Chapter 40 Agriculture

Introductory<ref>Since the first draft of this chapter was written, and since the Bibliography was printed off, Mr. G. W. Robinson, Adviser in Agricultural Chemistry to the University College of North Wales, has published (*Journ. Agric. Sci.,* Vol. viii, Part iii, pp. 338–84) a most important paper entitled Studies on the Palaeozoic Soils of North Wales', in which he gives 45 pairs of analyses (made according to the latest methods) of soils and sub-soils from Anglesey, with discussions and comparisons. They are taken from the outcrops of the Mona Complex, the Ordovician, and certain Later Superficial Deposits. To prevent any misunderstanding of the terminology, it should be noted that the Mona Complex, though referred to by him as Pre-Cambrian, is included under his general heading of 'Palaeozoic';' and particularly that the technical terms of Agricultural Science, 'gravel', 'sand', 'silt', and 'clay', are not used in a geological sense, and so do not imply a sedimentary origin for, but merely the relative coarseness and character of the mechanical constituents of a soil. Further, that the title 'Paleozoic Soils', being but a condensed expression for Soils derived from 'Paleozoic Rocks', is not intended to mean that such soils were formed in Palaeozoic times; for all the soils of Anglesey have been developed since the close of the Pleistocene Glacial Episode. Some geological discussions of Mr. Robinson's results have now been incorporated with the present chapter.</ref>

The paramount position of Agriculture among the industries of Anglesey may be gathered from the latest census, wherein 6,118 males above the age of 10 are given as engaged upon it, as against 6,082 upon all other industries put together; and when we reflect that, of these other industries, by far the greater part are in one way or another accessory to agriculture, we see that, either directly or indirectly, nearly the whole of the population is dependent on it. For the most part it is pastoral agriculture, for in the last returns<ref>Written before the recent great ploughing-up of pasture-land.</ref> 94,513 acres are given as permanent pasture, and 54,308 as arable land; while of the latter (in 1912) only 21,136 acres were under cereals (19,234 being under oats), revealing that even of the arable land, a very large proportion is devoted to cattle food. In the same year, the number of cattle and sheep, respectively, were 57,239 and 94,590. Thus, the characters which gave rise to the inedimval epithet 'Mon Mam Cymru' (see p. 2) remain as pronounced to-day as they have been for centuries.

The applications of geology to agriculture are now beginning to be systematically studied, and for the general principles of the subject the proper books should be consulted<ref>These should include a good elementary text-book of Geology itself, such as those by Prof. Lapworth or Prof. Watts, followed by one of the handbooks of Agricultural Geology by Dr. Marr and Mr. Rastall, and that by some such work as Hall's The Soil'.</ref>. We may remark here, however, that the zone of material usually called sub-soil is really the rock itself in the act of decomposing in place, the zone called soil being the same material, still further decomposed, and enriched by carbon compounds that are products of the decay of the plants that have grown thereon. The composition and characters of the soil are therefore functions of those of the underlying rock, so that (climate and site being given) we ought, ideally, to be able to infer the nature of the soil from the nature of the rock<ref>And infer, accordingly, the kind of treatment which that particular soil should receive. Treatment, however, is a purely agricultural question, and is outside the scope of this work. Advice would, no doubt, be given by the Agricultural Department of the University College of North Wales.</ref>. But it will presently appear that this ideal statement needs, at any rate for Anglesey, some serious qualifications, necessitated in part by the fact that the geological investigation of soils is but in its infancy; in part by the great complexity of the geology of the Island. For some time to come, therefore (while the farmer may certainly be invited to avail himself of such results as have been achieved), no more than a moderate degree of new light upon the subject must be expected.

Soils of the principal formations

As many as 80 different types of rock are known in the Island, but the information as yet available concerning the soils that they have developed compels us to generalise them for the present, under five principal heads, a sufficiently unsatisfactory proceeding.

1. *The Mona Complex* — Minerals of anamorphism are apt to be comparatively stable, so these rocks (being for the most part composed of such) do not readily break down by weathering into fine and flocculent particles. Accordingly, they yield soils whose components are tolerably well balanced, which Mr. Robinson groups together under the term 'Anglesey Medium Loam', and which have considerable fertility. The most siliceous components thereof he finds to be coarse sand ' and 'fine sand', a character which we may ascribe to the liberation of granoblastic quartz in the process of decomposition. Of this important loam he gives 33 analyses, 26 of which are of what he describes as the main type, and seven of two sub-types. The first sub-type is merely a mixture of the main type with the blown sands of the western coast. The second, found upon the Coedana Granite and the Gneisses, yields (as against 0.51 per cent. K_2O from the principal type) 0.790 per cent. K_2O, which we should have had no hesitation in ascribing to the orthoclase and muscovite of those rocks, but for the singular fact that soils from Ordovician shales yield 0.795. Estimates of sodium are not made in soil-analyses at the present day, though in view of the great importance of that element in the Mona Complex, they would certainly be of geological, if not of economic, interest. Calcium carbonate was found only at Holyhead, where a soil and sub-soil from a spot half a mile west of the second milestone on the main London road yielded 1.52 and 0.30 per cent. respectively.

As no limestones are known in that district, this is probably partly of artificial origin, partly due to shell debris blown in from Pentthos beach. The very moderate ranges of the constituents (especially of K_2O, P_2O_5, CaO, and MgO) are not a little surprising, seeing that the Mona Complex is composed of some 60 different types of rock, with a petrological range from serpentine to quartzite<ref>In a country of this kind, any limited range would seem to be of less significance than extreme range.</ref>. It is in fact, impossible for sedentary soils<ref>A term applied to soils derived directly from the underlying rock by decomposition in place.</ref> derived from such a variety of materials to differ so little from each other, and a possible cause of this comparative uniformity in the results of the analyses will be discussed further on. Owing also to the complicated structures, there is very rapid local change across, often even along the strike, change that may be at once abrupt and extreme. To know, therefore, from what member of the Complex a given soil is really derived it is necessary in many cases to know the precise position<ref>It should be made clear that, within the space occupied by his tables, it was difficult, if not impossible, for Mr. Robinson to give positions in this way. But he has retained records, which can be consulted where desired, of the particular fields from which the samples came.</ref>, on a six-inch geological map, from which the sample was obtained.

2. The Ordovician rocks — Soils upon the grits are said by Mr. Robinson to differ but little from those upon the Mona Complex, which is readily explained by the derivation of those grits from the erosion of the Complex. He gives seven analyses of soils obtained upon the shales, to which (in common with many more samples from the mainland of Wales) he applies the term 'Palaeozoic Silt Loam', from its high percentage of 'fine silt', evidently due to the politic matter of the shales, though 'clay' is lower than might have been expected. These loams are consequently very sticky when wet, but their plasticity is low. Potassium is high, and it would be interesting to know the minerals in which it is contained; as well as, again, to have estimates of sodium. Phosphorus, calcium (nowhere in the form of $CaCO_3$), and magnesium differ but moderately from the same elements in the soils of the Complex, another anomaly which will be discussed below. The agriculture is much the same as that carried on upon the Mona Complex.

3. The Carboniferous rocks — No analyses are given from these tracts, but they are extensive and important. The soils appear to be light and friable, and those on the limestone have a very free natural drainage owing to the many open fissures of the rock. Often they are less calcareous than might be anticipated, because they consist in great measure of the insoluble residues left when the carbonate is removed in solution by the rain. The sandstones, being open-textured rocks, may be expected to yield light soils. We may hope that Mr. Robinson will ere long furnish us with analyses.

4. The Glacial Drifts — Theagricultural importance of these deposits will be best appreciated by a glance at the Drift edition of the one-inch map, on which they are shown (and see, moreover, p. 703) as occupying considerably more than a half, probably some two-thirds of the surface of the Island. The lower grey boulder-clay of the east, and those of the

Ordovician tracts are typical grey tills', dense and argillaceous; but, those upon the Mona Complex, being full of small grains of quartz, are comparatively loose and sandy, as is also the red upper boulder-clay of the eastern sea-board, and the soils will vary accordingly<ref>These different boulder-clays have not yet been separated upon the one-inch drift-map, a fact which must be borne in mind by anyone using that map for agricultural purposes.</ref>. Mr. Robinson gives no analyses, but remarks that the soils of the drifts resting upon the Mona Complex are slightly heavier than the 'Anglesey Medium Loam'.<ref>He writes me that he is now (1918) at work upon the soils of the Drifts and Later Superficial Deposits.</ref> The glacial sands and gravels will, of course, furnish a far lighter soil, besides affording a free sub-soil drainage. The relations of the boulder-clays to the rock, and the peculiar nature of their local variations, are dealt with below.

5. The Later superficial deposits — Mr. Robinson gives five analyses of these, two from the Blown Sand of Newborough, one from the Marine Alluvium of the Malldraeth (pp. 768–70), and two from Peats of the Fresh-water Alluvia. The Blown Sands yield 93.72–94–33 per cent. of 'coarse sand', very little 'silt', and no 'clay', but more K_2O, P_2O_5, and CaO, than might have been expected, probably due to their felspars, micas, and shells. The soil from the Malldraeth Alluvium yielded 49.00 per cent. of 'sands', the sub-soil 58.51 per cent., but silts, clay, and organic matter are lower in the sub-soil than in the soil. Mr. Robinson writes me that it was obtained just below Fferam, where (p. 769) a thin sandy clay- rests upon some 20 feet of marine sand. The two peats were from Cors-y-bol and Cors Bodeilio, and the following differences between them are instructive:

	Cors-y-bol	Coes Bodeilio
Organic matter	75.28	54.82
CaCO3	Nil	1.37
CaO	80	3.72

Reference to the map will show that Cors-y-bol rests upon nearly limeless Ordovician shales, while Cors Bodeilio lies in a hollow of the Carboniferous Limestone, its peat being also (p. 771) underlain by a Chara-marl. On 48 hours' digestion with HCl the Cors-y-bol peat yielded only 0.154 per cent. P_2O_5, but its ash yielded (p. 771) 1.75 per cent. to Mr. J. O. Hughes.

The distribution of the drifts

In the foregoing discussions it has been assumed that true, unadulterated, sedentary- soils can be obtained with ease and reliably identified. This, however, in such a country as Anglesey, is far from being the case. On p. 703 it has been pointed out that the published one-inch drift-map is a mere abstract, and that the distribution of the drifts is extremely complex. No identification of a soil as purely sedentary<ref>Mr. Robinson, in fact, refrains from stating that the soils analysed by him are purely sedentary.</ref> can be regarded as reliable unless its precise position can be identified upon the six-inch geological map. Nor is this all. Rock (especially in the Mona Complex) rises to the surface in steep and narrow bosses (pp. 700, 703, 803–5), which are seldom cultivated, so that most of the arable and pasture land on that formation is really upon drift. Such drift may be thin, but even if there be but an inch thereof, an apparently sedentary sub-soil will be adulterated with some proportion of glacial drift. Even on the slopes and the very summits of the bosses thin shrouds of boulder-clay can sometimes (pp. 702–3, 737, 759) be detected. Moreover, where there is the least glacial shattering (pp. 700–701), boulder-clay mingles imperceptibly with local breccia. Such being the case, it is evident that, in samples obtained from a field by means of the auger, it will usually be impossible to know whether sedentary be not adulterated with drift material, and this must be allowed for in considering the results. Only in the immediate vicinity of a clear open section can we be sure that we are dealing with a pure sedentary soil.

Zones of glacial overlap

The Glacial Drifts being derived from the mechanical (as distinct from chemical) disintegration of the rocks, their soils may be expected to have many points in common with the true sedentary soils. But it must not be supposed that the drifts derived from any one rock-formation are to be found resting exclusively upon the outcrop-area of that formation. The very movement of the ice that enabled it to erode the surface of the rocks, compelled it to sweep along the material

thus worked up. Therefore, at the boundary-line between two formations, the drifts derived from one of them are always carried forward' on to the surface of the other. As soon, however, as that boundary is passed, material from the second begins to be mixed with that of the first, the proportion increasing until, after several miles, little of that first remains. It is somewhat as if a series of bands were coloured on a sheet of paper, then a tracing of them taken, and then the tracing-paper shifted a little, so that the tracing of each band should overlap its original on to the next one. Only, in the natural overlap-zones of glacial drift there are no sharp outlines. In Anglesey, the direction of ice-movement was, in a general way, from north-east to south-west, so that the overlap-zones must be looked for in a generally south-westerly direction. But the direction is not constant; there are variations, and these may be found from the glaciation-symbols on the one-inch map, or, at a glance, from the generalised chart of the path of the ice given in (Figure 325).

The principle just expounded has another curious result. All along the eastern and northern margins of the Island the ice was moving from the sea-basin on to the land. Those coasts, therefore, are a boundary along which we may expect to find a zone of overlap. The drifts, accordingly, of the eastern and northern sea-boards are composed almost as much of the materials of the sea-floor as of the rocks in place. The red boulder-clay of the east owes its colour to this source. It is ferruginous and sandy, thus tending to lighten the drift-soils of those tracts and to enrich them with iron.

We have just seen that hardly any sedentary soil in the Island can be free from drift-adulteration, and the lave controlling this is now discernible. Such adulteration, on any given outcrop, will always be a glacial scour from the formations (chiefly the adjacent formation) lying to the north-east. The proportion of adulteration will wax towards the north-eastern boundary of any outcrop, so that, when searching for sedentary soils, the samples should be taken as far to the south-west as possible. Further, if we take two rocks, A and B, and two soils therefrom derived, S (A) and S (B), then, if S (B) be adulterated with glacial scourings of A, so that it would be properly expressed by a symbol S (BA), it is evident that the analyses of S (BA) and S (A) will differ less from each other than will the analyses of B and A themselves. This principle, applied to Anglesey, will result in a general reduction of differences between all the soil-analyses, as compared with those which would have been obtained from pure sedentary soils. We can thus understand how it is that, in spite of the great differences of the several members of the' Mona Complex from each other, of the Complex from the Ordovician, and of both from the Glacial Drifts, the soil-analyses display a moderation of range that is at first sight a little disappointing. Perhaps from the exact positions, and from a careful study of the graduated disposition of the drifts, a scale might be obtained for compensation of this, by which an approximation to the ideal sedentary soil-figures might be arrived at. But the rapid local changes within the Mona Complex would probably introduce a number of disturbing factors that would be difficult to eliminate. In the meantime, given the precise positions of the soil-samples, light may be obtained by comparing their tables with the chemical and other petrological studies which will be found on pp. 40–149, 404–7, and elsewhere.

Reclamations of land

Large tracts are covered by freshwater alluvium, a good many being still very marshy, but others are under cultivation, their fine loamy silts yielding excellent soils when drained. Much marine alluvium has (p. 768) been reclaimed near Valley. By far the greatest work of the kind, however, has been the draining and embanking of the Malldraeth Marsh (pp. 768–70). There is mention of 'banks, shores, and seawalls' at Esgeifiog and Hir-drefaig as far back as 1.565, Sir Nicholas Bagenal covenanting to keep them in repair. Embankment of the Cefni is also implied in two law-suits brought by Sir Thomas Holland of Berw against one Chedle of Lledwigan for diversion of that river towards Berw about the year 1610; the second offence being said to have been a reprisal for an apparently malicious charge of murder, on account of which Chedle had been tried 'for his necke'! The first determined undertaking, however, was made under an Act of Parliament<ref>The details concerning this work have been kindly supplied by my friend Mr. Thomas Prichard, of Llwydiarth Esgob, Chairman of the Drainage Commissioners.</ref>passed in 1788, and work seems to have been begun at once. Fresh Acts were passed in 1790 and 1811, reciting that the embankments had been destroyed by the sea, and conferring powers for reconstruction. In 1821 the award was executed by the commissioners, and all works of importance appear to have been completed by then. In 1858 a fourth Act was passed, which is still in force, the area dealt with by the whole series of Acts being 3,821 acres. The fall along five and three-quarter miles of river is only 11 feet. Though of course liable to floods, much of the land is in fair condition, most of it affording pasture and some being even cultivated; but Mr. Robinson remarks that the drains are not working well, and that if they could be made efficient the value of a

large area would be greatly increased. The marshiest part is not the seaward end, but the peaty tract to the north of Holland Arms. No doubt the thick marine sand (p. 769) which underlies the outer parts is favourable to the condition of the surface.

The woodlands

The windy climate (p. 2) might be supposed to forbid all serious attempts at arboriculture, and the Island must be adthitted to be poor in woodland ((Plate 50), also 41, 55), yet ancient writers testify to the existence of extensive oak forests at the time of the Roman invasion; a memory of which, indeed, is preserved in the bardic epithet of 'Ynys-Dywyl', the 'Shady Isle'. Whether any of this ancient forest remains is very doubtful, but the woods which range for some four miles along the steep, feature from Garth Ferry (Plate 51) past Baron Hill and Henllys, as well as a part of those at Lligwy, are very old, and probably of natural origin. Even to-day there is a good deal more woodland than is usually supposed, several tracts, among which are the beautiful woods of Bodorgan, being close to the stormy western coast. There seems, indeed, to have been an increase of trees in the course of the last 100 years, for Lentin, writing in 1799, speaks of the girdle of woods along the Menai Strait (Plate 51), (Plate 52), (Plate 53), as the only one in the Island, and as 'hiding the aspect of desolation which its interior presents to the eye'. 'Rugged, and even hedge-less', he continues, 'not a tree enlivens the landscape, or spreads a welcome shade around, all which imparts to the Island the melancholy appearance of a place desolated by barbarians'! No one could write thus of Anglesey to-day, — for, though massive timber is not to be expected, there are (in addition to the old woods on the Menai-side) some 45 plantations, parts of which contain trees of considerable height, while innumerable others have grown up along the older hedgerows. Nevertheless; things might be very much better still. For, looked upon merely as 'coverts', several of these woods have been miserably neglected; and have become, through lack of drainage, little better than swamps, that produce an annual swarm of poisonous flies, with all manner of fungi; while the trees are stunted by an almost impenetrable tangle of briars. With a very small part of the discerning care that is bestowed upon the forests of the Continent, these little woodlands of Anglesey could be made to furnish a steady supply of timber, while contributing much more than they do now both to the health and the beauty of the country.<ref>A Department of Forestry being now established in the University College of North Wales, skilled advice would no doubt be gladly given by the Professor of that subject.</ref>

Experience shows that, given suitable shelter and position, trees will grow readily on all the more widespread formations of the Island, with the exception of the quartzites and blown sands, where they could not be expected. But, seeing that certain trees (like certain herbaceous plants) flourish better on some soils than they do on others, future planting should be selectively adapted to the local geological formations, whose physical characters (and not only their chemical compositions) should receive particular attention.

Root-hold — In the stormy climate of Anglesey a firm hold for the roots must (next, of course, to shelter) be the most vital of all necessities. The success of certain little plantations upon the meagre soil of bosses and escarpments is really surprising, and may be ascribed to the hold which the rocks have afforded to the roots. Others have done well even on the exposed surface of the Menaian Platform at seine 300 feet above the sea, the reason being, probably, the same. Deep boulder-clay will, of course, give good hold, but then it is usually valuable for ordinary agriculture. Some of the most successful plantations are upon the Carboniferous Limestone, and their success may be ascribed to the hold afforded by its cavernous weathered surface. Quite as successful, however, have been those upon Gwna Mélange (such as the woods of Baron Hill and Bodorgan), which is probably due to the manner in which the roots are able to insinuate themselves by splitting the fissile matrix between the hard lenticular augen. The Gwna Mélange of the Middle and Aethwy Regions and of the Pentraeth Inliers is likely to give the best results because, being on high tectonic horizons, it is riddled by countless late thrusts which yield readily to decomposition and thus add to the penetrability of the rock by roots. Where the foliation is (as at Bodorgan) at a very high angle, good conditions may be expected. When the angle is but moderate, an easterly dip would seem to be the better, because roots would be less easily wrenched out by the prevalent westerly gales.

A point of importance is that, when the glacial deposits are only a few feet thick, trees, owing to their depth of root, will pass down through them in a way that crops will not, and will consequently be seriously affected by the nature of the underlying floor. The glaciation of that floor is, accordingly, a vital point. If the boulder-clay rest upon a shattered surface

(p. 700), roots will obtain a firm hold as well as nourishment. But if, beneath a thin cover of boulder-clay, there be a smoothed and striated floor of undecayed rock, not only will there be a lack of nourishment, but roots will fail to obtain security of grip, so that, as soon as the trees attain to any size, they are certain to fall victims to the force of the wind.

Grass-weaving

The sand-wastes, their encroachments, and their soils have been described on pp. 772–3, and in this chapter. There is, however, a curious local industry at Newborough, which, as it is directly dependent upon the great deposits of blown sand, may be appropriately mentioned here. Every year, towards the end of July, the women (for it is they who appear to carry out the industry in all its stages) go out in little parties into the dunes, and cut the tough bent-grass (*Ammophila arundinacea*) ('morhesg' of the Welsh) which grows there. Then it is taken home, prepared by soaking and drying, and put aside for use during the later part of the year. This unpromising material is twisted and woven into cords, mats, and especially into large broad coverings for haystacks, which are wonderfully efficient and strong. It might with great advantage, Lady Boston remarks, be used for horticultural protective coverings. One may often see women standing at their cottage-doors talking to each other and yet all the time rapidly weaving the short wisps of stubborn-looking grass into strands that may be several yards in length, which nevertheless one may pull hard at, and they will not break. This remarkable, and one may say, original industry has evidently existed at Newborough for at least three centuries, for Mr. Thomas Prichard writes me that there is a reference to cutting of bent (though at Aberffraw, where grass-weaving does not seem to be practised now) in the Act of Parliament 41 Elizabeth.

Summary

Agricultural geology in Anglesey has now been inaugurated by the analysis of 45 sub-soils and soils, from which it appears that the Mona Complex is covered with a medium and the Ordovician shales with a silty loam. To enable us to make full use of these valuable data, certain conditions must be fulfilled. The geology, especially in the Mona Complex, is extremely intricate, so that, in order to establish correlation between soil and rock, the precise positions from which the analysed samples came need to be plotted upon the geological maps. The difficulty of obtaining reliable samples of pure sedentary soils has to be allowed for in the discussion of soil-analyses. Finally, there are the overlaps introduced by the movement of the ice of the Glacial Period always to be borne in mind. In short, the Agricultural Geology of such a country as Anglesey cannot escape from partaking of the difficulties of its Pure Geology. Corresponding methods of precision must be employed, frequent allowances must be made for complications, and progress must not be expected to be as rapid as in simpler countries.

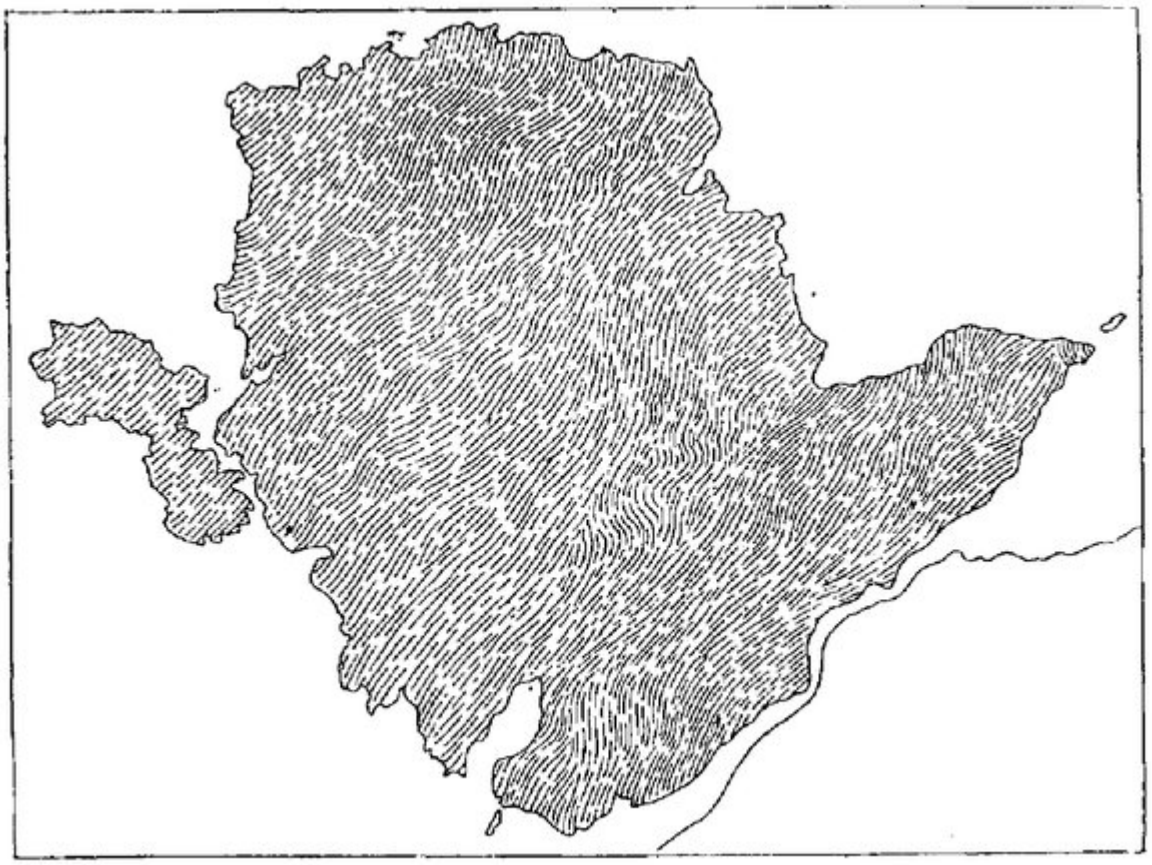
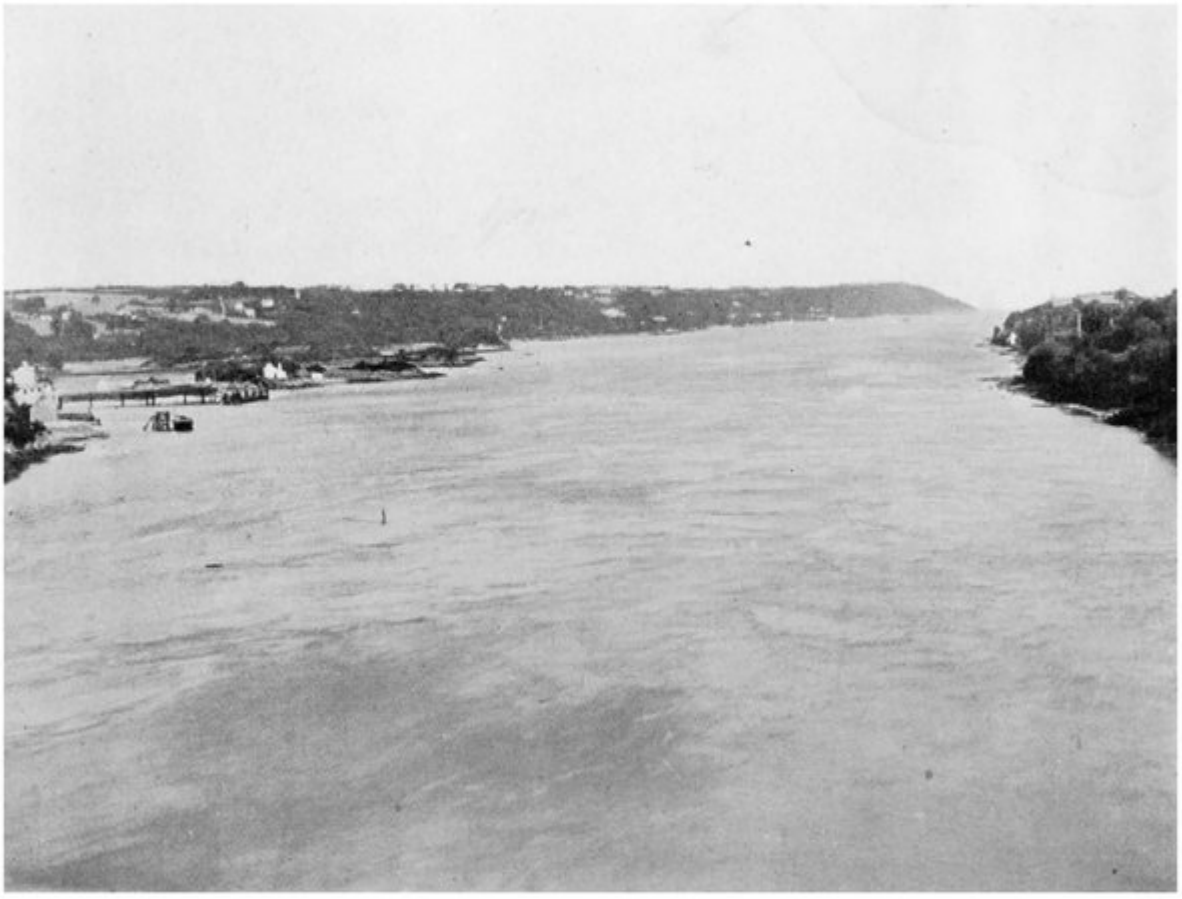


FIG. 325.—THE PATH OF THE ICE.

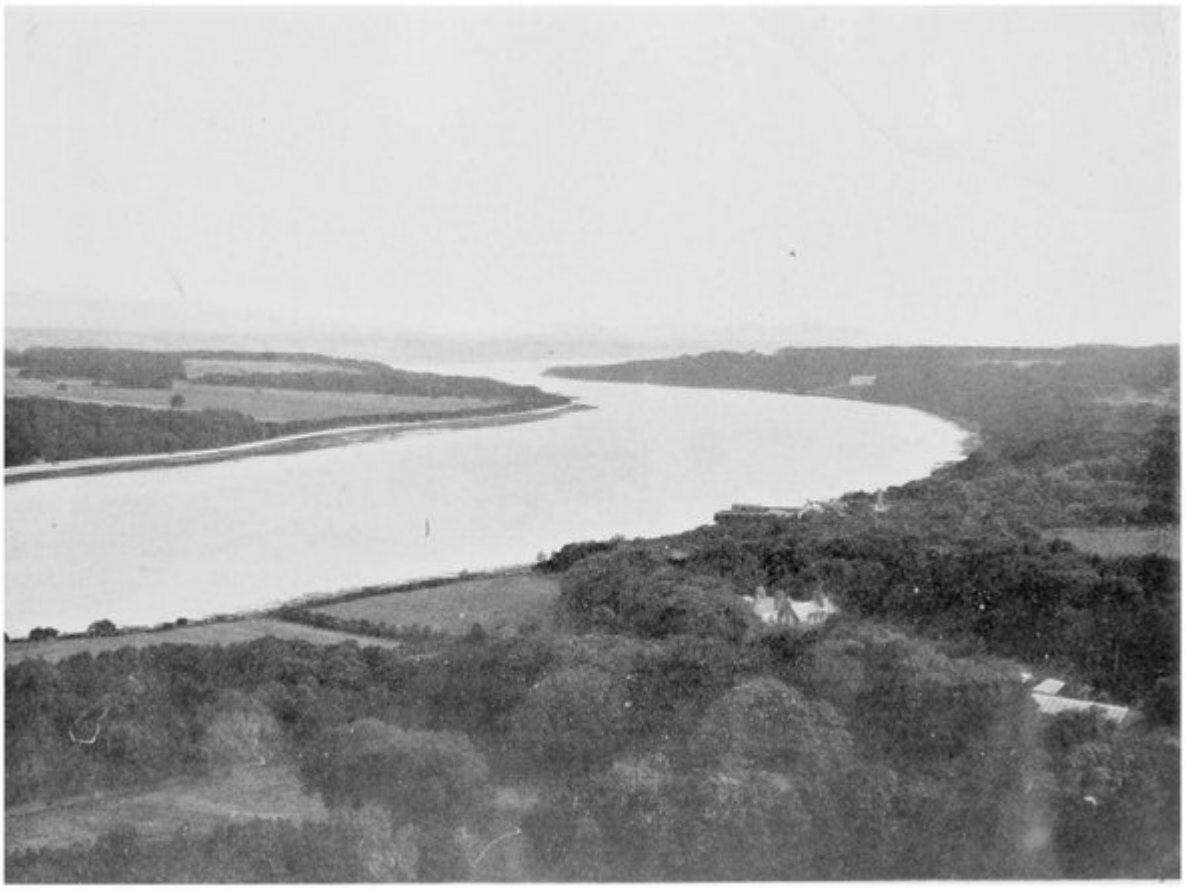
(Figure 325) The path of the ice. Scale: one inch = eight miles.

(Plate 50) The Menaian Platform and the Bodafon monadnock. From the roadside at Mynydd-mwyn-mawr, Llanerchymedd.



(Plate 51) The Eastern Reach of the Menai Strait. From the Suspension Bridge.

(Plate 52) The Menai Strait at the submerged watershed. Looking towards the Mountain-Land of Wales. From the top of the column..



(Plate 53) The Middle Reach of the Menai Strait. From the top of the column.