Memoirs of the Geological Survey.

EXPLANATION

TO ACCOMPANY

SHEET 105, WITH THAT PORTION OF SHEET 114

THAT LIES ON THE NORTH OF GALWAY BAY,

OF THE

GEOLOGICAL SURVEY OF IRELAND.

By G. H. KINAHAN, M.R.I.A.

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The heights mentioned in these explanations are all taken from the Ordnance Maps.

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LIST OF ILLUSTRATIONS.

EXPLANATION

OF

SHEET 105, WITH THAT PORTION OF SHEET 114

THAT LIES ON THE NORTH OF GALWAY BAY,

OF THE

GEOLOGICAL SURVEY OF IRELAND.

General Description.

The principal place of note in the area contained within the limits of this sheet of the map, is the town of Galway, on Galway Bay and the River Corrib. The latter is the small river through which the waters of Lough Corrib, the second largest sheet of fresh water in Ireland, find their way to the sea.*

Further west, on the same seaboard, are the villages of Barna and Spiddle, while seven miles N.W. of Galway is the village of Moycullen, and extending northward a few miles north of Galway, is the lower or south part of Lough Corrib.†

1. *Form of the Ground.*

The road from Galway to Oughterard, Yar-Connaught, Connemara, and the country to the north-west, runs in a nearly north-west line from Galway, dividing the area contained within the limits of this sheet of the map into two parts, which are remarkably dissimilar, that to the east on both sides of the south part of Lough Corrib being low, and comparatively speaking flat, while the country on the

* The ancient name of this river is said to have been Galvia, from which the town built by the English colony in the thirteenth century was named Galway, the latter part of the name being considered to be Latin. Previous to that time there was a castle called Caislen-na-Gaillim, and a fishing village called the Claddagh, which still exists. "This spot is supposed with every probability to have been occupied as a fishing station since the first peopling of this island. That it was so in the *fifth* century of Christianity appears from the life of St. Endeus, compiled from ancient authorities by A. MacRaiden, about A.D. 1390, and published A.D. 1645." ("O'Flaherty's History of Hiar Connaught" p. 42. *Note*). Lough Lurgan was the ancient name for Galway Bay, and Lough Orbsen corrupted into Orib for Lough Corrib.

† The surface of Lough Corrib is twenty-eight feet above the sea and this part of it is found, on a reference to the chart published by the Admiralty, to be very shallow: at the south extremity of the lake being about eight feet deep, from which it gradually increases to eighteen feet a little N.W. of Rabbit Island. Northward of that deep part it again becomes shallow, and at the islands between Portdarragh on the west and Woodpark House on the east, there is only one channel over four feet deep, which lies between the point west of Woodpark House and Illaunatee. This channel is ten feet deep, and hereafter if a railway was made from Galway into Connemara, the shallow hereabout would be the most advantageous place to cross the lake. North of this shallow the depths are very irregular, varying from two to ten and twelve fee as far

west and south-west is wild and hilly; a ridge of high ground extends from Galway north-westward, and afterwards westward, the highest peaks being Killagoola,* 471, S.W. of Moycullen; Lealetter, 469; Newtownhill, 654; Knockranny, 606; Doonmore, 698; Knockseefin, 872; Knocknalecky, 955; Shannarea, 759; Seecon, 932; Knocklettercraffroe, 908; Derrada, 955; Knockwaumnamoe, 794; and Shannapheasteen, 776; a little westward of Seecon Lough. From this high rise of land the ground slopes toward the east, suddenly at first, and afterwards more gradually to Lough Corrib. On the north it has a high gradient from the valley of the Fough river or Owenriff, while southward it is undulating and very gradual to Galway Bay; however, there are numerous hills rising in this slope, their altitude usually becoming less the nearer they approach the sea. The low ground in the neighbourhood of Lough Corrib rarely exceeds 100 feet in height, its average being about fifty; on the west of Lough Corrib, however, and N.W. and north of Ross lake, there are rises of ground 154 and 113 feet, and on the S.E. of Lough Corrib overlooking the Marble Quarries, is a hill 225 feet, and further S.E. north of Merlin Park, another 234 feet.

The drainage of the low country and of the valleys in the hills that open towards the east and north belongs to the Lough Corrib basin, while the southern slopes of the hills are drained by numerous streams that flow into Galway Bay, the largest being the Boliska, that empties itself at Spiddle.

On the east watershed of the Boliska there is a remarkable lake, called on the map Slieveaneena Lough, which has two outfalls, one being into this river basin, and the other eastward into that of Lough Corrib.

Adjoining the south end of Lough Corrib are extensive alluvial flats which seem formerly to have been part of the lake, but subsequently were filled up with silt and peat.

north as Gallcharrick island, north of which there is a place marked twenty-three feet, while none others exceed nineteen feet—in general the depth not exceeding fourteen or sixteen feet. The chart from which these depths are taken was made previous to the navigation works; these latter lowered the summer level of the lake three feet. The river from this lake to the sea is recorded four times during the historical period as having suddenly gone dry—namely, in the years A.D. 1178, 1190, 1647, and in 1683. I have tried to account for these sudden droughts in a paper, "On the formation of the Rock Basin of Lough Corrib." (See "Geological Magazine for November, 1866.")

* As nearly all the names in this district are Irish or corruptions of the Irish, perhaps it would not be out of place to give the English of some of the Irish words that are continually being met with, more especially as on the maps it is not unusual to find two words of identical meaning joined together, as for instance, "Owenriff River," the English of "Owenriff" being *Sulphur river*.

Aille, a cliff; *Annagh*, a bog; *Ard*, a height; *Bally*, a town or village; *Beg*, little; *Carrow*, a quarter or division; *Cloon*, a backward place, a retreat; *Croagh*, a rick, or rick-shaped hill; *Derry* or *Darragh*, an oak wood; *Doon*, a hill, this is also applied to a fort that forms an artificial hill; *Eighter*, upper; *Erin*, iron; *Esher*, ridge; *Fadda*, long; *Gloss* or *Glass*, green; *Gort* or *Gurt*, a garden, or enclosed field; *Inch*, *Innis*, and *Illaun*, an island; *Kill*, a church; *Knock*, a hill; *Kyle* or *Cuil*, a wood; *Letter*, a slope; *More*, big; *Oughter*, lower; *Owen*, a river; *Poll* or *Poul*, a hole; *Ross*, a promontory; *Sheoge* or *Phuca*, a fairy; *Slieve*, mountain; *Sruffaun*, a stream, or brook; *Tober* or *Tubber*, a well; *Tully* or *Tullagh*, a hill.

2. *Formations or Groups of Rocks entering into the Structure of this District.*

Aqueous Rocks.

	Name.	Colour on Map.
	Bog and Alluvium.	*Pale Sepia.*
	Drift.	*Engraved dots.*
Carboniferous.	d. Limestone.	*Prussian Blue.*
Carboniferous.	d. Sandstone and Conglomerate.	*The same, washed with Indian ink, and dotted yellow.*

Metamorphic Rocks.

ν. & *μ.* Gneiss and Schist.	*Crimson lake.*
λ. Limestone.	*Cobalt.*
Q. Quartzite or Quartz Schist.	*Chrome yellow.*

Igneous Rocks.

F. Felstone.	*Vermillion.*
Fp. When Porphyritic.	*do.*
D. Greenstone or Diorite.	*Rose lake.*
G. Granite.	*Carmine.*
Gp. When Porphyritic.	*do.*
Gf. When Foliated.	*do.*

Igneous Rocks.

Granite.—The granite of this district may be divided into three kinds, which will be spoken of under the names of *Intrusive Granite, Foliated or Stratified (?) Granite* and *Porphyritic Granite;* moreover there are varieties of the latter, one being a granite in which none of the minerals are developed in large marked crystals, but apparently its constituents are similar to those of the Porphyritic granite, the other varieties will hereafter be described.

Intrusive Granite.—This kind of granite occurs in tracts, courses, veins, and pipes among the metamorphic sedimentary rocks; it also occurs in places in the Porphyritic granite, and the Porphyritic foliated granite, but usually near the margin of the mass. When in veins it generally seems to be a compound of felspar, quartz, and a greenish mineral that may be a green mica (*lepidomelane?*) or perhaps an earthy chlorite; and this last-named mineral also often occurs in nests and lenticular patches. The silica apparently is in greater excess than in the Porphyritic granite and its varieties. In the tracts and wide courses the granite nearly always is micaceous, having black mica in places, also white mica, and iron pyrites as essentials, and sometimes being so silicious as to look like a quartzite. Sometimes this class of rock becomes *Pegmatite*, when Scapolite seems to replace part or the whole of the felspar; at other times it loses its felspar and becomes *Greisen*, "a crystalline granular compound of quartz and mica,*" from which in some places it seems to become *Quartzite;* however, this may be only apparently,

* "Rocks classified and described."—B. von Cotta. Lawrence's trans. Page 321.

as the mica may be in such minute flakes as to be nearly invisible. On the other hand, it seems to lose its quartz, mica, &c., and become *Felsite rock*, "a rock of compact texture about the hardness of felspar, with dull or smooth conchoidal or fissile fracture, colour yellowish, reddish, gray, greenish, or bluish, weathering white."*

Its conspicuous accessories are galena, copper pyrites, barytes, calcite, and fluor spar, which often occur in geodes, nodules, lenticular patches or drusy cavities that are lined with crystals of quartz. The chlorite (*blue peach*) appearing in the rock seems also to indicate the presence of these accessories, as also pockets of iron pyrites.

A peculiarity of this granite is a structure that at first sight has the appearance of an obscure foliation, and yet it can scarcely be so called, as the constituents of the rock do not appear to have a tendency to occur in leaves. It is only conspicuous when the rock is weathered, and usually is more prominent in the tract and courses than in the small veins. Perhaps it might possibly be a close irregular rudely-parallel jointed structure, introduced during the cooling of the rock.

The usual constituents of the Porphyritic granite appear to be pink, or flesh-coloured and white felspar (*Orthoclase*), green felspar (*Oligoclase*), black mica, and quartz, while the following seem locally to be constituents—hornblende, sphene, a green mineral that may be a mica, or perhaps an earthy chlorite, as suggested by Professor King, of the Galway College, a white felspar, epidote, iron pyrites and white mica; however, in other places these seven minerals seem only to be accessories, to which may be added copper pyrites, galena, fluor-spar, and garnet; while others may also occur, but were not particularly noted. The orthoclase occurs usually in large crystals often twins, some of which are two inches in length, and in places some of these large crystals of orthoclase of a pink colour are enclosed in an envelope of a white felspar. The green mineral is usually disseminated through the mass, but often it occurs in pockets and irregular segregations. The hornblende, when an essential of the rock, is nearly always accompanied by sphene, and sometimes by the greenish mineral, or by epidote. In places there are irregular patches or veins of a variety that is "very coarsely and irregularly constituted of orthoclase, quartz, and silvery white mica," answering Cotta's description for Pegmatite.† Professor Melville, M.D., recognised some of the mica in Pegmatite north of Furbogh as Margarodite.

In some localities most of the felspar crystals in this variety are two inches or more in length. Veins of a compact variety, which may, perhaps, be called *Eurite*, a fine grained crystalline aggregate of quartz, felspar, and mica, where the latter is often in such minute flakes as to be invisible to the naked eye, varying from half an inch to four or five feet in thickness, occur generally in these granites. On the south of the Porphyritic granite, near the seaboard of Galway Bay, the granite is generally evenly grained, rarely porphyritic, and this kind seems to extend in "courses" into the Porphyritic granite. It also seems to be divided up into

* Cotta. Page 220.

† Cotta. Page 206.

courses of different varieties, some courses having similar essentials to the Porphyritic granite, while in many there are as constituents white or pink felspar, quartz, and black and white mica, with as accessories, iron and copper pyrites, green felspar, and rarely hornblende, titanite (*sphene*), galena, calcite, fluor, garnet, &c. Another variety was remarked, in which the essentials seem to be white felspar, hornblende, sphene, black mica, iron pyrites, and quartz, with white mica, copper pyrites, &c., as accessories. Perhaps it should here be observed that among these varieties in the vicinity of Galway Bay, there are many courses of the supposed metamorphic felspathic igneous rocks (*page* 11). The varieties of these granites, as before remarked, seem to lie in courses, and what is perhaps more remarkable, in one place where gneiss overlies them the dip and strike of the courses seems to be similar to that of the beds of the overlying gneiss.

It usually happens that in hand specimens, or even large pieces of the Porphyritic granite, no foliation is perceptible; but on looking at a still larger expanse of the rock, the large crystals of felspar are found usually to lie in irregularly parallel lines, and, as followed northward and north-eastward, this structure becomes better developed, until the rock gradually become a *Porphyritic foliated granite*. The last named seems to have similar essentials and accessories to those characteristic of the merely Porphyritic granite, but the mica and chlorite, &c., for the most part are arranged in leaves, giving it a gneissic aspect; moreover, the large pink crystals of felspar generally are dispersed rudely parallel to the layers of mica. It is, however, not unusual to find some of these crystals cutting across the layers of mica, and it was not remarked in any place that the leaves of the latter occurred bending round them. It should be mentioned that no undoubted bedding was observed, only foliation. The Porphyritic granite not only passes gradually into the Porphyritic foliated granite, but the latter sometimes gradually loses its porphyritic character, and seems to pass into gneiss and schist. Moreover, when it passes into an hornblendic gneiss apparently it is impossible to point out where the Foliated porphyritic granite ends and the gneiss begins, unless a few beds of schist occur in the latter.

Dr. Haughton, of Trin. Coll., Dublin, as mentioned in a *resume* of his conclusions on the granites of Ireland, and published by Professor Smyth,* believes them to belong to three classes, viz.:—I. *The granites of Leinster*. II. *The granites of Mourne and Carlingford;* and III. *The granites of Donegal, Mayo, and Galway*. The *first* are quarternary granites, composed of—1, Quartz; 2, Orthoclase; 3, Margarodite; 4, Lepidomelane. The *second* are quinary granites, composed of—1, Quartz; 2, Orthoclase; 3, Albite; 4, White Mica (Margarodite?); 5, Black or green Mica (Lepidomelane?); and the *third* are also quinary granites, but their constituents are—1, Quartz; 2, Orthoclase; 3, Oligoclase; 4, Margarodite; and 5, Lipodomelane. Of this third class of granites he says—"They differ from the granites I. and II. in being stratified, and not intrusive, and therefore vary considerably in different localities according to the beds from which they have been formed by the metamorphic action."

* Presidential address, for 1868, of W. W. Smyth, A.M., F.R.S. to the Geological Society, London, page lxxiv. of their Quarterly Journal, vol. xxiv.

In the general description of the granites of this district, as given above, it will be seen that the granites there called the *Foliated or Stratified granite* and the *Porphyritic granite* are those referred to by Dr. Haughton; but that, besides these, there are granites evidently irruptive, and in the description (page 7) called *Intrusive granite.* These latter answer Haughton's description of the Leinster granites ; moreover, as he says of them, "they are also occasionally traversed by mineral lodes, particularly lead lodes." These intrusive granites, to distinguish them from the other granites, which are generally known by the name of *the Galway granite*, might be called from the small town, in the district to the north, near which they are so largely developed, *the Oughterard granite.*

Besides the above, there are rocks which lithogically are granites, being composed of quartz, mica, and felspar. In them the quartz occurs in globules, and as petrologically, some appear to be the same as certain felstones, they possibly might be metamorphic felspathic rocks, therefore their general description is given among the "Felstones probably metamorphose" (page 11).

Felstones and Greenstones.—In Yar-Connaught the more modern igneous rocks seem to be of different ages, the lines of demarcation being particularly marked in the Basic rocks, as there are Basaltic rocks, Dioritic rocks, and Diabasic rocks; the first being somewhat similar to the intrusive rocks, which are newer than the end of the Carboniferous period; the second seemingly being similar to those found associated with rocks of Carboniferous age, and the third to those found among the older Palæozoic rocks. The divisions in the Felspathic rocks are not marked; one kind, however, seems to be compact and to have a fracture from smooth to conchoidal, while others are of a splintery or granular nature, and break with an uneven to a hackly fracture; moreover, in these quartz globules are not unusual. The former seem to be newer than the latter, but no conclusive proofs have yet been found. In this district there appear to be the two classes of the Felspathic rocks, while of the Greenstones there were only remarked those supposed to be Dioritic and Diabasic. However, some of those supposed to be Basaltic, may possibly occur, as they were remarked a short distance west of the district.

F. and FP. (*Felstones* and *Porphyries*). In colour these are usually bluish, greenish, or gray. In some there are white crystals of felspar thinly scattered in the matrix, while in others the crystals become so numerous as to change the rocks into porphyry. Those that have an even to a conchoidal fracture are usually compact, with an impalpable structure, and subtranslucent; while the varieties that have an uneven to a hackly fracture are usually coarsely granular and translucent to subtranslucent ; some of the latter in places are scarcely distinguishable from the slightly altered portions of the supposed Metamorphic felspathic irruptive rocks. In places the felspathic rocks may be in part dioritic, as before the blowpipe they fuse on the edge, although in them globules of quartz disseminated through the mass were detected. Minute and flying dykes of compact felstone rocks come up in places through the cracks and joints in the granite.

D. (*Diorite* and *Diabase*). The first are of a dark green, inclined to

blackish colour. They have from an uneven to a hackly fracture, compact, although at the same time easily broken into small fragments on account of their reticulated structure, which seems to be due to a rude columnar structure perpendicular to, and a platy structure rudely parallel to, the walls of the dykes. In some there is a submetallic glimmering lustre, while others are dull, and all seem to be opaque. Before the blowpipe they melt on the edge into globules with greater or less facility.

The Diabase vary from a pale to a dull greenish colour, from flaky to granular, of a sub-metallic glistening lustre with an uneven fracture. Before the blowpipe it fuses easily

Felstones and Greenstones probably Metamorphose.—The Igneous rocks, which are supposed to have been effected by a subsequent metamorphic action, are both *Hornblendic* and *Felspathic.* Excepting the compact varieties of the Felspathic class they are usually highly crystalline, inclined to be porphyritic.

Hornblendic Rocks.—These generally are not found among the granites,* but among the metamorphic sedimentary rocks they occur in tracts, courses, pipes, elongated nodules, lenticular patches, and between the beds (*lay in lay*). There are numerous varieties, but the most common is the variety called by Haughton and Krantz *Hornblende rock*, a compound of hornblende, felspar, (*labradorite?*) epidote, and iron pyrites, the two latter also occurring in nests and strings. Crystals of felspar, quartz, &c., appear as accessories. When the rock is coarsely crystalline the hornblende crystals are often half an inch long, at other times the crystals are so fine and small that the rock is nearly compact. Sometimes the rock becomes porphyritic, distinct crystals of white felspar crystallize out, and the rock being a crystalline granular compound of felspar and hornblende; this latter rock may take up quartz and change into *Syenite*, a crystalline granular compound of felspar, hornblende, and quartz. In places the Hornblende rock becomes schistose, changing into Hornblende schist, which is "usually thickly foliated and at the same time fibrous, this texture being occasioned by the parallel position of hornblende of various thickness."† It possibly may originally have been a trappean ash associated with the intrusive rock, of which more hereafter. This variety rarely seems to contain quartz as an accessory, but quartz and felspar occur in nests and veins, sometimes of considerable magnitude.

The varieties of Hornblendic rocks usually merge into one another, the schistose generally occurring near the margin of a tract, but not always, as it has been observed near what was apparently the centre, usually in lenticular masses. A bright purplish copper coloured mica sometimes is an accessory, as also chlorite. In some places the hornblende rock appears to change into a granite that seems to have as essentials felspar, epidote, quartz, and iron pyrites, also in places hornblende and perhaps chlorite.

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* As will be hereafter mentioned, irrruptive hornblendic gneissose veins occur in some of the granites.

† Cotta's description for Hornblende schist, p. 253.

Among some of the granites are dykes of a hornblendic rock that seems to be irruptive, but at the same time is foliated and of a schistose gneissic aspect. This rock consists chiefly of leaves of hornblende, quartz, and felspar, but in some places the quartz seems to be absent, and in others mica appears as an accessory. The foliation usually is parallel, or nearly so, to the walls of the dykes.

The supposed metamorphosed felspathic intrusive rocks* are of various textures and compositions, most of them however may petrologically be similar, as they seem to change imperceptibly from one lithological variety to another.

They occur in tracts, courses, pipes, and dykes in the metamorphic rocks, and also in the granites, excepting the intrusive granite, which seems to have been subsequently irrupted. *Felstones* occur in various places among the granites, usually they may be some of the more modern intrusive rocks, but in some places it seems highly probable that they are metamorphic. These latter varieties consist of *Striped Felstone,* composed of thin layers of somewhat dissimilar texture and colour, hence the fracture appears to be striped like a riband, and the rock splits more easily in the direction of the layers than straight across. The layers are often much bent and twisted.†

This rock often contains globules of quartz, and changes into the rock *Quartziferous Felstone.*‡

There are strong courses of *Quartziferous Porphyry,* a rock in which the matrix is compact throughout, often dark coloured (green or blue), and contains separate crystals, globules, and laminæ of Orthoclase, sometimes Oligoclase, quartz, and mica. Much of the quartz is in globules; on the outside of some the crystal faces can be recognised, but most of them are regular minute balls. Some of these have an internal stellated structure, in which case there is often a minute hollow in the centre. These globules are usually scattered through the mass, often very sparingly, but in places they are so numerous as to give the rock a pisolitic appearance. This rock seems to change into a variety that has a "matrix resembling granite, but distinct crystals of Orthoclase, Oligoclase, globules of quartz, and also laminæ of mica are separately and prominently developed."§

This latter rock usually loses these characters gradually, and becomes undistinguishable from the associated granite. In some of these rocks many of the Orthoclase crystals (pink) are enclosed in an envelope of light green Oligoclase, similar to those in the rock that has been called Rappakivi granite. There is also a dark

* If these are metamorphosed igneous rocks, it would not appear at all improbable that in places they should be scarcely, if at all, altered, while in other places they might be almost changed into a granite. In the first case they would be scarcely, if at all distinguishable from an unaltered felspathic igneous rock, while in the latter they are practically undistinguishable from a granite.

† This and the following rock possibly may be unaltered rocks, in which case they should be described among the felstones; in places, however, they seem gradually to change into a rock with a granitic aspect.

‡ Called by Cotta *Striped Porphyry.* Cotta. Page 217. A vitrified variety of felstone, called by Cotta, "Hornstone," was observed in some localities, but as it is more probably an altered sedimentary rock, it is not included among the igneous rocks

§ Cotta's description of a rock that he calls "Granitic Granite Porphyry." Page 213.

purplish, or greenish, felspathic rock, containing crystals of felspar, globules of quartz, and bunches of minute crystals of epidote Moreover, in some of the purplish varieties of this rock there are crystals of two kinds of felspar, seagreen Oligoclase, and pink or flesh-coloured Orthoclase, and inside some of the latter there is a decomposed brownish green sand.* Occurring as courses and dykes in the metamorphic rocks and in the granite, excepting the intrusive granite, are dykes of gneiss-like rocks, that vary in texture from that of a typical gneiss; regular leaves of mica, felspar, and quartz—to a granite-looking rock, with an obscure foliation, caused by most of the mica being arranged in irregular leaves. In many of these the foliation is parallel, or nearly so, to the walls of the dykes, but in others it is oblique, and in some it seems to have a similar bearing to that of the associated metamorphic sedimentary rocks.

There is also a light yellowish rock with a greenish tinge, that seems to be a mixture of felspar and epidote; it usually contains globules of quartz. It is of a granular aspect, and breaks with an uneven to a hackly fracture.

Metamorphic Sedimentary Rocks.

v.μ.—(*Gneiss and Schist*)—Among these rocks the varieties are various both in composition and structure. The gneiss is seldom typical, that is, only composed of leaves of mica, quartz, and felspar, as usually there are various other essentials—some are very micaceous, others very quartzose, or felspathic; locally hornblende, iron pyrites, epidote, chlorite, &c., are essentials, or, perhaps, these minerals, separately or combined, may replace the mica. Similarly among the schist there are various compositions. Many of the various mica schists having been observed, as also Limestone schist, quartz schist, hornblende schist, felsite schist, talc schist, chlorite schist, epidote schist, &c. Of the limestone alone there are four or five varieties, very little of it being pure, but most being more or less schistose, and some containing so little limy matter, that it more properly should be called a calcareous schist.

In structure the gneiss is sometimes very granitic in aspect, at other times so little metamorphose as to be scarcely distinguishable from a grit, while others pass into mica schist; and of the latter there is every grade between coarse and fine, but in all, the most remarkable structures are those caused by the different kinds of foliation. In the gneiss and schist three kinds of foliations were observed—namely, a foliation parallel to the bedding, an oblique foliation, and a curled, or nodular, foliation. The first of these seems to have been introduced by ordinary lamination in the original rock. The second may possibly, in some cases, have followed the cleavage lines, but more probably in all cases in this district it has been induced by the lines of oblique lamination, and the third, by the curled, or nodular, lamination. Besides these there is a fourth in the schists, very crumpled or wavy, which seem to follow the lines of the crumpled or wavy lamination in the original rocks.

* Somewhat similar crystals seem to occur at Niederschöna, near Freiberg, and of them Cotta says:—"It would almost seem as if the nucleus of the Orthoclase crystals had originally consisted of Oligoclase, or a compound of Oligoclase and quartz." Page 213.

Limestones usually are peculiarly constituted, being rarely evenly laminated, but generally having a concretionary or curled, spheroidal, curved, or lenticular structure, or, perhaps, all combined; therefore, as the foliation seems to follow the most marked structure in the original rocks, the foliation in metamorphic limestones ought to be peculiar. In this district, usually it is most complicated, rarely being parallel to the bedding, but more often being concretionary, curled, or nodular, and crumpled or wavy, or perhaps all combined.

In some shales, and more rarely in grits and sandstones, the structure is spheroidal, while in others there are enclosed masses of foreign substances, round which the lamination of the rock curls, giving them a nodular structure.* Besides, in other shales, there is a wavy or crumpled lamination, that does not coincide with the planes of stratification.† And apparently, it is these structures in the original rocks which seem to have introduced the complicated kinds of foliation in the metamorphose rocks Some of these nodules are very irregular in shape, being twisted and contorted, while others have the appearance of veins, more especially when they are of a granitic aspect. However, that these vein-like portions have not been injected into the rock, seems proved by their all being (although some are so irregular) lenticular masses, that is, *dying out every way and thus being enveloped in the mass of the rock.* Moreover, that they are due to the metamorphic action, which, by some process, has separated their constituents from the others in the rock mass, and that they have not been portions of previously existing rocks floating in a half melted and semi-fluid mass, would seem to be proved by their occurring as frequently, if not oftener, in the limestone as in the other kinds of rock.

Some of the metamorphic sedimentary rocks are conglomeritic, containing large and small blocks, sometimes sparingly scattered through the mass, but often thickly together, the matrix being sometimes gneissic, but more often schistose. When the nodules are few usually they are very similar in their constituents, and appear to be due to a nodular structure in the original rock, but when they are numerous the rock seemingly is a metamorphosed conglomerate, as the enclosed blocks may be of quite different characters. In this district in the neighbourhood of some of the supposed metamorphic hornblendic intrusive rocks these conglomeritic gneiss and schists occur; their matrix always being more or less hornblendic or basic, and the mass of the contained blocks being some of the varieties of the hornblende rock, but not all, as associated with them are pieces of foliated quartzite and gneiss; moreover, in some places the latter kinds predominate to the almost total exclusion of the former.

It should here also be mentioned that in the original rocks there seems to have been faults, small displacements, joints, &c., all of which more or less have effected their present structure. Thus, for instance,

* In the Coal-measure shales a spheroidal structure is common, and in the sandstone and grit under, and interstratified with the Carboniferous limestone, a similar structure sometimes occurs. Nodules of iron ore in shales is an instance of foreign substances occurring in rocks, round which the lamination curls, as also the masses of grits in the coal measure shales, called locally in the Queen's Co. "Cat Heads" and "Stone Mine" (*See Memoir Ex., Sheet* 137.)

† For examples, see *Notes on the Foliation in the Gneiss and Schist of Yar-Connaught.*—"Dublin Quarterly Journal of Science," vol. vi., page 185; and *on crumpled lamination in shales*, ibid., vol. iv., p. 112.

when there is metamorphose "Fault-rock" the foliation is twisted, broken, and crumpled as it followed the broken-up and distorted structure of the fault rock; and when there was displacement the foliation is also displaced, rising and dipping to the upthrow and downthrow of the original fault; while the old joints have left in the metamorphic rocks hard lines that weather less freely than the other portions, and through some of which the foliation does not seem to pass. Examples of these different varieties in structure will be given hereafter in the detailed description.—(*See page* 39.)

Conclusions.

The *Felstones*, the *Porphyries*, the *Diorites*, and the *Diabases* would seem to be much more modern than any of the granitic or metamorphic rocks, as they occur in dykes cutting through them in various directions, but whether the acid or basic varieties are the newer does not seem proved in this district, as in no place were rocks of these different classes found together.

Next in order of age may be the *Intrusive granite*, as it has been found breaking up through all the metamorphic and granitic rocks. However, its age is not quite apparent, for when the courses of the Intrusive granite are traced into the Porphyritic granite, they seem to change in character, and may possibly, as is hereafter more fully stated, be veins from the mass of the Porphyritic granite.

The Porphyritic granite and its varieties are newer than the metamorphic rocks, and older than the more modern intrusive rocks, while the supposed metamorphosed Felspathic and Hornblendic intrusive rocks seem to be newer than the metamorphic sedimentary rocks, but older than the Granites.

The supposed metamorphosed Felspathic intrusive rocks appear breaking through the metamorphic sedimentary rocks; moreover, they appear to be newer than at least some of the supposed Hornblendic metamorphosed intrusive rocks, as in places the former were found coming up through the latter.*

From the above facts may it not be suggested that the sedimentary rocks, which are now metamorphose, previous to that action taking place were the oldest in the district; that they were invaded by what are now the metamorphose hornblendic and felspathic intrusive rocks, and afterwards all were affected by the granite, which action ceased after the Intrusive granite had been formed; and lastly, perhaps at a, comparatively speaking, recent period, the country was cut up by dykes of the more modern intrusive rocks.†

It has been mentioned, that to the north, the Porphyritic granite seems gradually to pass into Porphyritic foliated granite, and the latter by slow gradations into gneiss and schist; moreover the strike and dip of the foliation in the Porphyritic foliated granite seem to

* Here perhaps it ought to be mentioned that the outbursts of the intrusive rocks of different ages often seem successively to have occurred in the one locality, for it is not very unusual to find alongside or breaking up through the Hornblendic metamorphosed intrusive rocks, dykes, or courses of the Felspathic varieties, and through or alongside them veins of granite, and in some places dykes of the more modern intrusive rocks have been found alongside, or breaking up through, these granites.

† As mentioned previously, there may have been four or more intrusions of the more modern rocks occurring with wide intervals between each.

coincide with that of the stratification in the gneiss and schist, which apparently overlie it. From this, would it not seem probable that the foliation in the Porphyritic foliated granite may coincide with original lines of stratification, and that part at least of the Porphyritic granite of this district was formed in *situ*—that is, *the obscure foliation in it points to its original stratification, which had similar relations, as to the dip and strike of the bedding of the gneiss and schist, as those that now exist.*

If the above is allowed, may it not be supposed that the rocks nearest to the seat of metamorphic action, no matter of what kind, were most changed, and all, or nearly all, traces of foliation which had succeeded the stratification obliterated; thus forming the Porphyritic granite. In the rocks farther away, the changes were not so complete, and therefore a foliated structure can still be found in the Porphyritic foliated granite, while in the rocks farthest away, the influence only mineralised them in a greater or less degree, thus forming the gneiss, schist, &c.

Moreover, may it not be possible, that while the metamorphic process was in progess, some parts at least of what is now the Porphyritic granite, were in a fluid or semi-fluid state, and afterwards as they cooled, a crust formed on the surface, and this crust as it contracted was filled with cracks and fissures, while its weight forced up into the vacancies, thus formed, some of the underlying fluid or semifluid stuff, and thereby produce veins, which may apparently be different to the mass, as they cooled under quite different circumstances?*

In this way the compact veins and the intrusive granite might originally have been part of the mass of the granite, and yet be of different compositions, and apparently of a newer age; for so much silex being one of their essentials, they should remain longer fluid than the mass of the granite, and thereby they would be liable, at a little later period, to be forced up into the fissures, cracks, and other vacancies in the associated rocks.†

The supposed Metamorphic irruptive rocks, including the dykes of gneiss-like rocks, as before mentioned, occur as tracts, courses, dykes, veins, and pipes, cutting through and breaking up among the metamorphic sedimentary rocks, while they are cut up by the granites; and although they, more especially the felspathic varieties, extend as courses into some of the latter, yet eventually, they are apparently absorbed into the mass of the granite. From this would it not appear possible, if not probable, that *originally they were tracts, courses, dykes, &c., of intrusive rocks in the sedimentary rocks before the latter were altered.*

The facts in favour of this supposition are the following:—Among the Metamorphic sedimentary rocks are found the supposed Hornblendic and Felspathic metamorphic irruptive rocks, while in the Granites the former are rare, the only rocks of that class that seem to

* They seem to be more siliceous, which would account for their taking a longer time to solidify.

† There seems to be very little difference between the compact veins and the intrusive granite. The former usually is compact and only slightly crystalline, while the latter may be similar, up to highly crystalline, but both usually are very siliceous.

occur being a few dykes of the hornblendic gneissic and schistose rocks, while none of the masses, tracts, &c., of the other supposed Metamorphic hornblendic intrusive rock occur; and might not this be naturally looked for, as the Hornblendic rocks should melt with a much less heat than the Felspathic varieties, and therefore disappear, being incorporated in the granite? Moreover, in the Porphyritic granite there are tracts and courses in which hornblende, sphene, chlorite, and epidote, separately or combined, seem to become essentials of that rock; and is it not possible that such places point to localities in which Hornblendic igneous rocks originally existed?

Courses, dykes, &c., of the supposed Felspathic metamorphic irruptive rocks are as frequent towards the margin of the mass of the Porphyritic granite, as in the metamorphic sedimentary rocks, but they do not occur among the Intrusive *granites;* moreover, when they are followed into the mass of the Porphyritic granite, as before mentioned, they disappear, seemingly having been absorbed into that kind of rock. From this might it not be possible that at first they resisted the metamorphic action better than the associated sedimentary rocks, but when the force of that action became too strong they also succumbed, and eventually disappeared in the granites? In some places this change seems to be quite perceptible, as the rocks appear gradually to lose all the globules of free quartz, and change into a granite.

Dykes, and courses of gneiss-like rock occur among the granitic and the metamorphic rocks. If these were injected among the different kinds of rocks, from whence have they received their present foliated structure? But if they were dykes of igneous rock in the original sedimentary rocks, might not the foliation have been introduced at the same time as when the associated rocks were metamorphosed? In many igneous rocks there exists a structure sometimes, but not always, nearly parallel to the walls of the dykes; and, as previously observed, the foliation is often, although not always, nearly parallel to the walls of the dykes or courses; therefore might it not be probable that the lines of foliation in the latter rocks followed lines of structure in the unmetamorphic rocks?

In many of the granitic, and in the supposed metamorphic igneous rocks, more especially in the hornblendic varieties, there are hard parts that weather out in raised lines. These seem to have been caused by some kind of structure in the original rocks. In the hornblendic varieties they are quite compact, while in the feldspathic varieties, and in the granites, there is nearly always an open joint line in the centre. In the granitic and the feldspathic rocks, when viewed from a distance, these lines have all the appearance of joint systems in ordinary intrusive rocks; while those in the hornblendic rocks have a combination, part being like joint systems, and part having the appearance of imperfect columnar structure. As the latter often are very prevalent in some hornblendic igneous rocks, and joint lines occur in all igneous rocks, may it not therefore be possible that among the granitic and feldspathic rocks the vapour, either wet or dry, charged with silex or some such substance, coming up through the joints, hardened the adjacent parts of the rock; while in the more easily melted horn-

blendic rocks the joints and other lines were not only hardened, but also fused, and thereby the open lines closed? What seem to be these old joint lines, as previously mentioned, also occur in the Metamorphic sedimentary rocks.

Aqueous Rocks.

d. Carboniferous Rocks.—These consist principally of dark gray and blue bedded, parallel-jointed limestones, with here and there a few beds or partings of shale; and in some places, nodules, lenticular pieces and layers of chert are frequent. Where the limestones approach the older rocks on which they lie unconformably, there is often a structure allied to oblique lamination visible, in some cases it being undoubtedly that kind of structure. When the limestones appear under these conditions, they usually have interstratified with them fine limestone conglomerates, the enclosed pebbles being small particles of white quartz. At the junction of the limestone and the older rocks, a brecciated conglomerate was observed; and in one place there seems to be good yellow sandstone. *Stylolites* which consist of "irregular and longitudinally striped cylinders, standing at right angles to the rock's stratification, and often ended abruptly" (Cotta), are not unusual in the limestone in the east part of this district.

The Drift and other superficial deposits will be mentioned in the *Detailed Description.*

3. *Relations between the Form of the Ground and its Internal Structure, with some Account of the latter.*

The low country in the neighbourhood of Lough Corrib, and N.E. and E. of the town of Galway, has everywhere rocks of the Carboniferous period under it, usually being limestones, but in a few places there are thin shales, and there may be a few sandstones and conglomerates; while the wild hilly country west of Galway, and south-west of the road from Galway to Oughterard, is composed of granitic, irruptive, and metamorphic rocks. The limestone country is usually more or less fertile; however, in places there are extensive bogs and alluvial flats, and in others, large crags, where the rocks come to the surface, being destitute of an envelope of either Drift or vegetable mould. In the hills, the country over the metamorphic rocks is also to a degree fertile, often producing good mountain pasturage; while the granite ground nearly always has an envelope of bog; in some places, however, there is a coating of Drift, which, by cultivation, can be made fertile; moreover, some of these hills produce a coarse pasture, and the inhabitants, by perseverance and industry, have brought parts of this wild country into cultivation, more especially in the neighbourhood of the seaboard, where they principally reside, on account of the facilities for fishing and collecting marine manure, besides the cutting of turf for shipment to Galway. That the granite and metamorphic rock country was once partly or entirely covered by the rocks of Carboniferous age would seem suggested by small patches of brecciated conglomerates, similar to the shore bed of that group, having been observed in detached places. It may here be observed, that the axes of the curves of elevation that forced up the metamorphic rocks, seem to

have a N.W. and S.E. bearing, while similar axes in connexion with the Carboniferous rocks, and the underlying conformable sandstones, slates, and shales, called the Old Red Sandstone, in the centre of Ireland, bear N.E. and S.W., or nearly so.

Detailed Description.

4. *Position and Lie of the Rocks.*

In this section of the memoir it is proposed, first, to describe the Carboniferous rocks, and afterwards the granitic and metamorphic rocks—the Drift alluvium, &c., also the mines and minerals, being reserved for separate sections. For convenience the area may be divided into six districts, namely:—I. The limestone country on the east of Lough Corrib, or *the Annaghdown District;* II. The limestone country on the west of Lough Corrib, or *the Ross District;* III. The limestone country lying N.W., N., N.E., and E. of the town of Galway, or *the East Galway District;* IV. The metamorphic rock country in the vicinity of, and N.W. and W. of the town of Galway, or *the West Galway District;* V. The wild hilly country N. of Galway Bay, or *the Killannin and Moycullen District;* and VI. *The Buffy Lough District,* a strip of hilly country between Ross Lake and the N.W. corner of the map. The first three are part of the country of the Carboniferous rocks, and the others of that in which granite and metamorphic rocks occur.

Carboniferous Rocks.

I. *Annaghdown District, or the Limestone Country east of Lough Corrib.*—East of the south part of Lough Corrib, in the neighbourhood of the Cregg and Claregalway rivers, is a large alluvial flat and bog, and on the north border of this flat, south and west of the hamlet called Barranny, are dark, gray, and blue jointed limestones that dip S.E. at 3°, or lie nearly horizontal. Further north, in the neighbourhood of Woodpark, similar rocks with nearly the same dip were observed; however, there is a broken crag immediately northward of this place, and a mile on the N.E. west of Lough Afoor there is rather an extensive crag, in many places covered with rock debris, or rocky drift. Surrounding Lough Afoor, within a mile radius, there are numerous detached quarries and small exposures of dark gray or blue limestone in which the rocks lie nearly horizontal, or have a slight dip towards the south, or south-south-east; west of the village of Annaghdown, in the vicinity of Cuildermot Wood, are similar rocks all nearly horizontal; and in the strip of country extending from Annaghdown to Kilroe, between Lough Corrib and the bog, are quarries and small exposures; the rock being nearly horizontal, but with a slight dip to the southward, or south-eastward.

Further east, between Kilroe Mills and the Roman Catholic chapel, the lie and dip of the rocks is irregular, for in the vicinity of the chapel they lie horizontal, while further north, in the neighbourhood of the trigonometrical point △ 97, they dip westward at about 10°, and between this place and the road they dip southward at 3°, a little more north they have a N.W. dip of 5°, but further north they are horizontal, and in the vicinity of Kilroe Mills they have a slight southernly dip. In the strip of country north of Ballinduff Bay there are some extensive crags partly covered with rock debris or rocky drift; the rocks are much jointed and all seem to dip southward at about 3°.

II. *Ross District, or the Limestone Country west of Lough Corrib.*—Immediately west of Lough Corrib, and at the extremity of the promontory south of Ower Bay, there is a nearly horizontal crag of dark gray or blue lime-

stone that seems to be nearly horizontal; however, a great part of it is covered with rock debris or rocky drift. In the neighbourhood of Portdarragh and Tullokyne, and from that to Gortachalla, there are small crags or rock exposures that lie nearly horizontal, or have a slight south dip; moreover, further north, in the vicinities of Gortmore, Gortbeg, and Wormhole, there are small crags and rock exposures, the rocks being nearly horizontal, or with a slight southward dip; there is also a north and south mineral lode, of which a full description will be given hereafter. Similar rock exposures will be found still further north in the neighbourhoods of Bleanoran and Cloonmore.

Eastward of Cloonmore, and extending eastward, southward, and westward, from the hamlet called Gortnandarragh, for a considerable distance, is a wild crag of limestone that in parts is covered with rocky drift or rock debris; all the rocks having a southward or south-eastward dip, at angles varying from 2° to 10°. North-west of Gortnandarragh in the vicinity of Knockbroughaun the rocks are very cherty. Further west and north-north-west of the hamlet called Killarone Eighter, on the junction of this district with that contained in Sheet 95, in the townland of Moyvoon, there is a nearly N. and S. lode *making* lead.*

In this part of the district, more especially north of Killarone Eighter and N.W. of the old church, the limestones are obliquely laminated and in some instances slightly conglomeritic, containing minute particles of white quartz and other foreign rocks; there are also, near the boundary of the metamorphic rock, angular blocks and slabs of conglomerate and sandstones, that seem to be near the parent rock; however, on account of the deep Drift hereabouts, in no place were rocks of this class observed *in situ*. The rocks hereabouts dip S.E. or E. at a very low angle.

Further south-east, west of Ross Lake, and immediately N.W. of the hamlet called Coolagh, incorporated with, and lying against, a granite cliff, is a coarse brecciated conglomerate, part of one of the shore beds deposited between the older rocks and the Carboniferous limestone.

All along the boundary between these rocks and the Carboniferous limestone, blocks of this brecciated conglomerate may be observed, and close to the village called Newtown, about a mile S.W. of the last locality, there is a piece of it exposed *in situ*, also, in the stream a little S.W. of Drimcong House, and another in the wood on the west of the road due south of the same house.†

In this neighbourhood between Ross Lake and Danesfield, the rocks have a decided dip away from the older rocks of 3° (towards the E. or N.N.E.); but it only lasts for a short distance, as, a quarter of a mile from the boundary, the limestones are either horizontal or have a dip to the south-east. In the country S.E. of Ross Lake the rocks seem to be in nearly horizontal undulations; however, in many places they are covered with rocky drift or rocky debris. East of Ballycuirke Lough the rocks lie nearly horizontal, while west of it they dip away from the older rocks (to the N.N.E.), at angles varying from 3° to 5°, and blocks of the brecciated conglomerate were observed, but not found *in situ*. In the Loughkip River there is a section showing the limestone within 100 feet of the granite; however, there may be room for between 5 to 10 feet in thickness of a shore rock, and that it may exist seems probable, as loose blocks of it were observed.

III.—*East Galway District, or the Limestone Country N.W., N., N.E., and E.*

* The details about this lode will be found in the memoir descriptive of the district contained in Sheet 95 of the Geological Map of Ireland, among the East Oughterard mines and lodes.

† Hereafter other small patches of this brecciated conglomerate will be mentioned that occur in detached places on the north shore of Galway Bay.

of Galway Town.—In the neighbourhood of Woodstock the limestone dips E.S.E. at 10°, and in the strip of country towards the S.E., between it and Jordan's Island, there are said to be a few limestone quarries, which are now closed. On Jordan's Island the rock is very peculiar, being the concretionary or *fenestrella* limestone, so common in other parts of Ireland, in which no bedding is perceptible. Here it seems to be remarkable, as apparently the mass is small, and no similar rock was observed nearer than Gort, over twenty miles to the south-east. On the east of Jordan's Island, and seemingly overlying the rock just mentioned, are shales and black limestones with bands of chert. These latter beds dip east at 10°, and north of them are dark gray limestones, with a bed of magnesian limestone that dips N.E. at 25°. The country east of Menlough and Angliham contains numerous crags of limestone, those at the south dip N.E. and N. at angles varying from 20° to 25°; but between Menlough and Angliham, east, at angles varying from 15° to 3°; while on the summit of the hill and further east they are horizontal, or nearly so.

Angliham and Menlough Marble Quarries.—On the south-east shore of Lough Corrib, and three miles due north of the town of Galway, there are black limestones in the townlands of Angliham and Menlough, which are worked for marble. The information received from the foreman at the Menlough quarry is as follows:—

"There are two beds of marble, one thirteen and the other fifteen inches thick; under these are thin flaggy beds, which can be used for tombstones; these lie on *rubble* (a loose gray limestone that breaks into small pieces). Over the marble there is forty feet of *clearing* (gray limestone). The largest block ever sent from it was 10 feet by 5 feet by 1·25 feet. The marble sells for about £5 a ton."

Mr. Abbott, the resident engineer at the Angliham quarry, supplied the following:—"There are three beds of marble, nine, twelve, and fourteen inches thick, called locally the *Thin bed*, the *London bed*, and the *Double bed*. The London bed is so called because it is preferred by the London marble workers, as they can cut it most economically, but the Thin bed is the purest marble. The Double bed is called from a parting that runs through it. Blocks can be raised of nearly any size, but those generally raised are from seven to ten feet long, by from three to five feet wide, as best liked in the market. The stone is sold at the quarry at 5*s.* a foot, or on the quay of Galway at 5*s.* 6*d.* a foot. The principal markets are London, Liverpool, Bristol, and Glasgow. Under the Double bed there is a black stone, but it is too earthy to make a good marble; the 'clearing' (gray limestone) above the marbles is about forty feet."

In the geological museum of the Queen's College, Galway, among the examples of the local marbles Professor King pointed out a specimen slab of a gray spotted and speckled marble, which was raised by Mr. Carter on the N.N.W. of his new cottage in Terryland, and about 200 yards west of where the village of that name is marked on the map. At the village of Terryland a large quarry has been opened, from which good stones for general building purposes can be obtained. A quarter of a mile north of Terryland quarry another was opened, in which the following section was measured (June, 1864).

		Feet.
9. Dark gray limestone,	*over*	20·0
8. Shale parting,		0·5
7. Dove-coloured limestone,		0·75
6. Pyritious whitish blue shale,	*from* 0·5 *to*	1·5
5. Flinty limestone (blackish),		0.5
4. Same as No. 6,	*from* 0·25 *to*	4·0
3. Blue flinty limestone,		0·25
2. Shale parting,	*about*	12·0
1. Blue compact limestone,	*over*	39·5

This section was measured near the centre of the quarry. The limestone beds thicken as they are followed to the south end of the quarry, and the shale beds thin; the colour also of some of the beds change. The columns in the St. Augustine Chapel, Galway, were cut out of stones raised in bed No. 1.

A mile N.E. of Terryland quarry and about half a mile S.W. of the old castle of Ballindooly, a small quarry has been opened on a stone good for tool work, of a light gray colour. Magnesian limestone was remarked in Menlough Woods, south-east of the castle. A little N.W. of the village of Twomileditch there is a line of quarries, out of which a coarse marble is said to have been raised. A very pyritious shale was remarked here, and in it was found a flattened carbonized stem of a jointed plant (like a Calamite), 1·5 inches wide, and over a foot long. Some of the limestones hereabouts are slightly magnesian.

In the neighbourhood of Twomileditch the rocks, dark gray and blue limestones, are nearly horizontal, but have a slight dip to the south; while further S.W., in the vicinity of Laghtavarna, there is a slight dip to the east. To the S.E. of the last village the dip is to the S.E., and further S.E. at Merlin Park it is N. and N.E., and along the coast of Galway Bay the limestones lie horizontal, or have a slight dip to the N.E. Near the east end of Lough Atalia, in the vicinity of Rinmore House, there are dark blue limestones that have a slight dip to the east; and in the yard of a house on the west of Eyre-square, immediately north of the new National Bank, there are gray limestones that seem to be *in situ*.

Joints in the Limestones.—Systems of parallel joints are prevalent in this limestone, and in the following table a list is given of some of the most conspicuous. The first column records those between W. and N.W., the second those between the N.W. and N., the third the N. and S. joints, the fourth those between the N. and N.E., the fifth those between the N.E. and E., and the sixth the E. and W. joints. Among the joints in the second, third, and fourth columns the master-joints will usually be found—they are also best developed—while the others are often continuous only for a short distance, and seldom cut through more than one or two beds of the limestone.

County Map.	Townland.	Between W. and N.W.	Between N.W. and N.	N. and S.	Between N. and N.E.	Between N.E. and E.	E. and W.
Galway.							
55/3	Srue,	–	–	N. & S.	–	–	–
–	Gortahoon,*	N. 60 W.	–	N. & S.	N. 20 E. N. 40 E.	N. 6[illegible] E.	
–	Gortahoon (east of Packalassa).	–	–	N. & S.	–	N. 50 E.	
–	Corraneilistrum,	N. 70 W.	–	–	N. 10 E.	–	–
–	Kylemore,	–	–	–	N. 10 E. N. 45 E.	–	E. & W.
–	—	–	N. 20 W.	–	N. 10 E.	–	E. & W.
55/4	Bleanoran,	–	N. 5 W.	–	–	N. 65 E.	–
–	Wormhole,	–	–	–	N. 5 E.	N. 80 E.	–
56/3	Muckcoort (shore of Lake).	N. 70 W.	N. 10 W.	–	N. 40 E.	N. 60 E.	–
–	Luimnagh, West,	N. 70 W.	N. 10 W.	–	–	N. 80 E.	–
–	Ballinduff,	N. 80 W.	N. 10 W.	–	–	–	–
56/4	Shanbally,	–	N. 20 W.	–	–	–	–
68/1	Cloonnabinnia,†	–	–	N. & S.	–	–	–
68/2	Larragan,	–	–	N. & S.	N. 10 E.	–	–
–	Gortmore,	–	N. 10 W.	N. & S.	–	N. 55 E.	–
–	Gortachalla,‡	–	–	N. & S.	–	–	E. & W.
–	Portadarragh,	–	N. 10 W.	–	–	N. 55 E.	–
68/3	Rinneen,	–	–	N. & S.	–	N. 80 E.	–
–	Drimneen,	N. 65 W.	–	–	N. 10 E.	–	–
–	Knockshanbally,§	–	–	–	N. 5 E.	–	–
–	Knockshanbally,	–	N. 15 W.	–	N. 10 E. N. 40 E.	–	–
–	Ballydotia,	N. 75 W.	–	N. & S.	N. 10 E.	–	–
–	Killarainy,	–	–	–	N. 25 E.	–	–
68/4	Ballynahallia,	–	–	N. & S.	–	–	E. & W.
–	Gortaghokera,	–	–	–	N. 15 E. N. 45 E.	–	–
69/1	Annaghdown,	–	N. 20 W.	–	–	N. 80 E.	–
–	Cloonleenaun,	–	–	–	N. 10 E.	–	–
–	Woodpark,	–	N. 20 W.	N. & S.	–	–	–
69/3	Shankill,	N. 80 W.	–	–	–	–	–
–	Mackrush,	N. 60 W.	N. 10 W.	–	–	–	–
81/2	Clooniff,	–	N. 10 W.	–	N. 40 E.	–	–
82/1	Kilroghtee,	–	–	N. & S.	N. 20 E.	N. 70 E.	–
82/3	Menlough,	–	N. 20 W.	N. & S.	–	N. 70 E.	–
–	Ballindooly,	–	N. 30 W.	N. & S.	N. 30 E.	N. 80 E.	–
–	Coolagh,	N. 70 W.	N. 40 W.	N. & S.	N. 40 E.	–	–
–	Ballinfoile (Terryland Quarry).	–	–	N. & S.	N. 45 E.	–	–
–	Ballinfoile (North of Village).‖	N. 80 W.	N. 30 W.	–	–	–	–
82/4	Ballygarraun,	–	N. 5 W.	–	–	–	–
–	Castlegar,	–	–	–	N. 5 E.	–	–
–	Ballybaanbeg,¶	–	N. 5 W.	–	–	–	–

* Occurs in different beds.
† Cross joints irregular.
‡ E. and W. joints irregular.
§ Cross joints irregular.
‖ N. 30 W. joints—very fine jointing cutting rock into thin plates. Professor King called our attention to these very fine jointing planes, which occur in various detached places in the neighbourhood of Galway, and pointed out that, except when seen in situ, they are almost undistinguishable from slaty cleavage. That gentleman has very fine specimens in the Queen's College Museum at Galway, some of which he has cut and polished.
¶ Cross joints irregular.

IV.—*West Galway District, or the Metamorphic Rock Country in the vicinity of, and N.W. and W. of the Town of Galway.*—The principal rocks hereabouts are metamorphic sedimentary rocks, with supposed metamorphose, felspathic and hornblendic igneous rocks; and associated with them are granite veins, courses, bosses, and small tracts. There seem also to be dykes of more modern intrusive rocks, as will hereafter be mentioned.

On Mutton Island, which lies south of Galway town, are gneiss and schist, through which run at least four courses of intrusive rocks of the class supposed to be metamorphose felspathic rocks. Among the sedimentary rocks there is a micaceous gneiss of a pink colour; but the principal metamorphic sedimentary rocks seem to be hornblendic gneiss and schist that contain a great quantity of iron pyrites and epidote, the latter also running through the rocks in strings and small veins; the half-tide rock, called Trout rock, a little south of Hare Island, seems formed of rocks similar to those last-mentioned. These metamorphic sedimentary rocks are of various grades and textures from a fine schist to a coarse gneiss.

The previously mentioned courses of supposed metamorphic felspathic rock run nearly parallel and strike about N.E. and W. Bounding the eastern side of the island there is one which is very massive, and in places of a very granitic aspect. In it the crystals and globules of free quartz are widely disseminated through the mass. The most conspicuous minerals that occur are pink, white, and green crystals of felspar, and as the former predominates the rock has a pink colour. Striking N.E. and S.W. under the lighthouse there is a course of similar rock, and alongside it, on the east, a green porphyritic rock that may be a more modern course of porphyry; it has a green felspathic base, in which are white, with a few pink, felspar crystals. The red rock was traced across the island, but what is supposed to be the more modern rock was only observed on the S.W. of the lighthouse; it may, however, be continued under the shingle on the north. In no place was it conclusive which of these rocks are the oldest, but it was considered that the green is unaltered, and it seems to cut the red rock. At the west point of the island there is a fourth course very similar to the two previously mentioned red rocks. The Metamorphic sedimentary rocks occur between these courses, and evidently are cut up and displaced by them; however, in no place were they remarked in juxtaposition.

At the S.W. extremity of the promontory, south of Lough Atalia, in the vicinity of Rinmore Point, north and south of the railway, are metamorphic sedimentary rocks with a few intrusive rocks. The former consist of micaceous and hornblendic gneiss and schist that have a steady strike of N. 75° E., with a northerly dip varying from 70° to 80°. In some of these the foliation is curled and nodular, and when the enclosed nodules are of the red gneiss, while the rest is black or hornblendic, the rock has a marked appearance. On the strand, about 500 yards east of Rinmore Point, there is a N. and S. dyke of blue compact, although riband, felspathic rock. This may be a riband felsite, the structure being introduced by the metamorphic action, as it is very similar to other *riband felsites* found further west among the granite, and that are supposed to be metamorphose; or it may be only a more modern igneous rock, the riband structure being lines of cooling. Here it may be mentioned that Mr. Mallet, in a paper read before the Royal Irish Academy,*, records that in the excavation for the new dock of Galway, which lies nearly half a mile west of this place, a white felstone was found at the lowest part of the works. He calls it "hornstone," and says it intrudes up into the associated gneiss and schist; pieces of this rock were observed in the walls about the dock, and all observed had a riband structure.

* Transactions R.I.A., Vol. I., page 56.

A north and south oval boss of red rock, very similar if not identical with the Mutton Island red porphyritic rock, breaks up through the gneiss and schist a little N.E. of Rinmore Point, and from it a large course extends towards the S.W. from a little S. of that point, having been traced during low water by Nimmo's Pier along the strand south of the Claddagh.

In the Galway river the rocks seem to be different varieties of gneiss and schist that strike about N. 60° E. and dip southward at about 80°. Among these rocks, besides the micaceous and hornblendic gneiss and schist, were observed rocks that might be called epidote schist, as epidote seemed to be an essential in the rock; also what may be called *epidote rock*,* as there seemed to be a total want of foliation in it, and the most conspicuous constituent was epidote. Veins of epidote rock also occur in the gneiss and schist; besides these some felsite schists were noted with one or two thin quartzites. In the neighbourhood of Galway there seems to be more gneiss than schist. The micaceous gneiss is often of a black or gray colour, containing black or black and white mica, white felspar, and quartz, but in places it contains a pink felspar which gives its colour to the rock. A greenish felspar, that seems to be Labradorite, was remarked in some, but it appears to be confined to the hornblendic varieties. In some places these micaceous gneiss occupy a considerable space, but more generally they are mixed up with the hornblendic varieties, running in and out in tangled layers and lenticular patches; generally the hornblendic gneiss has epidote as an essential. While opening sewers in the town of Galway, in Abbeygate-street, they cut through gneiss that was very epidotic. Iron pyrites occurs more or less in minute veins, specks, and layers; but, seemingly, more especially in the hornblendic varieties, some, in which magnetic pyrites abounds, might be called *Pyrrhotite schist.* A bed of Pyrrhotite schist was observed in the field opposite the gate into the grounds of the Queen's College, some of the ore being changed into peacock ore.

A little west of the Galway river, at the bridge into Nun's Island, a rock similar to the Mutton Island red porphyry occurs; it was also observed near the Lying-in Hospital and West House; moreover, we were informed by Mr. Roberts, the County Surveyor for the West Riding, county Galway, that they cut through nothing but this red porphyritic rock in the south half of the new canal (Eglintoun canal). From this it may be supposed to occupy an irregular tract, immediately west of the Galway river, as it was also observed on the road a little south-east of the Union Workhouse, in the field opposite that institution, and in an irregular course at the north boundary of the Queen's College grounds; in the latter place it first extends east and west, and afterwards turns towards the north. Near the latter place, in the new mill-race, where a junction between it and the metamorphic sedimentary rocks is exposed, the former was observed overlying the latter. Here, adjoining this red porphyritic rock, on the edge of the callows, due east of Belmont (which is now the medical school of the Queen's College), is a tract of "hornblende rock,"† supposed to be metamorphic, hornblendic, igneous rock. It is an aggregate of large crystals of greenish black hornblende, with green felspar (Labradorite?), epidote, and iron pyrites.

This rock was only remarked here, but a course of it is said to have been seen a little more south, while sinking the Eglintoun canal, on the north of the Fever Hospital. Near this, in the cutting for the mill-race, N.E. of the Queen's College, a thick course of epidote rock was observed, perhaps a

* This rock seems to be nearly if not identical with the rock specimen, No. 361, in Krantz's collection at the Geological Survey Museum, Stephen's-green, Dublin, and called by him epidotfels or epidote rock.

† Similar rock specimens in the Geological Museum, Trin. Coll. Dub. are called by Professor Haughton, F.R.S., &c., &c., by this name, as also specimen, No. 308, in Krantz's collection at the Geological Survey Museum.

bed, as apparently it lay conformable with the associated beds of gneiss and schist. In the field opposite to the College gate the gneiss and schist strikes east and west, and seemingly with the same strike is a white riband felsite or felstone, very like those previously mentioned as occurring near Rinmore Point, and in the new dock.*

West and south-west of West House there is gneiss with a few schists; however here the strike has changed to N.E. and S.W., and west of this is a marked course of the supposed metamorphic felspathic irruptive rock; not only for its own peculiarities, but also as west of it only three exposures of the metamorphic sedimentary rocks were observed; one being about 100 yards north of Shantallow, another in the vicinity of Straw Lodge, and the third a detached locality north of Blackrock, of which more hereafter. This course of supposed metamorphic, felspathic, igneous rock extends nearly N. and S., and towards the south can be first observed at the road west of the Recorder's Pier, from whence it can be traced northwards by Merrion Cottage into the Shantallow demesne, where it seems to divide into three branches, the western extending north to Straw Lodge, the middle branch seems to run only a short distance north of the Shantallow road, while the eastern branch apparently does not cross it. This rock is of a very porphyritic nature, and generally of a grayish green colour; the most conspicuous minerals it contains, in an aggregate, being crystals of green pink and white felspar, globules of quartz, and minute spangles of mica. The globules of quartz in places are so numerous as to give it a pisolitic appearance, and often with a lens their crystalization can be seen, in fact in some it is visible with the naked eye. Up against and seemingly lying on the middle branch immediately N. of Shantallow road are gneiss, and also in a quarry at the east side of the townland of Shantallow; with the west branch the gneiss is in junction a little south of Straw Lodge. West of Brickpark Lodge, which lies nearly a quarter of a mile west of Newcastle House there is a white felstone or felsite, that seems to be in a north and south dyke; whether this is a metamorphic, or a more modern igneous rock, is not apparent, the exposure being so small. Further north, from the Queen's College to Ashley Park, there are various small exposures of nearly perpendicular gneiss, with a few schists, that are generally of a hornblendic nature; they strike nearly east and west (N. 75°, E. to N. 85°, E). Associated with these, a little N.W. of Rock Lodge, is a north and south course of a porphyritic rock, that is supposed to be a metamorphic felspathic igneous rock.

The rocks in the part of the *West Galway district* where metamorphic sedimentary rocks occur, associated with what are supposed to be metamorphic igneous rocks, have now been described. In the rest of this district, although the mass of the rocks are supposed to be metamorphic, yet in no place, excepting a very small patch north of Blackrock, were metamorphic sedimentary rocks observed; however, they possibly may exist between the courses of the other rocks, as they are of a much more friable nature, therefore more easily denuded. If this suggestion should chance to be correct, the metamorphic sedimentary rocks are now covered up and obscured by the Drift. However, in many places it is impossible that they could exist, and in most localities it is quite evident they were superseded by the igneous rocks that are supposed to have invaded them subsequent to their first formation, and prior to their being metamorphosed. Previous to entering into the description of the other rocks it may be mentioned, that among the metamorphic sedimentary rocks just described, no vein or tract of granite was observed; the nearest exposures of this kind of rock to them being a boss of granite, situated about 100 yards north of Shantallow, very

* These are somewhat like Krantz's "Leptinite" or "white stone."

near which, on the S.E., is an exposure of gneiss; a granite boss in the S.E. part of Shantallow demesne, which is also a little N.W. of an exposure of gneiss; and a north and south granite vein south of Ashley Park, close to where hornblendic gneiss seems to come.

In the rest of this district the supposed metamorphic felspathic igneous rocks range from a rock very like a granite, to a rock that is nearly a pure felstone. Immediately west of the metamorphic sedimentary rocks they seem to occupy most of the country, but further west they are much interlaced with the granites, and west of the road from Barna to Kirkullen most of them disappear, seemingly having been gradually absorbed into the mass of the granite. Also, they all seem to have a tendency to run in courses. A little W. and N.W. of Galway the courses bear nearly N. and S.; at Salthill and Blackrock, and from that to some distance north of Rahoon, they strike about N.N.E. and S.S.W., while further north, south, and north-west of Bushy Park the bearing changes to about N.N.W. and S.S.E. North-west of Blackrock they run nearly N. and S., while further north, on the east of Ballyburke, they strike about N.N.E. and S.S.W., and west of that hamlet N.N.W. and S.S.E. to nearly N.W. and S.E. The courses on the east of Ballyburke seem to keep to their bearing of N.N.E. and S.S.W., as far north as Tonabrocky, after which they change to nearly N. and S. The courses on the west of Ballyburke run with the above bearings for only a short distance, for N.W. of Lough Nacreeva they run nearly N.E. and S.W., and further north they extend in wavy lines, that have general bearings between N.N.E. and S.S.W., and N. and S.

Among the above rocks are granites that generally occur in courses, having a similar bearing to the courses of the associated rocks; however, this is not always the case, as they often are found in masses and irregular bosses, that dovetail into the supposed Metamorphic felspathic igneous rocks. The masses and bosses, especially those farthest towards the west, generally are the porphyritic granite, with large pink felspar crystals, while the courses and veins usually are of finer varieties, in which no one mineral is developed in conspicuous crystals, all the minerals being somewhat of nearly equal-sized crystals. Of them there seem to be two marked varieties, one being a fine mottled red and yellow rock, and the other pink; besides these there are veins and tracts of the typical *intrusive granite*. In the latter the felspar base seems sometimes to predominate nearly to the exclusion of the quartz and mica, changing it into *felsite rock;* it is often of a greenish pinkish white colour, and through it are numerous minute greenish chloritic-looking veins, from which the stone splits up into irregular pieces, thereby spoiling it for anything but the coarsest building purposes. The relations between the granites and the supposed metamorphic irruptive rocks are obscure, as no sections are exposed, the only ones observed being as follows:—in the shallow quarry, about 100 yards north of Shantallow House, where an E. and W. vein of fine red granite cuts through a course of the Metamorphic felspathic irruptive rocks; in the road cutting at Taylor's Hill, where there are two or three veins of fine red granite, breaking through a green felspathic slightly porphyritic rock; at the cross-roads S.W. of Merville Lodge, where the typical *intrusive granite* is protruded into a mass of greenish slightly porphyritic felsite, the vein seemingly ending towards the west in a wedge-shaped mass; in the cutting at Barna Hill, west of Barna House, a red granite vein breaks through green slightly porphyritic felsite; and at Blackrock, as will presently be mentioned, there is also a junction seen.

The rocks on the sea-shore, beginning towards the east at the Recorder's-quay, are as follows:—First, a fine red granite, that runs in a N. and S. course; next it are greenish gray porphyritic felspathic rocks, that contain globules of quartz and greenish white and pink crystals of felspar. In these porphyritic rocks it was observed that some of the crystals have a structure

similar to the felspar crystals in the so-called *rappakivi granite*, having a pink centre enclosed in a pale greenish envelope, the centre of the crystals being orthoclase, while the outside portion is oligoclase. Near the sea-shore these crystals are very minute, but further north they are well developed. At the ladies' bathing place there is a fine felsite, in which are minute globules of quartz; here it may be mentioned that in nearly all the felsites of this district there are globules of quartz, but in some they are so minute as to be scarcely visible, while in others they are widely disseminated through the mass, the only exception being a white or yellowish white felsite, that hereafter will be mentioned as being supposed to be part of *the intrusive granite*. At the boundary of the townland of Lenaboy there are red and green felsites, and abutting against them green felsites. South of the site of Loughaunpatrick, opposite Mr. Blake Foster's house, is a peculiar ferruginous lumpy granite, which seems to be part of the *intrusive granite*, and in it are strings showing traces of copper and lead. To the west side of this granite are green felsites. At the east of the half-tide rock, called Trawclogh, is a red felsite, while to the west is fine red granite. Opposite the east gate to Rockbarton is red felsite with green veins, and alongside it is green felsite; a little further west is a course of fine red granite, and further west are red and green felsites. Nearly opposite the west Rockbarton gate a red felsite folds in a curve over a green; further west a peculiar fissile granite occurs, and is succeeded by a white felsite. Opposite Seamount Lodge there are porphyritic felspathic rocks. At Blackrock was observed a vein of fine granite breaking up through a porphyritic felspathic rock. West of this, between the road and the sea, the rock seems to be a mass of the *intrusive granite*. In a few places very small detached patches of the Carboniferous brecciated conglomerate were observed in hollows among the above-mentioned rocks; one may be seen on the strand, nearly opposite the Eglintoun Hotel, and another 300 yards farther west.

On the north of the Blackrock road, between it and the Taylor's Hill road, the rocks seem to be usually felsites or porphyritic felspathic rocks, as only two short courses of granite were remarked. These lie nearly immediately N. of Claremount Lodge; however, about a quarter of a mile N. of Ballynacarrickadoo is a very small patch of gneiss and schist similar to those in the immediate neighbourhood of Galway. In the tract contained between the Salthill road, the Taylor's Hill road, and the road from Ballynacarrickadoo are various felsites and porphyritic felspathic rocks; and masses of *intrusive granite* are found in the hollow about a quarter of a mile south of Taylor's Hill House, and N. and S. of Mr. Daly's new house. Forming the hill north of Vicar Croft there is a boss of evenly grained red granite, and further eastward, E.S.E. and W. of Shantallow House, are courses and veins of a similar rock. In this neighbourhood there are numerous varieties of the porphyritic felspathic metamorphic irruptive rocks, the most remarkable being one in which there are large and small crystals of bright red orthoclase, enclosed in an envelope of pale sea-green oligoclase, some of these compound crystals being two inches long, these crystals, as previously remarked, being similar to those constituting the Finland rock called *rappakivi granite*. Another marked rock is found a little west of the last, containing, besides various felspars, crystals of a green epidotic mineral.*

About a mile north of Shantallow House, and N.E. of the hamlet called Ballymuntervally, there are courses of red and yellow evenly crystallized granite, some of which seem to extend to Ashley Park. Alternating with these are courses of quartziferous porphyry. The first are a reddish granite, with much yellowish white felspar, pink felspar, black mica, and quartz,

* A Greenish rock containing bunches of minute epidote crystals is very like the rock No. 363, in Krantz's collection, and called by him *epidosite*.

while the latter are purplish rocks with crystals of red felspar, globules of quartz, and flakes of a greenish mineral that looks like an earthy chlorite. In places they are very granitic in aspect, more especially in parts adjoining the granite courses. In the neighbourhood of Letteragh, which lies a little N.W. of Ballymuntermally, a few fine grained granite courses were remarked that may be the southern extension of those found between Lough Aguse and Ashley Park. To the north of Lough Aguse there is a small tract of country occupied by the typical porphyritic granite. S.W. of this, a little S.W. of Tonabrocky, there is another small tract of porphyritic granite, and among the felspathic rocks hereabouts there are veins and courses of it. North and north-west of this, S.W., S., and S.E. of St. Oran's Cottage, there are numerous courses of granite, some of which are the porphyritic granite. S.E. of St. Oran's Cottage, and immediately S.W. of River View, there are white felsites, in which there are few or no globules of quartz. In all the felspathic rocks adjoining the Limestone country, strings and small veins of iron pyrites were remarked, with (in places) traces of galena and copper pyrites.*

About half way between St. Oran's Cottage and Woodstock House there is a small tract of porphyritic granite, and on the west of Woodstock is the margin of the mass of that rock. S.W. of Woodstock the felspathic rocks appear to be interlaced with the outside part of the mass of the porphyritic granite, and further south the latter rock seems to extend eastward to about half-way between Drumlough and Drumlough East. South of this, and east of Corboley, there are felsites and porphyritic felspathic rocks, interlaced with courses of the porphyritic granite. Moreover there is a narrow tract that extends into the mass of the porphyritic granite for about a mile on the S.W. of Corboley, in which are courses of porphyritic felspathic rocks, the most western running about N.N.E. and S.S.W., while the others bear about E.N.E. by E. Half a mile S.E. of Corboley the boundary of the mass of the porphyritic granite is deflected towards the east as far as the nearly N. and S. road north of Cappagh, and from thence it goes in a curved line towards the west until it meets the road a little north of the hamlet called Aille; hereabouts, a little S. of where the "y" in Corboley is engraved on the one-inch map, there is a vertical dyke in the porphyritic granite. It strikes about N. 60° E., is 1·75 feet wide, and seems to be one of the more modern igneous rocks. It is felspathic, but at the same time may be dioritic, as before the blowpipe it fuses slightly. However, in it globules of quartz were remarked. This dyke can be traced for about a quarter of a mile towards the east. On the border of the bog it is a porphyry, that seems to be divided into two branches, the southern of which is four feet wide, and strikes N. 40° E. A quarter of a mile N.E. of Aille there are some thin compact felstone dykes, slightly porphyritic, in the porphyritic granite.

The boundary of the mass of the porphyritic granite in the neighbourhood of Aille and Cappagh, and from that to Barna House, is very irregular, as courses from it extend into the felspathic rocks, and courses of them into it. N. of Cappagh the porphyritic granite and the felspathic rocks may alternate in courses. In this neighbourhood are some thin dykes of apparently more modern igneous rocks, very felspathic in their nature, and one being bifurcated. They lie about a quarter of a mile N.N.E. by N. and E. of Cappagh. South of the porphyritic granite which is situated S. of Cappagh there are courses of porphyritic granite, alternating with others of the *intrusive granite*, or with felsites, or porphyritic felspathic rocks. In some of the latter there are crystals similar to those in the *rappakivi granite*.

To the N. of the road that runs by Barna House there are masses of the *intrusive granite* in the felspathic rocks, also some courses of the porphyritic

* They may occur in other places, as traces were remarked nearly everywhere, even in the porphyritic granite, but not one that was remarked seemed to be of any promise.

granite. North-east of Barna House, and west of Kingstown House, there is a peculiar scraggy white felsite rock in which no globules of quartz were detected. This seems to be part of the intrusive granite, which has lost its other constituents, and changed into a "felsite rock."

On the N. of the White Strand, at the grove on the east of Barna House, is the porphyritic granite, while there are felsites south of Barna House, at Barna House, and about 500 yards east of it. To the west of the White Strand the rock is similar to that on the north, being the typical Galway *Porphyritic granite*, containing large flesh-coloured or pink crystals of felspar, with crystals of hornblende and sphene. Nearly due S. of Barna House, and about half a mile S.W. of Seaweed Point (in Sheet 114) there is a rock called Gray Rock, which is composed of dykes of greenish felstone and courses of porphyritic granite that run nearly E. and W. The felstones seem to be one of the more modern igneous rocks.

In the vicinity of nearly all the tracts of the porphyritic granite that comes up through the felspathic rocks, and also near the margin of the mass, are patches of the felspathic rocks lying on the porphyritic granite, or curiously entangled with it, or perhaps the latter may be entangled in the courses of the former; this can be well seen in the neighbourhood of Tonabrocky, south of Woodstock, at, to the east, and south of Corboley, in the neighbourhood of Aille, and in other places; and from the relations of the rocks to each other it would appear as if the granites were in a plastic state at a later period than the felspathic rocks.

V. *The Killannin and Moycullen District, or the wild hilly Country north of Galway Bay.**—The typical rock of this district is porphyritic granite, having as its conspicuous essentials large pink or flesh-coloured crystals of felspar (orthoclase), with smaller of sea-green (oligoclase), and white felspar, glassy quartz, and black mica. In places are found as local essentials hornblende, sphene, white mica, a greenish mineral that may be an earthy chlorite, a mineral that seems to be epidote, and iron pyrites. However, in places this granite is not porphyritic where the pink crystals of felspar are of a similar size to the other constituents, and in some places there is a granite in which the pink felspar, or the green felspar, is absent, while in others the conspicuous crystals are a white felspar. In some places the rock seems to be massive, in others there appears to be an obscure foliation, while to the north and north-east there is a well developed foliation that becomes more and more conspicuous, as the margin of the granite is approached. In some localities there are courses of a black or syenitic granite, with masses, veins, and courses of the *intrusive granite* and of the supposed metamorphic felspathic irruptive rocks; the latter being more numerous among the rocks in the West Galway district, in the vicinity of Galway Bay, and near the north and north-east margin of the granite, more especially in the two first mentioned localities. The *intrusive granite* would also seem attached to localities near the margin of the mass of the porphyritic granite. North of Barna there are many courses of the felspathic porphyritic rocks, and felsites; near that village they have a tendency to run nearly north and south, while further north they bear about N.E. and S.W. N.W. of the Barna Coastguard Station, in the granite, there are four dykes of gneissoid rocks; the three eastern bear about N. 30° E., two of them being gray and hornblendic, containing hornblende, quartz, felspar, and flakes of a mineral like an earthy chlorite; while the third, which lies west of the others, is of a yellow colour, and seems to consist of quartz, felspar, and mica. The fourth lies further west, bearing N. 45° E., being of a gray colour and hornblendic nature.

S.W. of Barna, at and near the shore, a nearly north and south course of

* A strip along the extreme south is in Sheet 114.

yellowish gray felsite was observed. The granite hereabouts seems to contain hornblende, sphene, copper, and iron pyrites as accessories; it also in places is foliated. Further north, and a little east of Trusky, is a small vein of iron pyrites, and north-west of that hamlet is a N.W. and S.E. course of riband felsite. To the N.E. of Trusky, in the neighbourhood of Cloghscoltia, there are courses, pipes, and small tracts of both felsite and porphyritic felspathic rocks; and similar rocks are found east, north-east, and north of Lough Inch, while N.W. of that lough there are courses of porphyritic granite alternating with courses of these kinds of rocks. The courses N.W. of the lough bear about N. 30° E., while those on the north and east vary from N. 45° E. to N. 70° E.

Along the sea-shore, between Barna and Furbogh, the granites in general are not porphyritic; however, courses of that variety occurs, and a little to the northward nearly all seems to be of that character, also to contain hornblende and sphene as essentials. Compact veins and strings are very numerous in these granites, and as they are of a harder nature than the latter, they weather much less freely, and now stand up from an inch to two inches high above the mass of the rock, thereby recording the amount of weathering since the glacial period. On the shore, near the barony boundary, more than half a mile eastward of Marino Cottage, and opposite Archdeacon Butson's new house, there is a large angular block of Carboniferous sandstone, that may be only a short distance removed from its parent rock.

A little west of Marino Cottage two nearly N. and S. dykes of slightly porphyritic felsite were observed; and a course of similar rock was traced for about three-quarters of a mile towards the northward, to a little S.E. of the hamlet called Polleeny. West of Ballyvoddy very large flakes of white mica were remarked. Near Furbogh Bridge is a felsite. Hereabouts, in porphyritic granite, are large crystals of felspar, that have a pink centre enclosed in a white envelope. Further westward, on the sea-shore, south of Lippa and Derryloughaun, are rocks with a well developed foliation, that bears N. 50° W. to N. 60° W. They seem to be a patch of gneiss and schist blending into the granite, or possibly they may be the gneissoid rock previously described; as a dyke of very similar rock, with a foliation that bears N. 55° W., was observed a little west of the Furbogh Wood. Hereabouts the fine granites are divided by joint-like lines into courses that have a bed-like appearance; moreover, the granites between these lines have different colours and textures, and appear to be of slightly different composition; besides, the lines seem to be in parallel planes with those of the foliation of the associated gneiss and schist.* North of Furbogh, places in the granite are very coarsely crystalline, the crystals of felspar being over an inch long,† and near Seershin, Mrs. Blake of Furbogh procured very curious quartz crystals that had a felspar interior. West of Seershin is a N. and S. course of red, finely crystalline felsite; and north-west of this locality, along the Knock River, was observed a green porphyritic felspathic rock, a compact felsite, and near the small lake a riband felsite and a porphyritic green felspathic rock, in which are minute red crystals, that seem to be garnets. East of these, in the vicinity of Shannafreaghoge and Derrycrib, two N. 25° E. courses of porphyritic green felspathic rocks were observed. Further north-west, at Gortgar, are two nearly N. and S. courses of felspathic, porphyritic rocks, and north of that place, due west of Laughil at the road, are courses of very similar rocks running irregularly, but having a general N.E. and S.W. bearing, while close to the village is a dyke of riband felsite, that bears nearly north and south. There is also a

* If these lines mark ancient stratification it would appear probable that the associated foliated rocks are gneiss and schist, and not the rock above suggested.

† The largest crystal measured was three inches long and one inch square.

mineral vein, that runs N. 30° W., containing chlorite and fluor-spar, in which pieces of galena are said to have been found. West and north of Laughil are courses of red felspathic rocks, slightly granitic in appearance. South-east of Laughil, in the country about Lough Kip, bosses and small exposures of the porphyritic granite were observed; and further east, north of Doocamphill Lough there is an obscure foliation in the granite, for when it is viewed in mass the large crystals of felspar are in rude lines. Hereabouts a N.E. and S.W. course of porphyritic felspathic rock was observed; also a course of red rock, like that in the vicinity of Laughil. Near Pollnaclogha there is a mass of felsite in porphyritic granite. Further northward, in the neighbourhood of Kirkullen, hornblende and sphene were observed in the porphyritic granite; however, they do not seem to be essentials, but only accessories; while still further northward, and west of Ballycuirke Lough, in the river, a course of granite was remarked in which iron pyrites seems to be an essential; and close by is a felspathic rock. Near the bridge the latter is of a greenish colour, with a few pale green felspar crystals and a little free quartz, while the east part is finely porphyritic, containing black mica and lumps of free quartz—the granites between this and the boundary of the Carboniferous rocks seem to be partly the intrusive granite, very coarsely crystalline, and partly the porphyritic granite. N.W. of the last locality in the vicinity of Uggool, is a tract of felspathic porphyritic rock, and northward of it near Moycullen is a peculiar greenish granite, in which a green epidotic mineral seems to be an essential; near these, in the vicinity of the road from Moycullen to Spiddle, are green and reddish felspathic rocks, while in the country west of this road about Loughs Atavamore and Derreendarra nothing but porphyritic granite was observed; but further southward, in the neighbourhood of Keeagh, there are well marked courses of these supposed metamorphic, igneous, felspathic rocks. Two courses near the lough are of a greenish colour; and another, that runs nearly parallel with the road, and through the place where the hamlet formerly existed, is very similar to the red rock near Laughil, having somewhat a granitic appearance, but having disseminated through the mass globules and crystals of quartz, and minute dursy cavities, with a green mineral-like epidote. West of this course, near Laughil Bridge, is another course of the greenish porphyritic rock. Further west, about Slieveaneena and the neighbouring loughs from this to the Owenboliska, and beyond this river to the margin of the district, no rocks, except the porphyritic granite, with its accompanying compact veins and strings, were observed; however, southward the supposed metamorphic igneous rocks do occur, one having been remarked at Knocka Lough, which lies more than two miles south-west of Laughil; this is a greenish, yellowish, porphyritic rock. West of this, near Boliska Lough, are N. 30° E. courses of red rocks, somewhat similar to those mentioned in the vicinity of Keeagh and Laughil. In the porphyritic granite hereabouts there is, as an essential, and also occurring in small patches, nests, and lenticular pieces is a greenish mineral, that seems to be an earthy chlorite. At the S.W. end of Boliska Lough there is a N. 50° E. dyke of a purple felsite, that in places contains semi-crystalline mineral which seems to be white quartz, and the rock mass weathers like a breccia. Further west, half a mile N.W. of Lough Naulla, there is a N. and S. course of white felsite; and half a mile west of the same lough is a nearly E. and W. course of gray felsite. About two miles S.E. of Lough Boliska, extending N.N.E. from the hamlet called Ballydonnellan, for a considerable distance, is a course of felsite that is either yellow or white, and in places foliated or of a riband structure; west of this at the road three nearly parallel courses were remarked, the two northern being riband felsite, and the other a quartziferous porphyry. From near the south end of the long course there is another running nearly N.E. (N. 40° E.) towards the hill called Knockagurraun; this towards the south is a yellow or white felsite, while near the

hill it has minute crystals of a green mineral, and there is a thin N.E. and S.W. dyke of felstone, one of the more modern igneous rocks, that has a platy structure cutting across it. South of this, between the hamlet called Park and the sea-coast, is a small tract of red felsite, and a little west of it a dyke of mottled felsite. Near the coast from this by Spiddle to the west of the district the granite usually is even-grained; however in places courses of the porphyritic granite extend into it. The following note was made on these granites:—"The granites near the coast are fine-grained, generally of a gray colour, but sometimes pinkish, greenish, or whitish; they are often foliated, especially the gray variety. The gray variety always contains hornblende, and often sphene; moreover, it often has small crystals of iron and copper pyrites, and specks of a green mineral (epidote?)" At the end of Spiddle strand is a course of foliated felsite, and at the west end is a N. and S. small quartz vein, in which is a trace of galena. North of Spiddle, alongside the road, is a course of riband felsite, and further N. is an east and west quartz lode (N. 75° E.). Two miles west of Spiddle, at Kilroe, is a nearly E. and W. lode (N. 80° W.),* and south of it on the shore is a N. 10° E. wide course of pink felsite, and further westward, at Loughaunbeg Point, is a north and south course of felsite. A little N.E. of the point are two bed-like courses of felspathic rock bending round a nucleus of granite, the lowest being porphyritic and the upper a green felsite. Further west, south of Tullaghalaher Lough, is a small N. 10° E. course of felsite, and a mile S.W. of it, on the sea-shore, are a series of intrusive courses and dykes:—first, at the east, a N. and S. felstone dyke; second, a N. and S. thin course of yellow or greenish quartziferous porphyry, which can be followed northward by Ballard to the road; third, a 10-inch green rock, one of the more modern igneous rocks, that bears N. 20° W., and can be traced northward nearly to the road; and at the by-road to Ballard there is an E. and W. 2-feet dyke of similar rock; fourth, a red felsite, slightly porphyritic; fifth and sixth, parallel dykes of the more modern igneous rocks; and seventh, a wide course of grayish yellow felsite, in places of a jasper-like texture, slightly porphyritic, and containing globules of quartz; north of this there is a small tract of felsite, and further north a N. 25° E. course.

To the north of the last locality at Lough Bealacooan there is a north and south course of yellow riband felsite, and northward of this is the previously mentioned large tract where porphyritic granite only was observed. However, when the metamorphic sedimentary rocks on the north and north-east are approached, although not so numerous as in the vicinity of Galway Bay and Galway, the supposed metamorphic igneous felspathic rocks again appear, and not only these, but also patches of the intrusive granite, and a foliation in the porphyritic granite that apparently is parallel to the planes of stratification in the overlying metamorphic sedimentary rocks.

Thus north-east of Seecon Lough there is a peculiar yellow felsite, that seems to be a mixture of felspar and an epidotic mineral, with in places globules of quartz;† while further N.W., and east of the south part of Lettercraffroe Lough there is a tract of country occupied by the *intrusive granite* and masses of porphyritic felspathic rock. There is also near the N.E. corner of the lake a small N. 60° E. felstone dyke, which evidently is much more modern than most of the irruptive rocks in the district. Hereabouts the porphyritic granites are foliated, and the strike of the foliation seems to agree with that of the stratification of the metamorphic sedimentary rocks further northward. On the west of the lake it runs nearly east and west,

* In the porphyritic granite at the river near the Kilroe Loch, there was remarked a porcelain white, inclining to bluish, felspar, that, when decomposing, effervesced with acid. *Query*, could it be Labradorite?

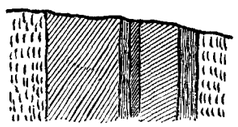
† This class of rock has a fracture approaching to *hackly*, while in the felsites and quartziferous porphyries it is *uneven*.

while on the east it bears nearly north and south and N. 45° W., with easterly and north-easterly dips at angles varying from 75° to 80°. In some of this granite there are systems of parallel oblique joint lines that bear east and west, with a north dip of 45°. East of this at Lough Namoreleen, the boundary of the granite suddenly jumps towards the north-east. This possibly might be caused by a fault, as the strike of the foliation in the granite, as before mentioned, is apparently in parallel planes to those of the stratification of the overlying metamorphic rocks, both having a bearing of about N. 50° W. which causes, as there is no bend in the strike of either, the continuation of the metamorphic rocks to be cut off by the porphyritic granite. Against the supposition of a fault is the enormous amount of the dislocation, being at least 6,000 feet; however, on looking at the one-inch map, it will be seen on the N.W. of this supposed line of fault, about a mile north of Lough Namoreleen, that the lowest beds of limestone above the granite are about the same thickness above the granite as the limestone at Buffy Lough, on the S.E of the line of the supposed fault. This question of a fault will again be referred to when describing the metamorphic rocks. Besides the supposition of a fault causing an irregularity in the boundary, it is quite evident that here an outburst of the intrusive granite helps to make it complicated, as a tract of this kind of rock, which sends veins into the metamorphic sedimentary rocks and the porphyritic granite lies half a mile west of the summit called Shannarea. South of Shannarea may also be a dislocation or fault jumping the boundary, a downthrow to the west. If it exists it would seem to be a compound or step fault consisting of two or three steps, two being apparent, and the third being suggested by the lie of the rocks. This would also be a large displacement, being about 1,000 feet; but that this fault does exist seems proved not only by the interruption of the boundary of the granite, but also by the beds of limestone in the neighbourhood of Buffy Lough, which also are displaced in coincidence with at least two steps in this fault.*

The boundary to the south-east of this is very regular, curving with the stratification of the overlying gneiss and schist, if we except the part south-west of Ross Lake, north of the summit called Knockranny, where there is apparently a large outburst of the intrusive granite.

What may be a proof that part of the porphyritic granite was formed *in situ*, that is, *some of the sedimentary rocks, from which it owes its origin, were only mineralized, not melted*, may be suggested by beds of what seem to be gneiss in the porphyritic granite. Some of these occur a little N.E. of Letter Lodge. Fig. No. 1, a diagrammatic sketch, shows these beds, which are peculiarly foliated, as apparently there are five separate divisions: the first, or south-west, having oblique foliation; the second, verticle, parallel to the foliation in the associated porphyritic foliated granite; the third, oblique; the fourth, slightly oblique; and the fifth, perpendicular. Further south-east, immediately north of the summit of Knockranny is a white rugged quartzite. Its relations to the granite are obscure on account of bog surrounding it, however, a little to the south, there is a green granite, having a mineral like epidote as an essential, which seems to be a peculiar variety of the intrusive granite; north of it, in the valley, is the large tract of the intrusive granite previously mentioned, while to the W., N.E., and E. of the hamlet called Cloghvalley, is the porphyritic granite. Between two and three miles

Fig. No. 1.



* It seems remarkable that hereabouts the metamorphic action should effect the beds in a greater degree only up to a certain set of beds, and apparently not irregularly, but that it does so would seem proved by the beds of limestone always being at about the same distance above the boundary. Further west, as will be mentioned in future Memoirs, the action does not seem to be so regular.

of Knockranny, a little N.W. of Danesfield, are felspathic rocks. A little west of the house, at the trigonometrical point △, 329, there is a N. and S. course of a poryphyritic rock, and a little further N.W. another, that is bounded on the east by porphyritic granite, while further north-west are small irregular tracts of yellow felsite, which in the stream west of the village called Drimmavohaun, is foliated, and dips N.E. at 80°, the overlying foliated porphyritic granite has a similar dip. West of these, close to the road, is a cliff of the intrusive granite, that in places is very pyritous and runs gaussen, on which account a short trial adit was driven in at the base of the cliff, but abandoned as no lode was found. North-west of this cliff of the intrusive granite, in the stream, mica schists occur between the foliated porphyritic granite and the boundary of the Carboniferous rocks. In the schist foliation seems to be oblique, and possibly may follow the cleavage planes, but it is just as likely to have been caused by oblique lamination.

VI.—*The Buffy Lough District or the strip of country occupied by Metamorphic Rocks on the N. and N.E. of the Porphyritic Granite Country.**—South-west of Ross Lake, and south of the village called Newtown, are gneiss beds that dip N.E. and N.N.E. at so high an angle as to be nearly verticle; some of these are granitic in aspect, and among them are a few small veins of granite. E., N.E., and W. of Shanballyoghery are small exposures of gneiss; in the last locality, there being an E. and W. vein of granite. Further north, south of Knockaunranny Eighter, are gneiss and felsite schist hat strike N. 70° W. In one place the gneiss seems to have small garnets; while further E. close to the boundary of the Carboniferous rocks, the dip of the gneiss, mica, and felsite schist is E. at 20°. At Knockaunranny Oughter, the rocks, gneiss, and felsite schist are much broken by veins and small tracts of the intrusive granite, the strike thereby running N. 50° W., N. 55° E., and N. 10° W., in the vicinity of the village. Further northward the lie and dip of the rocks are very much confused, the dips being, in various directions, apparently caused not only by veins and small tracts of the intrusive granite, but also seemingly by a mass of the supposed metamorphic hornblendic rock.

It was before mentioned, that southward of Knockaunranny Oughter, there was a slight dip to the N.E, while at this village it is to the S.W. at 80°, north of it, W. at 70°; and to the north-west at the hamlet called Doon S.W. at 60°. Further west, at the summit called Doonmore, and from this for a considerable distance to the N.W., near the boundary of the porphyritic foliated granite, there is a regular N.E. dip of about 80°. Further north-east, near the margin of the Carboniferous rocks, the beds again becomes confused, perhaps on account of the numerous veins and outbursts of granite and other intrusive rocks, combined with a synclinal fold; as the rocks which to the S.W. seem conformably to overlie the porphyritic foliated granite hereabouts again appear to crop up. Although the rocks adjacent to the porphyritic foliated granite strike so regularly, yet there are outbursts of intrusive rock among them. Forming the summit of Doonmore there is a small tract of hornblende rock, the conspicuous essentials in it being hornblende, felspar, epidote, and iron pyrites; and breaking up through it is the intrusive granite. Forming a slightly lower peak, a little to the N.E., is a small tract of similar rock, with granite coming up through, and alongside, it. It may here be observed, that many of the peaks of the hills in this country are formed of these supposed metamorphic, hornblendic rocks, although now they weather much more freely than the associated, metamorphic, sedimentary rocks, as proved by the ice striæ rarely being preserved on them, while they are common on the latter. On the slopes to the N.E.

* This is the south extension of the metamorphic rock west of Oughterard.—See Memoir, Ex. Sheet 95.

three dykes of granite were observed, the two southern bearing nearly E. and W., while the other runs N. 65° W. The foliation S.W. of the latter runs N. 65° W., while to the N.E. it is N. 47° E., which seems to prove that the granite vein runs along a line of dislocation, or fault. About a mile north-west of Doonmore, at and in the vicinity of the summit of Knockseefin are various intrusive rocks; a little south of the summit is a N.E. and S.W. dyke of a gneiss-like rock, supposed to be a metamorphic, felspathic, rock, was seen cutting the beds obliquely. Forming the summit, but ruptured by granite veins, is hornblende rock, of which the following description was noted:—"Schistose hornblende rock forms the peak of this hill. It breaks up through and across the beds of the associated gneiss and schist; nevertheless, its foliation, although wavy and curled, has a general parallelism to that of the metamorphic sedimentary rocks. Patches and pipes of similar rock, occur in the vicinity of the peak, especially to the south and south-west." A little north of the peak is a second vein of a gneissose rock that bears N. 50° W. The metamorphic sedimentary rocks are principally hornblendic gneiss and schist; however, many of them are micaceous, moreover, there were beds of felsite and epidote schist observed. Half a mile north-west of Knockseefin a small tract of granite was observed, and north of the peak is a N. 30° E. course of quartziferous porphyry. The latter is probably connected with a small tract of similar rock, observed about half a mile S.W. of Buffy Lough, being a somewhat similar rock to the quartziferous porphyry, under the west part of the town of Galway; here one of the essentials of this rock seems to be a green mineral like epidote. From a mile to a mile and a half E.S.E. of Buffy Lough there are small veins and outbursts of granite in vertical gneiss and limestones. The granite ruptures the beds, also a nearly N. and S. fault a downthrow to the west, however the beds on both sides of the fault strike nearly east and west, while further west they range N. 67° W. The limestones are very white and pure. Lying immediately south of the granite, on the west of the fault, is a very small tract of hornblende rock, and east of the fault, south of Gortacarnaun Lough, is a small mass of white quartzite, but its relations to the other rocks are unknown, as it lies isolated. The limestones can be traced north-westward to Buffy Lough; however, they seem to be shifted twice by faults, one being S.W. of Knockaffrin Lough and the other a little S.E. of the south end of Buffy Lough. Immediately west of Buffy Lough the beds (gneiss and schist, with a few beds of greenish quartzite and felsite schist), dip S.W., at from 70° to 75°. Immediately south of the old Corn Mill is the site of an ancient iron furnace; when this was used could not be learned; however, there is a tradition, that the ore was brought here from Spiddle for the sake of the fuel on the hills hereabouts, which at that time were clothed with wood; and as the ore thereabouts is the bog iron ore, perhaps it was that which was smelted.

North-east of Buffy Lough a rather extensive tract of the intrusive granite occurs. The gneiss and schist on the north of it dips south at from 70° to 80°, while farther north, on the margin of the bog, is hornblendic gneiss that dips N. at 60°. This anticlinal curve seems to extend north-westward along the margin of the bog. A little N.E. of the lake that lies N.W. of Buffy Lough, and forming the summit of the hill called Maghera, is a small tract of intrusive granite, while a little S.E. of it is a much smaller patch, and associated with the latter is green felsite. The metamorphic sedimentary rocks hereabouts dip S.W. at from 80° to 88°, while south of this lough they dip N.E. at from 75° to 88°. At the south-east end of the lake is a bed of limestone; this is about a mile from the boundary of the foliated porphyritic granite, as also were all the detached pieces of this limestone bed previously mentioned, which would seem to suggest that the jumps in the boundary of the foliated porphyritic granite are caused by faults. A little south of

the limestone is a mass of rock that seems to be one of the more modern dioritic igneous rocks. West of Buffy Lough, in the river, is a vein of granite with flying veins of quartz, containing calcite, fluor spar, and traces of copper with iron pyrites.* Further west, running parallel with the boundary of the porphyritic foliated granite is a dyke of compact felstone in hornblende schist; this dyke-rock seems to be one of the more modern intrusive rocks, as it runs across one of the lines of fault that displaces the boundary of the granite. N.W. of this, immediately east of the summit of Shannarea, is a tract of seemingly metamorphic hornblendic igneous rock, being partly hornblende rock and partly the greenish granite, before described, as sometimes being an associate of the hornblende rock. Here these two kinds of rock seem to merge into another, but possibly the granite may be the intrusive granite, which has taken up constituents from the hornblende rock and become incorporated with it. Hereabouts the sedimentary metamorphic rocks dip E.N.E. at from 60° to 70°, those nearest the foliated porphyritic granite having the lowest dip and being principally hornblendic gneiss, with a few beds of green schist; and in the gneiss there seems to be small patches of hornblende rock. Above them are hornblendic and micaceous gneiss and schists. In a few of the latter, epidote seems to be an essential. Among these rocks will also be found a few small veins and patches of granite. Farther west, a little N.W. of the previously mentioned considerable tract of the intrusive granite is a patch of hornblende rock, lying a little S.E. of Loughaunorn, through which is a granite vein, and south-west of it at the edge of the lake is an outburst of the granite that seems to be entangled up with an epidotic felsite. Here there is a rupture in the beds of the gneiss and schist as the strike suddenly turns to the S.W., however west of the stream the beds follow their original course. South and south-west of the lake is a long irregular N.W. and S.E. tract of hornblende rock, cut up with veins and patches of granite, and further S.W., forming the peak of Derrada, is a tract of hornblende rock. The sedimentary metamorphic rocks dip N.E. at from 75° to 85°, and seem principally to be hornblendic; however, interstratified with them are micaceous schists and gneiss. In some of them were remarked small nodules of an acicular variety of hornblende rock. A little N. W. of the summit of Derrada is a small patch of hornblende rock, alongside which is granite, and in the neighbourhood are veins of the latter kind of rock, while to the S.W., a little north of the north end of Lough Namoreleen is a small tract. A little farther west is an outburst of hornblende rock, and to the south-west of Lough Namoreleen is an E. and W. course of granite, while to the N.W., half a mile N.E. of Lettercraffroe Lough, is a vein of gneissoid rock cutting across the beds, but being foliated. Here the strike in the beds has a slight easting, the dip being a little more towards the east (N. 60° E.) than that last recorded. Half a mile northward of the foliated dyke is a small oblong tract of hornblende rock, and farther west, at and in the neighbourhood of Knockwaumnamoe, there are veins of hornblende rock in the gneiss and schist, and close to the trigonometrical point, △ 794, is a vein of epidote rock, while south of it are pyritous and epidotic schists.

A mile N.E. of Knockwaumnamoe there are beds of limestone that strike about N. 50° W. parallel to the boundary of the foliated porphyritic granite; they are also about a mile from that boundary. These facts seemingly are important, as this locality is north-west of the large jump in the boundary, and as these limestones are at the same distance from the boundary as those previously mentioned in the neighbourhood of Buffy Lough, and the dip is about the same, it would seem to suggest that this jump must be caused by a fault notwithstanding the enormous amount of a throw a fault would necessitate.

* Small trials were made at this place, but only flying veins were found.

At the north-west corner of the district there is part of a tract of the intrusive granite, which extends into the districts on the north and west. Half a mile east of this, in a ravine, is a remarkable dyke-like mass of conglomerate, which seems to be part of the basal conglomerate of the carboniferous rocks that was deposited, filling up a fissure in the more ancient rocks. South-east from this there seems to run the axis of a synclinal curve, as thereabouts are limestones that on the south dip N.E.,at from 50° to 80°, while those to the north dip S.W. at 70°. Under the limestone is a massive gneiss, or perhaps some kind of eruptive felspathic rock ; it breaks up into angular fragments. A little west of this there seems to be a nearly north and south fault, that shifts these beds to the northward, beyond the limits of this district ; however, further east other limestones appear at the margin of the bog, seemingly brought into their present positions by a fault, a downthrown to the E. They are nearly vertical, but appear to have a slight dip to the north, while the rocks on the west of the fault dip N.N.E. at 80°. A little N.N.W. of these limestones is a small tract of granite. Farther eastward, and S.E. of Lough Ateeaun, are beds of limestone that dip to S.W., at from 75° to 88°. In these are lenticular patches, irregular beds, and nodules of gneiss and felsite ; moreover, they are much broken by veins of granite, and to the S.E. they are replaced by a tract of that kind of rock ; no limestones occurring for nearly a mile to the south-east, where they were observed in the neighbourhood of Lough Tawny, south of the hill called Croagh-na-cloosh. In the neighbourhood of this hill the country seems very much disturbed, for as just observed, there are limestones to the N.W. and S.E. of the S.W. spur of it. These have similar strikes, and lie in the same course (nearly N.W. and S.E.), and dip S.W., at from 75° to 88°, but between them the rocks strike east and west ; moreover, on the north of Croagh-na-cloosh, at the south Cregg lode there are limestones that strike E. and W., and dip S. at 80° ; evidently being part of the limestones that lie to the south and east, but pushed out here by some rupture or dislocation. Even in the vicinity of the lode the ground is very much disturbed, as proved during the mining operations, as the limestone at the lode is ruptured by an outburst of granite and a wide course of fine hornblende rock, and a very little further west is cut by a slide that runs N.W. and S.E. A little west of the slide are two nearly north and south dykes of granite, which seems to be cut off a little to the south by an E. and W. vein, of a similar rock ; south of which, in the strike of one of the granite veins, is a N. and S. dyke of felstone, that hades west at 60° ; while further south, in the same strike, and apparently in its continuation, is a dyke-like course of a rock, that seems to be quartzite. Immediately to the south, to the west of Croagh-na-cloosh, is a considerable tract of white quartzite, while at the peak, and extending west into the quartzite is an irregular long tract of granite ; moreover, on the east of the summit, and extending for some distance towards the S.S.E. by S. in a course of quartzite, that is bounded on the east by a course of granite, and a little S.S.E. of the latter course, in the gneiss and schist, are irregular veins of the same rock. The relations between the quartzite and the associated gneiss and schist are not very clear, as the hill is more or less covered with bog. These latter rocks in the neighbourhood of the south Cregg lode, east of Croagh-na-cloosh, southwest and immediately north of the quartzite strike E. and W., and dip at a high angle to the south, except due west of the quartzite, where they enter into it, and at which place there seems to be an anticlinal curve, the rocks dipping N.N.W. at 65° at S.S.W. by S. at 70° ; also further north, near the margin of the bog, where they strike in the gneiss and schist suddenly changes and turns round to the north. Among the last-mentioned, seemingly lying between the beds, and very near to the western tract of the granite, is a nearly north and south course of white quartzite. All the

quartzite in the large tract seems to strike E. and W., and be vertical or dip north at a high angle. From this it would appear that the gneiss and schist do not overlie it, neither do they seem to be interstratified with it, but possibly it may in some way be connected with the granite, for in other places, as presently will be mentioned, the intrusive granite seems to lose its felspar, &c., changing through *greisen* into quartzite. That this quartzite is an irruptive rock would seem to be suggested by the dyke-like course, which extends S.S.W. by S. from the peak of Croagh-na-cloosh. Some of the metamorphic sedimentary rocks bordering the granite seem changed into hornstone. North of Croagh-na-cloosh, at the margin of the district, is the south extremity of the Oughterard granite district (*see Memoir, Ex. Sheet* 95) ; and further north, outside the limits of this area, mixed with the granite are quartzite, greisen, and felsite rock, all apparently being parts of one mass of irruptive rock. If this is the case the granite, in places, must have lost its felspar to become greisen ; more of it, also its mica and other constituents to change into quartzite, while in some places, on the other hand, part has lost its quartz and mica, and changed into felsite rock. In the quartzite and greisen there is a structure somewhat like foliation ; however, it is very irregular, as in some places it seems to strike nearly N. and S., while in others E. and W., and N.W. and S.E. Might it not be possible that for some cause, with which we are unacquainted, the constituents instead of being incorporated together to form granite, have been separated, thereby appearing in some places as quartz and greisen, and in others as felsite rock ; while in the places where this cause did not act the constituents formed the ordinary intrusive granite.*

Foliation in the Metamorphic Sedimentary Rocks.—In this part of Yar-Connaught the foliation in the gneiss and schist appears always to follow the lamination in the original rocks. In a few places there is an oblique foliation that possibly might be induced by the cleavage planes ; however, it is more likely it was caused by oblique foliation, for, to the north, in the country a little S.E. of Westport, county Mayo, where the rocks are partly metamorphose, it is evident that rocks, in which a similar foliation appears, were originally obliquely laminated highly micaceous sandstones. Rocks, in which this oblique foliation was remarked, occur in the country S.W. of Ross Lake, especially in the stream a little S.W. of Drimcong House. The lamination in the original rocks would seem usually to have been parallel or nearly so to the planes of stratification, therefore, in general, throughout this district the foliation is parallel or nearly so to the bedding ; but in some places, as previously remarked, there is oblique lamination, and in others, there is spheroidal, wavy, or curled and crumpled foliations, which seem respectively to be introduced by the oblique, spheroidal, crumpled and curled laminations. In both arenaceous and argillaceous sedimentary rocks oblique lamination occurs, but more especially in the former, therefore the oblique foliation appears in both gneiss and schist.†

Spheroidal lamination usually effects shales, but in some classes of sandstones it also occurs, therefore, spheroidal foliation may be found in either gneiss or schist ; but in this district the spheroidal foliation seems nearly altogether to be confined to the schists.

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* The geology hereabouts is very much obscured by bog, the rocks appearing in detached bosses. Possibly the felsite, quartzite, and greisen, may be metamorphic rocks entangled with the vein granite ; however in places, outside the limits of the area now being described, quartzite and greisen are known to gradually change into the intrusive granite, and in the neighbourhood of Barna House, as previously mentioned, (see page 29), the granite seems to change into felsite rocks, for these reasons it has been considered possible that here these different varieties may be part of one mass.

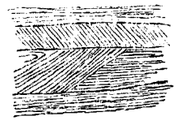
† Argillaceous rocks, first generally are metamorphosed into varieties of schist, but arenaceous rocks do not always alter into gneiss, as, for instance, a nearly pure sandstones changes into a quartzite or quart schist, and a micaceous sandstone may change nto a mica schist.

The crumpled or wavy lamination seems only to occur in shales, therefore crumpled foliation ought only to be found in schist, and as nodular lamination is common to both arenaceous and argillaceous rock, so nodular foliation occurs in both gneiss and schist. The metamorphic limestones that here occur, are, for the most part, schistose, and may be classed with the other schists; however, it might be mentioned that the foliation which seems most to effect them are the crumpled and nodular; and when these occur together it is not unusual to find all traces of stratification obliterated.

To the N.W. of the district, a little north of Knockwaumnamoe, there is nodular, curled, and oblique foliation in the rocks; of one locality the following note was made—"nodules of gneiss in mica schist; in the former the foliation is oblique, while in the mica schist it curls round the nodules." Fig. No. 2, is a plan of part of this bed. These nodules of gneiss in schist seem to be caused by the lumps of grit found in many curled shales. A little south of Knockwaumnamoe peculiar oblique foliation was observed, of which, Fig. No. 3, is a plan showing parts of four beds. At the left-hand side of the second nearest beds, the foliation is inclined to be nodular.

Fig. No. 2.

Fig. No. 3.



In the townland of Rusheeny, south-east of Lough Ateeaun, there is most complicated foliation in the schistose limestone; as there are lenticular masses, irregular beds, and nodules of gneiss and felsite in the rock round which the foliation curls; moreover, in places combined with the nodular foliation, there is a sort of spheroidal foliation with crumpled foliation; but, as there are such peculiar and intricate structures in most unaltered limestones it does not appear remarkable that in the metamorphose rock the foliation should be complicated, if this induced structure always follows the conspicuous structures in the original rocks. The foliation at this place is so complicated that no sketch can be given, as it would be impossible by hand to make a fair picture of them.

In the townland of Killaguile and S.S.E. of Buffy Lough, rocks were observed in which the foliation curls round nodules, while in the latter there is oblique foliation. On the south of the summit of Knockseefin a peculiar crumpled foliation was observed (see Fig. No. 4), which seems to have been caused by small faults in the rock before it was metamorphosed. Farther south-east, near the old road S.W. of Doonmore, peculiar oblique foliation was observed, of which the Figs. 5 and 6, represent two separate sets of

Fig. No. 4.

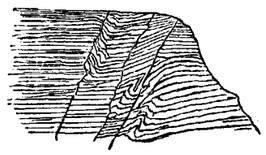


Fig. No. 5.

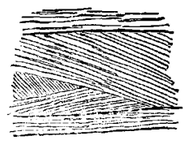
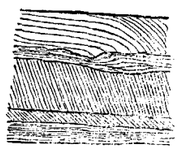


Fig. No. 6.



beds. In the neighbourhood of Galway the foliation generally is parallel to the stratification; however, in the flat south-west of Lough Atalia, some good examples of curled and nodular foliation may be observed.

Drift and other Superficial Deposits

In the drift there seems to be three well-marked classes, viz., *Boulder clay drift*, *Boulder drift*, and *Esker drift*. However, there are also varieties of these drift, as will presently be mentioned. The first is a clayey deposit containing rounded, polished, and scratched blocks; the second is a sandy clayey accumulation, in which some of the blocks are rounded, but more usually the contained blocks and fragments are semi-angular, and in some cases angular; and, the esker drift seems to be the boulder clay drift, or boulder drift, well washed and sifted, perhaps by marine and tidal currents. Seemingly the passage from the latter to the former, is a half-washed drift, which on account of the numerous blocks it contains, might be called *Rocky drift*.

On the low country in the neighbourhood of Lough Corrib, the usual drift is boulder clay drift, that in places is washed into the esker drift, with the accompanying half-washed rocky drift. In the boulder clay drift, the rounded polished and scratched blocks and fragments generally lie in a clayey matrix; however, in a few places will be found small lenticular masses and layers of gravelly sands. Besides, in it a good per-centage of the blocks and fragments are usually of foreign extraction, while in the boulder drift they are generally local.

J. W. Dawson, LL.D., F.R.S., &c., Principal of M'Gill's College, Canada, in a paper published in the *Canadian Naturalist and Geologist*, new series, vol. iii., No. 1, on "Comparisons of the Icebergs of Belle-Isle with the Glaciers of Mont Blanc," seems to make a similar division in the boulder drifts. What here is called the *boulder clay drift*, he supposes to be partly of marine origin, that is, having been deposited from floating ice (icebergs), while what is called *boulder drift*, he believes to be of glacial origin. Of the former he says—"Floating ice sometimes heaps its debris in abrupt ridges, but more usually spreads its load in a more or less uniform sheet—they carry their deposits to great distances from their sources—mud is mixed with stones and boulders;" and of the latter, "Glaciers heap up their debris in abrupt ridges; the material is all local; the stones carried are mostly angular, except where they have been acted on by torrents, and most of the mud is carried off by the streams and deposited elsewhere."

The boulder drift, when in low valleys, often merges into clayey gravel and sand, and on some of the hill slopes, or in sloping valleys, becomes full of large blocks, and may be called *Rocky boulder drift*. That this latter drift is glacial seems proved by the rock surfaces under it always being polished and scratched, while the half-washed or rocky drift lies on weathered rocks or on boulder drift. The rocky boulder drift consists of innumerable local blocks, of all shapes and sizes, up to tons in weight. The sands and gravel associated with the boulder drift are distinct from the esker sands and gravel; for, while the latter are usually sharp and clean, like marine sands and gravel, these are clayey like those deposited by rivers. The esker drift, or post drift gravels, sometimes occur banked up in eskers (*anglice* ridges), at other times in low undulating hills, or piled against "drumlins," the esker-shaped hills of boulder clay drift.

There are also in a few localities a gravel that seems to be newer, and to have been ancient sea beaches, and scattered over the drifts are *erratic blocks*, while apparently subsequent to all are the *peat bog* and *alluvial flats*; the two last named are still being added to yearly; however, some of these bogs, or perhaps others that have now disappeared, seem to have existed prior to the formation of at least some of the gravelly drift, as will be hereafter mentioned.

In places along the shore of Galway Bay, peat with the roots of trees is found below high watermark; this might not prove that the land had sunk,

for at the present day, about two miles west of Galway, between Blackrock and Blake's Hill, is a morass below high watermark, in which peat and shrubs are growing. This morass is divided from the sea by a barrier of shingle, and in other places, where peat now occurs below high watermark, similar barriers might once have existed; however, against this theory, we find in a half-tide bog west of Blake's Hill, an oak stem, 12 feet long and 2 feet in diameter, immediately above the "corker" or butt. This tree could scarcely have grown on ground below the sea level; moreover, on the Aran islands at the mouth of the bay, there are proofs of the islands having sunk since they were first inhabited (*see Memoir Sheet*, 113).

The Low Country.

Adjoining Lough Corrib are extensive flats, consisting partly of marl and partly of peat; some of the marls contain recent shells, of which the following is a list named by Dr. Melville, of Queen's College, Galway:—

Limnea stagnalis.	Valvata piscinalis.
——— anbulata.	Planorbis marginatus.
——— peregra.	Cyclas cornea.
Bithynia tentaculata.	Succinea putris.

In some places the marl is laminated, a section of the alluvial flat alongside the Claregalway river gave—

Peat,	2 feet.
Marl, over	5 ,,
	7

The marl is usually of a mealy aspect, and in it are often thin layers of peat. It is of the same nature as that usually found adjoining the lakes and rivers whose waters are highly charged with carbonate of lime, and, as previously mentioned when describing similar deposits in Limerick and elsewhere, it appears to be deposited as the waters evaporate; while the peaty layers are plants, &c., carried or blown into the lakes or rivers.

At the south of Lough Corrib, bounded on the south-west by the river Corrib, and on the east by a lesser river called Menlough Creek, is a low peaty island now divided into two by a canal called the Friar's Cut,* which, during the works to make the lake navigable, was deepened and widened.

Under the bogs south and N.E. of Ballinduff Bay, and the bog S.E. of Annaghdown, there are clays from which are made a coarse brick.†

The most prevalent trees in the bogs are deal and sallow; however, in some, oak and yew, &c., also are found. Many of the deal "stick" are of considerable size. In connexion with the bog timber, it ought to be mentioned that on the limestone crags north of Ross Lake, there are the remains of very ancient yews, which seem to be coeval with the yew found in the bogs. Of these twelve were counted; however, many of these are mere stumps, parts of the trunks of three or four only remaining. Sir W. Wilde has figured the most perfect of these in "Lough Corrib," page 299.

Country near Galway.—The Country east of Galway between the sea and the alluvial flat adjoining the Claregalway river, is in a great measure covered by an irregularly undulating boulder clay drift. The fragments and

* The Friar's Cut is remarkable, as evidently it is artificial, and seemingly was opened as an exit from the lake, but why it was not made straight across the island is hard to conjecture. In the old or any records of Galway, there is no mention made of it, and if it was cut as a passage for boats, it ought to have been recorded. From its appearance it would seem as if it was begun from both ends at once, and when the operators saw they were cutting at nearly a right angle to one another, they joined their work by a straight line. This would seem to suggest that originally it was only made for a mearing or boundary ditch, and that afterwards it was deepened and widened by the water flowing through it.

† These are sold for 10*s.* a thousand.

boulders in it are, for the most part, limestone, but many pieces of foreign rocks were remarked, and Professor King, of Queen's College, Galway, informs us that a little south of Merview demesne he took out of it a block of Andalusite similar to what he found *in situ* in a vein in the hills S.W. of Lough Mask. Under the east suburbs of Galway, there are two ridges of the drift or "drumlins" that bear about N. 35° E., while under the suburb called the Claddagh, south of the town, is a drumlin that runs nearly N. and S.

Extending into the S.E. part of the flat, along the Terryland River, are ridges of rocky drift, that seem to be the boulder clay drift partly washed, and in the north-west part are small ridges of gravel. The latter seem remarkable for being nearly altogether composed of the debris of granite and metamorphic rocks, as the drift about is not of this nature; however, as this valley formerly was one of the exits for the waters from Lough Corrib, this gravel may thereby have been swept into it, they being of a similar nature to the beach next to be mentioned. On the hill above, on to the N.E. of Menlough, there are remarkable sea-beach-like banks of granite, gravel, and shingle, extending round the W.N. and E. sides of the hill. On the west side, it begins at the bifurcation in the road, immediately east of the small lake east of the village of Menlough, at a height of about 62 feet, and extends from that towards the N.E. for a mile, when it turns gradually round the hill and ends a quarter of a mile S.W. of Ballindooly Lough. To the north-west of the summit it spreads over a considerable part of the slope of the hill, a height of 152 feet being marked just above its margin. On the north-east end it is a well-defined shingle beach, on the N.E. an undulating gravel, while to the east on the slope of the hill it is in a sheet; a height of 64 feet being marked near its south margin, and one of 172 feet on the limestone crags a short distance above it, and in the Terryland quarry, Professor King drew our attention to a remarkable funnel or chimney full of a similar gravel. This funnel was opened for a depth of over 30 feet, and may be considerably deeper. Opposite to these gravels on the hills, west of the river, there is a remarkable terrace covered with small mounds, that have a general north and south bearing. This terrace, however, seems to be a little higher than the gravel beach just mentioned, as there is a height a little below it on the north, of 118 feet, and one on it at the hamlet called Letteragh of 176 feet. Below it, at between 40 and 70 feet levels, skirting the high ground from Glenlough to near Shantallow is an undulating drift principally a granite gravel that often forms well-defined small mounds and ridges. Those between Glenlough and Ashley Park being very irregular, while those in the neighbourhood of Newcastle have a nearly N. and S. bearing. Further south: north and west of Salthill, are other gravel mounds and ridges, that are on ground from about 45 feet high to the sea level, those to the north being more or less regular, and being nearly N. and S., while those to the west are very irregular, but still have a general similar bearing.

Country east of Lough Corrib.—East of Lough Corrib, and north of the Claregalway river flat, usually there is an irregularly undulating boulder clay drift, but in some places there is rocky drift, the latter occurring in the neighbourhood of Woodpark, and from this, in places, east to Lough Afoor, where there is an E. and W. esker about three quarters of a mile long, associated with it. Rocky drift will also be found N.E. of Lough Afoor, and in the country north of Ballinduff Bay. Granite erratic blocks are not plenty in this tract, the most marked being a large block a little east of Barranny, on the margin of the Cregg river flat, and another a mile further N.E., a little west of Lisheenanoran.

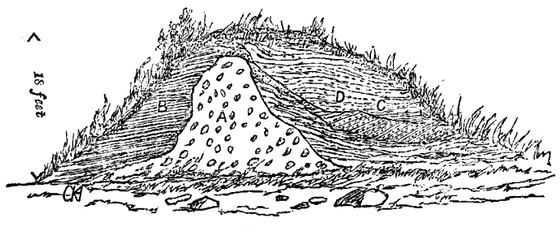
Country immediately west of Lough Corrib.—The low ground west of Lough Corrib is nearly altogether occupied by crags, undulating rocky drift, and bogs. Notwithstanding, there is boulder clay drift east of Ballycuirke Lough; between Moycullen Bay and Knockshanbally; in the neighbourhood of Gortachalla Lough; and patches N. and E. of Ross Lake. Banked against the

boulder drift east of Knockshanbally, there is a large deposit of fine quartzose sand of the kind usually called "rabbit-sand." The rocky drift is uneven and irregular, forming a very broken country, some of the contained blocks (limestone, granite, and metamorphic rocks) being very large.

Extending from near the south shore of Ower Bay to the N.W. end of Ross Lake is an esker. It is continuous from a little N.E. of Gortachalla Lough to a little S.W. of Ower, where it widens out, and extending northward from it are a few gravel duns in the bog. West of Ower, detached gravel duns and short ridges appear above the bog for about a mile, and further west the esker is continuous to the Galway and Oughterard mail coach road. The ground in the neighbourhood of this esker is between 30 feet high at Gortachalla Lough, and 60 feet in the neighbourhood of Ross, being on much lower ground than that on which the eskers in the central plain of Ireland usually occur; it also would seem to be of a more recent age, its formation being contemporaneous with the formation of the sea-beach (?) on the Menlough Hill, as the gravels forming them are similar. Moreover in gravel, that seem to be of the same age, pieces of peat were found.

North-west of its west end, skirting the hill country, is an undulating drift nearly always gravelly; however in a few places the boulder clay drift was observed, and in a gravel pit at Killaguile a section is exposed that shows the marked boundary between these two drifts (see Fig. No. 7). The drift

Fig. No. 7.



Reference.

A, boulder clay drift; B, stratified gravel; C, obliquely stratified gravel; D, pieces of peat in the gravel.

hills are very irregular, nevertheless the general tendency is to run at a right angle to the slopes of the hills to the westward, thereby gently curving the drift hills round their base. Some of these gravelly drift mounds are of a considerable height, others are low, while south-west and south of the Glebe there are regular small eskers. Some of these gravels appear to be similar to those of the esker, while others have a clayey nature like the gravels associated with the boulder drift—the former may have been formed at the same time as the esker by marine currents, while the clayey gravel, although formed contemporaneously, might possibly be of glacial origin, deposited at the edge of the sea by the glaciers flowing down the hill slopes. That peat bogs existed during the formation of some of the gravel, is proved by pieces of peat, marked D in the sketch, fig No. 7, having been found in the gravel at Killaguile.

At the east and west road, north of Knockaffrin Lough, there is an accumulation of very fine sand. This seems to be similar to the *blowing sand* that occurs in various places on the sea coast, but here being in a sheltered situation it is capable of being cultivated.

The blowing sand on the sea coast seems always to be at or opposite to the mouth of a valley down which it is likely a glacier once flowed, as the rocks in them are planed, rounded, and scratched, from which it may be considered probable that these sands are in some way connected with the ancient glaciers. In the present instance the accumulation of fine sand is

opposite the mouth of a valley down which a glacier is supposed to have come; as also are the fine sands mentioned a short time since, as occurring a little east of Knockshanbally.*

N.E. of Knockaffrin Lough, in Lough Naneevin, there is a crannoge or artificial stockaded island.

The following is its section near the centre of the island:—

Section No. 2.	feet.
3. Bog stuff, with a few bones, some sticks and stones,	3.5
2. A bed of regularly laid fern stalks and leaves (*Pteris aquilina*) on a flooring of wicker work, made of hazel rods, about an inch in diameter. Over the ferns were a few bones and a quantity of nut shells,	0.5
1. Bog stuff, mixed with branches of trees, and containing a few stones and logs of timber, this stuff was not bottomed,	5.0
	9.0

South-east of the west end of the Ross and Ower esker, there are also drift mounds and small ridges fringing the hills; they are more regular than those to the north-west having a generally N.W. and S.E. bearing, and only some being of the gravelly drift, while many are of the rocky drift.

To the N.W. at the foot of the eastern slope of Croagh-na-Cloosh, the gravelly drift is on ground between 120 and 50 feet high. S. of the Glebe there is a gravel hill whose summit is 125 feet, while further S.E. a little south of Laghtgannon, there are gravel and sand ridges on ground only 38 feet high, but it occurs up to 120 feet. West of Ross Lake there is gravelly drift on ground 33 feet high and extending up to 220 feet. West of Deerfield House, there is a well-marked terrace cut in the drift banked against the hill, at a level of about 154 feet. In the neighbourhood of Moycullen no gravelly drift was remarked, the ridges and mounds being of rocky drift; but further S.E., in the neighbourhood of Woodstock, the gravelly drift mounds again occur, and continue southward to those previously described at and to the S.W. of Glenlough.

From the above heights it appears many of these gravels may have been formed while the sea surface was on a level with the beach round the hill, N.E. of Menlough Castle. Those that are sharp and clean, partaking of the nature of esker sands and gravel, may have been washed by the sea, while the clayey, may be those whose origin was solely due to the glacial streams. In favour of this supposition it is found, that on the lower levels usually most of the gravels are of the former nature, while all on the upper levels are of the latter.

It was previously mentioned that on nearly all of the low tracts west of Lough Corrib, there is rocky or half-washed drift, and it ought here to be observed that this part of the district lies in the low valley of Ireland which extends from Killala Bay on the north, to the Shannon mouth on the south, skirting the high land of west Mayo, Galway, and Clare. (*See Captain Larcom's map to accompany report of the Land Tenure Commission*, 1845.) It therefore seems evident, that as the land rose, this ground ought to have been part of the land last under the sea, which may perhaps, account for its being nearly denuded of its envelope of drift, more especially if a current flowed over it from north to south, which does not appear unlikely, for scattered over these bare crags are numerous blocks, some of very large size, most of which seem to be the residue from the drift, and under some of them are patches of the boulder clay drift. These patches usually only occur under blocks, *whose northern ends rest on the crag*, from which it has been inferred that the drift was swept away by a current from the north; only one exception to this general rule was observed; which occurs at the west margin of the

* The rivers and streams from glaciers are "white and turbid" from the amount of silt carried down in them, and may not these fine sands in connexion with glacial valleys be the silt which was deposited from these rivers at or near their mouths?—See description of blowing sand on the Aran Islands, with suggestions as to their origin, Memoir Sheet 113.

Ower bog, where a large horizontal table-shaped block of limestone, about 15 feet square, rests on a pedestal of boulder clay drift. As the land rose the current must have been deflected out of this valley; after which the waters in it would have been affected only by the tides, and by these latter the esker bar may have been formed, it marking the place of meeting of the north and south tidal waves. Many of the larger erratics, evidently since they were deposited in their present sites, have been split into pieces; some observers suggest that these are blocks which were dropped from passing icebergs the force of their fall shattering them; this, however, does not seem satisfactory to account for their present condition, as some of these split-up blocks occur on drift, and before the force of the fall could have shattered them, it must have buried them in the drift, or the drift would have acted as a cushion to break the force of the fall. A good example of one of these split-up blocks on drift occurs immediately west of the coach road from Galway to Oughterard, due south of the S.W. arm of Ballycuirke Lough, and a little N.W of Lough Aceelagh; it now consists of eight blocks, each of which would fit into its fellow, and thereby show the original size. To us it seems that as the joints in the rocks weathered, they filled with water, which during frosts became ice, and thereby acted as wedges to split them up; more especially as in the hills to the west large blocks have been observed, which must have been moved from their natural beds by an exactly similar process.

The amount of loss the surface of the limestone rocks have undergone from atmospheric denudation can be learned from such of these blocks which lie on the wild crags away from human works, as under them the limestone has not weathered, and they now stand on low pedestals of rocks. In cultivated land, and where they are near the fences across the crags, the pedestals are much higher, as the natives have removed sometimes more than a foot in depth of the surface stones to form houses, &c., thereby apparently increasing the weathering. It should be mentioned that nearly all the smaller blocks lie along the open joint lines, while the larger ones are scattered promiscuously about; from this it would seem that after these joint lines were weathered, the smaller blocks were rolled about by water or some other force. On the eastern shores of the lakes there are more blocks than on the western. This seems to be due to the prevalent winds coming from the west, therefore the water acts upon and carries away the clayey matter in the drift, leaving the rocky residue on the eastern shores more than in other places.

The Hill Country.

On the hilly country the drift is usually the boulder drift; on the hills and slopes often the rocky variety; while in the low valleys the sands and gravels may occur; however, on the ground south of Lough Corrib, patches of a boulder clay drift, in which the principal blocks are carboniferous limestone, are frequent in all the valleys that open to the north, and a similar drift was observed in the valley south of Knockbane, and extending to the sea between Spiddle and Furbogh. There are also drumlins of this kind of drift between Blackrock and Barna; the two nearest to the former place being called Knocknacarragh and Blake's Hill; these bear about N. 25° E., and have at their N.N.E. ends post drift gravels banked against them. The matrix of the boulder clay drift is very limy, and many of the contained blocks are carboniferous limestone; however, there are many blocks and fragment of granites, and metamorphic rocks, *all* of which were recognised as belonging to rocks *in situ* among the hills to the northward.

Professor King pointed out that near the base of the sea-cliff, bounding Blake's Hill on the S.W., there is a lenticular mass of a stratified sandy clay.* Knocknacarragh is thirty-eight feet high, and Blake's Hill 105 feet;

* When this extends below high water of neap tides it is full of Pholas.

the cliff at the S.S.W. being forty feet high. South of Blake's Hill is a smaller drumlin, fifty-six feet high, called Illaunafamona, seemingly entirely composed of the boulder clay drift, and having a similar bearing to the two others. S.W. of Blake's Hill is a nearly N. and S. drumlin (N. 10° E.) called Knocknagoneen, which slopes from the cliff (seventy-eight feet) inland, and has at its north point post drift gravels banked against it. In Knocknagoneen cliff section, lenticular beds of gravel, that seem to merge into the boulder clay drift, occur in the western part of the section. N.W. of the last hill in the neighbourhood of Barna House, there seems to be limestone drift. Further northward E. and W. of St. Oran's Cottage, there are shallow nearly N. and S., valleys where some of the previously mentioned patches of this limestone drift occurs; those in the former being observed as far south as the hamlet called Tonabrocky. In the valley extending southwards from Woodstock, limestone drift also occurs in small detached patches, being observed nearly as far south as Drum Lough, east. In the valley, S.S.E. by S. of Kirkullen, detached small patches of this drift were observed near Pollnaclogha, Corboley Lynch, Corboley Morgan, and at Aille, but in the last named place, the blocks and fragments of the limestone are not very numerous.

In the valley south of Knockbane, the patches of this drift extends nearly across the granite ground to the sea, however here also the drift becomes less limy, and the blocks and fragments of the limestone fewer as the deposit is followed towards the south. South of Knockbane at Polleha, Drimmavohaun, and Carrowlustraun, the patches are rather extensive, being respectively at heights of about 270, 275, and 260 feet. Further south, in the neighbourhood of Keeagh Loughs there is good limestone drift, although in very small patches, and some of the contained blocks are so large that at first they might be mistaken for an outlying patch of the Carboniferous limestone; and near Laughil there is limestone gravel worked for manure. S.S.W. of Laughil, there are N. 15° E. drumlins of drift in all of which fragments and small blocks of limestone occur, the drift being so limy that it can be profitably worked for manure. Hills in which this drift was observed occur at Gortgar, Knocka Lough, Knock, and between that and the hill called Knockagurraun. Of the latter hill, no section could be seen; however, it is noted—"the drift seems to be limy;" but a little south southwest of Knockagurraun is a small narrow drumlin, in which the drift does not seem to have any limy matter in it; but further south, a little north of the hamlet called Ballintleva, there is another drumlin, in which a few limestone blocks and fragments were detected.* Further west, in the valley of the Boliska river, are detached drumlins of drift, some of which seem to be limy, more especially those in the neighbourhood of Ardderroo Lough, but as in none of them are sections exposed, no limestone blocks or fragments were detected.† The hills south and south-west of Cloghvally bear N. 60° E. to N. 40° E.; the hills about Ardderroo, and from that to Knockatee Lough vary in bearing from N. 5° E. to N. 25° E., and a small hill that lies about half a mile north of Boliska Lough, ranges N. 10° E., and S. 10° W. Still farther west there are other drift deposits; inland, they occur in massive steeply undulating hills, that southward are inclined to have more regular features, while farther south towards the sea-board, they occur in well-marked drumlins. In the neighbourhood of Seecon Lough, Finnaun, and Shannapheasteen, there are massive drift hills, all of which have more or less a coating of peat. These extend about half a mile south of Bealan-

* As the boulder clay drift in all these valleys becomes less limy as it is traced towards the southward, it seems to point to the drift having come from the northward; moreover, the granite blocks in the hills east of Barna, as previously mentioned, are similar to rocks *in situ* in the country to the northward.

† All these Drumlins have certain relations to the striæ observed on the rocks in their vicinity, for particulars see "Remarks" in the accompanying table of supposed ice striæ.

ambrack; however, south of Loughaunayella, and west of the north part of Loughanillaunmore there are N. and S. drumlins. There is also further west, a little north of Lough Bealacooan, one, the south slope of which is covered with blocks, and about a mile and a half N.W. of the same lake there is an isolated N. and S. drumlin, called Tullynasheoge and half a mile on its S.E. another. In general, all these hills have bluff ends, pointing southward, while they tail northwards, and this would seem to be the general rule with similar drift hills on these and other hill slopes in Yar-Connaught;* moreover, on the south end of some of them, not only here, but also on uncultivated drumlins in the low country, east of Loughs Mask and Corrib, there are numerous large erratic blocks (see Ex. Sheet 85). Southward of the last mentioned hill, for near three miles, no drumlins occur, but near the sea there are four; three on the west of Dooletter, and one on the east, immediately west of the hamlet called Caher, on the one-inch map. These four hills run due N. and S., and their matrix appears to be a little limy, although after careful searches, not a fragment or boulder of limestone could be found. Further N.W., a little S.W. of Tullaghalaher Hill, there is a very small isolated drift hill.

In some places on this slope will also be found the rocky boulder drift, as for instance, near the west margin of the district between Loughs Ugga-More and Nambrackmore; further E., N.E. of Loughaunbeg, and near the sea between the west limit of the district and Barna, more especially in the neighbourhood of Furbogh, where the dressed hummocks of rock are capped with hillocks, in which some of the contained blocks are tons in weight.

In some of the northern and north-eastern valleys that open towards the Oughterard and Clifden valley, and the valley of Lough Corrib, there are remarkable drifts. The valley between Knockwaumnamoe and Derrada is very steep, and at the head of the valley is a "*maum*" or "connecting mountain gap," while above the maum, or to the southward, is an extensive undulating table-land.† In this valley is a very rocky boulder drift formed of most irregular hillocks, usually thickly together, but sometimes scattered about; on them, in them, and between them, are angular blocks of every size and shape, up to tons in weight, the largest being 36×54×15 feet. Most of the large blocks are the porphyritic granite brought from the south, and the largest block is nearly a mile north of the porphyritic granite *in situ*. These hillocks of rocky boulder drift would seem to have been the rock debris carried in a glacier, and left here, when it finally melted. It should be mentioned that to the N.W. of Shannapheasteen there is a valley also leading out from the table-land just mentioned, in which there are irregular hills of drift, but not as rocky as these in the valley last mentioned; another leading south-eastward into the valley of the Boliska river; while towards the east there is a valley leading out of it occupied by the rocky boulder drift. The last named valley will hereafter be mentioned.

* See description of drift hills N.W. of Oughterard. Memoir, Ex. Sheet 95.

† North of this valley, immediately outside the limits of this district, is a lake called Lough Agraffard, which must be of considerable depth, as the people of the neighbourhood say it is unfathomable The lakes in the valley between Clifden and Oughterard, and in fact in all the valleys of Yar-Connaught, are usually long and narrow, coinciding with the lie of the valleys; however, in some places where transverse valleys join into the main valleys, the lakes are not of the usual shape, but a gut will run from them towards the transverse valley, or they will incline to be more or less roundish. As the lakes run with the valleys, and the latter have evidently been occupied by glaciers, may it not be presumed that their "rock basins" have been scooped out by ice? If this is allowed, would it not account for the shape of lakes opposite to transverse valleys being modified, as the ice from the transverse valley must affect them more or less; and this would seem to be the case with Lough Agraffard, opposite the valley between Derrada and Knockwaumnamoe, for this lake is of a roundish shape, extending southward to meet the transverse valley; moreover, the great depth of the lake might have been caused by the steep slope down which this glacier flowed, and on the table-land may there not have been a sheet of perennial snow, or *mer-de-glace* to supply the glacier?

In the Clifden and Oughterard valley the drift seems as if it was slightly modified by water, and of it the following note was made.—"On the slopes of these hills, to the south of the valley, the drift above the 300 feet level is always rocky and rugged, and has on it perched blocks, while below this level much of it is gravelly, and forms smooth hills." Fig. No. 8 is a sketch of some of the hummocks of rocky boulder drift on the north slope of Slieverusheeny. Adjoining the bog south of Lough Ateeaun, are small ridges of clayey gravel, and in the high valley to the S.E. and S.W. of Croagh-na-Cloosh, there are small mounds of boulder drift, most of which bear about N. 75° W. On Croagh-na-Cloosh there are many large perched porphyritic granite blocks that must have been carried a considerable distance, the lagest is 25×19×15 feet, at a height of 420 feet.

Fig. No. 8. Hillocks of Rocky boulder drift (Slieverusheeny).

On the east, nearly due-west of Buffy Lough, there is the previously mentioned valley coming out from the undulating table-land, having its slopes covered with most irregular hillocks of very rocky boulder drift. It seemingly was also the site of one of the ancient glaciers, fed by the perennial snow or *mer-de-glace* which may be supposed to have formerly occupied this undulating table-land; moreover, opposite this valley is the previously mentioned bank of quartzose, or rabbit sand, at Killagille, which, when being described, was suggested to have been carried down by a glacial river, and deposited opposite its mouth.

West of Knockbane there is a valley where the slopes are also covered with the rocky boulder drift, and apparently a glacier formerly also flowed down it, more especially as opposite to it is the deposit of rabbit sand, previously mentioned as occurring near Knockshanbally.

In other small valleys the rocky boulder drift was also observed, and in each case it seems to have been the residue left when a glacier finally melted.

It may here be mentioned that just above the gravelly drift south of Glenlough, at the hamlet called Ballagh, there are huge porphyritic granite blocks, seemingly being part of the rocky boulder drift that occurs thereabouts. The largest is 21×24×20 feet. Part of an adjacent one was split off and carried to Dublin to form the pedestal for Dargan's monument, Leinster Lawn, Merrion-square. Other huge boulders occur further south in the vicinity of the road from Shantallow to Corboley.

Dressed rocks, striæ, &c.—All over this district the rocks are more or less rounded, planed, polished, or scratched, seemingly by ice, as they are similar to the dressed and planed rocks moulded by the ice of the present day in Arctic and Alpine regions. In this area there appears to be two distinct systems of striæ, the oldest, which may be called the *Primary striæ*, have a general nearly N.E. and S.W. bearing, and are supposed to have been made by the ice that planed down the central plain of Ireland, and formed the boulder clay drift, while the others seem due to a system of glaciers that had their source in the hills of Yar or West Connaught. Of the latter, the main glacier would seem to have come down the valley of Lough Corrib, and then turned west down the valley of Galway Bay, having a large branch up the valley west of Oughterard, and another up the valley of Maum, both outside the limits of this district; however, some of the ice, from the hills to the N.W., would seem to have gone northwards into the Oughterard valley, previous to reaching the Lough Corrib valley. Besides these great branches, all the minor valleys seem to have sent down tributaries not only into the Lough Corrib valley, but some direct into the valley of Galway Bay; and after the ice had retired up into the Lough Corrib valley, there would seem to have been a few small local glaciers still coming down from the hills on the north to the Galway Bay valley, otherwise some of the striæ could scarcely be accounted for.

In the accompanying table there has been an attempt made to group the different striæ according to the parts of the glacier, or branches of the glacier to which they belonged.

TABLE OF SUPPOSED ICE STRIÆ.

County Map.	Townland and Locality.	Striæ A.	Striæ B.	Striæ C.	Striæ D.	Striæ E.	Remarks.
–	–	–	–	–	–	–	Striæ A are supposed to be the primary striæ, while the others seem to belong to local glaciers; B being those of the Galway Bay glacier; C of the Lough Corrib Valley glacier, a branch of the former; D of the feeders into the Lough Corrib and Galway Bay glaciers, and E those of the minor valleys.
Galway, 53/4, .	Derryeighter, near summit of Knockwaumnamoe.	–	–	–	–	–	Rocks rounded and dressed; but striæ obliterated by weathering. Height, 794 feet.
Galway, 53/4, 54/3,	Derrada, on the N.W. slope of the hill.	N. 55 E.	–	–	–	–	This striæ seems to have been cut by a force coming from the N.E. Nearly all the rocks are dressed and striated between the heights 600 and 800 feet. On the hill of Derrada there is a steep escarpment at about 650 feet towards the west, while towards the east, at about a height of 500 feet, there is a sloping escarpment. In this townland, and also that of Derryeighter, the northern slopes of the hills are covered with hummocks of rocky boulder drift, with large erratic blocks down to about the 300 feet line, below which most of the drift is more or less gravelly, and occurs in ridges or small drumlins.
Galway, 54/3, .	Glengowla, a little west of Lough Ateeaun.	–	–	–	{ N. 76 W. / N. 59 E. }	} N. 2 W.	All on one rock's surface. The N. 59 E. seem to be the oldest, and they and those that bear N. 76 W. may possibly have been cut by slightly different movements of the glacier flowing down the Oughterard valley, while the N. 2 W. belong to a minor flow from the hills on the south.
" . .	Rusheeny, ...	–	–	–	–	–	Drift mound (drumlins) in a highland valley about 300 or 400 feet in altitude; these have a general bearing of W.N.W. and E.S.E. with that of the general trend of the valley. To the north-east, at the margin of the flat bog, the rocks are polished, but no striæ were remarked.
" .	Clooshgereen, on the west shoulder of Croaghnacloosh.	–	–	–	–	–	Large perched erratic porphyritic granite blocks. Largest 25×19×15 feet.
" . .	Bunnagippaun, ...	–	–	.	–	–	The axes of the dressed hummocks bear nearly N.W. and S.E. They tail towards the N.W. and crag to the S.E.

TABLE OF SUPPOSED ICE STRIÆ—*continued.*

County Map.	Townland and Locality.	Striæ A.	Striæ B.	Striæ C.	Striæ D.	Striæ E.	Remarks.
Galway, 54/4,	Magheramore, on the west side,	–	–	–	–	–	At about an altitude of 300 feet there is a sloping escarpment of gravelly drift.
,,	Magheramore, at Kilgariff,	N. 68 E.	–	–	–	–	On the N.E. slope of a small hill.
Galway, 55/4,	Knock, on the road to the ferry,	N. 33 E.	–	–	–	–	This and the last-mentioned are supposed to belong to the primary striation.
Galway, 66/2,	Lettercraffroe, N.E. of the Lough,	–	–	–	–	N. 42 E.	As these seem to come from the S.W. they are supposed to have been cut by one of the ice streams flowing into the Oughterard valley. They occur at a height of about 650 feet, and about 50 feet below them is a rocky escarpment.
Galway, 67/1,	Derrada, at the summit, 955 feet,	N. 53 E.	–	–	–	–	These have a similar bearing to the older striæ on the low country east of Lough Corrib, and this hill is open to that plain, as no high ground intervenes.
,,	Lettercraffroe and Seecon,	–	–	–	–	–	Rocky drift escarpment, at an altitude of about 650 feet.
,,	Seecon,	–	–	–	–	–	No striæ remarked. There are conspicuous dressed rock hummocks that slope to the N.E. and crag to the S.W.
,,	Luggakeeraun,	–	–	–	–	–	No striæ observed; but the slope of the hill is covered with very irregular hillocks of very rocky boulder drift, with numerous large and small blocks, as if a glacier once flowed down the valley and left this debris when it finally melted away. The largest block observed is 27×12×15 feet.
,,	Derryvoghil, north face of Knockalecky.	–	–	–	–	–	No striæ remarked; but this face of the hill is planed into a gradual slope.
Galway, 67/2,	Derryvoghil, north-east slope of Knockalecky.	–	–		–	N. 45 E.	These might possibly be part of the older striæ; however, it seems more probable that they were cut by the glacier that left all the rocky boulder drift in Luggakeeraun.
,,	Carrowndulla, at a height of 200 feet,	–	–	–	–	–	No striæ observed; but the axes of the dressed hummocks bear N. 72 W.
,,	Killaguile, a little N.N.W. of the summit of Knockseefin, 872 feet.	–	–	–	–	N. 10 W.	These seem to have been cut by the ice stream that came down the valley on the southward. A block of the porphyritic granite, 15×15×7 feet, is perched close to the summit of the hill.
,,	Killaguile, S.W. part of townland,	–	–	–	–	–	A remarkable line of cliff at about an altitude of 600 feet, and fringing it below is an esker-like ridge of rocky boulder drift.
,,	Killaguile, south of Knockaffrin Lough.	–	–	–	N. 20 W.	E. & W.	The first are grooves; the second, striæ. The former would seem to have been formed by the ice sweeping round the edge of the high ground into the Lough Corrib valley, and the latter by an ice stream coming from the hills on the west.
Galway, 67/2,	Doon, summit of Doonmore, 698 feet,	–	–	–	N. 50 W.	N. 5 E.	Northward slope of the hill all dressed; however, the first striæ seem to have been cut by ice coming from the westward, more especially as there are numerous large erratics of the porphyritic granite, that rock occurring *in situ* to the westward. This granite may also be found *in situ* about a mile on the south; but rock brought from thence would come in a line oblique to these striæ. These blocks might possibly have come down on the Oughterard valley glacier, and been brought here by the ice that cut the N. 5 E. striæ, which seem to be due to ice going south.
Galway, 67/3,	Seecon,	–	–	–	–	N. 60 E.	These appear to have been cut by ice coming down one of the minor valleys to join the glacier in the Owenboliska valley, one of the tributaries of the Galway valley.
,,	Finnaun, on east slope of hill,	–	–	–	N. 15 E.	–	Formed by the ice flowing into Galway Bay.
,,	Finnaun, on west slope of hill,	–	–	–	–	N. 10 W.	These seem to have been cut by ice flowing into the Owenboliska valley glacier.
,,	Uggool, north-east of Lough Glenn,	–	–	–	–	–	Rocks dressed into a slope. No striæ observed.
Galway, 67/4,	Letter, hill north of the lodge, 746 feet.	–	–	–	–	–	Rocks all rounded and dressed, but no striæ observed. A line of cliff at an altitude of about 300 feet.
,,	Ardderroo and Knockranny,	–	–	–	–	–	Drift mounds, or "drumlins," that have a general bearing of about N. 45 E. to N. 60 E.
,,	Knockranny,	–	–	–	–	–	Sloping escarpment of rocky boulder drift at a height of about 340 feet.
Galway, 68/3,	Newtown, on its east slopes,	–	–	–	N. 10 W.	–	Seems to have been cut by ice flowing into the Lough Corrib valley. Near the summit there is a cliff at a height of 550 feet.
Galway, 79/4,	Borroughaun, Lough Crockaillenalee,	–	–	–	N. 70 W.	–	These seem to have been made by ice coming out of the valley to the north-west and on its way to Galway Bay.
Galway, 80/2,	Boliskaoughter, at Lough-na-Nalliagh.	–	–	–	N. 10 W.	–	Cut by ice flowing down the Owenboliska valley. Drumlins west of Ardderroo Lough bear N. 15 E. At the west of this townland there are well dressed hummocks of rock that slope to the N.E. and crag to the S.W.
,	Ardderroo,	–	–	–	–	–	One drumlin has a bearing of N. 15 E., while another close to it at Tullaghnanoonbeg Lough bears N. 45 E.
	Slieveaneena, a little west of the summit, 554.	–	–	–	N. 50 E.	–	The first seem to have been made by ice going to the Boliska river valley, while the newer may have been cut by ice sliding down into the small valley immediately on the south. The older coincide with the axes of the dressed hummocks of rock which slope towards the N.E. and crag to the S.W. The mounds of drift, or drumlins, in their vicinity have a bearing similar, or nearly so, to the striæ at the centre locality (N. 30 E.).
	Slieveaneena, a little farther south,	–	–	–	N. 30 E.	–	
	Slieveaneena, a little farther south,	–	–	–	N. 50 E.	N. 10 W.	

TABLE OF SUPPOSED ICE STRIÆ—*continued.*

County Map.	Townland and Locality.	Striæ A.	Striæ B.	Striæ C.	Striæ D.	Striæ E.	Remarks.
Galway, 80/3, .	Clogheralama, at the east side of Loughaunnagun.	–	–	–	N. 20 E.	–	Cut by ice flowing down the slope into Galway Bay.
Galway, 80/4, .	Knock, at the south end of the lake,	–	–	–	N. & S.	–	Seems to have been cut by ice flowing down into Galway Bay. The drumlins in the vicinity of the lake bear from N. 5 E. to N. 15 E.
Galway, 81/1. .	Kylebroghlan, Killagoola hill, 471 feet.	–	–	–	–	–	Rocks all dressed, but no striæ observed. About half a dozen very large perched granite erratics near the summit of the hill.
,, . .	Killagoola, a little north of the village.	N. 50 E.	–	–	–	–	Supposed to belong to the primary system of striæ, similar to those in the country on the east of Lough Corrib.
,, . .	Killagoola, at the S.W. of the townland.	N. 45 E.	–	–	–	–	
,, .	Keeagh, near the north-east of the townland.	–	–	–	N. 30 E.	–	Grooves that coincide with the general line of the fall of the valley into Galway Bay.
. .	Keeagh, at the old village, . .	–	–	–	N. 25 E.	–	These have similar relations to those last-mentioned. To the south of them are planed and dressed rock masses, the axes of which bear N. and S.
,, . .	Keeagh, at the south boundary, .	N. 50 E.	–	–	–	–	These may belong to the same system as those in Killagoola (see above).
Galway, 81/3. .	Laughil, west of the village, . .	–	–	–	N. 20 E.	–	These seem to have been formed by the ice on its way to Galway Bay. South of Laughill there are drumlins that bear N. 10 E., but immediately west of the Spiddal road they are curved, bearing N.W., and then turning to the south.
,, . .	Laughil, at the road to Spiddal, .	–	–	–	N. 20 E.	–	
,, . .	Knock, near the hamlet, . . .	–	–	–	N. 10 W.	–	As the valley turns hereabouts, these striæ may have been formed by similar ice to the last mentioned. The drumlins at Knock bear N. 10 E., while those a little on the east at Gortgar seem to go with the general bearing of that part of the valley (nearly N. and S.)
Galway, 81/4, .	Corcullen, ...	–	–	–	–	–	Dressed hummocks, but no striæ observed.
Galway, 81/4, .	Drum, west, E.N.E. of Drumlough,	–	–	–	N. 5 W.	–	These, excepting those in Boleynasrahaun, seem to have been formed by the ice sliding into Galway Bay. Those in Boleynasrahaun may possibly belong to the primary striæ of the low country.
,, . .	Drum, east, north of Drumlough, east,	–	–	–	N. 10 E.	–	
,, . .	Boleynasrahaun, on the east slope of small hill.	N. 40 E.	–	–	–	–	
,, . .	Tonabrocky, a little S.W. of the village.	–	–	–	N. 10 E.	–	
,, . .	Corboley (Morgan), on a cliff that bears about N.W. and S.E., a little S.S.E. of the village.	–	–	–	N. & S.	–	
Galway. 82/3, .	Ballagh, ...	–	–	–	N. 15 E.	–	At this and a few localities in its vicinity the N. 10 E. striæ are the newest, while farther west all the striæ with a westing are the newest, cutting those with a easting. Might not this be caused by two ice streams, both flowing into Galway Bay, advancing and retreating across one another's tracks; or perhaps the striæ with a westing may be due to ground ice forced along by a current, as they have only been observed on the low ground?
Galway, 91/2, .	Cornavona, Lough Uggamore, .	–	–	–	N. 45 W. / N. 10 E.	–	
Galway, 91/4, .	Loughaunbeg, at the Galway road, .	–	–	–	N. 10 E.	–	These seem to have been cut by ice sliding into Galway Bay.
Galway, 92/1, .	Loughaunbeg, at the lake, . .	–	–	–	N. 15 E.	–	
,, .	Kilroe, ...	N. 40 E.	–	–	–	–	Might possibly be the primary striæ.
Galway. 92/2. .	Shannawoneen, south of the wood,	N. 35 E.	–	–	–	–	
,, . .	Truskaunnagapple, . . .	–	–	–	N. 10 E.	–	All seem to be cut by the ice sliding into Galway Bay. The dressed hummocks of rock bear about N. 10 E., and slope to the N.N.E. by N.
,, . .	Spiddal, west, ...	–	–	–	N. 15 E.	–	
,, . .	Killough, ...	–	–	–	N. 20 E.	–	
Galway, 92/3, .	Kilroe, east, about Polleen, . .	–	–	–	–	–	Rocks dressed—axes of hummocks bear N.E. and S.W., while they slope to the N.E.
,, . .	Kilroe, east, on the tidal rocks, .	–	–	–	N. & S.	–	The axes of the dressed hummocks bear N.E. and S.W.
,, . .	Bohoona, west, on the sea-shore, .	–	N. 70 E.	–	N. 10 E.	–	The first seem to be cut by the ice of the Galway Bay glacier; the second by tributaries. The half-tide rocks in the last locality are a glacial surface, with perched blocks, showing how little action the sea has had on this part of the shore since the glacial period.
Galway, 92/4, .	Bohoona, east, on the sea-shore, .	–	N. 70 E.	–	N. 10 E.	–	
,, .	Spiddal, middle, on the sea-shore, .	–	–	–	N. 20 E.	–	
,, .	Sheeaunroe, on the sea-shore, .	–	–	–	N. 25 E.	–	
,, .	Park, on the sea-shore, . . .	–	–	–	N. 20 E.	–	
Galway, 93/1. .	Lippa, at the north boundary, .	–	–	–	N. 20 E.	–	
,, .	Allphreaghaun, ...	–	–	–	N. 25 E.	–	These seem to be due to the ice sliding into Galway Bay.
,, .	Derrycrih, ...	–	–	–	N. 15 E.	–	
,, .	Knocknagreana, ...	–	–	–	N. 20 E.	–	
Galway, 93/2, .	Keeraun, ...	–	–	–	N. 15 E.	–	
,, .	Clybaun, ...	–	–	–	N. 15 E.	–	
,, .	Ailli, on the cliff S.E. of the village,	–	–	–	N. 20 W.	–	These seem to have been cut by the same ice as the last, but to be deflected by the cliff.

TABLE OF SUPPOSED ICE STRIÆ—*continued.*

County Map.	Townland and Locality.	Striæ A.	Striæ B.	Striæ C.	Striæ D.	Striæ E.	Remarks.
Galway, 93/3,	Lippa, on the sea-shore,	–	N. 85 E.	–	N. 20 E.	–	
,,	Lippa, on the sea-shore,	–	–	–	N. 20 E.	–	
,,	Derryloughaun, west, on the sea-shore.	–	E. & W.	–	N. 25 E.	–	
,,	Derryloughaun, east, on the sea-shore.	–	–	–	–	–	
,,	Ballynahown, on the sea-shore,	–	–	–	N. 20 E.	–	The striæ in column B seems due to ice coming down Galway Bay from the eastward, while those in column D to ice sliding into Galway Bay.
,,	Knocknagreanea, on the sea-shore,	–	–	–	N. 20 E.	–	
,,	New village,	–	–	–	N. 25 E.	–	
Galway, 93/4,	New village, a little east of last,	–	–	–	N. 15 E.	–	
Galway, 94/1,	Rahoon, N.W. of Shantallow House.	–	–	–	N. 20 E.	–	
,,	Shantallow, S.W. of Shantallow House.	–	–	–	N. 5 W.	–	
,,	Lenaboy, on the sea-shore,	–	–	–	N. 5 E.	–	
,,	Mutton Island, on the east side of the island.	–	–	N. 30 E. N. 35 E.	–	–	
,,	Mutton Island, on the west side of the island.	N. 55 E.	–	–	–	–	The striæ in column A are supposed to be part of the primary striation; those in column B to be due to the ice going east down Galway Bay, while those in column C seem to be formed by the ice coming out of the mouth of the Lough Corrib valley.
Galway, 94/3,	Mutton Island, on the south side of the island.	–	N. 80 W.	N. 35 E.	–	–	
Galway, 94/2,	Murrogh, half way between the 124¾ and 124¾ mile-posts on the Midland Railway.	N. 60 E.	–	–	–	–	
,,	Murrogh, half way between the 124¾ and 124¾ mile-posts on the Midland Railway.	N. 50 E.	–	–	–	–	
,,	Rosscam, on the sea-shore,	N. 45 E.	–	–	–	–	

MINES, AND MINERAL LOCALITIES.

County.	Townland.	Minerals.	Proprietors.	Agents.
Galway, 55/3, .	*Corraneilistrum*,	Iron pyrites & galena,	J. Martin, esq., .	Mr. Jackson.
Galway, 68/2, .	*Gortmore*, . .	Iron pyrites, copper pyrites, galena, & blende.	J. Ryan, esq.	
Galway, 54/3, .	*Cregg*, . .	Iron pyrites, copper pyrites, galena, & barytes.	G. O'Flahertie, esq., & Messrs. Waddle & Co.	Capt. Floyd.
,, . .	*Clooshgereen*, .	Iron pyrites, galena, and barytes.	E. C. Burke, esq.	Capt. Spargo.
Galway, 54/3 & 4, and 67/1 & 2.	*Bunnagippaun*, .	Copper & iron pyrites.	Mr. Robb.	
Galway, 54/3, .	*Rusheeny*, . .	Galena & iron pyrites.	Messrs. Cottingham & Regan.	,,
,, . .	Derrada, . .	Iron pyrites,	Rev. C. Whittaker.	
,, . .	Derryeighter, .	—	Capt. Nolan.	
Galway, 53/4, .	*Leam, East*, .	—	Law Life Society,	Mr. Robinson.
Galway, 68/1, .	Doon, . .	—	R. Martin, esq., jun.	
Galway, 81/4, .	Attyshannock, .	Iron pyrites & galena,	F. Comyns, esq.	
,, . .	Oranhill, . .	Iron pyrites, galena, and blende.	Law Life Society,	Mr. Robinson.
,, . .	*Brownville*, .	—	Mr. Rooney.	
,, . .	Gortaleva, . .	Iron pyrites & galena,	—	
Galway, 82/3, .	Ballagh, . .	—	J. O'Hara, esq., D.L.	
,, . .	Barnacranny, .	—	—	
,, . .	Kentfield, . .	—	T. Blake, esq.	
,, . .	Dangan, Upper, .	—	J. Reddington, esq.	
Galway, 84/1, .	Townparks, . .	Iron pyrites, . .	—	
,, . .	*Cappanaveragh*,	Galena, . . .	Blake Foster, esq.	Mr. Morris.
Galway, 93/1 & 3, .	Furbogh, . .	Tumblers, with copper pyrites.	A. W. Blake, esq. D.L.	
Galway, 92/4, .	Spiddle, West, .	Galena, . . .	J. Bunbury, esq.	
Galway, 92/3, .	*Kilroe, West*, .	Galena and mundic,	Judge Morris, .	Mr. Morris.

Townland names printed in *italics* are places where works have been carried on.

The minerals of commerce observed in this district are *Galena*, *Iron pyrites*, *Copper pyrites*, *Blende* and *Heavy Spar* or *Barytes*; there is also *Bog-iron ore*, which formerly was smelted for iron. Of the iron pyrites there are three or four varieties found: first, crystalline or anhydrous iron pyrites, commonly called *Mundic*; second, hydrous iron pyrites, called in this district *Bastard Mundic*; third, coppery iron pyrites; and fourth, magnetic iron pyrites; the two latter being here called *Sulphur ore*; the two first are very poor ores, containing only a trace of copper. The Copper pyrites or Copper ore, and the Blende or Zinc ore have not yet been discovered in large quantities; but in one vicinity the Barytes (*Heavy Spar* or *Cawk*) seems to be plentiful.*

Some of the mineral localities are in the Carboniferous limestone, but most of them are in the metamorphic or granitic rocks; none of the minerals that occur in the Carboniferous rocks appear to be in true lodes, but rather in enlarged joints occurring in pockets and lenticular patches.

The mineral localities in the metamorphic and granitic rocks occur in lodes, strings, flying veins, and scattered through the rocks. In some schists, the pyrites seems to take the place of the mica, and changes the rock into Pyrrhetite schists, some of which, in the districts on the north,† have been worked for this ore. Some of the lodes may be very ancient, and have been metamorphosed with the rocks in which they now exist, while most of them are much more modern, and have been subsequently formed; but all of

* The name Cawk seems only to be applied to the compact variety of Heavy Spar.
† See Geol. Memoirs Ex. Sheets 85 and 95.

them are older than the overlying Carboniferous sandstones and limestones. When these lodes pass through the primary limestones, they always make Galena, in other cases iron and copper pyrites are the general minerals.

The Kiloummin Mines.

These mines are in the Carboniferous limestones, and lie S.E. of Oughterard near the Ferry of Knock.

Corraneilistrum (Galway [55]).—Thick calcite N.10° W. lode, that contains at the surface *iron pyrites* and a little *galena*. A small trial was made on it in the boreen that leads from the main road to the village. It is very massive where exposed in this place, and might possibly be a true lode; however, it bears with the course of the principal joints.

Gortmore and Wormhole (Galway $\frac{68}{2}$).—A north and south lode, in which is *galena*, *copper pyrites*, *iron pyrites*, and *blende*. Two shafts were sunk about twelve fathoms deep, and in both good "tumblers" of lead found. An oblique lode is said to have been proved in the shaft behind the forge. A ten-horse engine was erected, but not being equal to the water, the workings were abandoned, and have not since been resumed (1868). Further north, in the townland of Wormhole, "tumblers" of lead are said to have been found.

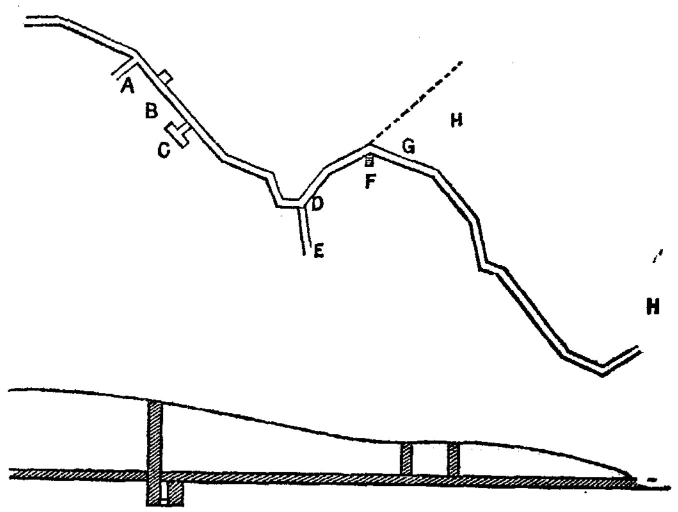
Part of the Oughterard, West, Mines.

Cregg (Galway $\frac{54}{3}$).—In the S.W. part of this townland there is a strong mineral lode that bears N. 66° W., and hades to the southward. A private company (Messrs. Waddle and Co.), in the years 1865 and 1866, under the agency of Captain Floyd, proved it for a length of 350 yards, and that at the S.W. it was over eight feet wide without reaching the north wall. Captain Floyd, in a trial shaft at the S.W., found in it very rich *copper pyrites*, *iron pyrites*, principally mundic, barytes with a little *malachite* and *galena*.

Clooshgereen (Galway $\frac{54}{3}$).—This is the continuation of the Cregg lode, but divided from it by a strong granite course. (See plan and section, fig. 9.*) Here some years ago works were carried on by a Mr. Kelly, and the accompanying plan and section furnished by the present proprietor shows what has been done, and the minerals found. The lode is cut off on the west by a slide, to the west of which it has not been discovered. Near the S. of this townland, at the north-west of Lough Tawny, *galena* was discovered in a bed of crystalline limestone, and may point to a lode in the neighbourhood. In parts of this lode there are masses of Barytes that is often crystalline, but when massive it usually has through it long crystals of milky quartz.

* For copies of the plan and section of this working we are indebted to the present proprietor; his son, E. Burke, esq., having verified them by a resurvey.

Fig. No. 9.
Plan and section of Cloosh lode.



Explanation of plan and section of Cloosh lode.

A.—20 tons of lead got here.
B.—A mass of barytes here.
C.—At the end of the cross cut there is seen the hanging end of a lode running in a westerly direction and dipping south. A small further trial has been made, and a good show of lead is to be seen.
D.—A lode leaves here two feet wide. Dips E. at 5°.
E.—A lode at the end of cross cut, 3 feet wide, with 3 feet walls.
F.—Copper obtained here.
G.—Lead found in level.
H. and H.—Lead found in these places by piting from the surface.

Bunnagippaun (Galway $\frac{54}{4 \& 4}$ and $\frac{67}{1 \& 2}$).—South-east of Lough Tawny there is a mass of *gaussen* in the drift close to the new road, this may lie on the back or in the vicinity of a mineral lode. In the river that flows at the south boundary of this townland are flying veins of quartz and fluor spar, with *copper* and *iron pyrites*. Trials were here made looking for a lode, but of course were unsuccessful.

The four following Townlands are in the vicinity of the Glengowla Mines:—

Rusheeny (Galway $\frac{54}{3}$).—In the north part of this townland, east of the Glengowla lode, there are traces of galena and iron pyrites. Near the south of the townland, on the course of a north and south break in the rocks, there is a strong iron spa spring.*

Derrada (Galway $\frac{54}{3}$).—Near the east of this townland there is a strong *spa*, that seems to come from a mineral vein.

Note.—A Company called the Gladstone Consols is being formed to work the minerals in the townland of Clooshgereen, with the adjoining townlands of Bunnagippaun and Luggakeeraun.

* The strong iron spas are recorded in these descriptions as they possibly may proceed from mineral lodes.

Derryeighter (Galway $\frac{53}{4}$).—Traces of *iron pyrites* were observed in different places, more especially in the ravine south of the herd's house. In the east and west valley, through the centre of the townland, there are strong *spa* springs.

Leam, east (Galway $\frac{53}{4}$).—Traces of *iron pyrites.*

The nine following localities are close to the boundary that divides the metamorphic and granitic from the Carboniferous rocks, but none of them extend into that newer formation :—

Doon (Galway $\frac{68}{1}$).—Trace of *iron pyrites.*

Attyshannock, Oranhill, Brownville, and *Gortaleva* (Galway $\frac{81}{4}$).—In these four townlands traces of *iron pyrites* and *galena* were noted, usually in strings or wild lodes; at the mail-coach road that divides Oranhill from Brownville, a small lode that contains iron pyrites and blende, can be observed crossing the road. A shaft of over thirty fathoms deep was sunk in the townland of Brownville without cutting the lode; but as it was sunk on the south of the lode, and the lode hades north, it was impossible to cut it without driving, which we are informed was not done. In Gortaleva, a small lode of iron pyrites was noted in the road cutting.

Ballagh, Barnacranny, Kentfield, and *Dangan Upper* (Galway $\frac{82}{3}$).—Traces of galena and iron pyrites were observed; but no regular lode.

The two following localities are in the suburbs of Galway town :—

Townparks (Galway $\frac{94}{1}$).—In the vicinity of the Queen's College, a bed of pyrrhotite schist, containing *magnetic* (nickeliferous (?)) *pyrites* and *iron pyrites* was noted.

Cappanaveragh (Galway $\frac{94}{1}$).—Some trials, consisting of two short adits, and an open cast were made at Salthill, following some flying wild veins in the granite that contained a little *galena.* The adits are northward of the Eglintoun Hotel and the open cast on the sea-shore. No regular lode seems to exist, nor does it appear likely that any profitable work could be carried on in this locality.*

The three following localities are in the vicinity of the north shore of Galway Bay :—

Furbogh (Galway $\frac{93}{1\&2}$).—Tumblers of vuggy quartz, with *copper pyrites* were found in the river and on the sea shore; but the parent lode has not been discovered.

Spiddle, West (Galway $\frac{92}{1}$).—Small vein with galena in the large rock at the west end of Tramore (*anglice,* big strand). There could scarcely be a profitable lode in this locality.

Kilroe, West (Galway $\frac{92}{3}$).—Small pits are said to have been sunk here about twenty years ago on a N. 8° W. lode, that showed traces of lead and copper. No trace of the lode to be seen at the surface, and the pit is full of water.

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* In Sir R. Griffith's list of Irish mines and mineral localities, these workings are mentioned as being in the townland of Lenaboy.

INDEX.

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RC
9/1/02

ORDNANCE SURVEY OF IRELAND.

GEOLOGICAL SURVEY OF IRELAND

(Ballyvaghan) SHEET 114.

EXPLANATION
of
Geological Signs and Colours

▨	*Sand, Gravel and Boulder Clay. (Drift Deposits)*
d⁴	*Flagstone Series*
d³	*Shale Series (Yoredale Beds)*
d²‴	*Upper Limestone*
F	*Felstone*
D	*Diorite (Greenstone)*
G	*Granite* G.P. *when Porphyritic*

Carboniferous Series

↘ *Dips*

Inclination of the beds, the figures expressing the angle below the horizon.

↘ *Contorted beds*

+ *Horizontal beds*

✱ *Fossil localities*

Gold lines are mineral veins.

ƺ *Lead*

Z *Zinc*

The lettering d
Tawin Island of
have removed f
engraving prior
of flagstone
should be alter
to be appropriate

The Geology of this Map published October 1862.
Sir R.I. Murchison D.C.L. F.R.S. &c *Director General.*
J Beete Jukes M.A. F.R.S. *Local Director.*
Surveyed by F.J. Foot M.A.
With additions by G.H. Kinahan in 1868.
Revised. 1882.

Index to the Six Inch Maps in this Sheet

Scale of One Inch to a Statute Mile $\frac{1}{63360}$

8 7 6 5 4 3 2 1 0 — 0 1 2 3 4 Miles

N.os of the adjoining Sheets of the One Inch Map

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