head there is a good deal of shattering, but by the lagoon-side at Cemlyn the hard grits are furrowed. Crosshatching (south-west and east-south-east) may be seen 350 yards north-east of Porth-y-pistyll Old Limekiln, and there is an interesting deflection (p. 741) from south-west to west-north-west along the cliff's face east of the Lifeboat Station, Cemaes. Striae cross the summit of Llanlliana Head, or Dinas Cynfor, the north point of Anglesey, at 200 feet above the sea, and can be found on the pebbles of the grey conglomerate. The pebbles of the Hell's Mouth purple conglomerate retain them, and the Graig Wen quartzite, the highest point of the district, 297 feet, is finely ice-worn. On the northern cliffs of Torllwyn strice are seen upon grit at a cliff edge only 50 feet in height, undeflected, though the headland rises steeply 150 feet above them, which may be. due to the fact that they are exactly at right angles to the contour at this place. The ridge of Pant-y-gaseg hill is also crossed at right angles. Many of the northern headlands are powerfully ice-modelled, such as the point west of Porth-wnol, Dinas Cynfor itself, Torllwyn, and the crags from Trwyn Bychan to Bull Bay, all of which wear unmistakable marks of glacial onset.

## Inland

Furrows cross Clegyr-mawr summits, and there is fine glaciation at Foel farm, close to the top of Foel Hill. The striae recorded on the summit of Mynydd y Garn (p. 697) were obtained on a square inch of weathered-out quartz, about four yards south-east of the extreme crest, but there are also broad shallow furrows across the conglomerate. Records too numerous to specify, indeed, have been obtained all over this rocky north-west portion of the Island. Leaving Mynydd y Garn, few are to be seen upon the high bare shale of Llanrhyddlad, but upon the tough Coeden beds about 30 records have been obtained. The south-south-west normal is very steadily adhered to, but there is a deflection to west 30° south on the face of a little crag south of the road at Careg-dros-ffordd. In the broad northern valley striae are seldom seen, but a slight tendency to west is perceptible.

## The Skerries

are strongly ice-worn, almost every islet having marked onset-and-lee sides, while striae have been found at four places (Folding-Plate 14). The direction is the south-south-west normal of the northern coast, and differs by some 35° from that of Carmel Head and the north-west corner of Anglesey.

## The Drifts

### The Coast

Beginning at Porth Swtan, because its decomposition phenomena are related to the position of the Garn and the Foel, we find the whole depth of rock decomposed down to sea-level, with the exception of some, quartzite. The cliff is 100 feet in height, and its upper 20 or 30 feet is occupied by grey boulder-clay with a little gravel. Rock then rises, but boulder-clay comes on again and is 30 or 40 feet deep at the stream-course north of Ogo Lowry, which is excavated in an old drift-choked hollow. Drift is then thin or absent all the way to Carmel Head.

**Drumlins** — Immediately to the east of that bare land, the drumlins begin, and in 180 yards the drift has thickened from nothing to 130 feet, for the cliff at the back of the cove west of Porth Padrig (Mynachdy) reveals an unexpected depth in the first of them. Though elongated parallel to the hill-face behind, it is crossed by a depression in the direction of the striae. On each side of the cove, rock rises about 40 feet, so that this drumlin actually stands over a Pre-Glacial hollow,

and the same is the case, on a rather smaller scale, with the next one. At Porth Padrig the clay darkens markedly over the black shales. Another large drumlin, 100 feet high, is dissected by the sea to the east of this, beyond which, on the western side of Hen-Borth, the thickness of the boulder-clay drops to 15 feet. Beneath the east end of this drum, the rock surface has been shattered and worked up into boulder-clay like it is at Porth-delisc. Between Hen-Borth and Trwyn Cemlyn (Figure 332) are three of the best dissections of drumlins to be seen in Anglesey. Their inland forms are perfect, and they are elongated in the direction of the striae, the sea laying open their north-western sides. Llanrhwydrys drum is 60 or 70 feet in depth, and has a Pre-Glacial hollow under it, while striae can be seen at three places where it rests upon the rock. Cemlyn drum is rather more than 50 feet in depth, and the section, which is very clear, is easy of access. There are two beds of sandy loam about two feet thick, and another at the north end, rather disturbed, all about six feet above the beach. A few shell fragments can be found.

**Cemlyn to Cemaes** — On the other side of Cemlyn Bay, east of the 'y', is a large mass of rock walling a creek but underlain by about a foot of breccia with clay matrix, which is in continuity with the drift of the land-surface, showing that the rock has been displaced and the drift thrust in beneath it. Mynydd-y-wylfa contains a Pre-Glacial valley, closed at its east end, and with good sections across its Western opening, showing 20 or 30 feet of boulder-clay. Beyond the Lifeboat Station, where the rocks are decomposed to a depth of 30 feet, the thick drifts of Cemaes Bay are really part of those of the drift-laden inland valley (pp. 742–3), reaching the coast through a gap of the rocky hills. Penrhyn drum, about 50 feet in depth, is the last of the sea-dissected drumlins on the northern coast. Its major axis lies west-south-west, which coincides with a local variation of the striae, suggesting that its accumulation was contemporaneous with them, and therefore that glacial pressure was not appreciably relieved. On the eastern cliffs of the bay a little headland is capped with tumultuous gravel, but in the cliff behind are 30 or 40 feet of boulder-clay. At Porth Wen brickworks the decomposed rocks are covered by about 15 feet of boulder clay, beyond which no more drift sections of importance are seen on the remainder of this coast.

**The Skerries** — There is hardly any drift upon The Skerries, but beneath some angular rubble in two hollows that cross Ynys Arw is a little true boulder-clay, resting in one case upon a striated surface. Erratics are rare, and none of definite significance identified.

**Boulders** — Hardly any Anglesey rocks are to be found in the drifts except a few of purely local types. About Mynachdy are many boulders of the unsheared purple conglomerate discussed on p. 469, which does not occur within the limits of the Island. By far the most numerous are the Posidonomya cherts, with their varieties of cherty shales and cherty limestones, whose fossils (p. 715) were obtained by Mr. J. O. Hughes at a small sea-oliff of boulder-clay just to the south of the large quarry near Gadlys (Penrhyn-mawr of six-inch map). Some fragments of the Ordovician cherty beds have been found at Cemaes. They resemble those of the Carboniferous cherts, but can be distinguished with care. Very likely a few small boulders of them accompany those of the northern quartzites all the way to Holyhead. There are also some extra-insular sediments of Ordovician (or perhaps Manx) types, but flints and shells are rare. Moderate-sized boulders of Galloway granite, and small ones of Ailsa eurite, can generally be found. At Cemaes Lifeboat-Station there was once a fine boulder of Galloway granite, about five feet long, which was broken up when the new lifeboat house was built, but the pieces were taken up to Wylfa House, and are preserved in the garden.

### **The Interior**

With the exception of a few eskers, no drift is to be seen but the grey boulder-clays. The lifted boulder (p. 717) on the northern slope of Mynydd y Garn, 420 yards west of Hendre-fawr, is eighteen by twelve by seven feet, and thus one of the largest in Anglesey. It consists of epidotised grit, such as (p. 299) occurs about Henborth, and attached to it, moreover, are small quantities of fine basalt, such as forms the selvage of the dykes which traverse the Henborth epidiosites, while close by are two blocks of dolerite which may have broken off from it. The Maen Arthur' (Arthur's Stone) north of Coeden, is a sub-angular perched block of dolerite of local type, about six by six by four feet, standing upon a boss of schist. There is a notable lack upon the Mynydd Mechell of boulders of the northern quartzites, which, as they are directly in the line of transport, and as such boulders occur in the country to the south, is not easy to explain.

**Drumlins of the Northern Valley** — More interesting than the drifts of the hills are those of the valley, a long Pre-Glacial hollow between the Barrier and the sea. It is important here to remember that while the sea-board hills are broken and

impersistent, the Barrier does not even in its gaps sink to the 200-foot contour, save at remote Fydllyn. The Drumlins (Figure 331)–(Figure 332) are the great feature of the Valley. They extend all the way along it, from Mynaehdy to Llaneilian, so that the drift phenomena of this country (determined, doubtless, by the persistence of the features) overlap into the northern part of the Eastern Margin. Cemaes Brickworks, in the south-west end of the Bay drumlin, which show 20 feet of blue boulder-clay, afford the only inland section of importance, but the evidence along the coast leaves no doubt whatever as to the nature of these hills (pp. 707, 740). They are very numerous, 73 having been mapped in this valley, and in its central portion are crowded closely together, so that they really cover nearly half the surface. They vary from small oval hills 200 yards or so in length, to great spreading masses like Rhydgroes drum, a mile along the major axis, or like Pen-y-Morwydd, whose net height is 150 feet. Indeed, to the eye, they obliterate the Valley and prevent its appearing as the hollow that it really is.

As in the North Central Country, they often sharpen curiously at the summit, so much so as to suggest artificial steepening, yet there is no cut platform or terrace at the place. The one south-east of Llanrhwydrys, with a general slope of 10°–15°, steepens to 30°; and the top of Pen-y-Morwydd, Rhosbeirio, is a small dome rising from the general form. Several of the largest ones are compound, with two or even more summits, a feature more pronounced here than in the North Central Country. Such are the great drums of Pentre'r-gof, Cemaes; those on each side of the ravine above the Brickworks; Carog; and Rhydgroes. Carog drum, indeed, spreads out into gently rolling downs, not at all like the typical features of a drumlin. Rock is not always visible between them, for the hollows are often smooth undulating surfaces of boulder-clay, and that even this may be of considerable depth is shown by seine of the ravines of the Post-Glacial streams. North and south of Nant-y-fran, north of Rhosbeirio Church, and east of Rhydgroes, there are grassy bluffs, all cut in boulder-clay, 10, 20, 30, and 40 feet in depth, with the stream at the bottom still flowing upon drift. Looking north from near Hafod-Ilin, the gap between Rhydgroes and Werthyr drums appears as in (Figure 331), the bluffs here (whose nature is revealed by a drain cut in the western one) being 40 feet in depth. It is easy to see that the hills once rose from a smooth sheet of boulder-clay.

The orientation of these drumlins (Figure 332) is of great interest. The drum north-west of Mynachdy lies parallel to the barrier-face close by; and Llanfairynghornwy drum, close to which are some south-easterly strivings, is banked up against the side of the Garn, and extends right and left accordingly. But these are only local exceptions. If two lines be drawn across the valley, one from the eastern side of Cemaes Bay to Llanifiewyn, and the other from Bull Bay Village to Rhosgoch, we shall find that from Mynachdy to the one line and from Llaneilian to the other line, that is" throughout some three-fourths of the Valley, the major axes lie, with few exceptions, parallel to the direction of striation. But in the part enclosed between the lines, which may be called the Rhosbeirio portion, some five square miles in area, that is not the case, and they seem to be governed by no general law. Cemaes (south-east), Dymchwa, and Pen-y-Morwydd have major axes lying north-west and south-east; Bodewryd, Ysgellog, and Criw-east drums are nearly circular; while the major axes of the great drums of Rhydgroes, Hafod-Ilin, and Werthyr lie east and west. What, now, were the conditions of this area? It is much the deepest and most walled-in portion of the Valley: its limits coinciding exactly with the lofty part of the seaboard that ranges from Ogof Gynfor to the eastern end of Pant-y-gaseg hill. These hills would protect it somewhat from the direct onset of the northern ice. East and west of -them, however, that ice would pour through the low gaps of Bull Bay and Cemaes Bay, and as it happens, would find easy passage across the Barrier, directly in its line of movement, through the gaps of Rhosgoch and Llanfflewyn. Sheltered by its rocky walls, and with these two powerful streams on either side, the Rhosbeirio portion of the Valley would become a region of relief from pressure, of uncertain and oscillating movement, of slack ice and glacial eddies. It became, accordingly, more heavily drift-laden than any other part, and its drumlins were arranged in the variety of directions that we have seen. The dominant ice-flow was not, however, without its influence, especially at the higher levels. Nant-y-fran drums have nearly the normal elongation, so has the one at Rhosbeirio Chapel; and some of the large transverse ones, especially the largest, that of Rhydgroes, are compound, and are traversed by depressions running from north-north-east to south-south-west. Transverse though it is, moreover, this great drumlin is rudely rhombic in its ground-plan, and its eastern and western faces are parallel to the general direction of striation.

## The Eastern Margin

This is the country of the red boulder-clay. For the most part it is relatively simple; but its Penmon wing is, like the Menai Country, complicated by reactions between the ice of the Sea-Basin and that of the Mountain-Land, and is given a separate heading.

## Surface and striation

### The Coast

***Bull Bay to Traeth Dulas*** — Porth Offeiriad is a miniature fiord, and its floor is ice-worn, but the ice moved up into it from below, and its guardian headlands are ice-modelled. Amlwch Port, a fiord like it, is one of the most interesting furrowed and striated places in Anglesey, the spot shown in (Figure 307) being about 170 yards north-west of the Port Lighthouse. On the rocky moor east of the village, about 133 yards east-north-east of the end of the street called Ednyfed Hill, slickensides are crossed by glacial striae in an instructive manner. Hence to Point Lynas is the ice-modelled coast (Figure 312) described on p. 700, the finest view of which is obtained from the eastern cliffs of Aber-cawell, and is most effective about the latter part of the forenoon, when the light brings out the rounded forms. Seen close at hand, they are found to have weathered to excessive jaggedness down the foliation. At the old slate quarries in Fresh Water Bay, the shales are striated, and so smoothed at the very edge of the high cliffs as to be dangerous foothold. Cross-hatching will be found at the south cliffs of Porth y Gwichiaid, a west-south-west series being subordinate, and apparently older than the normal one.

***Dulas Bay to Red-Wharf Bay*** — Upon the Old Red Sandstone 12 records have been obtained, with a normal direction of about south-west. But the deflections are interesting. At the estuary's mouth some of the striae are actually a little north of west; while under the south cliff of Porth-y-mer they run west 5° south on the level, and west 15° south on southerly dip-slopes, but conform completely to small step-escarpments facing north, running even along their upright faces. The narrow coves just beyond, which run due west, also exact the same obedience. The glaciation is unusually fine along the Carboniferous coast-line from Lligwy Bay to Porth-helaeth, where the Moelfre Point escarpment causes deflections; but after we pass the village a group runs due south along a fault-scarp. At Porth-yr-aber, glaciation is again finely seen, ledges only three to six inches high deflecting the strip due west, the local normal of west-south-west being resumed at their brows. In Traeth Bychan there is another fine display, especially at the cliff's foot north-west of Dinas house, where the stria (with a normal of south-west) enter an east to west crack six inches wide and run along both sides of it to the depth of 12 inches. Penrhyn Point, again, is an ice-worn floor, with striae passing down it on both sides, and furrows along old cracks upon the eastern face. Beneath the lofty cliffs at Pen-y-coed gap is a deflection to south 10° west, the normal being resumed where the slope opens out at Benllech, and on the north cliff of Huslan is the undercut shelf with boulder-clay shown in (Figure 311). The last of these large glaciated floors of limestone is that at Trwyn-dwlban, where the remarkable deflections and under-cuttings are (Figure 308), (Figure 309). But Nature has been obliterating her own records; for the scour of the shingle in heavy gales from the north-east has, since 1907, gone far to erase the deflected striae, and the deeply undercut furrow has been partly buried. The photograph (Plate 43) has therefore an unusual value.

### The Interior

Turning inland, we find in the Carboniferous country, very few striae to be seen upon the limestone, almost all being on the sandstones. Two groups call for special notice. The sweep of the ice up into the Vale of Lligwy can be finely studied, 13 records having been obtained upon the sandstones. The other group is in the Vale of Caban, where nine records were obtained, rock-floors about 200 yards to the south-west of Caban house, being scored with furrows 18 feet long, and embossed with pebbles, about half an inch across, ice-worn on their onset sides, and leaving tails of sandstone on their lee sides three or four inches long. The sharpness of the limestone escarpments, which is remarkable, will be considered in Chapter 34.

***The Striation of the Hills*** — The striae that cross the summit of Mynydd Eilian can be seen (on slightly altered shale) about 40 yards to the south of the cairn, where there are furrows two inches wide, and fine striae on a quartz vein that stands up about an inch. Upon Parys Mountain 22 records have been obtained. The actual summit at the old Engine house is covered with mine-debris, but a siliceous crag 63 yards south-east of the Windmill, which is within a few feet of,

if not at the same level, is polished and striated, as is the great boss 220 yards east of the summit, which can scarcely be any lower. The conspicuous knob of lode-quartz at the west end of the mountain, north of the 'u' of 'goleu', is the most splendid case of ice-polishing in Anglesey, and shines in the sun. The miniature crag-and-tail' described on p. 699 can be seen in many places on the hard shales of the northern slopes, but the best locality (with excellent striae and furrows as well) is about 130 yards south by east from the spot where the road from Llyn Llaethdy reaches the foot of the open hill-side. The granite summit of Pen-y-graig-wen, which just reaches 300 feet, retains striae in two places. The mountain-like bosses of Mynydd Bodafon, with the great north rampart-curve of quartzite and the moor of mica-schist enclosed therein, have yielded 19 records, and more could easily be obtained at sunset. The quartzite is beautifully polished. The strim that cross the summit are a trifle east-northeast of the cairn, and are (p. 744) superimposed upon slickensides, which they cross at 70° or 80°, partly erasing them. Others can be found close by, some being on a nearly vertical face.

## The Drifts

### The Coast

***Bull Bay to Point Lynas*** — The boulder-clay begins to show a red tint at the bluffs in Bull Bay, near 'cave', where it rests against a Pre-Glacial cliff (Figure 333), a few shells being recorded in it at a boring about quarter of a mile to the south-west, where 11 feet were passed through. At Porth yr Ysgaw a good red clay (with blue beneath it) contains fragments of shells, flints, black cherts, and soft red sandstones, but local rocks are rare. Close to the west cliff of the cove is the great Galloway granite boulder (Plate 46). The red clay at Porth yr

Ysgaw is 50 feet thick, and a ravine cut in it by the stream shows that the old lake of Eilian alluvium was held up by it, and that a Pre-Glacial valley ran along the north side of the mountain where the marsh now is, parting that hill from those that skirt the sea, but that this valley turned northwards, cutting off what is now Point Lynas from the rest of the rocky seaboard range to which it really belongs.

***Mynydd Eilian to Dulas Bay*** — Along the lofty coast east of Mynydd Eilian there are no good sections, and it is evident that the driftless ' area extends as far as this. Not, probably, any farther. For there are grassy bluffs that may be banks of drift resting against steep eastern slopes. Drift comes on again thickly in the vale of Rhos-mynach, for in the secluded little bay of Porth-y-Gwichiaid no less than 100 feet of boulder-clay occur, red resting upon blue, but the actual clear sections are not very high, and the junction is obscure. The stones are chiefly Ordovician, with some Carboniferous conglomerate and limestone, beautifully striated, and extra-insular material, but very little from the Mona Complex. On its north cliff, in what appears to be an old hollow, about 20 feet of gravel may be seen, well bedded, and composed chiefly of large thin slabs of shale, lying very flat. Above it (though not well exposed) is red boulder-clay, while between it and the rock are three feet of rubble. Drift is again 100 feet thick in Porth Helygen, but the section is not clear. Thence to the Estuary a grassy bluff above the cliffs of rock indicates continuous drift, seen here and there to be boulder-clay, sometimes red. At the opening of Traeth Dulas there is a fine section in the red boulder-clay, 50 feet high, the clay being stiff and even jointed. Stones are few, and material of the Complex is rare if not absent altogether. The clay thins to the south-west, and opposite the sand-spit about 20 feet of it rests upon a breccia of black shale, the change of colour being remarkably sharp. On the shore at Coch-willan lane-end is a 10–13-foot block brought from the Old Red country by the west-south-westerly deflection.

***The Old Red Sandstone*** — Crossing the inlet, red boulder-clay is again seen near the estuary's mouth, and at intervals all along the coast of the Old Red Sandstone. But the boulder-clays are by no means always red, and at the cliff east of Penrhyn is one of the sections where two are seen, the red being above the blue, which is more stony and more local in origin, the blocks being chiefly Carboniferous. The red clay contains much red sandstone and mottled marl which, however, have the characters described on p. 714, and are quite unlike those of the adjacent Old Red Series, the composition of the clay indeed being the same as it is all along the eastern coast. These facts, as well as the circumstance that the lower and more insular of the two clays is blue, show that the colour of the red clay is not derived from the Old Red Series of the district, but from later red rocks that lie beneath the sea. That the base of the Carboniferous is very close to the present coast-line (pp. 589, 630) is evident from the great bank of Carboniferous blocks on the foreshore, so that neither of the boulder-clays has traversed more than a few yards of Old Red Sandstone.

**Lligwy Bay to Red Wharf Bay** — Beyond the dunes of Lligwy Bay we find that the change to a floor of grey Carboniferous rocks makes no perceptible difference to the nature of the red clay. All the way to Red Wharf it is the same, containing the usual red sandstone, flints, shells and other extra-insular erratics, Ailsa rock being not uncommon.

Fine sections are seen along the cliffs. At the little cove east of Porth-y-forllwyd about three feet of blue clay are seen below some 10 feet of red, the blue being again more stony and more local in character. One of the best and most accessible sections is between the old quarries and Porth-helaeth, where some 30 feet of red boulder-clay rests upon an ice-worn platform of the Royal Charter limestones. The red boulder-clay passes out on to Moelfre Point, but no drift was seen on the Islet. Between the Lifeboat Station and the Swat there is a limestone rubble, partly bedded, which at one place is seen to underlie the boulder-clay, and passing down into torn rock, to descend into deep fissures in places. It does not appear to be sharply marked off from the boulder-clay. There is no sign of its being an ancient beach, but it seems rather to be debris filling hollows in the limestone, into which boulder-clay was afterwards kneaded.

At Porth-yr-aber are some 30 feet of red clay with six inches of blue beneath it. Grassy bluffs of red clay continue to Traeth Bychan, and at Penrhyn-y-gell is a fine section showing four feet of blue boulder-clay below the red. There is the usual difference of characters, and when the section is not obscured by slipping, the junction is quite sharp. In Traeth Bychan, above the southern quarry, red clay, descending between the escarpments, thickens to 30 feet where it comes down upon the beach. Shells are more than usually abundant here. The last section in this part of the coast is that on the eastern side of Penrhyn Point. About eight to ten feet of drifts are seen, most of which is red boulder-clay with a few gravelly seams, resting on an impersistent sheet of the dark blue. The junction is not perfectly sharp, but the change is complete in two inches, as if the red clay had slightly ground up the surface of the blue.

The next good section is that at Trwyn-dwlban (Plate 43), where the remarkable deflections and under-cuttings (Figure 308), (Figure 309) are. About 12 feet of red boulder-clay with the usual characters rests upon the ice-worn limestone, but a little blue clay is visible beneath in places. In Red-Wharf Bay the same red clay is exposed at the Hotel, at the cliff east of Croes-fryn, at Talgwyn, and at the Bridge at the river's mouth, beyond which, though rugged hills rise immediately at its back, the shore becomes low and alluvial all the way to Llanddona.

### **Interior of the district**

The drumlins of the north (p. 742) are found almost as far east as the western slopes of Mynydd Eilian. There are some interesting boulders near Bull Bay. In a wall 370 yards east-north-east of Llechog-isaf are fragments of a large boulder of porphyritic felsite (sliced, see p. 727) that resemble those of the Welsh Mountain-land. But no undoubted mountain-land boulder has been found in Anglesey further out than Gaerwen, and it may not have come from Wales at all. At Amlwch, 333 yards north-west of Mona Lodge, there is a boulder of Galloway granite three and a half feet long; and a one-foot block of garnetiferous felsite from Lakeland is built into a roadside garden wall 200 yards west of the 105-foot level.

In the Western Pit on Parys Mountain, about 20 feet of brown boulder-clay are well seen along the brow of the north cliffs ((Plate 60), left and middle parts), in a place where, had not the ground been opened, drift would hardly have been suspected. Mynydd Eilian is very bare, but is bounded by clay-choked valleys, except towards the hill of Nebo. The deep ravines that trench the slopes of Llanwenllwyfo are full of dense bush, and so are the shallower ones on the eastern slopes of the mountain, so that it is not possible to determine the thickness of drift that lies upon the shales. Mynydd Bodafon also is very bare, and even the smooth moor carries hardly any drift, though at the lake there are four feet of boulder-clay, showing that it creeps in between the bosses in the usual way. Large blocks of cornstone are frequent. Deep drift runs up the Vale of Lligwy, and the limit of the red boulder-clay is obtained in the river at Plâs Bodafon, west of which the clay is brown, as at Frigan quarry.

How much drift there is between the crags of the Limestone country generally is not easy to say, but a little boulder-clay can sometimes be seen to begin just behind an escarpment, and thicken down the dip-slope to the foot of the next escarpment. Much more comes on as we approach the Berw faults, and some good sections were exposed during the cutting of the Heil-Wharf Branch Railway in 1907. At Croesfryn, south of the road, 12 feet of red boulder-clay were seen, the bottom not being reached, but an ice-worn escarpment of limestone suddenly rose and formed the surface for a few yards, the drift coming on again upon its dip-slope (Figure 334). At Goronwy cross-roads 12 feet of stiff red clay were cut

through, containing Carboniferous Limestone, flints, Coal, and shells, an underlying sand appearing in this case. The red boulder-clay (though with occasional emergences of grey) sweeps west along the great hollow, and has been traced as far as the stream northeast of Llanffinnan Smithy, more than a Mile beyond the watershed. Sweeping back, it is seen again at Tyfry, and has been exposed at Pentraeth Church and the old brickyard. as well as at the bridge upon the Red-Wharf shore.

***The Gravels and Eskers*** — The eskers, at their western end, shade off into gentle, broad undulations, but at their full development, between Llanddyfnan Church and Rhos-y-gad, they are steep, winding mounds, rising sometimes 40 or 50 feet above the hollows between them, the highest' attaining to about 140–150 feet above sea-level. There are no large sections, but quite enough of small ones to prove the nature of the mounds. The major axes of most of them lie north-east and south-west, but several are nearly at right angles to that direction. Between Tan-y-graig and Hendre they are banked against rock. They rise from just above the 100-foot contour and stand upon the watershed a little to the north of the deep trench that crosses it.

The best developments of the Pentraeth bluff-gravels (p. 706) begin on the north face of the vale at Tan-y-graig, on the south at Pentraeth Church. On the north side they end against the Fron-goch escarpment; and in the opposite direction, although they reappear at Hendre, and even as far as Llanffinnan Church, the features suggest that they are interrupted by boulder-clay. On the south-east side, there is boulder-clay at the Mill, and the new railway cutting (now covered in) overlooking the bog that lies upon the watershed at Hendre showed 15 feet of it. On the north side, the railway exposed for a short time a very fine section, for it went right through the bluff. Rock, which was striated, was covered by about 12 feet of highly false-bedded sand and gravel containing blocks of Carboniferous Limestone 11 feet long, and with a deposition-dip of as much as 30°, by which the face of the bluff may be determined, as it slopes at about 20°, and may, of course, have been washed down a little.

With regard to the mutual relations of these complicated drifts of Pentraeth, it is clear, first, that the bluffs overlook boulder-clay, for west of the village, where the mill-lead crosses the road, at the 54-foot level, the blue is seen, 20 feet of it being also exposed at the old factory. The railway definitely proved that the same blue clay underlies the bluff-gravels; and, just above the gate of the Fron-goch footpath, the same gravels could be seen some 20 years ago, resting on an eroded surface of a similar drift. No junctions of either set of gravels with the red boulder-clay have been laid bare, but the features leave no doubt that it is older than both of them. Nor have the relations between the bluff- and esker-gravels been seen in any section. The eskers, however, have already (p. 706) been shown to be the older, while the relations of both of them and of the bluff-gravels to the watershed have already been discussed on p. 725.

## **The Penmon Country**

This is really a wing of the Eastern Margin, and is, like it, a country of red boulder-clay; but being isolated by Red-Wharf Bay, and being very well defined as a district, separate description will be a more serviceable guide to the exposures. It is remarkable for the complex cross-hatchings of Penmon, which have been discussed on p. 724; and for the fine suite of gravel and boulder clay sections between Penmon and Beaumaris, which are the most interesting drifts in the Island.

### **Surface and striation**

Striae are rare on the lofty limestone tract, whose northern crags must have (Chapter 34) weathered back into sharpness in Post-Glacial times. The deflections and cross-hatchings begin at Trwyn-dinmor, where the crossing striae that run south 18° west are fresher and sharper than, though not as deep as, those that run south 20° east. The south-south-east deflection is felt all the way to the Lighthouse. At the cove about a quarter of a mile southeast of Trwyn-dinmor there are large furrows, and the glaciation is unusually fine. The south-south-east deflection is again seen 440 yards south-east of Trwyn-du cottage; then at the eastern quarries, and in the quiet old-world nook at the Wishing-Well the direction is nearly south. Finally, at the south-west end of the quarries beyond the ancient church, cross-hatching may be seen again, with striæ running west-south-west, south-west, south-south-west, and south 20° east, the last appearing again to be the older. Striae were recorded by Prof. Gregory on Puffin Island in 1887, running south 20° and 25° west, but were not seen when that island was surveyed in 1911.

## The Drifts

Nearly all the sections are along the coast, for although the Vale of Llanfaes is filled with drift to an unknown depth, the only good exposures that have been seen in it were some excavations at the R. E. Park in 1896, which proved more than six feet of red boulder-clay, very poor in stones. There can be no doubt that this clay extends all the way to the steep rocky feature that parts the Penmon from the Menai country.

### Llanddona to Penmon

On the coast, the Penmon country may be said to begin at Llanddona. North of the Church, a thick mass of boulder-clay is banked-up against the high ground, and there are fine sections on the cliffs for about half a mile. The lower part of this is brown,, with large blocks of Carboniferous Limestone and other rocks, and on it rest some seams of half-consolidated gravel, above which is a ruddy rather than red clay. More than 50 feet are visible, and unless the rock rises underneath, there must be 100, perhaps even 150 feet of drift; but this great mass dies out very suddenly, and on the high cliffs of Careg-onen there is no drift at all.

Beginning again on the Fedw-fawr, it thickens to 50 feet at the west cove, and in the oast cove, which is excavated in a narrow Pre-Glacial hollow, there are nearly 60 feet. The eastern wall of this hollow, however, is but thin, and in about 330 yards 40 to 50 feet appear again. The cliffs are now chiefly of drift for about a mile, filling an old valley of the dip-slope. Near the streamlet, a massive limestone has been torn up, and great blocks of it, hardly rounded, crowd the boulder-clay. Rock rises at the edge of Penmon Park, but in about 330 yards there is again a deep old hollow, this time, however, 120 by 100 yards in extent, filled with drift. Trwyn-dinmor is bare, but the clay thickens again, and there are depths of 40, 30, and 15 feet in the narrow hollows that cross the headland. Puffin Island appears to be bare, though there may be a little drift on the undulating dip-slopes north of the old Church.

The boulder-clay all along this coast is red; and nearly all its boulders are foreign to the Island. Blocks from the Welsh mountain-land are rare, and have not been seen west of a point north of Llangoed Church. Shell-debris is not uncommon. Triassic sandstones are always to be found, and Coal-Measure ironstones are quite frequent. The Ailsa-eurite may also be met with. But there are great numbers of granites, andesites, and banded greywackes, which should be studied by geologists familiar with the Lake country, the Isle of Man, and the South of Scotland.

### Penmon to Beaumaris

Drifts come on again in force near Penmon Church, and along the shores of the Vale of Llanfaes there is a fine series of sections in complicated boulder-clays and gravels all the way to Beaumaris. Out of the three and a half miles of shore there are two miles of cliff, all in drifts, and varying from five to 50 feet in height.

**Pennon** — At the first cliff, south-east of the old Priory Church, about 40 feet of drifts are seen, dipping gently westwards. All along the top is a brownish-red boulder-clay. The colour varies, being sometimes almost as full a red as at Moelfre, sometimes hardly red at all. But it has the other characters of the red clay, stones being small and few, and the matrix often a little sandy. In it, however, are a few large, striated, boulders of limestone. At the east end, near the quarries, it occupies about half the cliff, resting upon gravels about eight feet thick. These run down on the low dip, and disappear about half way along, four feet of them, however, reappearing-a little west of the streamlet that comes down from the Wishing Well. In part they are good ordinary gravel, but in part they are a wild jumble of great sub-angular blocks of limestone, which form a conspicuous line along the cliff. From below them emerge six or seven feet of still lower drifts. At the east end these are dark sand, well bedded; but about half-way along a lower boulder-clay appears for some yards, tough, grey, and packed with local stones, though the large blocks of limestone in it are subangular and unstriated, which may be due to the immediate proximity of the parent rock. Here, therefore, we have a tripartite succession, with the red boulder-clay as upper member.

The next section is that of Trwyn y Penrhyn, quarter of a mile of low cliff 10 to 15 feet high, between the points where the roadway leaves the coast. At the two ends of this cliff, all of which is boulder-clay, stones are scanty, there are some sandy seams, and the matrix is a good full red; but this colour gradually disappears towards the middle and the matrix



becomes brown, the other characters of the red clay disappearing too, for the stones at the same time become large and numerous, as if some of the lower clay were being kneaded into the upper. The stones are inclined gently upwards to the south-west. On the foreshore, between high and low water-marks, is a low reef of semi-consolidated gravel and sand, false bedded, and with all the characters of the glacial gravels. It is manifestly below the boulder-clay of the cliff, but the junction is concealed by shingle. There are a good many boulders of Penmaenmawr stone here, and by the roadside is one of Galloway granite a foot and a half long.

Where the road again turns inland another cliff of boulder-clay begins. This is once more of a good red colour, but with reduction to grey down the joints, giving it a mottled aspect. Stones are rather few and small, but striated, the clay being tough and free from sand. Carboniferous Limestone is abundant, but there are felsites of the mountain-land, and some foreign erratics. One boulder was seen breaking up in place.

**Llienawg**<ref>So spelt on the last edition of the one-inch map, which is used for the new geological map. Mr. S. J. Evans, Headmaster of the County School at Llangefni, writes that the spelling Lleiniog', adopted on previous Ordnance maps, is correct.</ref>—A little way further on is Lleiniog north cliff, about 30 feet in height, but of small extent. It is a rather sandy boulder-clay, brownish-red, and with horizontal seams that are a good deal redder. Though evidently the true red boulder-clay, it is packed with large stones, chiefly Carboniferous.

At the river's mouth are the great blocks of limestone mentioned on p. 711. One of them (Plate 47), 18 by 12 by 10 feet, stands, with its bedding vertical, by the pool on the alluvial terrace just beyond the cliff; and the largest of all, its bedding also vertical, a little way off upon the foreshore between tide-marks, its top just covered at high water. These blocks must once have been enclosed in the red boulder-clay.

Beyond the mouth of Lleiniog river, which issues from a little wooded valley cut out in the drifts, is Lleiniog south cliff, extending as far as the cottage east of Tre-castell, a distance of about a third of a mile. It is about 20 feet in height, and is the most complex and striking drift-section in the Island (Plate 44). Except at full high water, it is (like the rest of the sections along this part of the coast) quite easy of access, and can be reached either from Lleiniog, or by a cliff-top footpath from the Friars Beach. Red boulder-clay ranges all along the upper part of the cliff, its base coming down somewhat at each end, where it is about ten feet thick. At the north end it is a good red colour, but soon becomes paler, and then resembles that of Penmon. Its base is rather confused, but has a few feet of bedded sandy clay at the north end. Beginning at the south end (for it will be convenient to describe the section from south to north) we find this red clay resting upon a tumultuous mass that looks like the blue boulder-clay but is not quite normal. Then sand and gravel begin to appear, and in a few yards thicken out so as to occupy the greater part of the cliff. At their base are two strips of good blue boulder clay, but gravel appears again below them, so that the two types of material must interdigitate along their junction. No more boulder-clay is then seen below. The gravel now becomes tumultuous, and extremely current-bedded sands appear, most of them dark, but some quite red (an unusual colour), and the two kinds passing into each other, while the dark sand is full of flakes of red laminated clay. In these sands there are small fragments of coal, and little black lenticular seams that appear to be due to the dragging out of coal blocks. Dark and red sand then alternate rapidly for some yards, and once more pass into gravel with a deposition-dip of 50°, and hard enough to weather into a little sea-stack ten feet high. This gravel contains a sandy seam, ten feet long and six inches thick, that is crowded with pebbles of coal some of which are two inches long. More of such coal-boulder seams follow, six occurring in a thickness of three feet of sand, the largest being 27 feet long and three inches thick, while some of the harder pebbles of coal are between five and six inches long and two to three inches thick. A block of Carboniferous Limestone measuring twelve by nine by five feet, and full of fossils, stands out on the beach just in front of the cliff; near which place the gravel has yielded a fragment of Old Red Cornstone. Then follow more gravel and sand of the same type, with many more coal-boulder seams, to the north end of the section.

**Friars Road Cliff** begins, at the turn of the coast, with a reddish-brown boulder-clay, rather sandy, evidently the same as that above the Lleiniog gravels. Round the point the cliff rises to 30 feet, with brown clay at the top and blue below, but their relations obscured by slipping; and the same continues for some yards beyond the cottage where the new Lifeboat Station is (1912) being built. Towards Friars Beach the section, still 20 to 30 feet in height, becomes quite clear, and it is an important one for the correlation of the drifts, as we find here a good blue boulder-clay at the base, and a good red one, poor in stones, above it, some 15 feet thick. The junction is (1912) well exposed, and for a few yards a little gravel

lies between them, but the change of colour and characters is quite clear and sharp where no gravel intervenes. Boulders of mountain-land rocks are not uncommon.

**Beaumaris** — Passing Friars house, broad, smooth, low drumlins can be seen on the green slopes between the sea and the steep, rocky, wooded feature above Baron Hill, and they occur inland as far as Llanfaes Church. One of them, known at Beaumaris as 'The Mount', and more than 50 feet in height, rises just before we reach the Castle. Cut into by the sea from top to bottom, this drumlin furnishes the loftiest, and the last, of this fine series of drift sections. It is not a simple mass of uniform grey boulder-clay like most of the great drumlins of the north and west, but is composed of a dome-shaped core of typical blue, covered by a gently arching sheet, some 15 feet thick, of brownish-red boulder-clay relatively poor in stones, but rich in erratics, nearly all of which are extra-insular. The contents of these drifts are much the same as those already mentioned, the great boulders of limestone at the Mount being wonderfully polished and striated. A piece of Old Red Cornstone was found on the beach, and the upper clay has yielded one or two small bits of the bedded siliceous rocks that (p. 712) resemble the jaspers of Amlwch. But with this exception, the whole suite of sections has not yet yielded a single fragment from the Mona Complex, not even at Beaumaris Mount, where those rocks are close at hand. As at Friars Cliff, there is a little sand here and there along the junction, but that is quite well defined, whether there be any sand or not. The base of the upper clay descends nearly to the beach at either end. What is this upper sheet of clay? Its colour, certainly, is faint, but after a study of the long suite of sections just described, no doubt can remain of its being really the red boulder-clay that we have found to be so persistent. An interesting feature of Beaumaris Mount is that it is a drumlin within a drumlin, the core of blue clay having been, apparently, moulded first, and then the red clay moulded over it, thus indicating (p. 708) a relatively late date for the production of these structures.

The wooded bluff by the road as we approach Gallows Point appears to contain the same deposits, for little slips reveal a faint reddish tinge in its upper parts. The drifts at this bluff are 60 to 70 feet thick, but the whole mass ends off suddenly just beyond Gallows Point, where the rocky feature comes down to the shore.

**Discussion** — The detailed evidence now given will be seen to support the statement made in general terms on p. 705, that there exist in Anglesey two distinct sheets of boulder-clay, and that the upper one, which is pronouncedly red along the Eastern Margin, loses its colour as we follow it westward. The full meaning of this appears in Chapter 33, where we shall see that the material from which the red colour was derived lay upon what is now the sea-floor to the east. Let us look forward for a moment to the Ty'n-y-caeau gravel pit (p. 757). A boulder-clay, poor in stones, rests there upon sands and gravels that closely resemble those of Lleiniog. At first sight one might describe this clay as brown, but in good sunlight a reddish tinge appears, fainter than that of Beaumaris Mount, but just discernible. It can hardly be doubted that here, five miles from Beaumaris, we see the last vanishing of the colour from what we can no longer call the 'red', but must call by the still more significant name of the 'upper' boulder-clay of Anglesey. A mile or so further west<ref>Similar characters have already been remarked (p. 736) at Trefollwyn and Tygwyn on the upper Cefni, which are about the same distance, along the direction of the glaciation, from the eastern coast.</ref> and only by the criterion of the stones could it be distinguished from the lower clay.

## The Menai Country

The phenomena of this district are complex, on account of the continually changing reactions between the ice of the Sea-Basin and that of the Mountain-land.

### Surface and striation

The rugged surfaces of the Mona Complex in Aethwy do not lend themselves to the retention of striae, but very likely they might be found upon the quartz-auger by careful searching. The basic schists retain them better, and there are furrows on the hill top about a quarter of a mile west by north of Four Crosses, with good striae near the Column; while at Castellior a gap only 30 feet wide is glaciated. On the Baron Hill rocks there is a fine series, with furrows, running south-west about 100 yards north of the drive-bridge. Very rarely seen on the Carboniferous rocks, the last ones in the far south-west are on limestone at Ynys Llwm running south-south-west. The Fanogle Sandstone at the Pla,s Newydd boring (p. 762) is evidently not striated but shattered. On Llanddwyn Island (Folding-Plate 15) striae are finely seen,

especially in its eastern coves, with a deflection to south-south-east along a hollow in the northern one; but from the spilitic lavas in the dunes of Newborough, they have been to a great extent erased by the sand-blast. At Newborough the southerly deflection, which may be connected with that of Cefn Cwmmwd near Llangefni, can be seen at six places. Passing up the western margin, we find that on the plateau, close to the barns of Treferwydd, the striae run south 10° west, but at the 100-foot contour north of Tyddyn-hir they sweep round to south 25° to 30° west, while at Fferam-gorniog, Pentraeth, there are furrows close to the house; also at a place 575 yards south-west of Careg-landeg. The strip that cross Mynydd Llwydiarth are about 155 yards west of the western summit, just outside the 500-foot contour.

About Castellior, Llanfair, and other places, the pitch of the glaucophane-schist has greatly facilitated the production of onset-and-lee sides, which are also developed on the islets in the Menai Strait.

## The Drifts

### The Coast

From Gallows Point to the Suspension Bridge no good sections are exposed, the low cliffs being cut out from the foot of a nearly driftless area.

West of the Bridge drifts come on, but still there are no good shore sections.

**The Ty'n-y-caeau Section** — The large gravel-pit at Ty'n-y-caeau (where 20 feet of drifts are visible), however, is quite near the shore, and may be treated here. Being still actively worked, it varies from time to time. Blue boulder-clay has been seen at the base, but is not now visible. Near the eastern end about eight or nine feet of reddish boulder-clay, poor in stones, and evidently the true upper clay of the Eastern Margin (pp. 704–5, 755), appears above the gravels, but only for a short distance. A thin tongue of gravel seems to steal over its western end, but this is obscure from slipping. The gravels are excessively current-bedded, and full of beds of sand up to three or four feet thick; but in much of the section they show scarcely any stratification, and look from a little distance quite like boulder-clay. Here and there they contain, especially in their irregular and sandy parts, huge blocks (a few of which are rudely striated as if washed out of boulder-clay) of Gwna Green-schist, one of which measured six by four by three and a half feet, the seams of sand sometimes bending over, sometimes under these, sometimes being truncated by them. Contortion has been seen occasionally, while at the east cliff the bedding is nearly vertical for five or six feet, the pebbles here being on end, as if the whole bed had been disturbed after deposition. Yet (Figure 335) these vertical beds truncate the ends of some horizontal beds of sand, with an aspect of pouring down over them.

There is a great variety of pebbles, local Gwna Green-schist and dyke-dolerite being plentiful, but it is noteworthy that the Penmynydd mica-schists, whose boundary passes through this very spot, have not been observed. Carboniferous sandstone is common, and Garth Ferry grit present, though rare. Rocks from the mountain-land are pretty frequent, but the volcanic rocks of Bangor have not been found. Granites and felsites from outside Wales also occur, but Galloway and Ailsa rocks must be rare, as none have been observed in the course of 20 years. The most interesting pebbles, however, which are also the most abundant, are of soft, dark shale, and it is chiefly for them and for the sand that the pit is worked. They are usually rather small, and the sand is full of the same material, but some are as much as six inches long. The shale is of Lower Ordovician type, and the pebbles have yielded Arenig graptolites and other fossils (p. 431), evidently washed out of the eastern reach of the Menai hollow.

Dr. H. H. Thomas has kindly examined some samples of the sands. He writes: 'Except for the large proportion of ferruginous cherts and of schists, the composition of this sand is almost identical with that of glacial sands from Cardiganshire, Pembrokeshire and West Carmarthenshire' Thomas, H. H., 'On Detrital Andalusite'. *Min. Mag.*, vol. xv, 1909, p. 241. and all have the same loamy character and pale yellow colour. The heavy residue (sp. gr. > 2.8) from the Anglesey sand consists chiefly of augite and iron-ores; also, in order of relative abundance of epidote, garnet, hornblende, hypersthene, tourmaline, andalusite, zircon, rutile, anatase and staurolite. The augite is a coloured variety, the colour ranging from a smoky green to purplish tint; the grains are angular, and have frayed-out ends, the fraying having taken place along the cleavage-planes; the iron-ores are magnetite with subordinate ilmenite; the hornblende is a pale green to greenish blue variety of actinolite, and occurs chiefly as cleavage fragments; epidote is represented by two

varieties, the commoner having a highly characteristic pistachio-green colour and strong pleochroism; the less common variety is yellow and of a much paler tint; anatase occurs in steel-blue octahedra, usually broken and showing signs of wear; the tourmaline is all of a brown colour, and the other minerals present the usual characteristics. The mineral assemblage clearly indicates a deposit left by the ice which moved landwards from the Irish Sea; for in all such sands examined from Bagillt in Flintshire to Pembrokeshire, augite, green hornblende, pink garnet, and, above all, andalusite are characteristic constituents. H. H. T.'

The absence of glaucophane, only 500 yards from the great outcrop of glaucophane-schist, is, remarkable, and is in accord with the absence, or at any rate rarity, of the mica-schist of the Penmynydd Zone, and with the direction of transport indicated by the shale. Some faint terrace features run along the slope, but the limits of the gravel to the west are very uncertain.

***The Bridges to Llanddwyn*** — Tumultuous gravel full of Ordovician shale appears again on the shore below Plâs Llanfair, beyond which, along the beautiful shaded cliffs of Plâs Newydd Park, overhung with woods, drift can be seen in places, but it is not well exposed. Then, just before we reach Moel-y-don, there is a clear section in tough brownish boulder-clay, about 15 to 20 feet deep, with a few sandy or gravelly seams, and large striated boulders, Carboniferous rocks being most abundant. Beyond the Ferry, the extensive gravels of the Menai slopes reach the shore from time to time, though there are few good exposures, and the cliffs are walled up in places. The next fine section is at Foel Steam-ferry, where an oval hill about 60 feet high has been cut into, showing some 40 feet of drifts, chiefly tumultuous gravels. A little further on, where the 50-foot contour leaves the cliff, about three feet of red boulder-clay rests upon them, but before the little cottage is reached, gravel again overlies boulder-clay. Thence to Ynys Llwm the drifts are red, but the sections are again poor, the cliffs being walled in for a good deal of the way, while westwards, the alluvium of the Braint's mouth and the great 'blown' sands conceal everything until we come to Llanddwyn Island.

***Llanddwyn*** — There is much blown sand on the island, but boulder-clay is to be seen in many of the coves, and it evidently climbs further up, and fills much smaller hollows than one would suppose, or than can be indicated on any but maps on the .0004 scale. It would seem, indeed, that all the smooth land between the bosses is really covered with it, as (pp. 700, 703) appears to be the case with all such ground in Anglesey. For the most part it is red, and contains, along with a large assortment of boulders from the north-east, abundance of soft red sandstone with faceted quartz derived from the Red Measures of the Marsh. As those rocks are buried under 100 feet or more of Pleistocene deposits, and the drifts rise on Llanddwyn to 40 feet above sea-level, the uplift may be put at as much as 140 feet.

***Correlation*** — The redness of these drifts of the south-west is a local phenomenon, due to their having incorporated large quantities of the Red Measures and of the stained limestones of the Straitside Area (pp. 606, 620, 649–51), and is not in itself any evidence for correlating them with the upper boulder-clay of the east. Nevertheless, as boulder-clays are found below and above the Foel Ferry gravels, it is probable that both the lower and upper members are present. The other gravels of the Menai slopes, though they usually seem to rest upon, are not known to pass under boulder-clay, and may belong in many cases to the Esker series.

### **The Inland Margins**

It will be seen from the map that most of these margins are driftless—driftless, that is, in the only sense in which the word can be applied in Anglesey, rocky land, namely, with little drift-filled hollows.

***Newborough to Mynydd Llwydiarth*** — Along the Newborough ridge the glacial deposits are for the most part covered by the great sand-dunes, but boulder-clay has been swept clear at a gap in Cerig-mawr, and at the springs west of the bend in the 100-foot contour. It contains fragments of the same red sandstone as at Llanddwyn, and the uplift must be still greater. Llangaffo cutting is described on p. 761. At the old quarry', about 233 yards to the north of it, drift is seen to climb up and mantle the slopes even of a rocky boss.

The long straight bold feature which has hitherto risen direct from the alluvium becomes rather less pronounced at Berw, for between it and the Marsh there is about half a mile of undulating slope composed of Carboniferous rocks, on which there is boulder-clay, visible in the quarry at the 137-foot level, in Rhyd-yr-arian ravine, and below Nant, while a good

section was also exposed on the new branch railway at Holland Arms in the year 1907. This clay, in spite of resting upon, and being on the lee-side of half a mile of Red Measures, is but rarely red, unlike that of Newborough and Llanddwyn, which are near the sea. Fragments from the Pentraeth Inliers are common, but from the Llangefni country are rare at Holland Arms. It would seem as if only the bottom layers of the ice were moving along the axis of the great hollow; and as if this grey clay came from the Llangefni side, in ice travelling due south (p. 735), over-riding that which filled the valley. The bossy land of the Mona Complex goes on as far as Rhyd-yr-arian, and then the marginal feature, steep and straight as ever, is continued in Ordovician slaty shales, - which east of Pla's Penmynydd appear to be very bare of drift.

***Mynydd Llwydiarth and Llanddona*** — At the lihiwlas cross-fault, however, there is a bold line of crags, and the marginal area suddenly rises into the mountain-like Mynydd Llwydiarth, exceeding 500 feet in height, and very rugged. Drift, though rarely seen upon these hills, is probably present, especially in the deep cross-hollows, the largest of which traverses the whole width of the mountain east of Hafod Leucu (Figure 11). The scenery at this place reminds one forcibly of that which is so characteristic of the Lewisian gneiss of the North-West Highlands, but a curious contrast meets the eye, as one turns from the stern and silent rocks about the little silted lake, and looks across the blue waters of the bay to the fertile dip-slopes of the lied Wharf limestones. In these and the Llanddona 'highlands' the driftless margin widens greatly, the steep Ordovician tracts bordering the bay being, though smooth, as bare as are those of the Mona Complex.

***Llanddona to Garth Ferry*** — As the margin turns round southwards, another steep feature begins to develop, which overlooks the vale of Llanfaes and goes all the way to Beaumaris. Into its bays, especially the large gap west of Gyfynys, the boulder-clay of the valley sweeps up in sloping sheets. From Beaumaris to the Bridge the margin of the Plateau has much the same characters as that along the Marsh, and there are some interesting pieces of evidence as to the presence of drift in the narrow hollows. A new house was built some years ago in the field some 250 yards west-southwest of Bryn Meurig, just at the brow of the Plateau, and two wells were sunk in a smooth space between rock-knobs about 100 yards apart, one of which pierced nine, the other 15 feet of boulder-clay. In the lane that goes up the steep hill from Garth Ferry, another new house was built 333 yards from the Inn, and a section exposed which showed that there must be a steep hollow, partly filled with drift, between this house and the knobs on the south-west side of the well-sections just described.

## **The Railway sections**

Although these have been turfed over for many years, it has been possible to ascertain the nature of the cuttings. They afford, therefore, even now, a much better general view of the distribution of the drift upon the Plateau than isolated inland sections, and they cross its whole width near the middle of the area. It has been found, just as in the other districts (pp. 732, 736), that whenever any fresh openings have been made in the sloping and grassed-over parts of the cuttings, they never fail (with the sole exception of those in the softer members of the Carboniferous system) to prove drift.

The first cutting in Anglesey, south of the Column, shows rock for about 400 yards, covered by some eight to ten feet of boulder-clay, but west of this there is about one-third of a mile of smooth-banked cutting, some 20 feet deep near the bridge. At Bryn-gof bridge there is a 12-foot bank above low rock, whence to Gaer wen Junction, two miles and a quarter, half the distance is in cuttings of the same nature, with a boss of rock rising just to the surface in one of them, south of the '18' mile-post.

The Branch line goes through a considerable hill close to the Junction in a cutting about 20 or 30 feet in depth, in which two low reefs of rock rise about three feet from the floor, all above this being grassy bank; and in 1908 a new opening showed that, close to these reefs, the very bottom of this bank was boulder-clay, and thus that the hill must be composed of drift. The next three cuttings on the Branch prove that the gentle risings are composed of boulder-clay to at least five or six feet, in which, east of Bryn-y-fedwen, debris of Ordovician shale is plentiful; but Berw-uchaf cutting, which goes through the plateau margin, demonstrates that it is nearly free of drift, boulder-clay being piled-up against its inner side. As drift was proved in the new cutting at Holland Arms, it may be assumed that the banks above the Red Rocks and dykes in the older cuttings are of the same nature; and along the Branch towards Pentraeth all the cuttings are in drift as far as Ceint.

Returning to the main line, the cutting beyond the Junction is wholly grass-bank, but boulder-clay has been seen along the bottom, so, combining this evidence with that of the Branch line, there can be no doubt that Myfyrian hill is really a drumlin. A group of drumlins can, indeed, be recognised about the station when viewed from a little distance to the south. Thence to Llangaffo Bridge the railway runs below the level of the land for about half the distance, all of which is in turf-bank. Llangaffo Cutting (Figure 178) exposes continuous rock for more than a third of a mile, but no such continuous exposures appear at the surface, for the railway has really been taken through a Pre-Glacial gap in the rocky margin. No drift is actually seen, but above the vertical walls of rock there is a grassy bank of variable depth, shown to be boulder-clay by a field-ditch on the southern side; while, where the rock does reach the top, there are bosses in the field adjacent. In the eastern part of the cutting, no rock is visible, so that here also drift is evidently piled-up against the inner side of the rocky rim of the district.

In general, the evidence of the railway sections is to the effect that the wide and gently undulating surfaces of much of the district are really features of the drift, whose depth in the gentle risings may be more than 10 or 15 feet.

### **The rest of the Interior**

The usual shallow sections confirm the view that inside the rocky rim there is drift over wide spaces, but that it is not very thick.

The top of Llandegfan hill, whose height is about 350 feet, has yielded some interesting evidence. Its highest part, an oval space of above one-eighth of a square mile, rises gently a little above the surface of the plateau, and in this no rock emerges within the 300-foot contour, though it appears just outside to north and south. Among the houses around the old windmill are four old wells and a new public one, whose depths are 9, 17, 20, 21, and 33 feet. Only the last-named, which is on the very summit, and is said to have been 'blasted a little near the bottom', appears to have reached rock, so we may assume a thickness of about 30 feet of drift (which all seems to be boulder-clay) upon the hill-top. This rising must therefore be a low drumlin resting on unusually lofty ground. An isolated esker also occurs at an exceptionally high level (239 feet) at a place where three roads meet, north of Penmynydd Church.

***Llanfairpwllgwyngyll to Newborough*** — At the Plâs Newydd boring (p. 658) 'clay, boulders, gritstone' are recorded for 16 feet, after which 'jointy gritstone' was entered. We may infer, accordingly, that, 500 yards west of the slateworks, there are 16 feet of boulder-clay, and that the surface of the Fanogle Sandstone is not striated but shattered. On the west side of the road near Druid Lodge, there is a good pit showing more than five feet of tumultuous gravel with its false-bedding inclined to the north-west. The larger blocks, about two feet in diameter, are of local origin. Ordovician shale, and many mountain-land erratics, are also present, but no Bangor volcanic rocks were seen. The Druid Lodge gravel may, accordingly, be correlated, with that of Ty'n-y-caeau, and so with those of Penmon. The gravels along the Vale of Braint appear to be eskers.

Along the Menai slopes, although large spreads of gravel have been mapped, there are no good sections, the evidence being derived from shallow cuttings and from features. The chief interest of the district is in the direction of transport of materials. Boulders from the mountain-land have invaded it in considerable numbers, but for all that the Anglesey materials themselves have moved from north-north-east to south-south-west. Between Newborough and Clynog, where the striae run from north to south, there is red boulder-clay with debris of Red Measure sandstone of the Malldraeth type and fragments of shells, so that the drift evidently climbed the hill, out of the Marsh, and descended towards Aber Menai. As there are 100 feet of superficial deposits in that part of the Marsh, and the hill is more than 130 feet in height, the uplift of the Red Measure boulders must be more than 230 feet. On the crest-ridge and far down the dip-slopes of Llanidan extra-insular boulders are small and few, compared with the vast numbers and often great size of those of mica-schist and glaucophane-schist; similar relations obtaining right out to the end of the Carboniferous area, which points to differential movement in the horizontal dimension (p. 723).

***The Trefarthen Boulders*** — Lastly, near Trefarthen there are four huge blocks of mica-schist, which are among the largest boulders in the Island<ref>Lord Boston has given instructions for the preservation of those on his land.</ref>. One is about a third of a mile to the north-north-east of the house, the others being some 350 yards to the south-west of Tycoeh. The biggest is in a hedge running west-north-west, and measures about eighteen by nine by six feet, and the

remaining ones, not much smaller, lie north-east and southwest of it. The last named (Plate 48), measuring about ten by four by five feet, is cracked, and has a little tree growing in the crack.

**Uplift of the Garth Ferry Boulders** — None were seen to the north of a line drawn west-south-west from the Ferry, but they appear in considerable numbers immediately to the south of this (Figure 326). They are sub-angular rather than round (whereas the Carboniferous and mountain-land erratics are well rounded), and are usually about a foot in diameter. It will be seen that they have travelled westwards during their uplift, which may be due to the pressure of the great Ogwen glacier, and it is noteworthy that a number of mountain-land erratics accompany them. But they soon turned round into the normal south-westerly direction, the last one found being at crossing walls 730 yards east of Rhos-bothan.

**Galloway Boulders** — On the hill north-east of Cefn-du, Gaerwen, <ref>This locality is from memory, the field-note having been unfortunately mislaid.</ref> a boulder was found of which Dr. Horne writes: 'The foliated granitoid chip has been compared with some specimens in the Museum from the Criffel and Dalbeattie mass. It closely resembles a specimen from near Killywhan, on the north-west margin of the great granite'. At Cefn-du-isaf is a boulder (four by three by two feet) built into a hedge, composed of a granite so crowded with Carlsbad twins of orthoclase as to leave but little room for matrix. It also is identified by Dr. Horne as a type that occurs between Criffel and Dalbeattie.

**Limit of Mountain-land Boulders** — A block of nodular felsite has been found a few yards to the south of the cross-roads, Tai-lawr, Llansadwrn; while traverses north-westward from the Bridge in search of boulders from the mountain-land have yielded the following results:

Waterworks, Menai Bridge.	Felsite	Grit	Diabase	Tuff
Farm south of Yr-allt.	Felsite	Grit		Tuff
West side Cadnant Park.	Felsite	Grit	Diabase	Tuff
Yr-allt to Four Crosses.	Felsite	Grit		Tuff
Castellior, lane to south-west.				Tuff
Penhesgyn.	Felsite			

Beyond this to the north-west they must be either extremely rare or absent. Several blocks of acid la-vas have been found about Llanddaniel-Fab and Gaerwen. The great boulder of mountain-land felsite at Hologwyn (p. 712) was identified by Dakyns as a rock very closely resembling those of the volcanic series with which he was so intimately acquainted. In the lane going south from Trefnant one of rather fluidal felsite may be seen; in the road east-south-east of the village is one of the well-known Bala-lava nodular type with chloritic inclusions; and about a quarter of a mile north-east of the village, one of typical dark Trifaen felsite, with small well formed porphyritic felspars. On the further side of the railway, between the Junction and the village of Gaerwen, are several boulders of similar rocks, one of which is of decided Bala-lava type; and there are also some about Newborough. But none have been found further to the north-west than this, and it will be seen that the furthest positions lie along a north-east–south-west line; which cannot, therefore, be far from being the limit of the invasion of Anglesey by mountain-land ice (Figure 326).

Summary of the district

The Menai Country slopes gently to the south-west but presents abrupt faces in the other directions. Everywhere except between Llanddwyn and Menai Bridge it has almost driftless margins, which are of the nature of rims or low ramparts, for they rise a little higher than the country just within them, drift being piled-up against their inner sides. Over them surged the ice from the sea-basin; but owing to its varying interaction with the mountain-land ice, there were great deviations from the normal, sometimes to right, sometimes to left, with complex inter-crossing of the boulders. The influence of the great Ogwen glacier is perceptible in several ways, notably in the westward uplift of the boulders from Garth Ferry. That of the Llanberis glacier is less conspicuous, but will no doubt be discernible when a thorough study can be made of the boulders of the district between Llanidan and Newborough. It is to be remembered (p. 723) that, owing to the concentration of the ice of the mountain-land into the deep valleys of the Ogwen and Llanheris, its deflecting influence

would not be felt equally all along the district, but at the parts that are opposite, or a little to the south-west of the openings of those valleys. Much work remains to be done in the investigation of the changing relations of the two ice-bodies, which can only be accomplished when the boulders along both sides of the Menai Strait have been studied in detail.

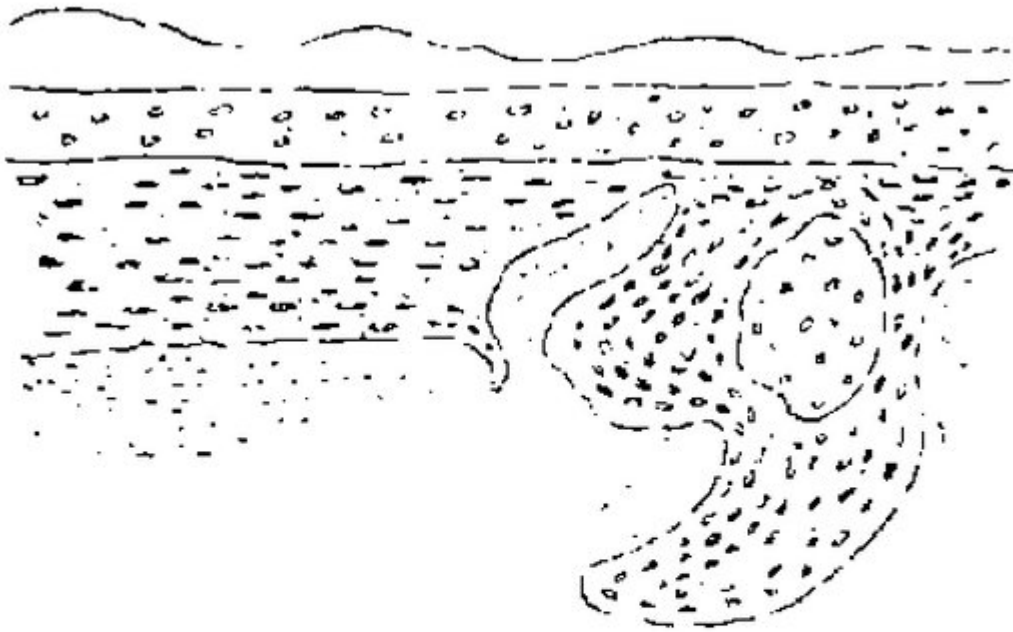


FIG. 328.

GLACIAL GRAVEL AND SAND,  
WITH BOULDER-CLAY.

Penrhos Beach, Holyhead.

*(Figure 328) Glacial gravel and sand, with boulder-clay. Penrhos Beach, Holyhead.*



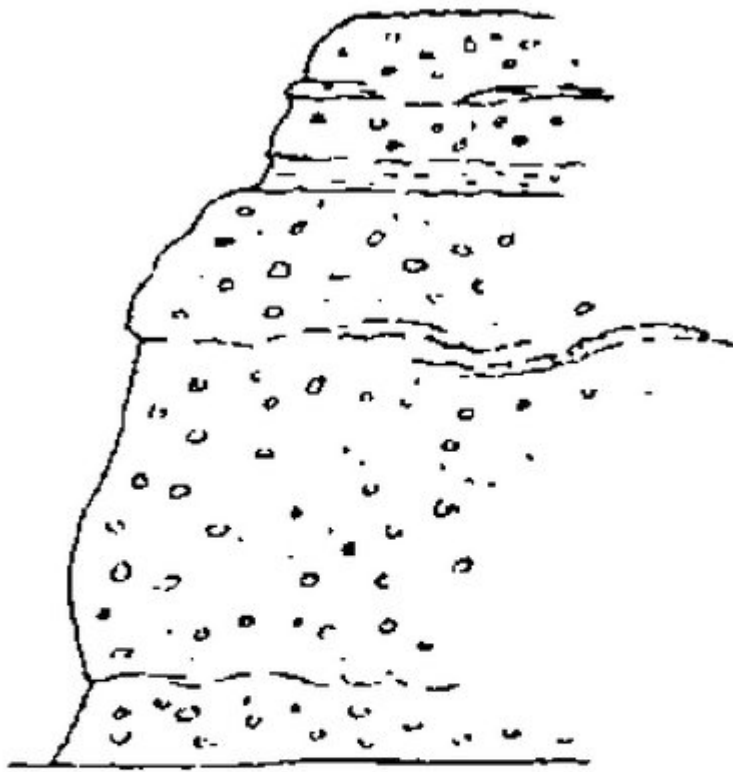


FIG. 329.  
SECTION IN  
PENRHOS DRUM.

*(Figure 329) Section in Penrhos Drum.*

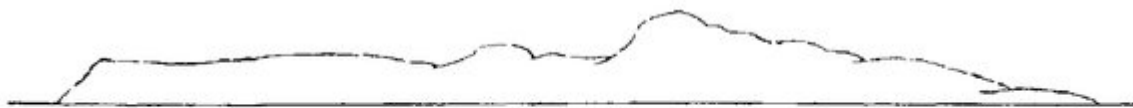


FIG. 339.—HOLYHEAD MOUNTAIN AND THE SOUTH STACK MOOR :  
SKETCHED FROM THE BWA GWYN, RHOSCOLYN.

*(Figure 339) Holyhead Mountain, from Rhoscolyn, and the South Stack Moor: sketched from the Bwa Gwyn, Rhoscolyn.*



(Plate 18) Minor isoclinals in the South Stack Series. Near Porth Rhwydan, Holy Isle.

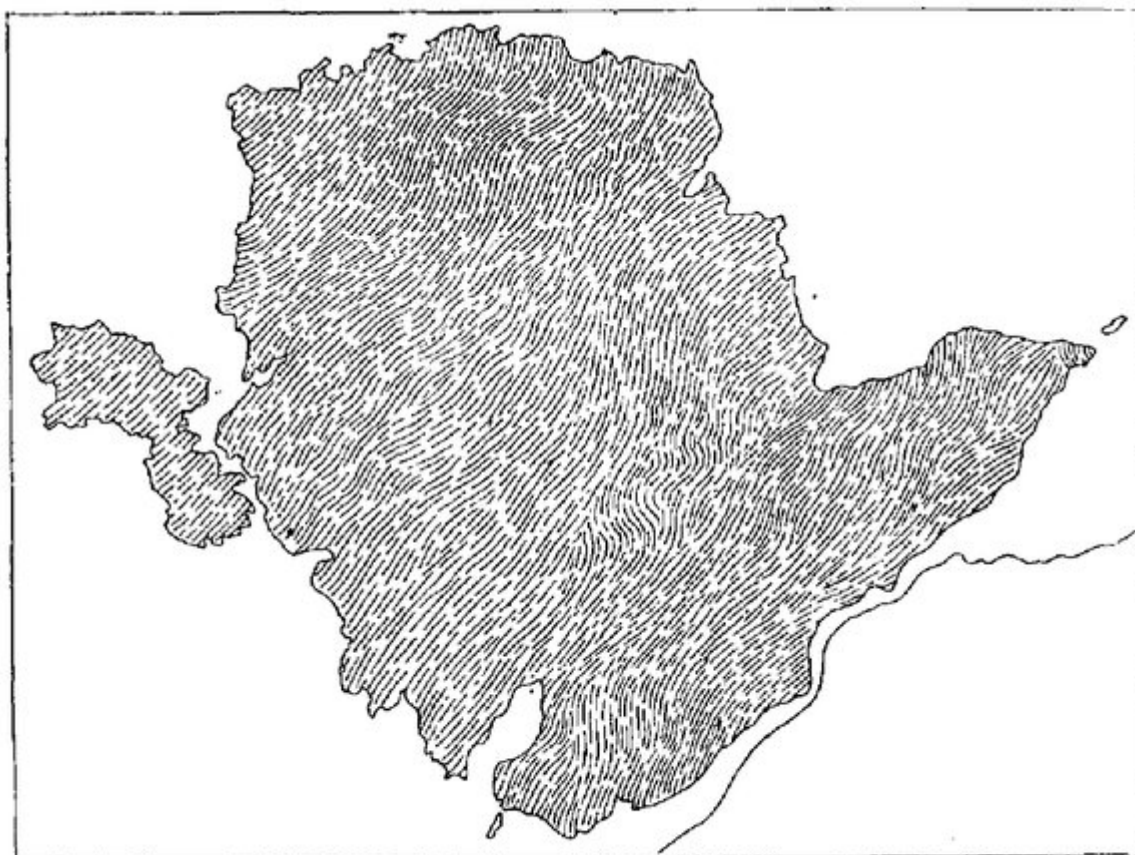


FIG. 325.—THE PATH OF THE ICE.

(Figure 325) The path of the ice. Scale: one inch = eight miles.

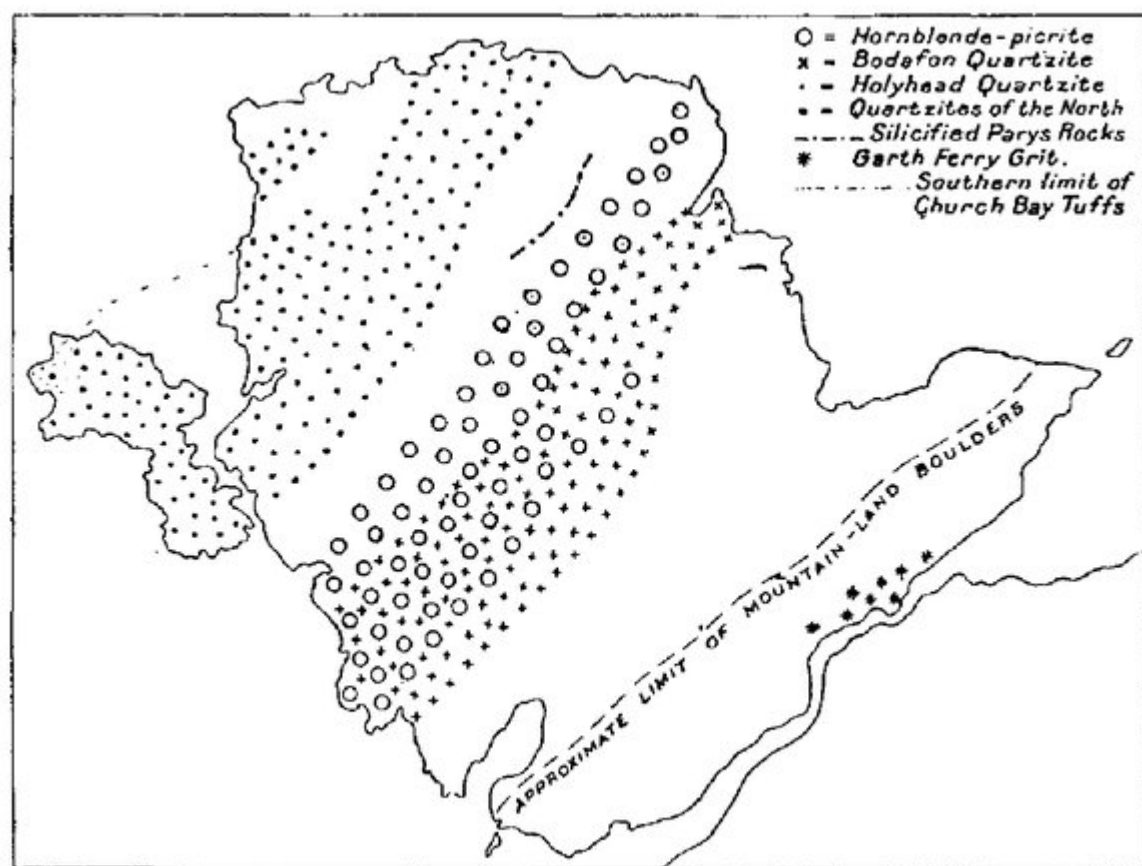


FIG. 326.—THE PRINCIPAL BOULDER-TRAINS.

(Figure 326) The principal boulder-trains. Scale: one inch = eight miles.



**FIG. 317.**

**BOULDER-CLAY  
FILLING TWO-FOOT  
HOLLOW ON BOSS :  
ABOUT QUARTER OF  
A MILE EAST OF  
BODIOR.**

*(Figure 317) Boulder-clay filling two-foot hollow on boss: about quarter of a mile east of Bodior.*



FIG. 310.

UNDERCUT  
SHELF, WITH  
BOULDER-CLAY,  
FELIN-WEN.

*(Figure 310) Undercut shelf, with boulder-clay, Felin-wen.*



FIG. 313.

GLACIAL  
DISRUPTION AND  
THRUSTING  
AT PORTH-DELISC.

*(Figure 313) Glacial disruption and thrusting at Porth-delisc. Height about one foot.*

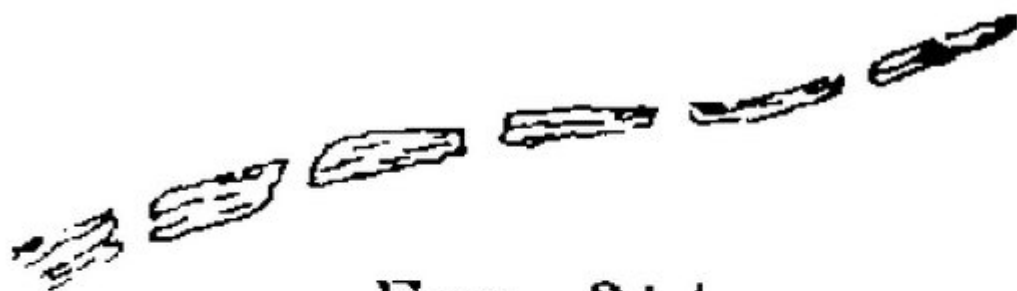


FIG. 314.

GLACIAL DISRUPTION  
AND DRAGGING-OUT  
AT PORTH-DELISC.

(Figure 314) Glacial disruption and dragging-out at Porth-delisc. Length about six feet.

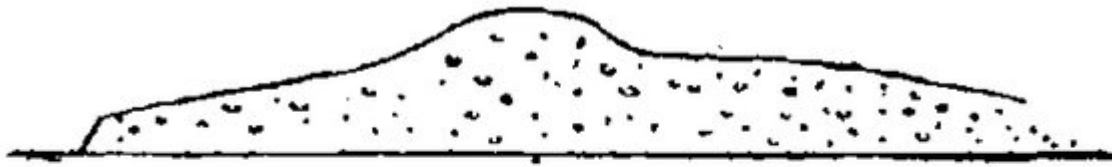


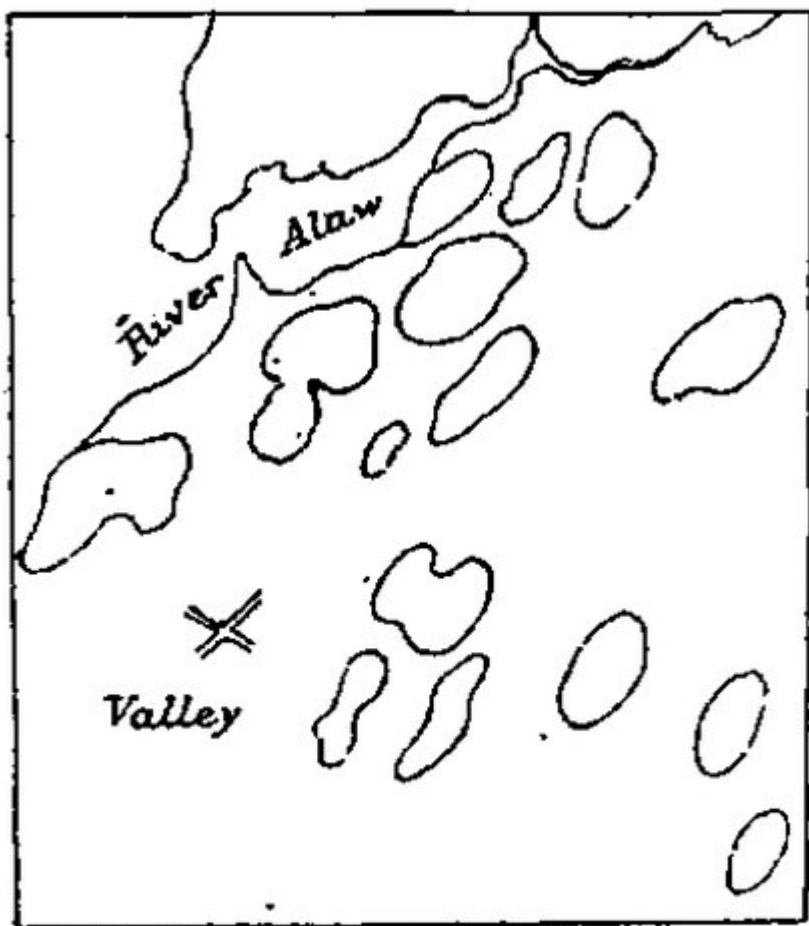
FIG. 321.  
PENIAL DRUM.

(Figure 321) Penial Drum.



FIG. 323.  
CLYMWR DRUM.

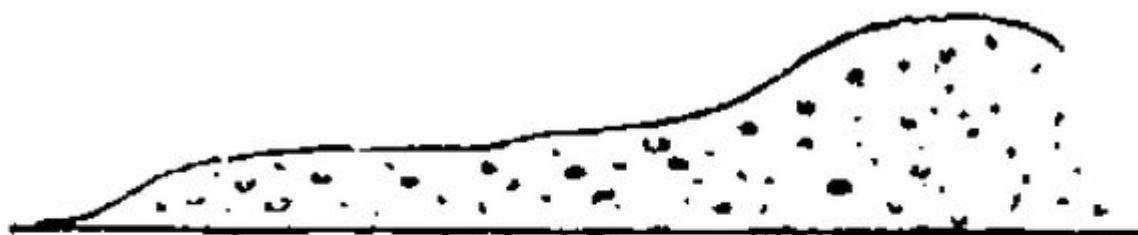
(Figure 323) Clymwr Drum.



**FIG. 324.**

**DRUMLINS NEAR VALLEY.**

*(Figure 324) Drumlins near valley. Scale: two miles = one inch.*



**FIG. 322.**

**LLANFACHRAETH DRUM.**

*(Figure 322) Llanfachaeth Drum.*





FIG. 330.

GLACIAL GRAVEL  
AND SAND  
AT TY-GWYN,  
LLANGFNI.

*(Figure 330) Glacial gravel and sand at Ty-gwyn, Llangefni.*

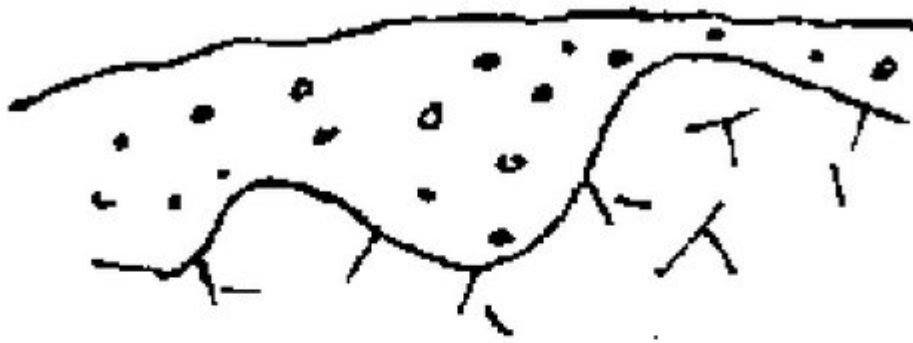


FIG. 316.

BOULDER-CLAY ON  
THE TOP OF A  
BOSS OF DOLERITE,  
NEAR PLAS MAELOG.

*(Figure 316) Boulder-clay on the top of a boss of dolerite, near Plâs Maelog.*



FIG. 320.

BOULDER-CLAY ON  
SLOPE OF BOSS :  
NEAR RHYTTY.

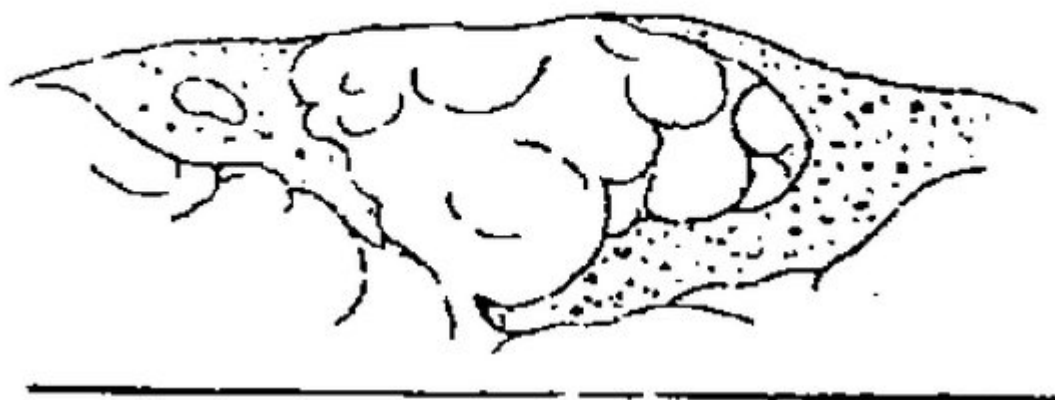
(Figure 320) Boulder-clay on slope of boss: near Rhytty.



**FIG. 319.**

**BOULDER-CLAY BETWEEN  
BOSSES :  
LLYN BADRIG.**

(Figure 319) Boulder-clay between bosses: Llyn Badrig.



**FIG. 315.**

**BOULDER-CLAY DRIVEN  
UNDER DOLERITE,  
NEAR PLAS-BACH.**

(Figure 315) Boulder-clay driven under dolerite, near Plâs-bach. Depth about five feet.



*(Plate 45) Transported boulder of hornblende-picrite. Near the railway, Mynydd-mwyn-mawr, Llanerchymedd.*

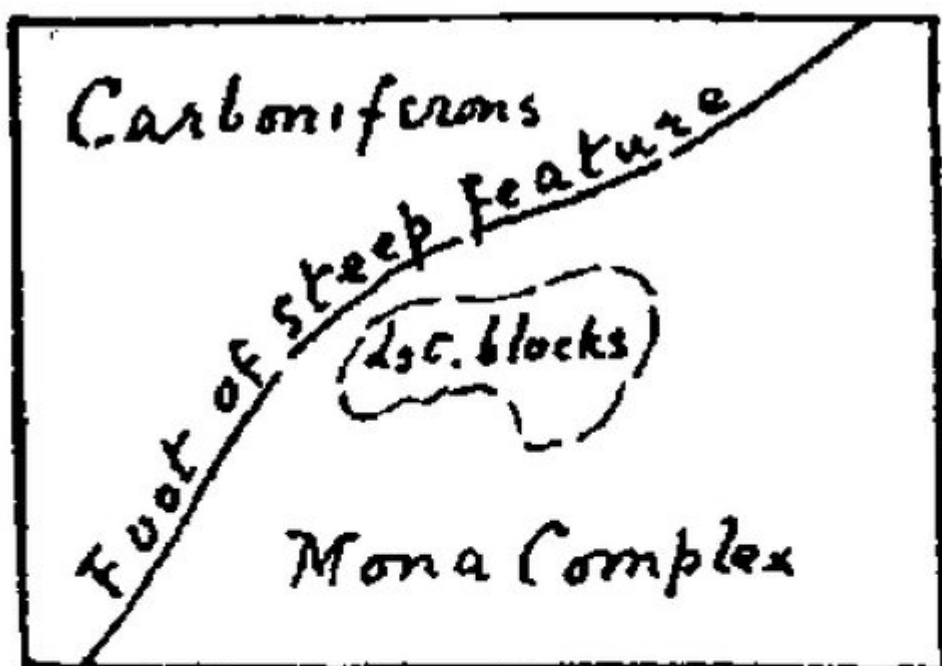


FIG. 327.

THE CARBONIFEROUS  
LIMESTONE  
OF BRYN-GWALLEN.

(Figure 327) The Carboniferous limestone of Bryn-gwallen. From the six-inch map.

## NORTH WEST CORNER OF ANGLESEY.

- Alluvium.
- Metamorphic Quartz.
- Palaeozoic Diabase or Dolomite.
- Palaeozoic Foliate.
- Ordovician Shale (black shale).
- Ordovician Conglomerate or Grit.
- Ambach Beds (chloritic mica schist).
- Church Bay Tuffe (pelite).
- Gwynn Diabase.
- Gwynn Limestone.
- Gwynn Quartzite.
- Gwynn Green Schist (chloritic quartzose schist).
- Helmsdale (Cambrian) clastic schist.
- Fyall's Beds (foliated schist).
- Granite of the Gwynns.
- Hornblende Gneiss.
- Gneiss.

Scale, 6 inches to one Mile.

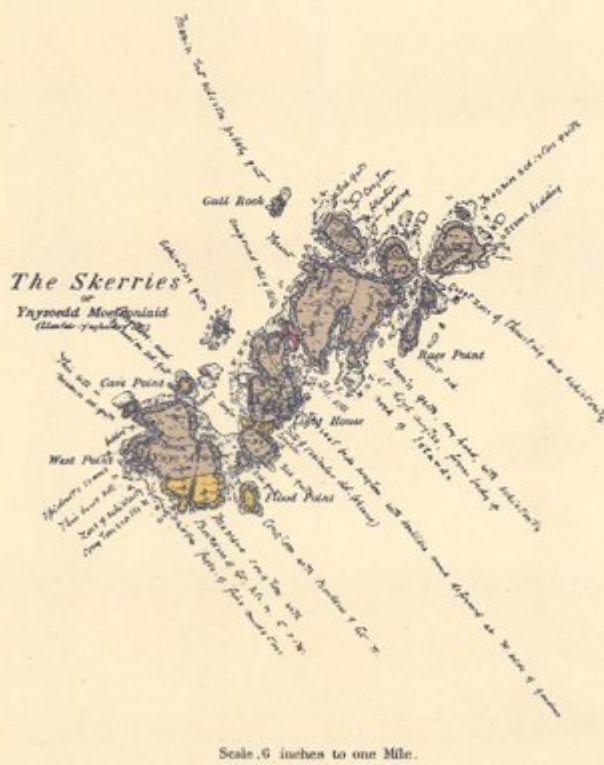


Mallory &amp; Sons Lith.

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



Do.	Palaeozoic Dolerite.
Cg.	Skerryss Conglomerates.
g & s.	Skerryss Grits.



Scale, 6 inches to one Mile.

Malby &amp; Sons, Lith

(Folding-Plate 14) *The Skerries. Reproduction of manuscript six-inch map.*



FIG. 332.—THE DRUMLINS OF THE NORTHERN VALLEY.

(Figure 332) The drumlins of the northern valley. Scale: one inch = two miles. High driftless ridges dotted. 1. Cemaes Drum. 2. Dymchwa Drum. 3. Pen-y-morwydd Drum. 4. Bodewryd Drum 5. Ysgelloog Drum. 6. Oriw Drum. 7. Rhyd-groes Drum. 8. Hafod-Ilin Drum. 9. Werthyr Drum. 10,10 Nant-y-frân Drums. 11. Carog Drum. 12. Llanfairynghornwy Drum.



**FIG. 331.—RHYDGROES AND WERTHYR DRUMS.**

(Figure 331) Rhydgroes and Werthyr Drums.



**FIG. 307.**

**GLACIAL FURROW AT  
AMLWCH PORT.**

(Figure 307) Glacial furrow at Amlwch port.

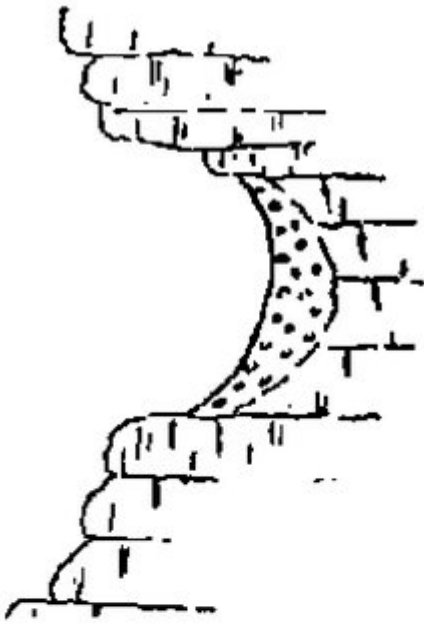




**FIG. 312.**

**ICE-MOULDED SEA-  
CLIFF NEAR  
ABER-CAWELL.**

*(Figure 312) Ice-moulded sea-cliff near Aber-cawell. Height about 50 feet.*



**FIG. 311.**

**UNDERCUT  
SHELF,  
Six feet in height,  
WITH  
BOULDER-CLAY,  
HUSLAN CLIFF.**

*(Figure 311) Undercut shelf, Six feet in height, with boulder-clay, Huslan cliff.*

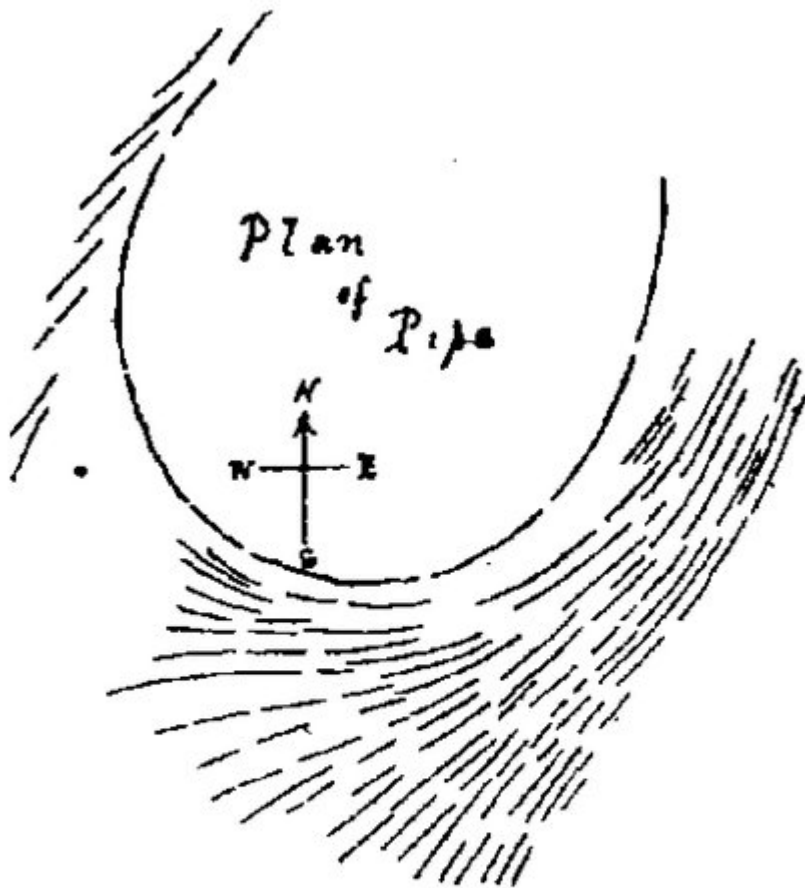


FIG. 308.

DEFLECTED GLACIAL  
STRIÆ AT TRWYN-DWLBAN.

(Figure 308) Deflect ed glacial stride at Trwyn-dwlban.

ESE



WNW

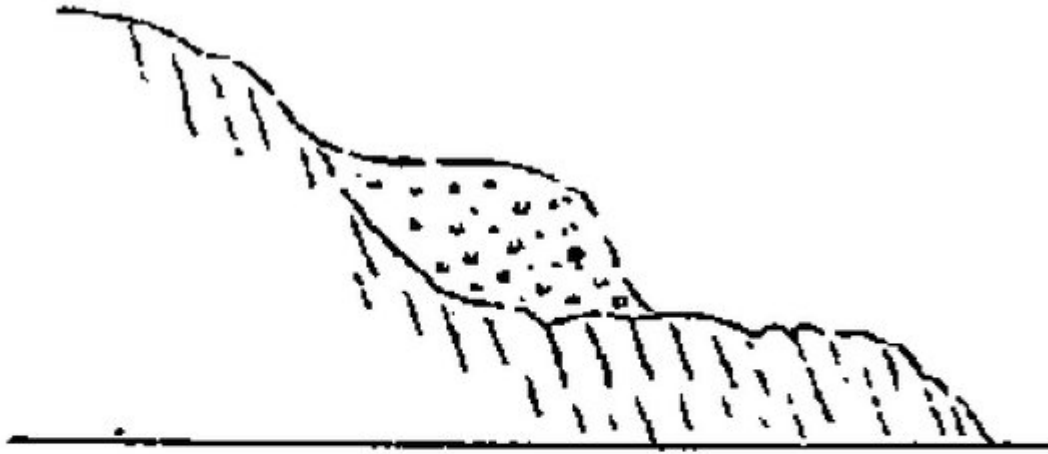
FIG. 309.

PROFILE OF  
UNDERCUT FURROW,  
TRWYN-DWLBAN.

*(Figure 309) Profile, of undercut furrow, Trwyn-dwlban. About natural size.*



(Plate 43) Glacial striae deflected into mouth of pipe. Foreshore, Trwyn-dwlban.



**FIG. 333.**

**BOULDER-CLAY BLUFFS  
IN BULL BAY.**

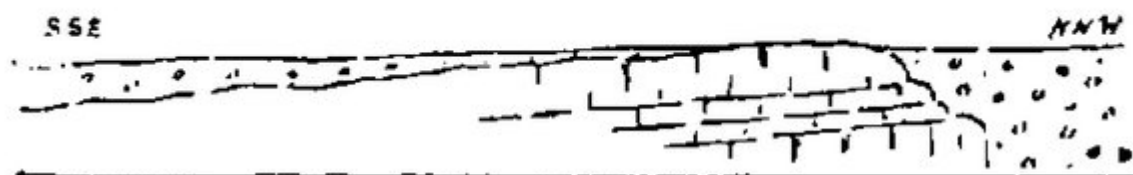
(Figure 333) Boulder-clay bluffs in Bull Bay. Height about 100 feet.



(Plate 46) Boulder of Galloway granite. Porth-yr-ysgaw, Llanellian.



(Plate 60) Parys Mountain, the West Pit looking towards the summit. Silurian Shale, Silicified Shale, Felsite, Boulder-clay, and Spoil-banks.



**FIG. 334.**

## **BURIED ESCARPMENT AT CROES-FRYN.**

(Figure 334) Buried escarpment at Croes-fryn.



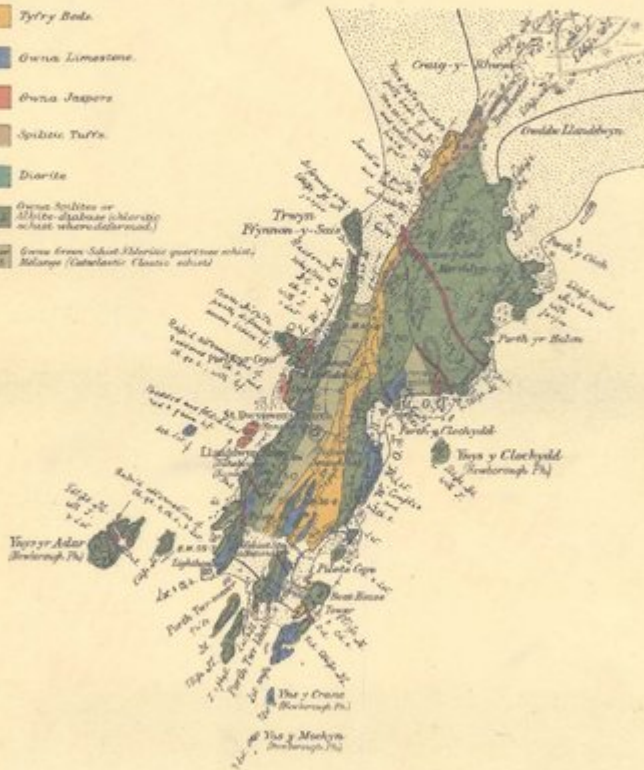
*(Plate 47) Transported block of Carboniferous Limestone. Lleiniog.*



*(Plate 44) Glacial sands and gravels with red boulder-clay above. Lleiniog South Cliff.*



D.D.	Paleozoic Diabase or Dolerite.
G.S.	Tyfri Beds.
L.	Owens Limestone.
J.	Owens Jasper.
S.	Spitzer Tuffs.
T.	Diorite.
W.C.	Owens Schists or Albite-diabase schist <sup>y</sup> (schist where determined.)
X.F.S.	Owens Gran Schist, Chlorite quartzite Mojave (Chlorite) Chert, schist.



Scale, 6 inches to one Mile.

(Folding-Plate 15) Llanddwyn Island. Reproduction of manuscript six-inch map.

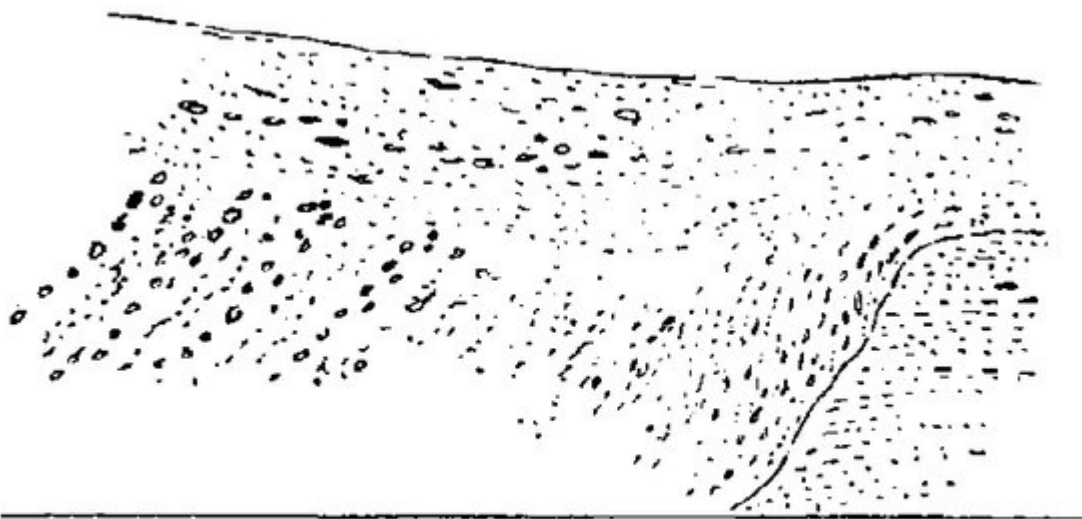


FIG. 335.--GLACIAL GRAVELS,  
TY'N-Y-CAEAU, MENAI BRIDGE.

(Figure 335) Glacial gravels, Ty'n-y-caeau, Menai Bridge.

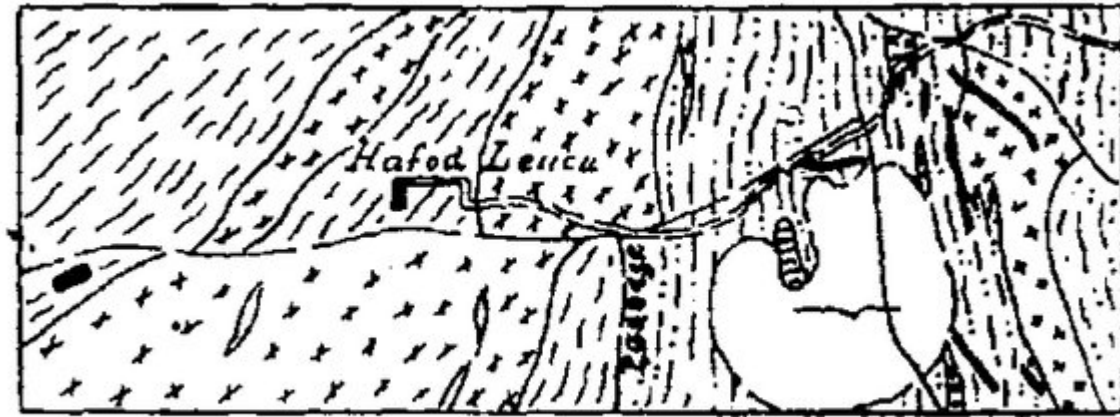


FIG. 11.

(Figure 11) Position of passage in Mynydd Llwydiarth. From the six-inch map. Dashes and dots=Gwna Green-schist. Dashes=Penmynydd Mica-schist. Crosses=Basic rocks. Dykes also shown.

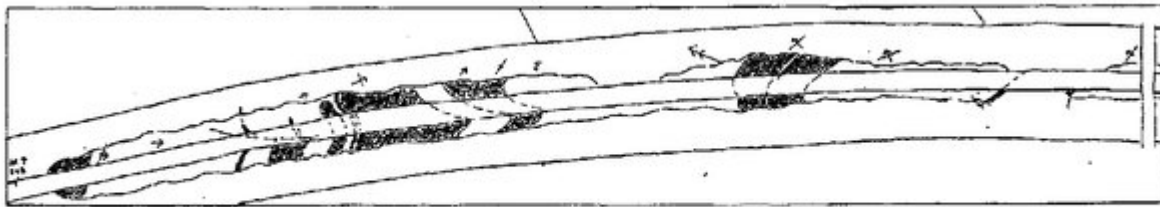


FIG. 178.—LLANGAFFO CUTTING. \* '0003 plan.  
Hornblende-schist and Diorite shaded, Mica-schist unshaded.

(Figure 178) Llangaffo cutting. Hornblende-schist and Diorite shaded, Mica-schist unshaded.



*(Plate 48) Transported boulder of Penmynydd Mica-schist, with tree growing in crack. Trefarthen.*