Memoirs of the Geological Survey.

EXPLANATION

TO ACCOMPANY

SHEETS 115 AND 116 OF THE MAPS, AND SHEETS 17 AND 18 OF THE LONGITUDINAL SECTIONS

OF THE

GEOLOGICAL SURVEY OF IRELAND,

ILLUSTRATING A PORTION OF THE

COUNTIES OF GALWAY, CLARE, AND TIPPERARY.

By G. H. Kinahan, F.R.G.S.I.

With Lists of Fossils by W. H. Baily, F.G.S.

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The observations made in the course of the Geological Survey are entered, in the first instance, on the Maps of the Ordnance Townland Survey, which are on the scale of six inches to the mile. By means of marks, writing, and colours, the nature, extent, direction, and geological formation of all portions of rock visible at the surface are laid down on these maps, which are preserved as data maps and geological records in the office in Dublin.

The results of the Survey are published by means of coloured copies of the one-inch map of the Ordnance Survey, accompanied by printed explanations.

Longitudinal sections, on the scale of six inches to the mile, and vertical sections of coal-pits, &c., on the scale of forty feet to the inch, are also published, and in preparation.

Condensed memoirs on particular districts will also eventually appear.

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

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This district was examined by Mr. G. H. Kinahan, except the eastern part of Sheet 116, which was done by Mr. A. B. Wynne, before his departure for the Geological Survey of India. Mr. Kinahan has drawn up the following Explanation of the district, the fossils having been examined and catalogued by Mr. W. H. Baily.

J. Beete Jukes.

LIST OF WOODCUTS.

EXPLANATIONS

TO

ACCOMPANY SHEETS 115 AND 116

OF THE MAPS OF THE

GEOLOGICAL SURVEY OF IRELAND.

General Description.

This district lies in the county Galway, except two or three square miles at the S.W. corner, which belong to the county Clare, and the tract at the S.E. corner, on the east of the River Shannon, which is part of the county of Tipperary. The small towns of Kinvarra, on Galway Bay; Loughrea, which takes its name from the lake on which it is built; and Portumna, on the River Shannon, are situated in it; there are also the villages of Eyrecourt, Kiltormer, Laurencetown, Killimor, Kilreekill, Tynagh, Duniry* Abbey, Kilchreest, Craughwell, Ardrahan, Kiltartan, Kilcolgan, and Clarinsbridge. Galway Bay enters the N.W. side of Sheet 115.

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1. *Form of the Ground.*

On the south of Loughrea there is some high mountainous ground, which is the extreme northern part of the group called Slieve Aughta,† the highest hills being Cashlaundrumlahan and Kylebeg, which reach

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* In an old poem, supposed to have been written in the ninth century, and translated by the late Eugene Curry (see *Natural History Review*, vol. vii., p. 44), that gives a list of all the wild animals in Ireland brought to the Hill of Tara by Cailte Mac Ronain, as a ransom to Cormac Mac Art, King of Erin, for his king and foster brother, Finn Mac Cumhail, this village is mentioned as "Dun Daighre."

"Two *Næscans* (Snipes?) from Dun Daighre."

The country about it is still famous for snipe.

† This is a corruption of *Sliabh Echtghe*, the derivation of which will be seen from a note by O'Donovan in the "Annals of the Four Masters." "Sliabh Echtghe derived its name from Echtghe Uathach, the daughter of Ursothach, son of Tinde, one of the Tuatha de Danaan colony. She married Fergus Lusca Mac Rindi, who held this mountain in right of his office of cup-bearer to the King of Olnegmacht. He had no stock, but she had; and she came to him with her cows, according to the law entitled *Slabhradh furiher fosadh*, and he gave up the mountain to her. On this occasion, according to the legend, two cows were brought there of remarkable lactiferousness, and equally fruitful; but on their removal hither it turned out that one of them which was placed to graze on the north side of the mountain, did not yield one-third as much milk as the one placed on the south side. The river that divided the two pastures was called Abhainn-da-Loilgheach, i.e., *the river of the two milch cows.*" It is now corrupted into Owendallulagh. This river rises a little S.W. of Marble Hill, and runs west through the valley of Derrybrien, and from thence into Lough Cooter. The breed of this cow seems to have been famous, and to have been called Echtach, as we find the following line in the poem previously referred to:

"Two Echtachs from the lofty Echtge."

the respective heights of 1,207 and 1,080 feet. One large E. and W. hollow cuts across this mountainous land. This at the west forms the valley of the Boleyneendorrish River, while towards the east it is occupied by the Owenaglana, the line of watershed between them sinking in one part to about 900 feet above the sea. Small secondary valleys run into it both from northward and southward. A large semicircular valley occurs on the south of Killchreest.

Fig. No. 1.

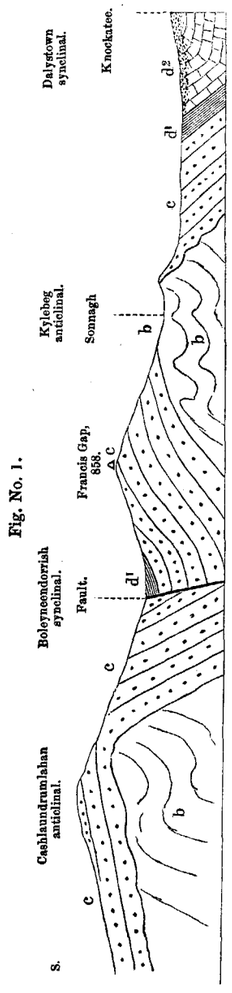
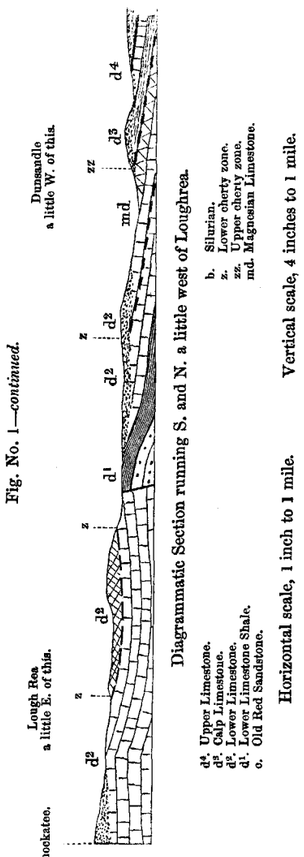


Fig. No. 1—*continued.*



Diagrammatic Section running S. and N. a little west of Loughrea.

b. Silurian.
z. Lower cherty zone.
zz. Upper cherty zone.
md. Magnesian Limestone.

d⁴. Upper Limestone.
d³. Calp Limestone.
d². Lower Limestone.
d¹. Lower Limestone Shale.
c. Old Red Sandstone.

Horizontal scale, 1 inch to 1 mile.

Vertical scale, 4 inches to 1 mile.

At the S.W. corner of the district is a hill 681 feet high. This is the extreme N.E. peak of the Burren Mountains.*

The rest of the area now being described is part of the great central plain of Ireland and has an average height of from 200 to 250 feet.

All the country within the limits of Sheet 116, except small tracts to the N.W. and S.W., belong to the water basin of the River Shannon; while all contained in Sheet 115, except a few square miles on the south of Loughrea, discharges its water into Galway Bay.

The drainage of the country in the northern part of Sheet 115 finds an outlet through the Kilcolgan and Clarins Rivers,† while the southern part belongs to that peculiar water basin which empties itself into Coole Lough, and from that by subterranean passages into Galway Bay.

In the explanation of Sheets 124 and 125 it is mentioned that the Gort River came into this district and disappears in the ground about half a mile S.E. of Kiltartan, at the old castle. From this it runs under ground for about six furlongs, and comes to the surface immediately W. of the village of Kiltartan. After sinking and rising two or three times in Coole demesne, it eventually rises S.E. of Raheen House, and from that flows into Coole Lough.

The Owenshree River, which flows by Roxborough, takes the ground half a mile W.N.W. of Castle Daly R.C. chapel, and rises again at Coy Lough and about two miles N.E. of Kiltartan, where it flows into the Boleyneendorrish River. This takes the ground in less than half a mile, but eventually appears near Raheen-house, and having mingled with the Gort rivers, flows into Coole Lough.‡ From Coole Lough the waters find their way in subterranean passages by Caher-

* The Burren is also referred to in the previously mentioned poem—

"Two wild oxen from Burren."

At that time it seems to have been famous for wild oxen, as we find that "Ten hundred oxen from Boirium, or Burren, was part of the tributes of Cashel to the Kings of Erin." (See paper by Sir W. Wilde, read before the Royal Irish Academy, May, 1859.)

† These two rivers, previous to the year 1850, were for the most part subterranean, but during the drainage carried on in that and the subsequent years by the Board of Works, the present courses were opened up.

‡ Mr. Nolan, of Newpark, does not agree with me about this river. His theory is, that except during floods this river does not flow to the S.W. into Coole Lough, but that it strikes across the country direct to Kinvarra. His reasons for this are, that in the summer weather, although there may be a large stream flowing by Castleboy, there may be little or no water flowing under the bridge at the W. of Castleboy demesne, all having disappeared through the various subterranean passages in the bed of the river above the bridge; also, that on the rise of ground to the north of Newpark, you can hear a subterranean rush of water, which he believes is the water from this river on its way to Kinvarra. He allows that during freshets the overplus makes its way down to the Blackrock turlough, on the south of Limepark, and from thence on to the Coy Lough, and eventually to Coole Lough. I must say, in favour of his theory, that the stream that joins the Boleyneendorrish River, near Newhall-house, is seemingly not as large as the Owenshree River; but here part of the water may run under ground. In favour of my theory it must be remembered that the vents in the bottom of the *turloughs* were formed from below, not from above; the water, when the subterranean passages were full, corroding and eating away soft portions of the roof, till eventually they burst through to the surface. This will appear evident to any one who will go down one of these outlets during the dry season. In the course I laid out there are vents in the bed of the river, also at Blackrock Turlough, Coy Lough, and under the river at Newhall-house, which would point to a subterranean river below.

glassaun Lough to the sea at Kinvarra, where most, if not all, of them find egress through the joints of the rocks in the vicinity of Dungorey Castle.

In Coole demesne a subterranean stream flows southward from Corker-house to join the open river. This must come from the Boleyneendorrish River, as when there is a freshet in that river, and none in the Gort River, the river at Coole becomes quite muddy; but if there is a flood in the Gort River, a stream flows from Coole up this subterranean passage towards Corker-house. Where the Gort River takes the ground, on the S.E. of Kiltartan, there are the traces of two older channels at higher levels than that through which the water during the dry season now finds its exit. The highest level is now entirely stopped, and a stream flows back along the old course down to the present river. The middle level, during floods, is still used, and the water rushing down into the subterranean channel below forms a small whirlpool. Most of the other rivers in the limestone country are partly subterranean, but none so extensively as the system we have now mentioned.

When these subterranean rivers, either at their ingress or egress, form lake-like sheets of water, they are locally called *turloughs;* or a turlough may be formed in a hollow under which a subterranean river flows, that during floods bursts up and forms a sheet of water. Many of the small lakes in this district, especially where the subjacent rock is Upper Limestone, have no surface outlet, and, although they are not dry in summer, are to all intents and purposes turloughs. In these, if the lake-basin is deep, the difference between the level of the water in the dry and wet seasons is most remarkable. A good example of this kind of turlough is a small lake called Lough Kinlea, which is situated about six miles west of Lough Rea. This, during the summer months, lies in the bottom of a deep cup-shaped hollow, being more than thirty feet lower than the road that lies on its north, while during winter floods it nearly reaches the road, but on account of its steep sides there is not much difference between the area in summer and winter.

A very large turlough is formed in connexion with Coole Lough. During the dry weather the water on every side flows into this lough, but when the floods arise the subterranean passages are not large enough to carry off all the water, which causes it to fill the lough and overflow to the south, where they form a most extensive turlough in the neighbourhood of the Newcastle race-course that lies to the N.W. of Gort, in the district included within the limits of Sheet 124.*

Lough Rea is the principal lake in the district, and from it flows one of the head waters of the Kilcolgan River. In it have been discovered four *crannoges*, or artificial islands, which must have been built when the lake was seven feet lower than its present level. As the old name of the lake was Riogh Lough, *i.e.*, Royal Lake (see

* On the 12th October, 1862, cricket was played on the race-course of Newcastle, and in the streams there was scarcely any water, but the succeeding week was very wet, and on the 21st of the month the whole of it was covered; in places being over twenty feet deep. The area under water, including the flooded land about Coole Lough, was at least 500 acres; but when we consider the extent of the water basin

"Hardiman's History of Galway"), one of these may have been the residence of the kings or chiefs of the district. Its sea-like appearance is quite remarkable, and has given rise to the tradition "that it has a subterranean passage joining it with the sea, and that it gets rough every time the tide comes in at Galway Bay;" but if there was a passage, the water from it would all drain away, as it is 270 feet above the sea. Its peculiar colour seems to be due to its being chiefly fed by springs, only two small streams flowing into it, one of which is itself a series of springs.

Lough Belsrah, five miles S.W. of Lough Rea, though small, may be mentioned, as it is perched on the ridge of the mountains. It lies in a deep fissure or gap, having steep sides, over fifty feet high, which in some places are nearly perpendicular. A stream is said to flow from it in the driest summer, from which it would appear to be fed by springs, as there is scarcely any catchment basin for its supply.

Some of the lakes and turloughs on the low ground are affected by the rise and fall of the tide, the rising tide damming up the egress of the fresh water, which accordingly rises in the lakes or turloughs. This cannot be observed during floods, as from the expanse of water the rise and fall would only be a few inches, but during dry weather it is most perceptible. This phenomenon can be very well seen in the holes in the vicinity of the mine on the west of Caherglassaun Lough. Caves are very numerous in the country towards Galway Bay, but as the ground has not much fall for its water, few of them can be entered except during the dry season. A very extensive cave occurs in Coole demesne.*

which drains into Coole Lough, it is not surprising. The October here mentioned was remarkably wet, as the Rev. C. Mayne, Rector of Kilmastulla, informs me that it was the wettest for the last seventeen years. I subjoin an extract from the record of his rain-gauge at Killaloe, which he kindly furnished me with:—

October.	Inches.	October.	Inches.	October.	Inches.
1846, . .	6·85	1852, . .	2·78	1858, . .	3·67
1847, . .	4·45	1853, . .	5·72	1859, . .	2·15
1848, . .	3·67	1854, . .	3·59	1860, . .	4·58
1849, . .	3·89	1855, . .	3·76	1861, . .	3·41
1850, . .	2·07	1856, . .	1·89	1862, . .	7·61
1851, . .	5·35	1857, . .	3·19	Average,	4·03

From this it is seen that in October, 1862, the rainfall was nearly twice the average of the last seventeen years.

* Mr. Gregory, M.P., of Coole Park, was kind enough to make a partial exploration of this cave for us, the Hon. Captain Gough, of Loughcooter, assisting in the operation. After breaking through a thick crust of stalagmite at one or two places, we turned over a thickness of three or four feet of fine unctuous red clay, but our search was not rewarded by the discovery of any remains of extinct animals.—J. B. J.

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

Aqueous Rocks.

		Name.	Colour on Map.
		Alluvium, Bog, &c.,	*Pale Sepia.*
		Drift,	*Engraved dots.*
Carboniferous.	d^4.	Upper Limestone,	*Prussian blue (dark).*
	d^3.	Middle Limestone or Calp,	*Indigo.*
	d^2.	Lower Limestone,	*Prussian blue (light).*
	d^1.	Lower Limestone Shale,	*Prussian blue and Indian ink.*
Old Red Sandstone.	c.	Upper Old Red Sandstone,	*Indian red (dark).*
Lower Silurian.	b.	Bala or Caradoc beds? / Llandeilo flags?	*Purple.*

b. *Lower Silurian.*—In the Boleyneendorrish Valley the rocks are gray and green grits, shales, sandstone, and fine conglomerates, being similar to the Silurian rocks of the part of Slieve Aughta described in the Explanations of Sheets 124 and 125. The rest of the Silurian rocks in this district consist of black, gray, blue, and green grits and shale. A few of the black beds are very coaly, but no regular coal was found, nor is it likely to occur; others of them contain graptolites. In places the shales are indurated into a rocklike hornstone, and the grit into one like quartzite. The last described rocks are unlike any of the other Silurian rocks in Slieve Aughta, but are like those in the north-west part of Slieve Bernagh (see Explanation of Sheet 133). In Slieve Bernagh, my colleague, Mr. Baily, by the palæontological evidence (see Explanation Sheet 133, p. 9, *et seq.*), considers the black graptolite shales to be equivalent to the *Llandeilo flags*, and the conglomerates, sandstones, &c., which there seem to overlie them, to be equivalent to the *Bala beds* or *Caradoc rocks*. In Slieve Aughta the coarse sandstones, &c., between Lough Cooter and Lough Graney, and the fine conglomerates, &c., in the Boleyneendorrish Valley seem to overlie the black graptolite shale in the most northern part of Slieve Aughta, and to be the representatives of the conglomerates in Slieve Bernagh. If this is the case, and Mr. Baily's conclusions are right, all the Silurian rocks in Slieve Aughta, north of the parallel of Kylebeg, would be equivalent to the *Llandeilo flags*, while all the rest of them would be of a newer age, and equivalent to the *Bala bed* or *Caradoc rocks.*

c. *Upper Old Red Sandstone.*—These are similar to those in the rest of Slieve Aughta, except that conglomerates are more frequent, and that the basal bed is rarely a cornstone. The principal pebbles in the conglomerates are white quartzite, next white vein quartz: red jasper and grits in some places are frequent, but we rarely find fragments of shales.

The Old Red seems to be of various thicknesses, ranging from about 500 to 1,150 feet.

Carboniferous Group.—In the west of this district the section of this group is similar to that in the district to the S. (Sheets 124 and 125),

while towards the east it changes, as will be seen by the following sections:—

	General Section to the W. of the District.	Feet.	General Section to the E. of Loughrea.	Feet.
Upper Limestone.	Dark gray and blue granular bedded limestone, with occasional black beds, and shale partings, with beds and nodules of chert. (These limestones are the same as the Burren* limestone)— over	1,500	Calpy† black limestone and shales, with chert nodules and beds. The limestone is generally compact, and always very argillacious and silicious— . . . over	‡400
	Upper cherty zone, composed of cherty limestone— about	40		
Lower Limestone.	Gray amorphous limestone, in which the bedding is rarely perceptible, and in which no chert occurs. This limestone is often more or less magnesian— . . from 30 to 60		Gray amorphous limestone, in which the bedding is rarely perceptible, and in which no chert occurs. This limestone is often more or less magnesian— . . from 80 to 150	
	Lower cherty zone, composed of chert, shale, and limestone; the chert generally predominating— from 90 to 120		Lower cherty zone, composed of chert, shale, and limestone; the chert generally predominating— . from 90 to 120	
	Dark blue exfoliating limestone, with shale and clay partings, and chert in places— about	400	Dark blue exfoliating limestone, with shale and clay partings, and chert in places— about	400
Lower Limestone Shale.	Shales, limestones, grits, flags, and sandstones— about	150	Shales, limestones, grits, flags, and sandstones— about	150
		2,270		1,220

From this it will be seen that the upper cherty zone, which in the district on the south is considered the lowest member of the Upper Limestone, here seems to expand out into a group that we have called Middle Limestone or Calp. In the west of the district we have Upper Limestone of the *Burren type* lying on the *upper cherty zone*, while in the east we have the *upper cherty zone* and overlying rocks replaced by *calpy limestone*. This change takes place north-west of Loughrea, in the neighbourhood of Dunsandle, where the two different types appear to dove-tail into one another, as will be seen by looking at the north end of the section, Fig. No. 1.

Towards the S.W. of the district the limestones again change, as

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* The Burren is a barony in the north of Clare, the extreme N.E. edge of which comes into this district. The Upper Limestone is well developed in it, and the limestone like its limestones may be spoken of as *the Burren type.*

† These are locally called *black rock*, or flint rock, while the lower part of the Lower Limestone is locally called *bog limestone*, or *bastard limestone.* The upper part of the Lower Limestone, and the limestone of the Burren type, only being called *limestone*, or *lime rock*, by the inhabitants of this country.

‡ No section across these beds was observed, and the thickness given is very uncertain.

will be seen by the following general section of the rocks in the vicinity of Portumna:—

		Feet.
Middle Limestone or calp.	7. Black limestones and shales, supposed to be about	400
Lower Limestone.	6.*Dark gray and blue granular limestones, like those of the *Burren*, except that they seem to be in one massive bed, and that no regular system of joints occur in them, . about	170
	5. Upper cherty zone, . . . ,,	30
	4. Gray and blue amorphous limestones, . ,,	150
	3. Lower cherty zone, . . . ,,	40
	2. Dark blue stratified limestones, with shale and clay partings, . . . ,,	400
Lower Limestone shale.	1. Blue and gray grits, shales, and limestones, ,,	150
		1340*

The *Lower Limestone shale* and the lower or stratified cherty part of the *Lower Limestone* are similar to those described in the Explanation of the district on the south (*see Explanations of Sheets* 124 *and* 125), but the upper or unstratified part, free from chert, will require a few separate remarks. In that Explanation the upper or unstratified part, free from chert, was noted as having become very thin in the neighbourhood of Gort. That peculiarity extends also into the south-west portion of this district, as there it is not more than from thirty to forty feet thick; but if we follow it toward the north-east, it seems to thicken south-east of Dunsandle, and in the neighbourhood of Loughrea, and on the west of Tynagh it covers a large area of ground,† and seems to be from 80 to 150 feet thick. In these places it also partakes of some of the characters which were remarked in the county Limerick, having often at the top of the group a thin bed of magnesian limestone, and near the top being red and variegated. The structure, which resembles oblique lamination, is also well developed, and very conspicuous in some places.

Of the *Middle Limestone or Calp*, we should observe that no good section is exposed across it, and only in one place was its junction with the Lower Limestone exposed. In this place a few thin sandstones and shales occur, which may be the most southern trace in Ireland of the Carboniferous sandstones, so well developed in Ulster, and called by Sir R. Griffith *Calp sandstones*. Hereafter this section will be mentioned in detail.

Many of the rocks belonging to the Upper and Lower Limestones are more or less magnesian, and as these are burnt for lime that is used for building purposes, we consequently find many of the houses

* Though we have put the sub-groups Nos. 5 and 6 in the *Lower Limestone*, they strictly belong to the *Middle Limestone*, as the sub-group No. 5 has always been considered to be above the Lower Limestone. In this locality we have classed them as above, on account of the sub-group No. 6 being only a lenticular mass, that dies out in a short distance E. and W. of Portumna; besides it is a good lime-burning stone, unimpregnated with silex, and without shale parting. For these reasons it has been considered expedient to class it in this place with the *Lower Limestone*.

† The thickness of this limestone is most uncertain, as no good section across it is exposed. In the neighbourhood of Loughrea, although it occupies a large area, it may be lying nearly horizontal, and a thin bed under these circumstances might cover a large surface, which is not at all unlikely, as in the vicinity of that town we find an outlier of the *upper cherty zone* not far distant from the base of the unstratified limestone. This will be more fully explained in its proper place in the *Detailed Descriptions*.

in the district more or less damp, as mortar made from magnesian limestone or dolomite never properly *sets*, as the magnesia in it is always inclined to crystalize, and may be remarked in bunches of small transparent glossy crystals on the inside walls of the houses during fine dry weather.

Drift, Alluvium, Bog, &c.—In this district we find as follows:—

4. Bog and alluvium (including the shell marls).
3. Post-drift gravels and esker drift.
2. Boulder drift or corn gravel.
1. Lower stratified drift.

The *Lower stratified drift* was only remarked in one place, and consisted of blue peaty clay and fine sand, in which are plant remains. It will be more fully mentioned in the *Detailed Descriptions*.

The *Boulder drift* occurs in places all over the district. On the hill country it is often of considerable depth, consisting of local detritus, with in places limestone and granite fragments, the former being often so abundant that they are collected by the inhabitants for burning into lime.* Most of the low country is covered with drift of some kind or other. Some of this is the *Boulder drift*, or as it is called nearly everywhere in Ireland, *corn gravel*,† while the rest is much waterworn, and consist of sands and gravels. These latter seem to have been formed from the boulder clay, being well washed and sifted, and occur in gently undulating plains or in ridges and mounds, which are called in Ireland *Eskers*. As they are of more recent age than the *Boulder* drift, I propose to call them *Post-drift gravels* or *Esker drift*. The eskers can be again divided into three classes, for which the following names are proposed:—I. *Fringe Eskers;* II. *Bar* or *Barrier Eskers;* and III. *Shoal Eskers*.‡

The *Fringe Eskers* occur fringing high ground, seemingly having been formed by the back wash of a current like the tidal current of the present day.

The Bar or *Barrier Eskers* stretch from one high ground to another, and seem to have been "bars" where two currents met.

* The loose stones in the drift are locally called *running limestones, running granite*, &c., &c.

† The term *corn gravel* more properly refers only to the Limestone Boulder drift.

‡ This attempt at classification of the eskers into varieties was made by Mr. Kinahan in a paper read before the Geological Society of Dublin on November 11, 1863. It does not appear to me that our knowledge of the exact method of formation of the drift mounds, or ridges, would be advanced by the adoption of these terms, which are obviously borrowed from Darwin's Coral-reef nomenclature. When our map of the esker regions is more advanced we shall probably be in a better position to discuss their mode of formation. In the meantime Mr. Kinahan's proposed nomenclature may stand in this Explanation, since it is impossible to decide *a priori* either for or against the value of any suggestion.

The *Fringe* eskers, however, differ from a Fringing reef, inasmuch as there is a space of two or three miles commonly between them and the foot of the hills, which they are said to fringe.

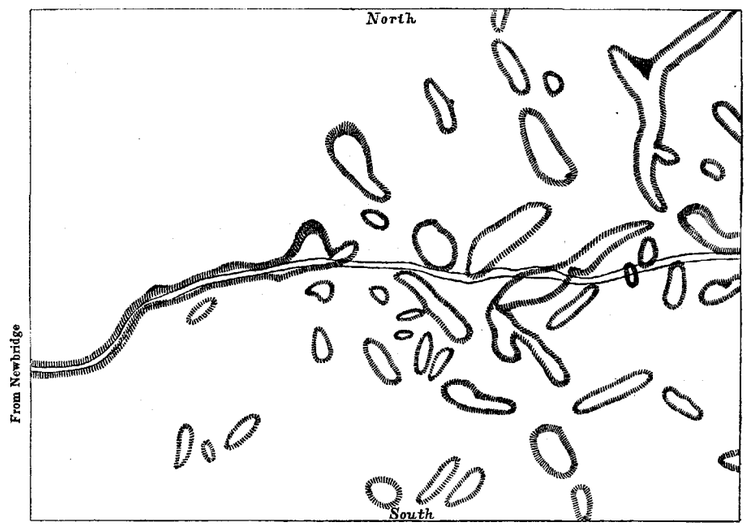
Every one who has examined these eskers has observed that they occasionally seem to be analogous to harbour bars in their mode of formation. Mr. Mallet, many years ago, in speaking of the Tymon Castle esker, near Dublin, remarked the relation between the position of that ridge and the valley of the Dodder or Glen Ismole.

There is no apparent difference in the structure of these bar-like eskers, or that of the long continuous ridges, and that of those more interrupted and discontinuous mounds which Mr. Kinahan proposes to distinguish as *shoal eskers*, neither is there any constant difference between them in local or any other circumstance, nor anything to induce us to suppose that the water was shoaler there than where the other eskers were formed.—J. B. J.

The *Shoal Eskers* may be so called, as they seem to have had a similar origin to the shoals and shifting banks of the present day, having been formed by cross and shifting currents in shoal water. They have no regular form, but generally occur in short ridges that run every way, often at nearly right angles to one another. In some places they are undulating masses of gravel, in others round mounds or short ridges and mounds.

These three kinds of eskers may be modified by local circumstances —*Shoals* occurring in a system of *Barrier* or *Fringe* eskers, and *Barrier* and *Fringe* eskers occurring in the *Shoals*. When the eskers are being described in detail, these modifications will be more apparent, and for the present it will be sufficient to refer to Fig. No. 2, which is a map of part of a *Barrier* esker breaking into a *Shoal esker*, copied from the six-inch or working maps.

Fig. No. 2.



A copy from the Six-inch Map of the Esker, half a mile W. of Fairfield, illustrating a ridge breaking into mounds, forming a Shoal Esker.

Bog, Alluvium, &c.—In the west of the district bogs are scarce, and many of those that do occur are shallow and liable to floods, which deteriorate their value. Towards the east there are good deep extensive bogs, which supply the country with fuel. On the hills there are also extensive bogs, but on account of the bad roads leading to most of them they are not as profitable as they might be. Very few of these bogs, either on the hill country or lowland, are properly drained or systematically cut, therefore there is a great waste of the raw material.

Alluvial flats are found along nearly every river in the district, and in all of them there is a mixture of alluvium, peat, and marl; the latter generally contains freshwater shells, all of which will be found living in the lakes and pools, as will be seen by the following list:—*Limnæa peregra, L—. stagnalis, Planorbis marginatus, Valvata piscinalis, Succinea putris, Bithynia tentaculata, Cyclas cornea.* There are also fragments that seem to be part of an *Anodonta*.

The principal trees in the bogs are *oak*, *yew*, *pine*, *birch*, *hazle*, and *sallow*. *Hazle nuts* were also found.

Many of these flats, especially along the Shannon, are rich meadow land, and are locally called *callows*.

3. *Relations between the form of the Ground and its internal structure, with some account of the latter.*

That part of Slieve Aughta which lies within the limits of this district, is principally formed of rocks belonging to the Silurian and Old Red sandstone formations, while nearly all the low country is occupied by limestones and their accompanying shales.

The steep slopes on the north-west of the mountain group are partly due to the high angle of dip of the Old Red sandstone, which here, contrary to the usual rule in the rest of Slieve Aughta, has a high angle of inclination, rarely being lower than 45°, and in places being as high as 85°, while in the rest of the high land, and in the district to the S., it seldom reaches 40°, and generally ranges from horizontal to 15°. The semicircular valley on the south of Kilchreest is partly due to the strike of the beds, which here curve round with the sides of the valley, but the large east and west valley is in a great measure due to the *force of denudation*, as along the Boleyneendorrish it has no regard to the strike or dip of the beds, but cuts through Silurian and Old Red rocks indiscriminately, but the eastern part lies along the trough of a synclinal curve.

When the large massive conglomerates of Old Red age lie nearly horizontal, they form long irregular terraces, that are sometimes continuous for miles up and down the secondary valleys.

In the neighbourhood of Marble Hill, near the S.W. corner of Sheet 116, the Lower Limestone forms hills, some of them 500 feet high (*see Fig. No.* 3), the small valley to the north of them being cut in the Lower Limestone shale and the Old Red sandstone. About four miles southward of Loughrea there are other limestone hills, one in the parish of Kilteskill being 707 feet high. On the south of these last named is the valley of the Dalystown River, which seems to have been excavated partly along the outcrop of the Lower Limestone shale and partly along the line of a fault which we will now mention.

Tynagh North Fault.—A fault, a downthrow to the north, has been proved across the low country to the N.E. of Dalystown, and at the eastern end of the Dalystown River valley. This, a little on the N. of the village of Tynagh, brings up a tract of Old Red sandstone, which forms low hills, that are well marked, looking at them from the south. This fault has been proved as far as Hearnsbrook on the N.E., and Dalystown on the S.W.

Tynagh South Fault.—Another fault, a downthrow to the south, seems to branch from that that we have just mentioned, a little west of the village of Killimor, and to strike S.W., bringing the lower part of the Lower Limestone and the Calp limestone into juxtaposition a little east of the village of Tynagh, cutting out the upper part of the Lower Limestone. If we follow the strike of this fault toward the S.W., we should find in the Owenaglanna River valley Lower Limestone shale, whose south outcrop could not anywhere be found; these may be bounded on the south by the S.W. extension of this fault, as

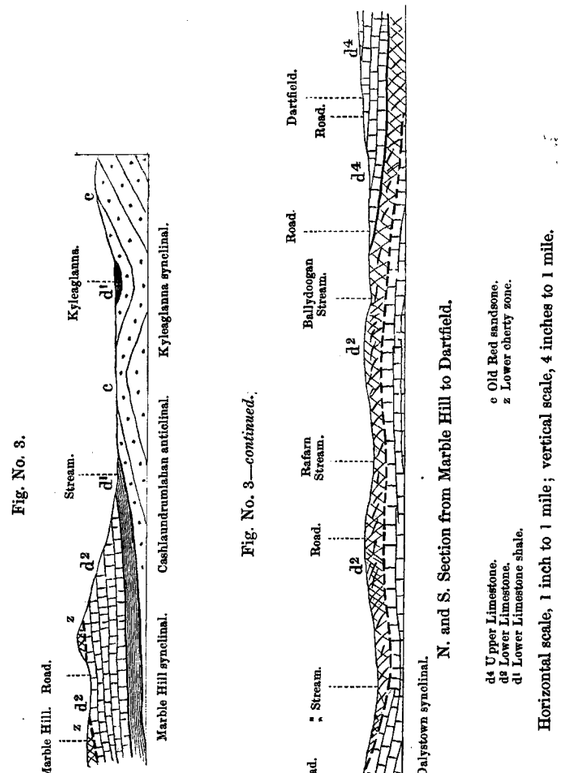


Fig. No. 3.

Fig. No. 3—*continued*.

N. and S. Section from Marble Hill to Dartfield.

c Old Red sandstone.
z Lower cherty zone.
d4 Upper Limestone.
d3 Lower Limestone.
d1 Lower Limestone shale.

Horizontal scale, 1 inch to 1 mile; vertical scale, 4 inches to 1 mile.

farther west, in the Boleyneendorrish River valley, we find an outlier of Lower Limestone shale, which has been proved to be bounded on the south by a fault; but the country on the south of the Owenaglanna River is covered with a deep drift or bog, and no positive proof of the westerly extension of this fault was obtained.

The hills and valleys on the N.W. of Marble Hill run along the lines of anticlinal and synclinal curves.—(*See Figs. No.* 1 *and* 3 *and Longitudinal Sections, New Series, Sheet* 18, *sections Nos.* 1 *and* 3).

The most northern may be called the *Dalystown synclinal*, the second the *Kylebeg anticlinal*, the third the *Boleyneendorrish synclinal*, the fourth the *Cashlaundrumlahan anticlinal*, and the most southern the *Marble Hill and Derrybrien synclinal*. The first is occupied by the valley of the Dalystown River and the high ground on the north, and the last by the hills about Marble Hill; the others are hills or valleys according as they are anticlinal or synclinal curves.*

The hill at the south-west of Sheet 115 is formed of Upper Limestone, and is most conspicuous, rising suddenly from the low country. The rocks in it lie nearly horizontal, and the continuation of the beds toward the east and north have been removed by denudation.

Detailed Description.

As the rocks of each separate formation lie near together we will describe them in geological succession, beginning with—I. *The Silurian rocks;* II. *The Old Red Sandstone;* III. *The Lower Limestone Shale;* IV. *The Lower Limestone;* V. *The Middle Limestone* or *Calp;* VI. *The Upper Limestone;* and VII. *Drift Alluvium* and *Bog.*

I. *The Silurian Rocks.*

The Silurian rocks all lie toward the centre of the south of the district in small detached outlying exposures, of which there are ten or eleven. The largest, which we may call the *Toberelatan outlying exposure*, stretches from half a mile S. of Kilchreest for nearly four miles to near Toberelatan. A mile E.S.E. of Toberelatan there are two; one was remarked half a mile N.W. of Lough Belsrah, and another at the village of Calluragh, three miles S. of Kilchreest. Two or three occur at Sonnagh, a mile S.E. of Calluragh; two to the N.W. of Cashlaundrumlahan, and one at Keelderry Lough, three miles on the W. of Cashlaundrumlahan.

Toberelatan outlying exposure.—This extends from near Toberelatan in a N.E. direction to near the village of Kilchreest, being about four miles long and of irregular widths. The rocks noted are green, gray, black, and blue grits and shales, some of the shales being indurated into a rock like hornstone, and some of the grits into a rock like quartzite; others of the shales are very black, and full of coaly layers like what are called by the Colliers *Coalrods*. Before the blow-pipe these burn with a slow combus-

* We may here mention that all the principal east and west valleys in the rest of Slieve Aughta are synclinal curves, the north sides of which have been cut off by faults.—(*See Explanation of Sheets* 124 *and* 125, *and Longitudinal Sections, new series, Sheet* 18, *section No.* 1).

tion. No regular coal was remarked, nor does it seem likely to occur. In places the strata are undulating in sharp curves, the general strike of their axes being N.E. and S.W., but they all seem to have a general dip to the southward.

The following fossils were found in the stream S.E. of Toberclatan:—

Diplograpsus scalariformis.
,, pristis.
Graptolithus priodon.

The small Silurian exposures S. of Toberelatan, the *Caluragh outlying exposures*, the *Silurians N.W. of Lough Belsrah*, and the *Sonnagh Silurians*,* consist of similar rocks to those just described.

Graptolites were observed in the stream at Sonnagh.*

Keelderry Silurians.—These lie about eight miles S.W. of Loughrea. They are green, gray, blue, and purple grits, sandstones and shales; all the recorded dips being toward the S.E., at angles varying from 40° to 80°. The boundary to the N. and N.W. is only provisional, as the rocks are obscured by deep drift. On the S. and S.E., however, the boundary is well marked, as the basal bed of the Old Red sandstone crops out nearly all the way. That these Silurians were a Peak at the time of the deposition of the Old Red sandstone seems probable, as they occupy higher ground than the Old Red rocks on the S.E., and the latter also dip N. toward them. That a fault does not bound the Silurians on the south is evident, as the basal bed of the Old Red can be traced from the south round to the west of the Silurians, and in some of the streams at the south the latter can be seen under the former. These Silurian rocks would seem to be equivalent to the beds in the south part of Slieve Bernagh, which, as before mentioned, are, according to Mr. Baily, *Bala* or *Caradoc Beds*.

The *Cashlaundrumlahan* and *Toormacnevin Silurians* are similar to those at Keelderry, except that fine conglomerates at Cashlaundrumlahan take the place of the coarse green grits.

A quarter of a mile W. of the hamlet called Toormacnevin, there is an E. and W. quartz vein, eighteen inches wide, containing micaceous iron and *peach* (chlorite).

II. *Old Red Sandstone.*

Country about Keelderry Lough.—Here the Old Red rocks are well exposed, especially between this Lough and Divney's, where there are large cliffs and terraces. The principal rocks exposed are coarse massive conglomerates. The dip is all toward the Silurians on the north, varying from 2° to 15°. A section is seen in the stream that flows from Keelderry Lough, by which the Old Red is calculated to be about 1,100 feet thick. A partial section was noticed in the Boleyneendorrish River, which shows a few small N. and S. faults.

Old Red Country S. of Kilchreest.—Among the patches of the Silurians we principally find conglomerates. Sections are exposed between the Lower Limestone shale and the Silurians, which show that the Old Red is of various thicknesses, and in one place, as represented in Fig. No. 4, in a stream about a mile south-east of Roxborough-house† the basal bed (a massive conglomerate) is found in steps on the Silurian. In the stream

* The two most eastern exposures at Sonnagh may be connected under the intervening drift hill.

† Mr. Hely Dutton, in his "Statistical Survey of Galway, 1824," page 34, mentions: "On the mountain near Roxborough a very fine kind of whitestone occurs; it is sold in the country for Lough Neagh hones."

S.E. of Toberelatan there is a good well-exposed section (*see Longitudinal Sections (New Series) Sheet* 18, *Section No.* 2), which is worth describing in detail. Here the rocks are nearly vertical, except the basal bed, which suddenly bends over and becomes nearly horizontal (about 10°).

Section No. 1, *S.E. of Toberelatan.*

			Ft.
25.	Yellow sandstone,	about	20
24.	Red clayrock, imperfectly cleaved,	,,	15
23.	Yellow sandstones, with shale partings,	,,	17
22.	Conglomerate,	,,	5
21.	Yellow sandstone,	,,	2
20.	Conglomerate,	,,	14
19.	Yellow sandstone, obliquely laminated,	,,	6
18.	Thin bedded yellow sandstone, with shale partings,	,,	6
17.	Yellow sandstones, with shale partings, some of the sandstones obliquely laminated,	,,	12
16.	Break in which the rocks are not seen,	,,	36
15.	Green sandy shales, with quartz strings,	,,	4
14.	Yellowish green sandstone with ditto,	,,	15
13.	Red sandstones,	,,	3
12.	Yellow sandstones,	,,	6
11.	Break (shales?),	,,	5
10.	Red sandstone, with a few yellow beds,	,,	39
9.	Yellowish green sandstone, with quartz strings,	,,	9
8.	,, ,, sandy shale, with red patches,	,,	21
7.	Green, yellow, and red sandstones and shales,	,,	75
6.	Fine conglomerate,	,,	8
5.	Yellow sandstone,	,,	6
4.	Conglomerate, very friable,	,,	21
3.	Break,	,,	66
2.	Yellow sandstone,	,,	45
1.	Massive conglomerate, the principal pebbles are white quartzite,	,,	30
			486

From this section we find that here the Old Red must be about 500 feet thick if there is not a fault in the breaks (Nos. 3 and 16 in section), which is unlikely; but about three miles on the N.E., at the section on the N.E. of Calluragh, it is calculated to be 1,150 feet, and farther east, due north of Francis Gap, it is about 1,000 feet.

Kylebeg.—About Lough Belsrah there are numerous cliffs and terraces cut across by deep fissures. On the northern slopes of Kylebeg terraces and cliff also occur; the eastern slopes are covered with bog, while the southern is partly bog and partly cliffs; rock being seen in the neighbourhood of Toormacnevin and in some of the streams.

Cashlaundrumlahan.—This is principally covered with bog or drift, rocks only occurring in some of the stream, and in protruding crags and bosses. A few of the conglomerates form short terraces at their outcrops.

Old Red Country N. and N.W. of Marble Hill and S.W. of Dalystown.—Nearly all this large tract is covered with hillocks of strong Old Red drift and mountain bog; the latter often being of a considerable depth, especially when in the hollows. Rocks only occur in some of the streams and on a few of the hill sides. Partial sections can be examined in the Dalystown and Duning rivers, but in no place is there anything peculiar about them which requires a special description.

Towards the east the boundary of the Old Red is deflected eastward by the *Kylebeg* and *Cashlaundrumlahan anticlinals*, and westward by the *Boleyneendorrish* and *Marble Hill synclinals*.

At the centre of the south margin of Sheet 116, between Davy's Grove and The Hill, there is Old Red sandstone the extreme northern part of the Old Red country which in the district on the south occurs all about Woodford.

Tynagh Old Red Outlying Exposure.—This is situated about seven miles S.E. of Loughrea, and about half a mile north of the village of Tynagh, being on the strike of the *Kylebeg anticlinal.* Rocks only occur *in situ* at a few places. In one place opposite to where the farm-road joins the road from Tynagh to Gortareask, yellow sandstones were remarked that may dip to the N.W. at about 10°, but all the other dips observed are southward, at angles varying from 15° to 20°.*

Flags were raised in the townland of Derry French by the occupying tenant, and used for flagging the Police Barracks at Killimor, and Brooklawn-house.

That this exposure is bounded on the north by a fault is proved by the Upper Limestone appearing immediately to the N., where the arrow is engraved on the map, and that it occupies the space assigned to it seems probable, as all that ground is thickly strewed over with angular blocks of Old Red sandstone and conglomerates, and the strip marked as Lower Limestone shale with the debris of the grits and flags that form the basal beds of that group. That it does not extend farther S. or E. is proved by limestones being remarked immediately outside of the limits assigned to the Lower Limestone shale.

Cloon Old Red Outlying Exposure.—This lies at Cloon-house, close to the centre of the south margin of Sheet 115. Rocks, that consist of yellow conglomerates and sandstones, are only seen in two places, which lie between Cloon-house and the road that runs to the village of Kiltartan. The Old Red sandstone may extend a little farther to the N.E. than marked on the maps, as no rocks are exposed thereabouts, but its limit to the S.E. is fixed by an outcrop of dark blue shaly limestone immediately westward of the road from Loughrea to Gort, that to the S.W. by a patch of blue fossiliferous shale, at the north margin of the district contained in Sheet 124 (*see Map and Explanation of Sheet* 124), and that to the N.W. by dark blue shaly limestone that crops under where the *l* in *Cloon* is engraved on the one-inch map. A fault, a downthrow to the N.W.,

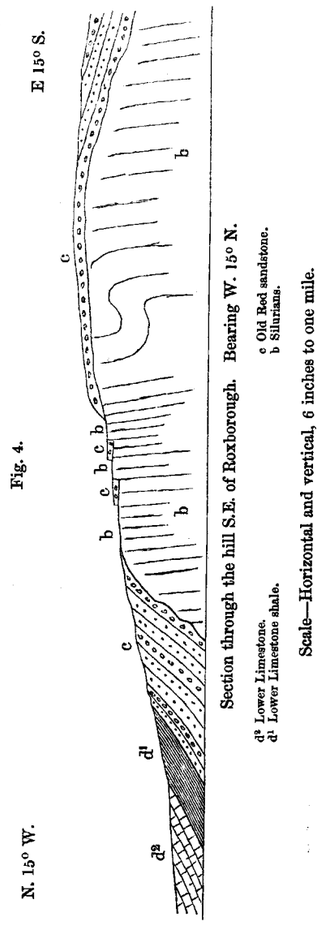


Fig. 4. Section through the hill S.E. of Roxborough. Bearing W. 15° N.

Scale—Horizontal and vertical, 6 inches to one mile.

* A few yards south of where the supposed N.W. dip was observed, in the stream there situated, I am informed by Mr. Lynch, of Springvale, that there is a sandstone full of iron pyrites (?).

may bound it on the N.W., as there seems scarcely room between the Old Red sandstone and the Upper Limestone for the whole of the Lower Limestone and the Lower Limestone shale to come in, but as there are no positive proofs of the existence of a fault in this place, it has been considered best to mark in the present provisional boundaries.

III. *Lower Limestone Shale.*

The place occupied by this formation in Slieve Aughta is usually covered with deep drift, but in the part we are now examining, on the northern slopes of Slieve Aughta, it is well exposed in various places. Beginning toward the S.W. it can be examined in the Boleyneendorrish River and in some of its tributaries. To the S. of the Boleyneendorrish, River it is shifted by a fault, a downthrow to the N.E., as marked on the map. It is again met with in the stream at Toberelatan, and in most of the streams that run down the hill-sides S. of Roxborough. In the neighbourhood of Kilchreest it is obscured by the drift, but about three miles on the S.E. of that village there are good sections across it, especially in the townland of Caheratrim. From this to the road on the W. of Dalystown it was noted in various places. Through the Dalystown demesne it is all covered by deep Old Red drift, or it may be cut out by the *Tynagh North Fault,* as before mentioned. From the Tynagh North Fault it seems to go over the Kylebeg anticlinal, turning round Ballyargadaun wood, as we find it in the stream on the east of Kylebrack and farther S.W. in Kyleaglanna. Along the northern outcrop of the Boleyneendorrish synclinal it was observed as far west as the end of Kyleaglanna, where it turns, but on the south outcrop it is not visible, and may be bounded by the *Tynagh South Fault,* as mentioned in the General Description (*see ante, p.* 16). A mile eastward of Kyleaglanna it turns across the *Cashlaundrumlahan anticlinal*, and up the valley occupied by the Duniry River. A little on the west of the village of Drumkeary it must turn more southward, and leaves the district on the south-west of Knockmoyle. This group is very fossiliferous, especially the shale.

Bounding the Old Red sandstone hill, at the south margin of Sheet 116, there is supposed to be a strip of Lower Limestone shale, but in no place were rocks belonging to it observed, nor do they seem to come anywhere to the surface, as the country thereabouts is covered with a deep stony drift.

Outliers of Lower Limestone Shale in Owenaglanna and Boleyneendorrish Valley.—Two of them occur to the W.S.W. of Kyleaglanna, lying in the trough of the *Boleyneendorrish synclinal;* one is situated about two miles west of Cullenagh-bridge, and the other farther west due south of Francis Gap. In the most eastern of these the rocks are only seen in the bed of the river, and are principally blue, gray, and black shales that are lying nearly horizontal. They are very fossiliferous, and on one thin blue sandy shale short annelid tracks were remarked.

The boundary of the outlier on Francis Gap is usually well exposed, and here, besides the shale, the lower beds are exposed, viz., gray, green, blue, and yellow, grits and flags, with gray and green shales and clayrock. A fault was noted in one of the streams on the south, and seems to form its southern boundary. This, as previously mentioned, may be the western extension of the *Tynagh South Fault*, and if it is, it is probable that it also bounds the first mentioned outlier, for which reason we have suggested a fault thereabouts.

Loughrea Lower Limestone Shale.—An exposure was remarked a mile N.W. of Loughrea. Here not much of the rocks *in situ* are exposed, but

numerous loose angular blocks abound, many of which have been raised in tilling the ground. In a few places the lower grits and sandstones were observed *in situ*, and in one place a bivalve shell was found in a decomposed blue calcareous sandstone, but on account of its frail nature, the species was not determined; it is supposed to be bounded on the S. by a fault (*see Fig.* 1, *and Longitudinal Sections, New Series, Sheet* 18, *Section No.* 1).

At the *Tynagh and Cloon Old Red Outlying Exposures* the Lower Limestone shale is also supposed to exist, as previously mentioned when describing them.

IV. *Lower Limestone.*

Country about Cloon.—This division of the Carboniferous rocks enters the district on the S. at the centre of Sheet 115, curving round the anticlinal axis that brings up the *Cloon Old Red sandstone outlying exposure.* In the river at Cloon-bridge the lower cherty zone which divides the stratified and unstratified portion is well exposed. At the new river, a little N. of Cloon-bridge, the upper portion is very magnesian, in places a good yellow dolomite.

From the south margin of the district, for about three miles as far north as St. Peter's Well, those limestones extend over a wide tract, as the angle of dip is low, often being nearly horizontal, but from that place, as far N.E. as Kilchreest, the dip rises to angles varying from 30° to 65°, and, consequently, the Lower Limestone only occupies a narrow belt outside the Lower Limestone shale. As there is deep drift over this country only a few rocks belonging to this group are visible, which all belong to the lower stratified portion. On this account the position and limits of the Lower Limestone would be most uncertain were it not that the Lower Limestone shale is so well exposed, and that the Upper Limestone also occurs in various places outside the limits that we have assigned to the Lower Limestone.

Country about Lough Rea.—At Kilchreest the angle of dip falls, and in the neighbourhood of Lough Rea we find the Lower Limestone rolling over a considerable area. Here the upper unstratified part seems to thicken considerably, but the dip is so low, being often nearly horizontal, that this may be only apparent, as a little on the north of where the Roman Catholic chapel is engraved on the inch map* the *Lower Cherty Zone* comes up in a flat nearly horizontal quaquaversal dome, and half a mile east of this, nearly north of the Charter-house, there is a small outlier of the *Upper Cherty Zone*.† The latter is on ground about 75 feet higher than the former, and, as in both places the beds are nearly horizontal, the unstratified limestones may only be that thickness. The fault that brings up the Lower Limestone shale on the W. of Loughrea, also shifts the Lower Limestone boundary, throwing it more towards the north.

On the south of the Lough the subjacent rock is principally the lower stratified portion, the Lower Cherty Zone being well developed; but many of the hills are capped with outliers of the unstratified limestone, the most marked of these being that which forms the previously mentioned* hill in the parish of Kilteskill, where the trigonometrical point 707 is engraved. On the west side of this hill the structure like oblique lamination is well developed, producing an apparent dip N. at 70°, but terminating downwards against the face of the Lower Cherty Zone. It can also be seen

* The site is all that remains of it now.

† This is where the four arrows are engraved on the one-inch map; the patch is so small that it was not marked with a boundary or by a different colour.

in an outlier that lies to the E. a little S.W. of Aille Castle. Here the dip of this structure is also N., at about 70°, and in one place there seems to be a shale parting, but immediately S. of it the cherty beds are found to dip N. at from 5° to 10°. On the west of Loughrea the limestone is very magnesian, in places a dolomite; and a nearly N. and S. dyke of yellow dolomite was remarked cutting across the Lower Cherty Zone and the underlying beds.

In the river near the corn-mill, a mile E. of Kilchreest, there are remarkable fine stones for building purposes, also in the quarry on the south side of the Galway road, half a mile N.W. of Loughrea.

In the neighbourhood of Rafarn, three miles east of Loughrea, the unstratified limestone is very fossiliferous, the following having been remarked :—*

Corals.

Amplexus coralloides.

Polyzoa.

Fenestella flabellata.

Brachiopoda.

Producta semi-reticulata.
Spirifera striata.
„ cuspidata.
„ pinguis.
„ glabra.
„ lineata.
Orthis resupinata.
„ Michelini
Athyris Roysii.
Rhynchonella pugnus.
Terebratula hastata.

Conchifera.

Cardiomorpha oblonga.
Pleurorhynchus aliforme.
Aviculopecten alternatus.

Gasteropoda.

Euomphalus pentangulatus.
„ Dionysii.
Natica plicistria.
„ elliptica.
Turritella suturalis. (?)
Platyschisma cirroide.

Cephalopoda.

Nautilus dorsalis.
„ biangulatus.
„ carinatus.
„ discors.
Goniatites furcatus.
Gomphoceras fusiforme.

At Bracklagh, two miles N.W. of Tynagh, there are numerous blocks that weather out and have the appearance of a conglomerate or trappean ash, and on the north of the bog that lies N.E. of Tynagh a similar limestone was noted in two quarries. A little east of "Tynagh Lead Mine" there is a very fine dark blue limestone that can be raised in large blocks. This was used extensively by the Board of Works for the new bridge during the works of the Drainage Commission.

The Tynagh North Fault cuts out the Lower Limestone shale and part of the Lower Limestone on the north of the *Tynagh Old Red outlying exposure.*

Country about Duniry and Marble Hill.—The boundary between the Lower and Middle Limestones is affected by the Kylebeg, Cashlaundrumlahan and Slieveanore anticlinal curves, the latter coming into this district on the S.W. of Marble Hill. Although the Kylebeg curve extends into the Lower Limestone nearly to Killimor, yet the upper boundary of the Limestone is not seen, as in that neighbourhood it is bounded north and south by the Tynagh Faults; but on the north of Pallas we find the natural boundary, and from that it runs to Newbridge, where it turns over the Cashlaundrumlahan curve and goes south, towards Killeen house, but meeting the Slieveanore anticlinal it is deflected toward the east to Harding's Grove, when it again turns southward, sweeps round Portumna, and leaves the district a little north of its S.W. corner.

On the south of the *Tynagh North Fault* the subjacent rock is the

* Determined by W. H. Baily, F.G.S.

lower or stratified part of the Lower Limestone, locally called *Bog Limestone* *

This kind of rock will be found all about Tynagh, Duniry, and Abbey; at Marble Hill it also occurs, but there three outliers of the unstratified limestone, or the Lower Limestone without chert, lie on it, one under Marble Hill house, another on the hill to the N., immediately north of the road from Gort to Portumna, and the third more east at Knockadrum.†

A mile east of Duniry, in the townland of Reaghan, there is a very fine stone for tool work. It also seems capable of being raised in blocks of a large size, but as only a small quarry is opened on it, no exact opinion can be given.

On the east of Tynagh, the gray unstratified limestone must be cut out by the fault, as we find the Lower stratified part and the Calp Limestone nearly in juxtaposition, but it sets in immediately south of that village, and extends by Pallas and Newbridge to Harding's Grove, and from thence to the south margin of the district. On the south of Portumna a lenticular mass of gray granular limestone comes in above the *Lower Cherty Zone*. This, for the reasons previously given, we have included in the Lower Limestone. A quarry has been lately opened in it, from which they are raising stones to build a new mansion in Portumna demesne. It is an excellent stone for tool work, but it is difficult to quarry, on account of a want of joints. On the N. and N.W. of Portumna the limestones are more or less magnesian, some of them being nearly a dolomite.

Killycross Outlying Exposure.—About Killycross, on the east of the river Shannon, and N.E. of Portumna, there is a tract covered with fragments and blocks of the gray unstratified portion of the Lower Limestone, which seems to be the debris of the underlying rock.

Red and Variegated Limestones.—I will mention in detail the places where these were noted, as at some future time they may be worked for marble. In the townland of Limehill, three miles on the westward of Tynagh, there are red and variegated limestones: these can be traced a long way east and north-west of the Fox-cover. At Bracklagh, two miles N.W. of Tynagh, fragments of red and purple limestone, with blood-red chert, are scattered about, and seem to point to the rock being *in situ* somewhere in that neighbourhood. At Quarry Hill, which lies half way between Tynagh and Pallas, in the walls, especially about the new plantations, pieces of red and variegated limestones are found, and I was informed by Captain Nugent, of Pallas, that they were raised in Quarry Hill.

V. *Middle Limestone or Calp.*

The Middle Limestone or Calp, as before mentioned in the General Description, lies on nearly the same horizon as the Upper Limestone, but we have put it in as a separate group, as it is so different lithologically. It begins N.W. of Loughrea, in the vicinity of Dunsandle, dovetailing into the limestone of the Burren type; but to the N.E., E., and S.E. of that place, it thickens considerably, and covers a large tract of country, as it generally lies at a very low angle, often being nearly horizontal for miles.

Country about Kilreekle, Gortymadden, Kiltormor, Laurencetown, Eyrecourt, and Killimor.—As this is a regular drift country, the rocks can only be seen in quarries, rivers, and streams; but, fortunately, the two latter, about thirteen years ago, were opened up by the works carried on by the Drainage Commissioners, and therefore rocks can be seen in most of the alluvial flats, but no continuous sections were observed.

* This limestone usually comes to the surface in the hollows formed by the drift, which are always more or less marshy, from whence its local name.

† All these limestones are very fossiliferous.

The junction between the Upper and Lower Limestones is to be seen in one place only, which is in a lane a little east of Pallas, the seat of A. Nugent, esq.

Section No. 2, at Pallas.

		Feet.
17.	Black limestone and shale,	over 10·
16.	Gray limestone,	,, 1·5
15.	Black shale,	,, 3·
14.	Gray limestone,	,, 1·
13.	Black and blue calcareous shale,	,, 1·5
12.	Thin layers of limestone, and greenish blue shales alternating,	,, 1·
11.	Gray limestone,	,, 1·
10.	Flaggy blue sandy shale,	,, 0·08
9.	Yellow sandstone,	,, 0·5
8.	Sandy yellow shale parting,	,, 0·08
7.	Yellow sandstone,	,, 0·25
6.	Sandy yellow shale,	,, 0·17
5.	Black shale,	,, 0·33
4.	Dark blue limestone,	,, 0·66
3.	*Space*,	about 1·
2.	Dark blue limestone,	,, 0·75
1.	Gray unbedded limestone,	over 20·
		42·82

These beds may be the first appearance towards the S. of Ireland of the sandstones which are called by Sir R. Griffith *Calp sandstone*. They were not remarked *in situ* except at this place, but similar sandstones are numerous in the drift on the N. and E.; but whether these *running stones* are of this or the Old Red age it is impossible to say.

About three miles N.W. of Tynagh, and a little S.W. of Streamstown-house, there is a quarry in which black flaggy limestone are full of large goniatites and flakes, that may be fish remains. On the N.W. of Brooklawn good flags have been raised in several quarries. About three miles northward of Killimor, and half way between Eskerboy and Raheen, in the Ardullagh River, there are black shale and limestones, so much twisted and contorted that we now find masses of the latter surrounded by the former. The black limestones hereabouts are generally a bad building stone, except for rough works, but good quarries have been opened in it near Eyrecourt, Laurencetown, Killreekill, &c. In all this country the beds are generally undulating, at a low angle, but seem to have a general dip northward.

Country about Portumna.—In the immediate vicinity of this village we find the Calpy Limestones near the surface in various places, and many quarries have been opened in it, principally to procure the stones wherewith to build Portumna-bridge over the Shannon.

Country East of the Shannon.—In this tract, excluding the previously described outlying exposure of Lower Limestones at Killycross, the rocks are all black and dull gray thin-bedded siliceous or agillaceous limestones, with shale partings and layers, and nodules of chert. Quarries are numerous, as the rock is generally near the surface. A good section has lately been opened in the cuttings for the Birr and Portumna Railway, in which some very remarkable shaly beds are exposed. These shaly beds for about 10 feet below the surface have weathered into a rotten shale, that often has a spheroidal structure. In one or two places the limestones are changed into dolomite of a pinkish colour. On some of the shaly parting numerous annelid track, like those which occur on Coal Measure flags, were remarked.

VI. *Upper Limestone.*

Country about Kinvarra, Ardrahan, and Clarin's-bridge.—The Upper Limestone is well exposed on the west and north of Ardrahan, occurring in large bare crags, miles in extent. In many places beds and parts of beds are more or less magnesian, sometimes a good dolomite. The most marked of these are as follow:—On the N. of Cloghballymore Lough, which lies three miles N.N.E. of Kinvarra, farther east a mile S.E. of Turloughnafrankagh, and two miles farther south about Drumtarsna Castle.

On the road from Kinvarra to Gort, about four miles south of the former place, in the townland of Rockpark, there is a vein of calcspar, about two feet wide, that bears N. 40° W.

Country between Ardrahan and Dunsandle.—On the east of Ardrahan the nature of the country changes, it being covered in a great measure with drift, crags being of rare occurrence, and when they are met with being of very small dimensions. Some of the limestones are also of a blackish colour. In the neighbourhood of Dunsandle we find the rocks of the *Burren type* dovetailing into the *Calp type*. At Saint Cleran's there are Burren limestones dipping north. In the river south of Dunsandle and Tooloobaun houses we find the Burren dipping under the Calp Limestones, while on the N.W. of Dunsandle the Calp beds are dipping under the Burren. From these facts we may safely say that hereabout they are interstratified.

VII. *Drift, Alluvium, and Bog.*

Glacial Roundings and Striæ.—Before entering into the subject of the Drift I must refer to the *Roches Montonnees* or *dressed rocks;* and as my colleague, Mr. A. Geikie's description of the Scotch hills (*see On the Phenomena of the Glacial Drift of Scotland,* by *Archibald Geikie,* F.R.S.E., &c., &c.), exactly describes those of Slieve Aughta, I cannot do better than copy it:—

"Not only do the hills when looked at from a distance wear the aspect of having their crags and knolls shorn down or rounded off, but the crags themselves exhibit the same structure in detail. The surfaces of such ridges and furrows, when they have been preserved from the influence of the weather by clay or turf, are sometimes as even as a piece of ashlar-work. It is true that as with the outline of the hills so with that of their component knolls; the action of frost, rain, and other causes has often split up the rock and worn it away, thus effacing its flowing lines and replacing them with a set of rough and irregular craggy surfaces. In this way the rounded form in not a few cases has ceased to be traceable. Yet in many instances, even where at first sight we seem to see nothing but an amorphous mouldering crag, with its joints and fissures worn into hollows, and the rock between them wasted into rude rough blocks, a little examination will enable us to trace the curved line still. It is no uncommon thing to find on one hill side knolls in all stages of decay; one or two having only been recently uncovered, retain as freshly as ever the moulded character; some have begun to lose it as they yield to the combined agencies of atmospheric waste, while from others, gnarled and mossy, it has wholly passed away."

The smoothest surfaces of the rocks are further marked with sets of finer groovings, ruts, and striæ; and as this subject has not previously been entered into in regard to Slieve Aughta, I shall give the following table, in which are mentioned not only the localities in this district at which striæ have been observed, but also those places which were remarked in the district included in Sheets 124 and 125, which lies on the south, and contains the greater part of the mountain group of Slieve Aughta.

List of Places in which Striæ and "Dressed Rocks" were observed in Sheets 115, 116, 124, and 125.

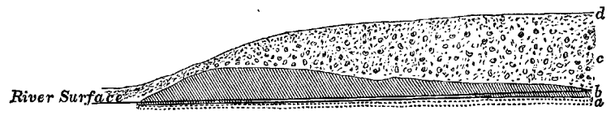
Number of One-Inch Map.	Number of Six-Inch Map.	Locality.	Direction of Striæ.	Depth of Drift.	Observations.
124	Clare 26/1	Ballyogan,	N. 20 E.	1 foot.	Rocks dressed and polished, but no striæ observed.
"	" "	Ballyline,	N. 10 E.	2 feet.	The striæ that bear N. 40 W. are nearly obliterated.
"	" "	Derrygarriff,	N. 75 W.	2 to 4 ft.	The N. 75 W. striæ are nearly obliterated.
"	" "	"	N. 10 E.		A little N. of the last locality.
"	" "	Dute S. of Tobermacduagh	N. 10 E.	1 to 5 ft.	The E. and W. striæ are nearly obliterated.
"	" 18/2	Cappanapeast,	N. & S.		The N. 45 E. striæ are nearly obliterated. The rocks here are slightly displaced.
"	" "	"	E. & W.		
"	" "	"	N. 45 E.		
"	" "	S. of Skehanagh Lough,	N. 10 E.	1 to 5 ft.	No second lines of striæ observed. About 200 yards to the northward in the railway cutting the boulder clay is found to be forced in between the bed of limestone, and to raise them several feet.
"	" "	"	N. 10 E.	2 to 5 ft.	
"	" "	"	N. 45 E.		In cutting for a new road.
"	Gal. 133/2	Knocktoby,	N. 10 E.	6 feet.	The N. 45 E. striæ are nearly obliterated. A large sheet of rock exposed.
"	128/4	Rathwilladoon,	N. 45 E.	2 to 6 ft.	Do.
"	"	Lurga,	N. 10 E.	4 feet.	There seems to be another set of striæ, but they are very obscure.
"	" 128/2	Laghtylaughnessy,	N. 20 E.	3 feet.	A little south of this there are limestones which may not be *in situ*, on them the striæ are N. 25 E. and N. 75 E.
"	" "	Cloonnahala,	N. 50 E.	6 feet.	
"	" 122/4	Lavally,	N. 45 E.		A very thin drift. The surface of the rock is slightly weathered.
"	" 123/3	" (North),	N. 25 E.		Here the striæ are well marked, and the rock beautifully polished.
"	" "	"	N. 45 E.		Knapp of rock forming nucleus of small drift hill.
"	Clare 19/4	Glendree, neighbourhood of Lough Graney,	N. & S.		This and the fifteen following localities are in the mountain group called Slieve Aughta; they are all on either Silurian or Old Red sandstone, while the preceding were on limestone.
"	" "	"	N. 10 E.		
"	" 20	Knockbeha,	N. & S.		In the pass on the S.E. of the Knockbeha Old Red outlier.
"	" 13	Cahermurphy,	N. 29 W.		N.E. of the Lough, and immediately N. of Cahermurphy-house.
"	" 12/4	Drumandoora,	N. 60 E.		Three miles W. of the north end of the Lough.
"	Gal. 124/4	Derrybrien, North,	N. 60 E.		On the north slopes of the Valley.
125	" 125/3	Derrybrien, Derrybrien Valley,	N. 65 E.		On the south slopes of the continuation of the valley of Derrybrien and north slopes of Slieve Aughta.
"	" 126/1	Moyglass,	N. 30 E.		
"	" 123/4	Lackan,	N. 50 E.		
115 & 124	" 123/2	Ballyeighter, N.W. slopes of Slieve Aughta,	N. 45 E.		S.W. boundary of Doonally, East.
115	" 124/1	Doonally, East,	N. 65 E.		This locality is in the Boleyneendorrish Valley.
"	" 115/3	Bohaboy, N. slopes of Cashlaundrumlahan,	N. 55 E.		A mile E. of the summit of Kyleba.
"	" 115/1	Sonnagold, N. slopes of Slieve Aughta,	E. & W.		
"	" "	"	N. 75 E.		
"	" "	Ballynamurragh,	N. 80 E.		On crest of hill between two small valleys.
"	" 114/4	Gortnaglear, N.W. slopes of Slieve Aughta,	E. & W.		On the hill south of Castleboy.
"	" "	Cloghaun,			

The seventeen first observations are on the low land, and from them we find that in most places there are two sets of striæ on the planed surfaces, and that the nearly N. and S. lines would appear to be the newest. The nearly N.E. and S.W. striæ I consider to be those made by the general movement of the iceflow, as the hummocks of rock and the general outlines of the hills have a similar bearing; the others may have been made by the ice when it was finally melting away sliding down the valley toward Ennis. The second set of striæ in the third observation has quite a different bearing to any of the others, for which I can suggest no reason.

In the observation taken in the hills, that is the last sixteen, no second set of striæ were noted. Those that run nearly east and west may have been caused in a similar way to the nearly north and south striæ on the low land, as most of the valleys in the hills have a nearly E. and W. bearing, while the others may lie in the regular direction of the flow, having an east or west tendency, respectively, as they occur on either the west or east slopes of the hills. In most of the valleys of Slieve Aughta the northern slopes are planed nearly smooth, while abrupt crags are found on the southern. The northern slopes are also much more gentle, from which it would appear that the ice-flow came from the N.E.

The Lower Stratified Drift.—This was only observed in the Boleyneendorrish River Valley, on the south of Cappard, at the junction of the townlands of Gortadragaun and Drumminacoosaun. This locality is about five miles N.E of the town of Gort. The drift is of different thicknesses, as will be seen by the accompanying Section,

Fig. 5.



Diagrammatic sketch, showing the relations between the Boulder and Preglacial (?) drifts.

d Re-adjusted drift and vegetable soil.
c Boulder drift, containing limestone and Old Red sandstone fragments.
b Black clay, containing fragments of plants, cones, &c.
a Layers of fine white sand. Black clay, with plants, sticks, leaves, cones, &c.

Scale—Vertical and Horizontal, 50 feet to 1 inch.

Toward the east end of the cliff an excavation was made and the following beds exposed :—

Section No. 3.

		Ft.
6.	Vegetable soil,	1·5
5.	Re-assorted drift,	1
4.	Boulder drift,	20
3.	Black clay; in the lower part a few cones and leaves,	4·15
2.	Lenticular layers of black clay and fine white quartzose sand, full of leaves, sticks, fir cones, &c.,	2·5
1.	Do., Do., with only a few leaves and fir cones, over	2·85
		32

The excavation was much deeper than the bottom of the bed of the adjoining river, and the water oozed in so fast through the numerous sand layers that we were not able to open more of the group No. 1. The sandy layers became much coarser as we went down, and then both No. 1 and No. 2 had a slight slope (about 3°) towards the east. These layers rarely exceeded four inches in depth in their thickest part. Quartz pebbles are found in these sand layers as we descend; they are also found in the upper part of No. 3, but not in the lower portion. In the Boulder clay (No. 4) there are numerous blocks of sandstone and limestone, the latter

being well scratched and polished, and so numerous that they are collected by the inhabitants to burn into lime. About half way up toward the centre of the cliff there was observed what seemed to be a bed similar to No. 3 in Section, but on opening it up it was found to increase in thickness, and seemed to join below into No. 3; I therefore thought it likely that the black clay is thicker in the body of the hill, and that at the exposed side (south side) the boulder drift had been piled up against it. In favour of this idea we find that the top of the black clay is much higher toward the west than it is toward the east, as will be seen by looking at Fig. No. 5. When this layer was remarked it was about ten feet above the mass of the black clay. Professor Melville, M.D., of Galway, who kindly assisted me at the excavation, has furnished the following description of the fossils found:—

"I have examined the collection of specimens from the lacustrine deposit. The important part consists of cones of the Scotch fir and of the common spruce; the remainder of fragments of wood chiefly coniferous, portions of branches, scales of bark, pieces of fir bark, and a single imperfect hazel nut.

"Three-fourths of the cones of the Scotch fir (Pinus sylvestris) are perfect, several retaining the stalk, many are more or less flattened, and all are of a dark colour externally, and present a brownish tint when cut; but they have not been mineralized.

"The largest is 1·9 inches long and 1·1 inch wide, and the smallest 7 lines in length and 5 lines wide. They present slight differences among themselves as to the prominence and recurving of the projecting point of the scales, in part owing perhaps to pressure.

"The remaining pine cones are rubbed as if in the transport, or possibly they may have been bitten or knawed by animals.

"Five portions of the cones of the spruce (Abies excelsa De C.) attest the presence of that species on the western portion of the British Isles in certain pre-glacial times. Many of the cones which when first dug up were regarded as those of the spruce turned out to be flattened or rubbed pine cones; the proportion of spruce cones to those of the pine is as 1 to 16. The two most perfect fragments are, I think, part of the same cone, separated in the digging: the basal portion is 2·5 inches long, and 1 inch wide; the apical piece is 1·5 inch long, and ·8 inch in its greatest width. Combined they form a cone, compressed and curved, about 3·5 inches long. The scales present the characteristic rhomboidal form of those of the spruce, but the apices are more broadly rounded, and not distinctly produced into the emarginate angle, as in the recent cones before me. This character may be regarded as a variable one. The scales are partly impregnated with pyrites.

"Cone No. 2 is 2·3 inches long, and 1·2 inches wide in its lower part; the scales are imperfect, and have expanded in drying. The upper portion is abruptly narrower, as if bitten round.

"The remaining cones are respectively 2·2 inches and 1·4 inches long, and about 0·6 inches wide. The scales are imperfect, and the cylindrical form of these fragments recalls the observation of Professor Heer on the condition of certain spruce cones from Norfolk (see "Lyell's Antiquity of Man," 2nd ed., p. 215).

"Much larger single scales of the spruce cones were observed during the excavation, but I have not found them in the debris brought home.

"The hazel nut is about the size of a large filbert; the upper portion is removed, exposing the nucleus of a brown colour, as if the nut had been nibbled by a field mouse or squirrel prior to the nucleus being fully ripe. The shell is carbonized, as if charred, and portions of it readily flake off."

Dr. Melville does not mention that the pith of some of the branches was changed into iron pyrites. I also remarked the same thing in one of the cones where the centre stalk was iron pyrites.

Boulder Drift on Slieve Aughta.—Most of the fragments in the boulder drift on these hills are either of Old Red or Silurian age; but in places, sometimes at considerable heights, limestone fragments also occur. In the Boleyneendorrish River Valley limestone boulders will be met with

all along the river in the parish of Kilthomas; farther east, on the north of Cashlaundrumlahan, and immediately south of Toormacnevin. About half a mile S.E. of Toberelatan on Silurian ground is a patch of deep boulder drift, full of limestone fragments, where a block of limestone, about half a ton weight, was remarked. This block is at a height of 450 feet above the nearest limestone, which has an average height of 200 feet above the sea. Farther S.E. on the ridge of the hill, at a height of about 955 feet above the sea, there is no drift of any kind; but where the bog is worn away by the rain, we find numerous fragments of limestone and chert smaller than duck eggs.

A mile N.E. of Toberelatan, over the Silurians, there is also a boulder drift, containing limestone fragments, and at a height of 600 feet, two large blocks of limestone were remarked, the largest being about 10 feet by 7 feet by 6 feet; and to the south of Kilchreest there is a similar drift, covering an Old Red and Silurian country. This on the west of the hamlet called Calluragh, reaches up the hill sides to a height of 660 feet, being 20 feet deep at the height of 640 feet, and lower down over 50 feet. To the S. of Calluragh the drift is very deep along the streams, and limestone fragments occur in it at the height of 740 feet. On the hill two miles S.W. of Dalystown, there are numerous small blocks of granite scattered about.

Drift on the Low Country.—The *boulder clay* or *corn gravel* often forms long undulating hills that have a general E. and W. bearing. On the south of Lough Rea an Old Red drift lies over some of the limestone country; this also occurs about Dalystown, Kyleaglanna, and Marble Hill. At Pallas, and for miles on the east of it, there are yellow sandstone blocks and fragments very frequent in the drift; some of these are undoubtedly of Old Red age, but others, as before mentioned, may belong to the sandstone beds of the Middle Limestone. On the east of the *Tynagh Old Red outlying exposure* there is an Old Red boulder drift, the blocks of that formation being numerous as far east as Killimor.*

On looking at the map of the area contained in Sheet 116, it will be seen that in the centre of it there is a large triangular tract occupied more or less by *Esker Drift*. The base of this triangle stretches from Kilreekill to within four miles of Marble Hill, while the apex reaches east to the Shannon. If we extend our observations into the district contained in Sheet 117 we will find at Clogher Castle, on the east of the Shannon, the esker occurring again, and from thence running by Birr and Frankfort to the flanks of Slieve Bloom. From this we find that the eskers we are describing are part of the large barrier or bar that was formed across the mouth of the strait that ran between the mountain groups of Slieve Aughta and Slieve Bloom when Ireland was partly covered with water.†

In the part of this great bar which lies in our district there are three well-defined branches, which we will now describe:—

The First or *North Branch* begins at the high land at Dartfield (four miles N.E. of Loughrea), and runs by Killimor to the *Alluvial Flat* bordering the Shannon, about four miles S. of Eyrecourt, being from beginning to finish about seventeen miles in length. This begins as a *Shoal Esker*

* Here we may remark that a very curious recent breccia was observed coping the gate walls at Huntly, which lies two miles south-east of Kiltormer; it consists of angular particles of a black calpy limestone, cemented together by calcareous tufa. It is said to have been raised while draining some of the low land in that neighbourhood, but we could not find it *in situ*.

† In the neighbourhood of Banagher, a few miles on the north of the gap in this system (which is occupied by the Shannon), there is an esker two or three miles long, that overlaps this break, and seems in some way to be connected with it.

in the neighbourhood of Dartfield, which shoal extends to Gortymadden; but on the E. of Brooklawn-house a regular ridge commences, that runs away S.E. to Killimor, a little on the west of which it splits into two; but the north part, though well marked, does not extend farther than the river. From Killimor it goes along the old road to Eyrecourt to the S. of Kilquain, where it changes into *shoals*. Here there is a break for about a mile, occupied by high ground, on which there is a thin skin of drift. On the east of this high ground, a little S. of the hamlet called Ballinlug, the esker commences again, and runs in a rude S shape toward the S.E., for about three miles, to the Callow along the Shannon.

The Second Branch begins at Masonbrook, three miles S.E. of Loughrea, and extends to Tynagh, and from thence along the road by Heathlawn to Fairfield, where it turns towards the N.E. and ends, having nearly reached the *First* or *Northern Branch*. On the south of the old house of Masonbrook we find dome-shaped mounds, and on the east of them a ridge begins to form, which runs S.E. to the Roman Catholic chapel, being modified into a *Fringe esker* by the high land at Newtown-Daly. A little to the east, opposite the break in the high ground through which the parish boundary runs, there is a small space in which there is no ridge, but farther east, over where Duniry is engraved on the one-inch map, it has become a well-marked ridge, that extends to the road a little N.E. of Tynagh Glebe-house. This part is also a *Fringe esker*, bounding the high land on the N. To the south of the ridge all about the Roman Catholic chapel are numerous mounds.

In the neighbourhood of Tynagh, we find that this branch has broken into a *Shoal esker*, which extends up by Lissduff to the north branch; but about a mile E. of Tynagh it again becomes a well defined ridge, which is occupied by the road that goes to Moat-bridge, where the esker has been cut across by the river. From the river it runs along the road to Heathlawn, and from thence to where the boundary between the parishes of Killimorbologue and Lickmolassy crosses the road. Here it again breaks into a *Shoal esker* that occupies the ground between Heathlawn and Fairfield bogs; but a *bar* begins again a little W. of Fairfield-house, and runs toward the N.E., ending about a mile beyond Corr Lodge, having nearly reached the northern branch. Between the latter part of the second branch and the northern branch the drift, which is partly *corn gravel* and partly *Post-drift gravel*, is all inclined to form ridges and mounds.

The Third or South Branch may be said to begin at Sandymount, five miles S.E. of Lough Rea, and extends by Duniry and S. of Pallas to Newbridge, and from thence to Fairfield, where it joins into the *Second Branch*. Sandymount is at the mouth of the valley before mentioned as being occupied by the Boleyneendorrish and Owenglanna Rivers. From Sandymount by Duniry to Pallas it is a *Shoal esker*, being composed of short ridges and mounds that run in every direction. At the road S.W. of Pallas, where it is seen to have a rock nucleus, it has become a regular ridge, and runs from thence in a zigzag line to Newbridge, where it is cut across by the river. From Newbridge it goes E.N.E. by Lecarrow, and joins into the shoal part of the second branch on the W. of Fairfield. Fig. 2, page 14, is a copy from the six-inch maps of this ridge, breaking into the shoal at this place. Excellent sections across this esker are exposed a little E. of Newbridge.

On the N.E. of Newbridge, between the second and third branches of the esker, the country is covered with *Boulder clay*, which is denuded into long flat nearly parallel mounds, some of which are over a mile in length. On the south of Heathlawn there are irregular mounds and ridges, some

of which are *Boulder clay*, the rest *Esker drift*. On looking for the reason why this esker splits into three toward the west, we should find that the second and third branches start from gaps or breaks in the high ground on the west. From this we may infer that the *first* would seem to have been the regular bar, the second to have been caused by the current that flowed in the break now occupied by Lough Rea, and the third by the current in the valley of the Owenaglanna and Boleyneendorrish rivers.

Portumna, Kilquain, and *Kiltormer Eskers.*—Seemingly in connexion with the great system of eskers are those *Shoal eskers* that extend across it from Portumna demesne to Kiltormer. These, though they are in a north and south line, may be divided into four groups:—*First,* those west of Portumna; *second,* those we have just mentioned, west of Heathlawn bog, as lying between the north and south branch of the great system; *third,* those that lie in the parish of Kilquain; and *fourth,* those about the village of Kiltormer.

The hills on the west of Portumna are not all composed of *Post-drift gravel,* many of them being *Corn gravel* or *Boulder drift.* The hills in the northern part of the parish of Kilquain lie on the north of the high land previously mentioned that makes the gap in the northern branch of the great system. These hills are also not all gravel, many of them being the boulder drift which has been denuded into short ridges and mounds, outwardly having the appearance of gravel hills. In some of them the post-drift gravel hills are banked up against the boulder drift. They extend easterly nearly as far as Eyrecourt.

The Kiltormer Shoal-esker lies about that village, and extends into the district on the N.; the great mass of hills occurring to the N. and W. The drift in some of them consist of angular blocks of the underlying rock (black limestone and shales), mixed with well washed gravels. This is rather singular, as in all other post-drift gravels that I have observed, no angular fragments were remarked. The ground occupied by this system of eskers extends from the large bog on the N.W. of Kiltormer to the east of Gortnamona.

Between Kiltormer and Kilreekill the country is covered with boulder drift, which is denuded into long mounds, that have a general east and west bearing; but to the north of them we find esker drift occupying the shallow valley that stretches from Wallscourt house north of Kilreekill, and N.W. of Burkeville, into the district on the north (Sheet 107).

Over the country that extends from Dartfield to the Yellow bog, which lies N.W. of Loughrea, the principal drift is stony or rocky, generally in irregular abrupt hills, but often forming a broken country, and interspersed through this we find short ridges and mounds of post-drift gravels. Well marked ridges and mounds that are partly boulder drift and partly post-drift gravels, and some of which are surrounded with bog, occur between one and two miles north of Loughrea.

S. and S.W. of the Yellow bog, there is also an undulating stony drift forming irregular ridges and mounds; but about a mile east of the village of Kilchreest a good esker ridge begins, and extends to a short distance on the west of that village. On the S.W. of Kilchreest, under nearly the whole of the Roxborough and Castleboy demesnes, is an esker drift which does not form any continuous ridges, but is either gently undulating or in mounds that generally strike N.E. and S.W., nearly parallel with the high land on the south. From Castleboy demesne sand dunes extend towards the S.W. as far as Limepark.*

* From this description we find that on the low ground E. of Loughrea there is esker drift; on the high ground to the northward of the same place there is boulder drift, which is half washed or denuded into hillocks; and on the low ground to the S.W. we again find esker drift, which nearly extends to the crag country in the neighbourhood of Ardrahan. From this I consider that the eskers about Kilchreest and Roxborough are part of the esker system which lies on the east of Loughrea. The esker drift occurring on the low country, where the waters had full power to wash the boulder drift, and on the intervening high ground, where there was only shoal water, the boulder drift is only denuded into irregular mounds, or partly washed.

Dunsandle, Aggard, and Monksfield Eskers.—In the neighbourhood of Dunsandle there are also eskers; one ridge being found in the valley south and another in the valley north of the mansion. The southern Dunsandle esker springs from the high undulating drift south of Tooloobaun House, and extends nearly to Riverville Castle, being in one place —immediately east of the N. and S. farm road—found to be banked against a reef of limestone. The north Dunsandle esker comes out of the district on the north (Sheet 106),* and runs S.W. to within a few perches of Riverville Castle, seemingly being part of the same system as the south esker.

On the west of Riverville Castle the country is occupied with an undulating drift till the road from Loughrea to Craughwell is reached, good esker drift only occurring in the hollow half a mile east of Stongfort Lodge; but on the south of the Loughrea and Craughwell road, all about Lambert Lodge, we find boulder drift denuded into well marked mounds, and lying on and up against it in various places are post drift gravels. To the south and west of Ballymanagh Roman Catholic chapel the drift is very rocky, and the mounds and ridges that lie east of Lambert Lodge have a general bearing of N. and S., while those on the north have a general bearing N.E. and S.W.

Farther towards the west, occupying the valley that extends from Aggard House to near Monksfield demesne, there are esker mounds and ridges. The esker system has a bearing nearly N. and S., while the individual mounds and ridges run in every direction. Many of these mounds were taken advantage of by the earlier inhabitants and constructed into *raths* or forts. To the southward, in the valley S.W. of Monksfield, we again find the eskers. The system here has changed its bearing to N.E. and S.W., to which bearing many of the mounds and ridges composing it conform, more especially toward the S.W. end, where we find a set of nearly parallel short ridges. On the west of this we only find boulder drift, but to the south, on the high ground S.W. of Fiddaun, there are post drift gravels lying on and among ridges and mounds of boulder drift, which extend nearly to the esker drift in the Castleboy demesne, being only separated from it by a flat ridge of boulder drift that runs nearly N.E. and S.W. on the north of the road that bounds that demesne on the N.W.

Kilcornan Esker.—This extends N.E. for about three miles from Clarinsbridge through Kilcornan demesne, by Lavally, into the district on the north (Sheet 106). Here it is a *fringe esker*, formed along the high ground, but it seems to be the western end of one of the branches of the system of eskers that run by Ballinasloe and Athenry.

Lough Fingall Esker.—This lies about three miles south of Clarinsbridge, bounding the lough on the east, and running nearly north and south. It may be classed among the fringe eskers, as it seems to have been formed by the high ground to the east. It is very remarkable, as it is altogether formed of blocks of the Upper Limestone, without gravel or sand, some of the blocks being tons in weight. In one place it has a height of at least thirty feet. Most of the surrounding country is a bare crag. It does not seem to be connected with any of the large systems of eskers.

* It seems to be a branch of the esker system that extends past Ballinasloe, Woodlawn, &c., for which see the Explanation and Maps of Sheets 106 and 107.

Remarkable Boulders.—Granite boulders and fragment are of common occurrence. I will mention the most remarkable of them. On the road from Loughrea to Derrybrien, a little N. of Cullenagh Bridge, and about three miles N.W. of Marble Hill, at a height of about 550 feet, there is a block that measures 3 feet by 2 feet by 1 foot; another 10 feet by 8 feet by 3 feet was remarked a little E. of Ballynasack Bridge, eight miles S.E. of Loughrea. High land intervenes between these blocks and the parent rock at Galway. Numerous large blocks were remarked N.E. and S. of Knockbarron; one on the N. of Rafarn House, at a height of at least 450 feet, measured 5 feet by 4 feet by 3·5 feet. About four miles north of Portumna, and a little S. of Ormond View, there is a block 6 feet by 4 feet by 3 feet, and a mile east of Duniry there is one 4 feet by 2 feet by 3 feet; but the largest remarked was 12 feet by 9 feet by 4 feet; it is perched on the slope of the esker at Killimor. Another large one about three tons weight, was noted in the river flat, two miles N. of the last. Large conglomerate boulders occur on the low country; and on a limestone hill, 664 feet high, and about four miles south of Loughrea, there are a number of them. They are all angular, and the largest is 10 feet by 9 feet by 6 feet. Between them and the Old Red country there is a deep valley. Most of these blocks would seem to have been carried to their respective sites by ice during the *Post drift gravels* period. There are other Erratics found, especially on the crags towards the west, but these would seem to be of a different class to those just mentioned, those having been brought by or dropped from floating ice, while these seems to be the residue of the boulder clay that was left when the rest was washed away. That these are part of the boulder clay would appear to be proved by some of them having a thin layer of it under them caught between them and the crag. That the boulder clay once covered the crags seem evident, as we find thin layers of it undisturbed in some of the small hollows and fissures, but most of the Erratics lie on the bare crags.

Alluvium and Bog.—The alluvial flat and bogs are similar to those usually found in a flat country, but in some places they require special descriptions. A little more than three miles west of Portumna, in the townland of Drimna, along the Cappagh River, there is a remarkable structure in some of the marl, as in places there are numerous round pipes that weather out, and on first sight have the appearance as if they were the large roots of flaggers or some such plants. On examination it is found that the marl in them is more sandy than the rest of the mass, and besides they are impregnated with peroxide of iron. That they are not rootlets seems evident, as the same lamination runs through them and the surrounding marl. To the south of the Cappagh River, in the bog there situated on the north of The Hill, numerous large trunks of oak and yew have been found. To the W. and S. of Crannagh, which lies a few miles to the N.W., there are large alluvial flats and bogs, and in the new cut for the Cappagh River, about three feet below the surface, a stratum of oak logs, some of them two feet in diameter, is exposed.*

To the west of this, in the marl at Ballin Lough, Mr. Hemsworth, of Danesfort, found a pair of red deers' horns.

Four miles N.W. of Portumna, in Heathlawn Bog, while cutting it in

* In the Catalogue of the Royal Irish Academy (*Part I., p.* 233), we find the following:—"Even so late as 1610, we read of Crannoge MacKnavin, in the parish of Tynagh, barony of Leitrim, and county of Galway—(*see the Tribes and Customs of Hy-many, edited by John O'Donovan*, LL.D.") The site of this crannoge must be somewhere in these flats or bogs; but after careful examination I was unable to discover it, and there is no tradition about it in the country, which is the more remarkable, as the country thereabout is still inhabited by people of that *sept*.

the year 1862, about a bushel of hazel nuts were found lying on the gravel under twelve feet of peat. The kernels had corroded away, but the shells were perfectly sound.—(*Communicated by Mr. Saunderson, of Heathlawn.*) About three miles W.N.W. of Heathlawn, and two east of Tynagh, in a bog there situated, there are pieces of marl from the size of an egg to that of a man's head that occur at various heights through the peat.

A pair of red deer's horns were found in Killimor Bog.—(*Communicated by Mr. Hemsworth.*)

In the vicinity of Killimor the alluvial flats usually consist of layers of peat and marl. The following is a section in the new cut through the flat two miles N. of that village:—

Section No. 4.

		Feet.
3.	Alluvium,	3·
2.	Peat,	1·
1.	Marl, over	3·
		7·

In the flat half a mile farther north, immediately north of the hamlet called Derrew, we get the following sections:—

Section No. 5.

		Feet.
3.	Alluvium,	3·
2.	Shell sand,	1·5
1.	Marl, over	4·
		8·5

Section No. 6.

		Feet.
6.	Alluvium,	3·5
5.	Ferruginous sand,	0·17
4.	Peat, 5 inches to	1·
3.	Shell sand,	1·
2. 1.	Dove-coloured sand, full of rootlets, more than	2·
		7 67

In this part of the flat about three feet of alluvium is uppermost, and under that is dove-coloured marl. In places, as shown in sections, shell, sand, and peat occur; also in the alluvium are thin veins of bog iron ore of a deep red colour. The shells in the sand are recent, and the marl is full of rootlets, and in no place is the bottom of it seen. We shall also draw attention to the section of the flat a mile and a quarter farther north, where there is the following section:—

Section No. 7.

		Feet.
3.	Alluvium, from 2 feet to	3·
2.	Peat, ,, 3 inches to	1·
1.	Marl, over	6·
		10·

Fig. No. 6.

Diagrammatic Sketch showing crumpled lamination in marl.

1 Alluvium. 2 Peat. 3 Marl.

Scale, 20 feet to 1 inch.

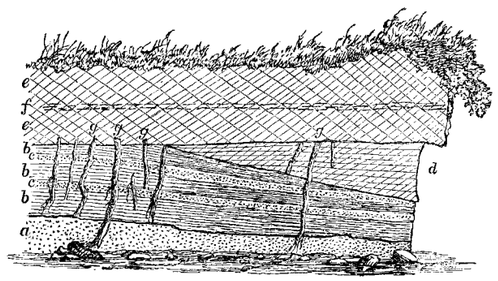
The marl has been deposited in beautiful laminations. In some places they were parallel with the top of the bed, as represented at A, in Fig. 6, while in other places, as shown at B, they are all crumpled. In Derry Bog, which lies north of Tynagh, a pot of butter or deer's lard was found.

Freshwater shell marl in places occurs under bog, a large deposition being remarked in the townland of Limehill, about three miles west of Tynagh. About half way between Loughrea and Kilchreest there are two bogs, one in the townland of Raheenoughten and the other in Ballynagran, in which the peat is interstratified with layers of marl.

In the Boleyneendorrish valley, immediately south of the village of Toormacnevin, there is a good section exposed by the river.

Fig. No. 7.

Diagrammatic Sketch of part of the river bank S. of Toormacnevin.



a. Sand.
b. Marl.
c. Layers of yellow sand.
d. Marl mixed with peat.
e. Peat.
f. Layers of birch bark.
g. Roots of trees that extend through the sand and marl, which end at or a little way after entering the peat.

Scale, 10 feet to 1 inch.

This, as shown in sketch, consist of sand, marl, and peat. In the marl are roots of trees, some of them three inches in diameter. None of these go up into the peat, and only a few of them could be traced down into the sand. In the centre of the peat is a layer of branches of the birch tree.

In the Boleyneendorrish River valley, on the N.W. of Cashlaundrumlahan, and a mile S.W. of the hamlet called Toormacnevin, there is a large mass of calcareous tufa which ought to be valuable as a manure for the adjacent Old Red country.

In Lough Rea, and under the adjoining moors, there is a large deposit of shell, marl, and sand. This, if raised, ought also to make an excellent manure for the Old Red country on the south.

Crannoges.—There are four crannoges situated near the S.W. and S. shores of Lough Rea.*

No. I., or Reed's Island, lies about a mile S.W. of Loughrea. It is surrounded by a circle of piles, and the following sections of it was obtained by boring:—

* A detailed description and plans of these were given in a paper by the author, read before the Royal Irish Academy (see *Quarterly Journal of Science*, 1864, p. 113).

Section No. 8.

	Feet.
7. Flat stone,	about 0·5
6. Marl, with a few stones,	1·25
5. Peat, with a few stones,	0·75
4. Large stones, with peat between them,	1·
3. A layer of branches and trunks of birch, some of them 6 inches in diameter,	0·5
2. Oak beams, 4×7 inches, running nearly N. and S.,	0·33
1. Oak beams, 4×7 inches, running nearly E. and W.,	0·33
	4·66

Sharpening stones, and the bones of pigs, sheep, and cows, were found in beds 4, 5, and 6, more especially towards the edge of the island.

No. II. Crannoge, or Shore Island, is about a quarter of a mile S.E. of Reed's Island, and is surrounded by five or six circles of piles. The following is its general section:—

Section No. 9.

	Feet.
7. Peat, clay, and stones,	2·
6. Marl and peat, with numerous bones,	2·5
5. Peat sods,	1·
4. Wicker flooring, on which were a quantity of bones, &c.,	0·08
3. Sandy clay in some places; peat sods in others,	2·92
2. Peat sods,	0·5
1. Marl, full of shells,	over 6·
	15·

Bones of sheep, deer, cows, pigs, and large birds, also a few celts and other stone implements; numerous hones and sharpening stones; one knife, with a rude bone handle, &c., &c., were found in it.*

Ash Island, or Crannoge No. III., lies to the S.E. of Shore Island. It does not seem to be enclosed by a circle of piles, but a great part of it has been washed away, so that if it was enclosed, the piles may now be gone. What is most remarkable about it is that seemingly scarcely any of the timber used in it was oak, which was the wood chiefly used in the others. The following is its section:—

Section No. 10 *of Ash Island, or Crannoge No. III.*

	Feet.
8. Clay, stone, and peat; the surface being coated with stones, laid in regular order,	1·
7. Peat, with bones,	3·
6. Stones,	1·
5. N. and S., round ash logs, 6 inches in diameter and 2 feet apart,	0·5
4. Peat,	0·5
3. E. and W., round ash logs, 6 inches in diameter and 1 foot apart,	0·5
2. Peat,	3·
1. Marl, full of shells,	over 6·
	15·5

No. IV. Crannoge, or Island M'Coo, lies at the south of the lake. It is surrounded by a circle of piles thirty-three feet in diameter. No excavation was made in it.

The bottom of bed No. 1, in the section of No. I. Crannoge, is 4·17

* Mr. Silk, of Loughrea, informed me that he got from this island, and from the boggy flat on the main land to the N.W., over 300 tons of bones, and the head of a *Megaceros Hibernicus*, &c.

feet below the ordinary surface of the lake. Bed No. 2, in Crannoge No. II., is six feet below the same; and bed No. 3, in the last section, is five feet lower than it. Bed No. 2, in Crannoge No. III., is eight feet below the level; but this bed was not proved to be artificial. From this it will be seen that the outlet of the lake must have silted up seven feet since the foundation of Crannoge No. II. was laid, and six and five feet respectively since the lowest beams in Crannoges Nos. III. and I. were placed. This could easily have taken place, as the outlet from the lake is a gap in a reef of limestone rock, now filled up with gravel and alluvium. This could easily be cut away so as to reduce its level fifteen feet, as the river, according to the Ordnance Survey, at White's Bridge, which is less than a mile on the north, is seventeen feet lower than its present surface.

Three crannoges were discovered in Ballinlough, which lies a little S.E. of Marble Hill. The lake lies in a rude cup-shaped hollow, high land occurring round it, except at the S.W., where there is a hollow, across which there is a wide bar of stony Old Red boulder drift, through which a cut over four feet deep has been made to let the water out of the lake. The floors of the crannoges, when visited, were three feet lower than the present surface of the lake, and before the cut was opened the water must have been seven feet over the floors; we have therefore to consider how the lake was drained when these crannoges were built. On examining the bar of drift, it will be seen that formerly there seems to have been a ravine through it, which was artificially filled. This may have been done by a hostile tribe to flood out the inhabitants of the crannoges.*

Minerals.

Metalliferous indications and mines occur in the following places; those which have been worked being printed in italics:—

No.	Townland.	County.	Chief Mineral.	Owner.	Agent.
1.	*Ballymaquiff*, .	Galway	1 1/2 3 Lead, .	W. Shawe Taylor, esq.	
2.	*Caherglassaun*,	,,	1 1/2 2 Lead, .	H. Hewson, esq. .	Capt. Thom.
3.	*Crannagh*, .	,,	1 1/2 2 Trace Lead,	Archdeacon Butson.	
4.	*Carhoon*, .	,,	1 1/4 7 Lead, .	J. Evans, esq.	
5.	Quarryhill, .	,,	1 1/3 7 Trace Lead,	A. Nugent, esq.	
6.	Killeely, .	,,	1 1/2 3 Trace Lead,	Rev. J. F. Moran.	
7.	Muggaunagh,	,,	1 1/3 3 Trace Lead and Copper,	J. G. Blake, esq.	
8.	Parkatleva, .	,,	1 1/4 3 Trace Lead,	,,	

Caherglassaun Mine.—Here we find an irregular spar lode that bears about W. 10° N., and underlies to the S. At the W. a cross course seems to strike from it toward the S.E., which to the N. of the lode breaks into *strings* and *veins* between the beds (*lay in lay*). Towards the east there is another cross course that bears nearly N.E. At the junction of these courses and the main lode, the ore forms in *bunches*, one that was raised being reported to have been about six tons in weight. The ore occurs in bunches and small strings, no regular vein appearing. It was principally *galena*, although a small quantity of copper was *got* at the junction of the east cross course and main lode, and many of the stones on the *banks* are

* A detailed description of these crannoges was read by the author, on November 30th, 1863, before the Royal Irish Academy. (*See their proceedings.*)

stained with the *green* and *blue carbonates*. That rare mineral, *Bournonite*, an ore of antimony, was found here in small quantities. The mine, when examined (June, 1862), had been unworked for about a year. The old workings are lower than the sea level, and consequently very wet, as the course of the previously mentioned subterranean river runs close to them.

Ballymaquiff Mine.—This is a large *pocket* of calcspar that was worked about fifteen years ago. It has not a good appearance, as the spar is very compact and white. No information about it can be obtained from the residents in the vicinity; but Sir R. Griffith, in his published list, mentions that "*lead* and *bismuth* were found there."

Tynagh Mine.—This old mine is situated in the townland of *Carhoon*, and about a mile and a half N.E. of the village of Tynagh. No tradition remains in the country of when or by whom it was worked; but that in former times it was worked rather extensively is evident by the remains of the old shafts and *spoil banks*. The lode seems to bear about E. 15° N.; and a little north of this line of strike, Mr. Algie, of Lisduff, found two *tumblers*, or boulders of galena, while opening a cut along the road which bounds Lisduff on the south. In the vicinity of the old workings various pieces of *galena* and *iron pyrites* were picked up, and the inhabitants of the hamlet there situated informed us "that when the ground thereabouts is tilled in the spring all their fowl die, being poisoned by something they pick up."

Mineral traces.—Colonel Burke, R.E., about the year 1843, found pieces of galena in the townland of Quarryhill, a mile S. of Tynagh. There are specks of it now to be seen in the walls thereabouts, but scarcely any spar was remarked. On the S. of Killeely Glebe House, a little N.E. of the village of Kilcolgan, there is a large *calcspar* vein that strikes about N.E. and S.W.; it can also be seen at the village. In the debris at the pit mouth, to the south of the Glebe House, traces of the *red oxide of lead* were observed, but the spar is so compact that it is very unlikely ever to pay for any trial sank on it.

Sir R. Griffith, in his published list, has recorded a trace of lead and copper ores in the townland of Muggaunagh, and a trace of the former in the townland of Parkatleva. These places are respectively about three miles south-west and south of Kilcolgan. In the townland of Crannagh, N.W. of Coole Lough, there is a large vein of calcspar. Captain Collins, about fifteen years ago, ran in on this for about six fathoms, and only found a trace of lead.

"*Tumblers* of mine" are said to have been recently found at Crannagh, which lies about four miles W.S.W. of Portumna, but of what kind I was unable to make out, as I could not procure a piece of any of them. While making the new cut for the Killimor River, on the south of that village, sandstone blocks were raised from the drift, some of which have since become copper stained, and on being broken are found to be full of little specks of *copper pyrites*. A few similar blocks are used as coping stones for the road wall on the N. of Hearnsbrook, and a large one was observed a little east of Tynagh mine, but in no place were cupreous sandstones observed *in situ*. Pieces of *Siliceous Hematite* were noted immediately N. of the bog that lies N.E. of Tynagh.

G. H. K.

April, 1865.

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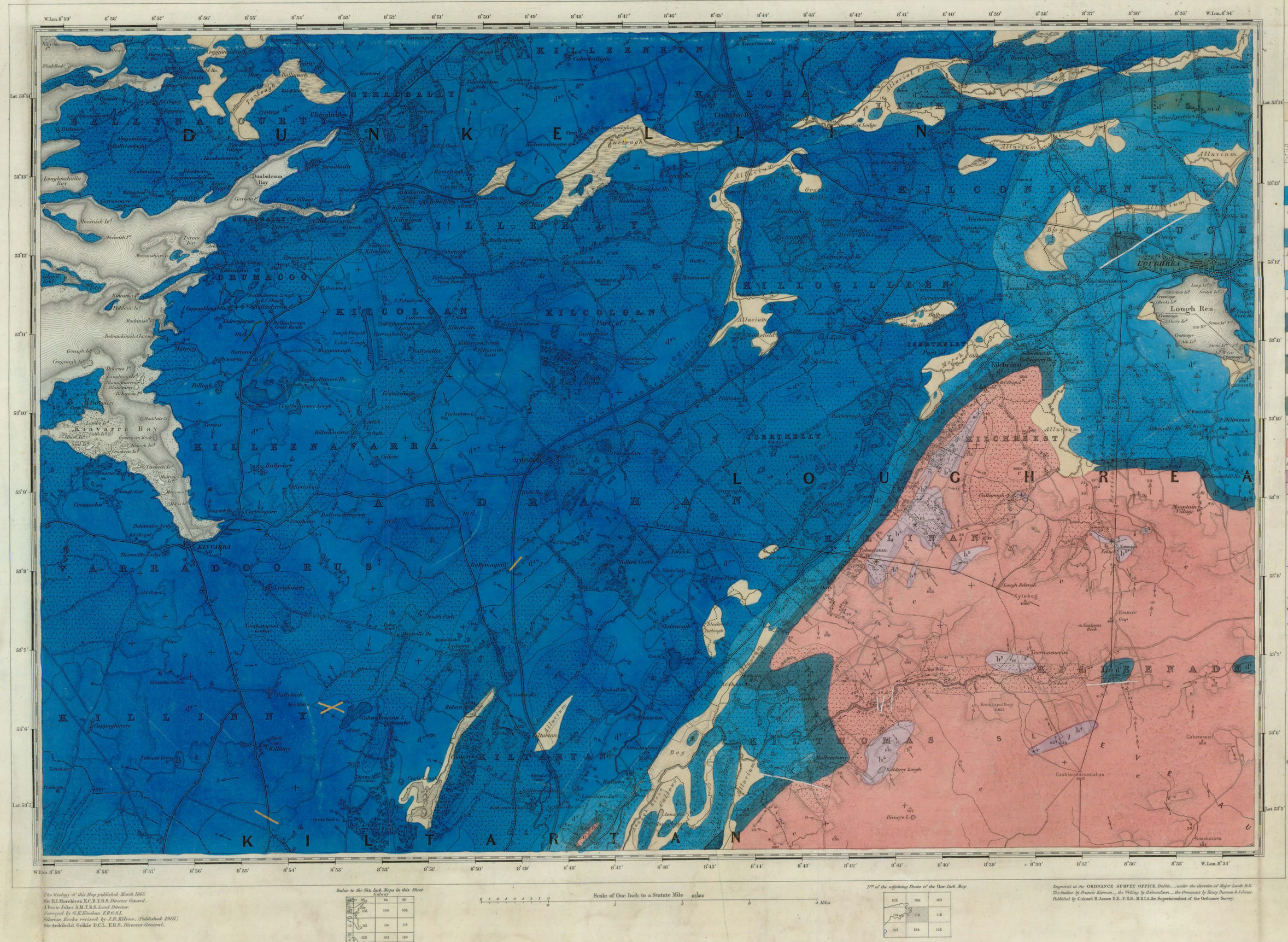
ORDNANCE SURVEY OF IRELAND.

GEOLOGICAL SURVEY of IRELAND

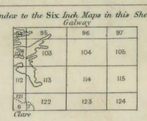
(Loughrea.) SHEET 115.

J. R. Kilroe
8th January 19



The Geology of this Map published March 1865.
Sir R.I.Murchison K.C.B.F.R.S. *Director General.*
J.Beete Jukes A.M.F.R.S. *Local Director.*
Surveyed by G.H.Kinahan E.R.G.S.I.
Silurian Rocks revised by J.R.Kilroe. *(Published 1901)*
Sir Archibald Geikie D.C.L. F.R.S. *Director General.*

Index to the Six Inch Maps in this Sheet



Scale of One Inch to a Statute Mile 63360

Nos of the adjoining Sheets of the One Inch Map

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