Memoirs of the Geological Survey.

# EXPLANATION

TO ACCOMPANY

SHEETS 98, 99, 108, AND 109 OF THE ONE-INCH MAP

OF THE

# GEOLOGICAL SURVEY OF IRELAND,

ILLUSTRATING PARTS OF THE

## COUNTIES OF WESTMEATH, ROSCOMMON, GALWAY, LONGFORD, AND KING'S COUNTY,

By F. J. FOOT, M.A., AND J. O'KELLY, M.A.

With Illustrations by G. V. DU NOYER, M.R.I.A.

*Published by Order of the Lords Commissioners of Her Majesty's Treasury.*

DUBLIN:

PRINTED FOR HER MAJESTY'S STATIONERY OFFICE.

PUBLISHED BY

ALEXANDER THOM, 87 & 88, ABBEY-STREET.

HODGES, SMITH, & CO., 104, GRAFTON-STREET.

LONDON:

LONGMAN, GREEN, LONGMAN, ROBERTS, AND GREEN.

1865.

THIS district was surveyed by Mr. F. J. Foot and Mr. Joseph O'Kelly, by whom the accompanying Explanations of it were drawn up; some of the illustrations, especially the views of the esker ridges, having been drawn by Mr. Du Noyer, who visited the district for that purpose.

J. BEETE JUKES.

THE

# GEOLOGICAL SURVEY OF THE UNITED KINGDOM

IS CONDUCTED UNDER THE POWERS OF THE

8TH & 9TH VICT., CHAP. 63.—31ST JULY, 1845.

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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.

AGENTS FOR THE SALE OF THE MAPS AND PUBLICATIONS:

Messrs. LONGMAN, GREEN, & Co., London;

Messrs. HODGES, SMITH, & Co., Grafton-street, Dublin;

ALEXANDER THOM, Printer and Publisher, Abbey-street, Dublin.

## LIST OF THE ILLUSTRATIONS.



# EXPLANATION

TO

ACCOMPANY SHEETS 98, 99, 108, AND 109

OF THE MAPS OF THE

# GEOLOGICAL SURVEY OF IRELAND.

## General Description.

The four Sheets of the Map included in the following Explanation, contain the S.W. half of the county of Westmeath, a portion of the S.E. extremity of the county of Roscommon, together with portions of the counties of Galway, Longford, and King's county.

The principal places in the district are—the town of Athlone, which lies partly in Roscommon and partly in Westmeath; the village of Knockcroghery in the county of Roscommon; the towns of Mullingar, Moate, Kilbeggan, and the villages of Ballynacarrigy, Moyvore, Ballymore, Castletown, Tyrrellspass, Rochford-bridge, and Ballynagore, in the county of Westmeath; the towns of Tullamore, Philipstown, Clara, Ferbane, and the villages of Shannon-bridge and Ballycumber in the King's county; and the small town of Ballymahon in the county of Longford.

### *Form of the Ground.*

This district is a portion of the great central plain of Ireland, and therefore does not include any very striking features. The mean height of this plain is less than 300 feet above the sea, sinking perhaps to less than 200 in the neighbourhood of the Shannon. The most conspicuous elevations in the district are Croghan hill, three miles north of Philipstown, which reaches a height of 769 feet above the sea; a small range of hills that stretches a few miles N.E. of Moate, including the hill of Knockcausta (660 feet) and the hill of Ushnagh (602 feet); the hill of Knockdominy (512 feet), immediately to the west of Moate, and the hill of Bellair (413 feet), about half-way between Moate and Ferbane. Besides these greater elevations, this district is remarkable as abounding in those long, low, serpentine ridges which often extend for many miles, and are known by the name of eskers. These will be described in detail under the heading "Drift."

The whole district, excepting a narrow strip on the east, is drained by the river Shannon and its tributaries—the Inny and Brosna. The greater part of Lough Ree, which may be considered an expansion of the Shannon, lies in Sheet 98; it has a height of 122 feet

above the sea. About a mile to the north of Athlone, the Shannon again contracts into a river, and winding thence in a southerly direction through dreary tracts of bog, leaves this district at the southern edge of Sheet 108, at a height of 115 feet above the sea, having a fall of only 7 feet in a course of 17 miles.

The Inny enters the northern edge of Sheet 99, at a height of about 200 feet above the sea, and flowing westward through Ballymahon, falls into Lough Ree, three miles west of that village. This gives a fall of 78 feet in about 13 miles.

The Brosna rises at a place called Bunbrosna, to the north of the present district, and flows into Lough Owel (329 feet), north of Mullingar. Leaving Lough Owel, it flows by the town of Mullingar, and thence through Lough Ennel (274 feet), whence it runs with a general S.W. direction by Ballynagore, Kilbeggan, Clara, Ballycumber, and Ferbane, and leaves Sheet 108 at its southern edge, two miles S.W. of Ferbane, at a height of 140 feet above the sea. The distance by the river course between Loughs Owel and Ennel is five miles, and the difference of level 55 feet. In the latter part of its course the river falls 34 feet in a course of 29 miles.

The country about Tullamore and the southern portion of Sheet 109, is drained by the Tullamore and Silver Rivers, tributaries of the Clodiagh, which joins the Brosna south of Ballycumber.

The main water-shed of Ireland passes across the eastern edge of the district, frequently crossing ground that has not a greater altitude above the sea than 300 or 350 feet. It enters Sheet 99 at its N.E. corner, passing near Crazy Corner, about two miles to the east of Mullingar, and thence by Violetstown House and Kilbride House, to a point a little east of Tyrrellspass. Thence it continues its course across the bogs to Kilduff House and Philipstown, leaving Sheet 109 at its S.E. corner, west of Rathfeston House. To the east of this line the drainage is into the Boyne; on the north by means of the Yellow River and other small tributaries, and into the Barrow on the south through the stream called the Philipstown River.

### 2. *Formations and Groups of Rock entering into the Structure of the District.*

| Name. | Colour on Map. |
|---|---|
| Alluvium, Peat Bog, &c. | *Pale Sepia.* |
| Drift, Sand, and Gravel, | *Engraved dots.* |
| $d^4$. Upper Limestone, | *Prussian blue (dark).* |
| $d^3$. Calp or Middle Limestone, | *Prussian blue and Indigo.* |
| $d^2$. Lower Limestone, | *Prussian blue (light).* |
| $d^1$. Lower Limestone Shale, | *Prussian blue and Indian ink.* |
| c. Old Red Sandstone, | *Indian red.* |
| **Igneous Rocks.** | |
| D. Greenstone, | *Crimson, dark.* |
| Ds. Greenstone Ash, | *Ditto, light with dots.* |

c. *The Old Red Sandstone.*—The rocks belonging to this group, seen in this district, consist of conglomerates composed of large and small quartz pebbles in a yellow and sandy base, with alternations of



reddish and whitish flaggy sandstones. Owing to the few exposures of rock, it is impossible to hazard a conjecture as to the thickness of this formation here.

$d^1$. *Lower Limestone Shale.*—The beds of this formation are for the most part green, calcareous sandstones, or arenaceous limestones interstratified with some bands of purer limestone, generally abounding in fossils and varying in thickness from flags to beds of three feet thick.

From the few and imperfect exposures, it is impossible to calculate the thickness of the Lower Limestone Shale.

$d^2$. *The Lower Limestone.*—As in the adjacent districts, this formation consists of gray limestones, generally very dark-coloured at the base and lighter above; they are usually massive and sometimes amorphous, but in many places the stratification is well marked—as usual they abound in the ordinary Carboniferous Limestone fossils.

$d^3$. *The Middle Limestone or Calp.*—Above the gray Lower Limestone no pure limestones are met with on the eastern side of the district, but black and dark-gray very impure earthy limestones occur, varying in thickness from flags of a few inches to beds three or four feet thick, and having numerous bands of black shale and chert. These beds rarely contain fossils. Their total thickness is very small on the western side of the district, where they are only visible in a few places; while on the eastern side they thicken out, or rather the whole of the upper part of the limestones assumes an earthy character.

$d^4$. *The Upper Limestone.*—Above the black beds on the western side of the district, occur beds of very pure gray limestone; some of these beds are full of crinoids and the usual Carboniferous Limestone fossils, and some assume an oolitic structure. They make first-class building-stones, and are in great demand.

It is impossible to say what may be the thickness of the Upper Limestone in this district.

D. *Greenstone.*—This rock is generally a tough, hard, compact trap, of a dark purple or bluish gray colour, with disseminated crystals of hornblende; it is usually more or less calcareous, and very deeply weathered. The trap sometimes becomes amygdaloidal, the vesicles being occasionally filled with carbonate of lime. Another variety is a very tough and hard compact granular greenstone, with green and yellow glassy crystals. The greenstone sometimes assumes a rudely columnar structure.

Ds. *Greenstone Ash.*—The ash is a very coarse breccia, made up of angular fragments of trap and limestone, some of the latter being large enough to exhibit the original lines of stratification, by means of the layers of chert which they contain. Crystals of iron pyrites frequently occur in the ash.

F. J. F., and J. O'K.

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### 3.—*Relations between the Form of the Ground and its Internal Structure, and General Account of the latter.*

Although the external features in this district are by no means conspicuous, they are nevertheless sufficient to form good instances

of that contrast between the external form of the surface and the internal shape of the beds below the surface, which we have so often had to point out. Some of the hills or high grounds rise above the plain, because their summits are made of higher beds of rock than those which lie below the low land, and which pass underneath the bases of the hills. Croghan hill, the hill of Knockcausta, and others are instances of this structure. They are hills of circumdenudation. Others again are hills of uptilting; that is, the beds which form them rise up from below the lower grounds about them, as if they had been pushed up by some internal force. There can be no doubt that these beds have been there pushed up above the level which they have in the surrounding region, but though they were pushed *up*, they were not pushed *through the higher beds*. At the time the upward thrust, or movement of uptilting, took place, those higher beds still stretched across the areas so disturbed, and they themselves partook of the movement. They have since been removed by denudation, and the lower beds exposed at the surface. We have instances of this structure in the hill of Knockdominy, near Moate, and at other places where the Old Red Sandstone makes its appearance.

Speaking generally, all the rocks composing the district have been thrown into low undulations, the axes of which appear to run about N.E. and S.W. curving sometimes more towards N. and S., sometimes more towards E. and W., so far as the rarity and obscurity of their exposures allow them to be traced.

The *eskers* are perhaps the most remarkable features in the geology of this district, and therefore a word or two as a general description of them may not be misplaced. We have not yet accumulated a sufficient number of facts respecting these remarkable ridges of gravel and sand, to allow us to do more than speculate very vaguely and uncertainly with respect to their exact mode of formation.

It has been pointed out in former Explanations, and in other places, that the form and distribution of the ridges seem occasionally to have some sort of relation to the form and height of the hills of solid rock in the neighbourhood, or the valleys that traverse them. We have instances of this apparent relation even in this flat district—the Rahugh eskers seeming to have some relation to Croghan hill, while the esker near Streamstown follows the course of a valley between two hills.

The most remarkable eskers yet mapped in Ireland are those mapped by Mr. O'Kelly about Kilbeggan, in Sheet 109. These may be said to commence at Judgeville, about five miles due east of the summit of Croghan hill, and the main ridge forms a horseshoe, the toe of which is pointed directly towards Croghan while the arms curve off symmetrically to the W.N.W. and E.S.E., for a distance of about ten miles, when they are about eight miles apart.

Down the middle of this horseshoe-shaped space, but curving a little to its southern side, runs another series of mounds and ridges, sometimes irregular, but often well defined. The southern arm of the horseshoe seems to terminate near Rahan, but the central ridge is continued, with some intervals, past Clara, Ballycumber, and Doon, up to the esker that runs by Clonmacnoise and Shannon Bridge, and extends thence past Ballinasloe to near Athenry. The northern arm



of the horseshoe seems to divide into two great branches, one running west by Moate and Athlone, and the other turning off north by Streamstown up to Moyvore. Parallel to this latter branch a number of other smaller branches spring out of the main esker, as we trace it towards the west from Newtownlow near Kilbeggan, by Moate and Athlone, and into the country still farther west.

If we disregard the minor breaks and interruptions, we may say that from Judgeville and Rahugh, five miles east of Kilbeggan, there are two esker ridges traceable westwards for a distance of at least 50 miles.

I have not seen anything yet to induce me to alter the general opinion I formed respecting their origin, when, in the year 1853, I mapped in the esker ridge of Tymon Castle and the Green hills near Dublin, namely, that they are due to the piling action of strong currents in a shallow sea, and that possibly they often mark the position of an eddy between two more or less conflicting currents.

The existence of occasional double and triple ridges completely encircling hollows (in some of which bare rock is seen) shows that the ridges have not been left by the denudation of a widely spread mass. These could, I think, only have been formed by the production of a central pile in the first place, and the subsequent addition of matter on each side, which was sometimes heaped up on the flanks of the original ridge, and thus added to its width, sometimes made into a separate ridge on a line that slightly diverged from the first, but again coalesced with it, a little farther on.

The great angular blocks of limestone sometimes seen on the ridges, such as the one shown in figure 3, page 21, show that the sea was deep enough to float small icebergs or large masses of shore ice.

J. B. J.

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## Detailed Descriptions.

### 4. *Position and Lie of the Rocks.*

In giving the details of this district we shall proceed by describing—I., Sheet 98, which includes the Athlone and Ballymahon district; II., Sheet 99, the Mullingar district; III., the Athlone, Moat, and Ferbane district; IV., the Tullamore and Kilbeggan district; and V., the drift and superficial deposits.

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### I. Sheet 98.

*The Athlone and Ballymahon District.*—The east and some of the south-west part of this sheet is occupied by the Lower Limestone, with several outlying patches of calp, while its western half is formed of the upper. The boundary line is extremely arbitrary on account of the rocks being concealed by bog and drift and the waters of Lough Ree. It appears however to come in on the map close to the centre of its northern edge, and running south and south-west in a wavy line, leaves it at the S.W. corner.

About the village of Knockcroghery the beds of the Upper Limestone may be seen in several quarries and natural exposures undulating at low angles in all directions. The principal quarry lies a little to the N.W. of the hamlet of Lecarrow, at the opposite side of the road to Galeybeg House. This quarry is extensively worked, the stone being very valuable

for building and other purposes. It is generally a gray, finely crystalline limestone, very regularly bedded, the beds varying from two to four feet thick. Some of the beds are very cherty. The main joints run in a direction of N. 30° W., and then are crossed by others running W. 40° S.

Near Kilmore wood, on the shore of Lough Ree, and also east of Lecarrow, are extensive natural exposures of beds of gray cherty limestone undulating north and south at low angles. The same beds are also largely exposed on the opposite (eastern) shore of the lake at Cashel, and about Newtown, the hills somewhat resembling those of Burren, though on a much smaller scale. In the railway cutting at the bridge S. of Lecarrow, may be seen black earthy beds, with chert and shales. They are marked on the map as calp.

South of Lecarrow, and east and south of Lough Funshinagh, the high ground is generally very rough and stony, being formed of beds of gray (often cherty) limestone of the Burren type, reduced *in situ* to a state of debris. This may be well seen in a large rocky patch at the southern end of Lough Funshinagh, on the hill, having the trig. point 328 west of Kiltoom, and on that west of Rockhill. On the remainder of the S.W. corner of the sheet, immediately around Athlone, the rocks are completely obscured by drift in the form of eskers and knolls, which will be hereafter described under the heading drift. Close to the railway, at the edge of the bog, W. of Ballybay, in the townland of Cornaseer, are several mushroom shaped blocks of limestone, evidently worn so by the waters of the lake when it stood at a higher level than at present. See fig. 1.

Fig. 1.

Waterworn blocks of limestone showing former levels of Lough Ree, near railway, W. of Ballybay. Ord. Sheet, Roscommon, 4ᵖ.

At Coosan Point, three miles north of Athlone, is a quarry of gray limestone, the beds dipping S. at 35°. Similar beds may be seen in a patch of rugged crags immediately opposite on the shore of the lake north of Killenure Point, dipping W.N.W. at 45°. These beds are highly fossiliferous. The beds of the Lower Limestone are also well exposed on the east shore of Killenure Lough, a little north of the hamlet of Ballykeeran, dipping W. at from 45° to 50°; and further north, beds, probably the same as these, occur in crags a little north of Harmony Hall, dipping N.W. at from 40° to 50°. The beds are here traceable along the strike for a mile and a half; they again crop out at Gannorstown Castle, dipping in the same direction at 45°, and traceable along the strike for more than a mile. There are here some beds of brownish crystalline dolomite.

On the high ground N.E. of Ballykeeran, due east of Rosanna House, are quarries of black earthy, shaly, impure limestone, thick and thin bedded, with flaggy beds and bands of chert and shale, dipping E.S.E at



from 25° to 30°; these beds are exactly like the calp of the county of Dublin.

Another quarry with similar beds may be seen near the S.E. corner of Carraun hill wood, in Waterstown demesne, the dip being S.S.E. at 30°, while on the slope of the hill to the northward, east of Ashbrook, the gray Lower Limestone crops out. The black limestone seems to have been left in outlying patches scattered at intervals over this part of the country. It may be seen in a quarry on the road side a quarter of a mile N.N.W. of Crockdastha bridge, and a little W. of the corn-mill, the beds dipping E.S.E. at 3°; also, westward, near Toberclare, two-thirds of a mile S.W. of Auburn House, dipping S.E. at a low angle. It again appears about two miles further west (the highly inclined beds of Lower Limestone above described intervening), close to the church in the townland of Portlick, dipping S.E. at 5°, and the high ground about here seems to be composed of the angular debris of this rock. On the western shore of Inchmore Island we again find these black beds dipping S.W. and S. at from 10° to 15°, and the Island of Inchturk is strewn with black debris, as is also that of Inchbofin and the opposite point of the mainland. The hill W. of Creggan Lough exhibits the black limestone, with chert and shales, dipping E.N.E. at 10°; and westward, on the shore of Lough Ree, are crags of the underlying gray Lower Limestone, dipping S.E. at 30°. The hill E. of Creggan Lough is formed of nearly bare crags of Lower Limestone, in places very fossiliferous and locally magnesian, the beds dipping N.N.W. and N.E. at from 20° to 50°; and crags of similar beds are exposed further N.E., to the S. and S.E. of Doonis Lough, and dipping N.W. at from 30° to 40°. The lower gray limestone and calp may be seen nearly in conjunction on the hill with the trig. point 193, near the old nunnery at the boundary of the townland of Bethlehem and Bleanphuthoge; the gray limestone crops out in crags on the side and near the top of the hill, dipping N.W. at 40°, while the calp occurs freely exposed on the slope of the hill and on the shore, dipping S.W. and N.W. at 30°. The rocks here probably form an oval shaped *quâ-quâ-versal*, and the boundary has been so drawn. From this to the northern edge of the map the boundaries are quite arbitrary.

About half a mile S.W. of Ledwithstown House, surrounded by bog, is a patch of ground strewn with large angular fragments of calcareous sandstone, evidently belonging to the Lower Limestone shale and probably not erratic, but the debris of the subjacent rock. This patch has therefore been coloured on the map as belonging to the Lower Limestone shale.

To the eastward at Mullawornia, and south of it, are extensive crags of the gray Lower Limestone, the beds dipping N.W. at 35°. Here also on the canal bank the black shaly limestone occurs, resting conformably on the gray. Half a mile to the north, and also on the canal bank, is a fine quarry in the black beds, which dip S.W. at 15°; and a little to the N.E., near Tirlickeen House, the gray Lower Limestone may be seen dipping S.E. at 30°.

At Ballymahon, and south of it, the Lower Limestone appears in several quarries and crags, the beds dipping at various angles. In the bed of the Inny, above the mill at Ballymahon, and north of Cartron, are beds of pink and gray, variegated, very compact limestone; these contain fossils.

In the townland of Creevaghbeg, half a mile S.E. of the town of Ballymahon, *Phillipsia pustulata* was found. These pink and variegated limestones seem to be a tolerably constant set of beds, as they are generally to be met with on this horizon throughout the west and south-west of Ireland. Economically they do very well for repairing roads, but their splintery character and the absence of regular joints in them, render them useless for building.

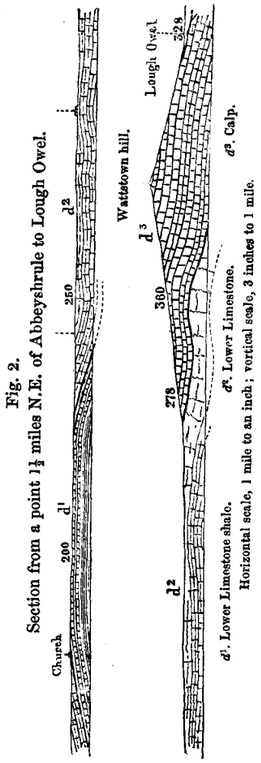
South of Ballymahon, and proceeding to the S.E. corner of the sheet, the gray Lower Limestone occurs in crags about Drumraney, where the beds dip to the N.W. at 40°; also, near Moyvoughly Lodge, dipping N.N.W. at from 40° to 50°, and a little north of the hamlet of Mount Temple, dipping N.W. at 40°.

## II. Sheet 99.

*The Mullingar District.*—Near the N.W. corner of this sheet, in the bed of the Inny, at the bend of the river just N.W. of Clynan bridge, are dark blue, very fossiliferous limestones, with shale bands and some sandy limestones, dipping S. at 5°. Further east, at Abbeyshrule, is a large waste heap, taken from the bed of the river during its deepening for drainage purposes, consisting of similar blue shaly beds, abounding in corals and bivalves. A small piece of the rock may be seen *in situ* on the west bank. The beds are nearly horizontal.

These beds are probably at the base of the Lower Limestone, and immediately over the Lower Limestone shale. The Lower Limestone shale may be seen W.N.W. of Abbeyshrule. There is a tolerably large exposure of it on the fair-green, near the National school, N.E. of Ballynacarrow bridge, consisting of gray and yellowish sandstone, weathering brown, with rusty calcareous bands, full of fossils; these beds dip S.E. at from 5° to 10°. About half a mile N.W. of the bridge, in a quarry at the north side of the road, near the ruined church, are thin bedded, earthy, dark gray, compact limestones, dipping S.S.E. at 5°. These beds are very like the Calp of this district, and if it were not for their position, with respect to the adjacent rocks, they might be mistaken for it. On the road side, at the ruined church, are gray sandy limestones and calcareous sandstones, with fossiliferous rusty bands, dipping S.E. at 5°.

Fig. 2.




Further east, near the edge of the map, north of Newtown and Conlanstown House, are several quarries of dark blue shaly, fossiliferous limestone, like that at Abbeyshrule; the beds are generally nearly horizontal, or rolling slightly. Similar beds may be observed dipping east at from 5° to 10°, on the road side a little north of the village of Ballynacarrigy; and again, two miles to the eastward, on the road side east of Orange Hall, with a dip to the S.E. at 15°. Proceeding to the S.E., crags of pale and dark gray compact limestone, occasionally magnesian, may be seen in the demesne of Sonna, a little east of the gate lodge. The bedding is here obscure. These limestones belong probably to the upper part of the Lower Limestone.

The Calp which occupies the principal portion of the eastern half of this map may be observed half a mile east of Sonna House, in a quarry, where



black earthy limestones and shales are visible, dipping east at 15°; the shales contain stems of plants.

On Wattstown hill, at the west side of and overlooking Lough Owel, these black beds are freely exposed, dipping at low angles in various directions. About one mile and a-half to the south, and a little north of the trigonometrical point 499, is a quarry of black limestone, the beds dipping south at 15°. Similar beds are exposed in another quarry on the shore of Lough Owel, south of Portloman; the dip is here to the S.E. at 10°.

These black beds are visible in many quarries to the east and north-east, at Ballynagall, Knockdrin, and about Crazy Corner, dipping at various angles in different directions. One of the chief exposures is a cliff which overhangs the road at its east side, a little north of the corn-mill, north of Parsonstown, near the north-east corner of the map; the dip is here N.W. at 50°.

South of Mullingar, between it and Lough Ennel, and along the shore of that Lough, the Calp is freely exposed, and also in the canal cutting S.E. of Saunders' bridge. At the bridge the beds undulate east and west at 30°, and less than a mile from it they dip N.W. at 10°. The upper portion of the Lower Limestone is visible a little to the eastward, in that part of the canal known as "the deep sinking," consisting of gray limestone, in which the bedding is quite obscure; it contains fossils in places, and is also locally very magnesian, being indeed here and there a good dolomite.

To the southward the gray Lower Limestone appears occasionally at scattered intervals. It occupies a large patch extending around and for some distance north and south of Anneville House, the rock forming crags with obscure bedding, or reduced to a state of debris.

The black limestone again forms an outlying patch, extending from a point a little north of Gaybrook House to the S.W. and S., into Sheet 109. It is visible in a quarry half a mile W. of Gaybrook House, the beds dipping S.E. at 15°; it may be also seen in a quarry north of Whitewell House, on the north side of the road, where the dip is S.S.W. at 5°, and again near Kilbride House, the dip being E. at 5°. A very small outlying patch may be also seen on the shore of Lough Ennel, due west of Loughanesker, where the beds dip N.W. at 15°. Another outlying patch occurs at the south edge of the sheet, near the corn-mill, S.W. of Dromore Lodge, at which place it may be observed dipping S.E. at 15°. This outlier intrudes into the adjoining Sheet 109. Eastward of this, about Castletown, and south of it, though there are no quarries, the debris and general aspect of the ground is that of the Lower Limestone. North of Castletown the gray Lower Limestone may be seen in the railway cutting N.E. and S.W. of Ballyhandy, also on the hill of Ushnagh, to the westward, and at the cross-roads, near the ruined church, three-quarters of a mile S.W. of that hill.

In the railway cutting close to Streamstown station are dark bluish gray thin beds, like those at Abbeyshrule, dipping N. and N.W. at 15°, and abounding in fossils. To the west, on the hill of Knockcausta, near the summit, is a large patch of crags of gray Lower Limestone, containing fossils. Further north a great portion of the country is free from drift, and the gray limestone appears in many crags and quarries around Clare Castle and east of Ballymore.

The section in fig. 2 will show the general relations and the lie of these beds in this district.

### III. Sheet 108.

*Athlone, Moate, and Ferbane District.*—The greater portion of this sheet consists of large tracts of bog. At its N.W. corner, W. and S.W. from Athlone, the pale gray lower limestone appears, chiefly forming rough stony ground, covered with the debris of the subjacent rock, as between Summerhill House and Mount Hussey, and about Thomastown, and *in situ* in the railway cuttings. Near Crancam is a quarry of pale gray very massive limestone, apparently dipping S.W. at 10°. West of this, and also in the railway cutting, similar rocks may be seen full of fossils. The bedding is here very obscure. In the railway cutting east of Newtown are beds of pale gray compact limestone with fossils, undulating E. and W. at 5°.

Five miles to the E.S.E. of the last locality, at Ballynakill, on the west side of the Shannon, are crags of pale gray fossiliferous limestone, evidently belonging to the lower limestone. Near the western edge of the map at Kidlawn, is a quarry, now not worked, and in which the rocks are imperfectly seen; they consist of dark gray limestones, having occasionally an oolitic structure. The angular debris of this rock may be seen in this neighbourhood, particularly on the high ground south of Moore bridge; these beds are considered as a part of the upper limestone.

The most important quarries, economically, of this district lie on the east bank of the Shannon east of Devenish Island. Here is an extensive tract of bare rock, consisting of beds of dark or pale gray limestone, abounding in crinoids and other fossils,* and dipping about S.S.E. at from 25° to 40°. These quarries have been rather extensively worked, the stone being in great request for building purposes, also for tombstones, gate-posts, &c., and their proximity to the river affords great facility of transport. Some of the beds are very crinoidal, and take a fine polish.† These beds also belong to the Upper Limestone.

About a quarter of a mile south of Shannon Bridge is an old quarry in which the black limestone is said to have been raised, but it is now filled up and nothing seen. One mile and a half due east of Shannon Bridge and known as "Curraghmore Big Rock," is a boss of pale gray limestone, in places magnesian; this probably belongs to the lower limestone. Further east, about Belmount and Moyclare, are some rather large exposures of pale gray Lower Limestone, apparently dipping to the N. or N.W.

In deepening the River Brosna at the corn mill, a little east of Ferbane, rocks in the bed of the river were blasted, and a large accumulation of angular blocks may now be seen on the bank. They are chiefly composed of dark gray sandy limestone or calcareous grits containing fossils. Some of the beds are full of *Bellerophon*, and at one place was found a tail of *Phillipsia pustulata*. The more calcareous beds abound in spirifers, orthides, and crinoids. These beds are probably part of the Lower Limestone shale.

About Lemanaghan Castle and Leabeg, where the patches of Old Red are marked on the map, no rock can be actually seen *in situ*, but the ground is thickly strewn over with large and small angular blocks of conglomerate and red sandstone, which are in all probability the debris of the subjacent rock. There is no actual evidence either for the Lower Limestone

* Good specimens of *Atrypa accuminata* occur here.

† One of the quarrymen showed me some ornamental articles, a looking-glass frame and a small table, which he had made from this stone. The beds vary from four to eighteen inches in thickness, and can be raised of any size up to twenty feet square. Finished tombstones bring 1*s.* per square foot; field gate-posts in the rough are 18*s.*, when finished, 27*s.* 6*d.*; demesne gate-posts, from £4 to £50, according to finish.



shale marked on the map near the above-named places, but from the local debris and general appearance of the ground, there is good reason to suppose that it would be reached at no great depth from the surface.

The pale gray limestone is freely exposed about the trig. mark 378 near Kilnagarnagh, also a mile and a half east of it, and again further east in crags a little N.W. of Cockroad wood, and in the hill of Bellair, west of Bellair House, where the trig. point 413 is marked on the map.

Bloomhill, an island in the bog, about midway between Ballynahown and the Shannon, is thickly strewn with pieces of calcareous shales and blocks of sandy limestone, and also of conglomerate; but a little to the S.E. of the trig. point 215, a well was sunk to the depth of 15 feet in beds of gray flags and dark calcareous shales which dip to the south. The debris of these rocks may be seen in a heap at the side of the well; they probably belong to the Lower Limestone shale.

The hill N.E. of Ballynahown, with the trig. point 270, is thickly covered with large angular blocks of conglomerate and old red debris, which is the only evidence for colouring it Old Red Sandstone, as the rock is not actually seen *in situ* at any one spot.

Near the house of Castle Daly, in a small stream which has been deepened, are exposed black micaceous shales and thin calcareous beds —the shales predominating. The following fossils were found here and identified by Mr. Baily:—*Leda attenuata*, *Chonetes papilionaceus* and *Hardrensis*, *Sanguinolites plicatus* and *transversus*, *Cypricardia sinuata* and *rhombea*, *Modiola ?* (species), *Orthoceras Goldfussianum*, *Fenestella*, *Producta*, and a well marked finely ridged plant stem.

A little S.E. of Cloghadoo corn-mill blue sandy limestone and calcareous blue grits are said to have been quarried, but no rock is now visible *in situ*.

In the demesne of Hall, half a mile E.N.E. of Hall House, is a rather large exposure of crags of dark, and pale gray, and variegated pink, and gray limestone, with a bed of gray shale dipping about S.W. at 10°; these are the same beds as those mentioned in page 11, occurring at and about Ballymahon, Sheet 98.

Near Farnagh House is a quarry in beds of coarse conglomerate, containing quartz pebbles, in a base of yellowish sandstone. These beds dip to the S.E. at 10°. Half a mile to the N.E. of the last locality, in the railway cutting, are beds of white conglomerate apparently dipping east at from 5° to 15°. Northwards on the west side of the road half a mile north of Ballynagarbry, are quarries exposing similar conglomerates, apparently dipping east at 5°. From the evidence of this quarry, the hill of Knockdominy has been coloured Old Red Sandstone. No other rocks are seen *in situ* in the neighbourhood of Moate.

F. J. F.

### IV. Sheet 109.

*The Tullamore and Kilbeggan District.*—The underlying rocks are much concealed by the drift, which, with few exceptions, is thickly deposited over the area included in this sheet of the map. At the N.W. corner of the district, in the railway cutting, five miles N.N.W. of Clara, near Ballinderry Lough,* blue, earthy, and shaly limestone is visible; some of the beds, which are nearly horizontal, are marked with ferruginous spots. A little farther to the east, similar beds may be observed dipping S.W. at 5°.

* Heads, horns, and bones of the red deer and of oxen have been found in abundance in this lough.

Light gray limestone is exposed a quarter of a mile S.E. of the trigonometrical point 408. Proceeding to the east, gray limestone again appears in the hill, half a mile S.E. of Ballynabarna, and, judging from the number of large angular blocks and general appearance of the ground about here, the underlying rock appears to be near the surface.

The only other locality where the rock is exposed in this part of the district, is in the village of Horseleap, where thick and thin bedded compactly crystalline limestone, of a dark gray colour, is visible in a quarry; the thin beds contain nodules of chert, and dip E.N.E. at from 10° to 15°.

The boundary of the outlying patch of Calp or Middle Limestone, coloured on the map to the N.E. of Horseleap, and extending into the adjoining sheet to the north is quite provisional, as no exposures of rock are visible about here, but the black earthy shaly beds, similar to these exposed a little beyond the limits of this sheet (see page 13), are reported to have been met with in sinking a well about three-quarters of a mile to the N.N.E. of Donore bridge, while the lower gray limestone is said to have been met with in some wells sunk to the N.N.W. of it.

In the neighbourhood of Clara the rocks are completely concealed by the large deposits of drift which are so common all over the district, and no quarries are open over many square miles of country.

The two patches of Old Red Sandstone, marked on the map to the N.W. of Clara, are entirely provisional, as the only evidence for them is the number of loose blocks of sandstones and conglomerates which appear over the space so coloured, while they are rare or entirely absent elsewhere.

These loose sandstone blocks are very numerous in Ballinaminton demesne, to the east of the house. They are also thickly spread over the ground about Gorteen Castle. The boundaries of these patches of Old Red Sandstone, with the accompanying bands of Lower Limestone shale, are of course quite uncertain, being drawn round the space where the Old Red blocks occur in such quantities as to become quite remarkable. The Old Red may possibly spread over a much larger area, or even be more limited in extent, but without further data it is impossible to draw any accurate conclusions. Half a mile to the S.E. of Ballycumber the limestone is exposed in the railway cutting, and in a few quarries. It is here of a gray, or pale bluish-gray colour, crystalline, massive, with the bedding very obscure, and containing fossils in great abundance.

The only locality where I was able to discover any rock *in situ* between Clara and Kilbeggan, was on the hill one mile north of Lismoyny, in the townland of Ballard, where the rock is near the surface, and may be seen in several places a little south of the height 349, consisting of massive gray limestone in which the bedding is very obscure; it contains corals and other fossils, the stone is of good quality and well suited for building purposes.

To the east of the last locality and north of Moycashel, are numerous large angular blocks of sandstones and conglomerates. These blocks occur in such quantity here, and are of so large a size, that although no rock was observed *in situ*, we are induced to believe that the Old Red Sandstone is the underlying rock, and have coloured it in accordingly.

The boundary of this sandstone is of course like those patches to the west, entirely provisional.

Gray limestone is reported to have been raised in the river at Coola bridge, north of Kilbeggan. Similar limestone is exposed in several places on the road between Kilbeggan and Ballynagore, near Split Hill, and the rock is bare of drift over a considerable area S.W. of Balrath



Castle, the bedding in it is very obscure, but appears to be nearly horizontal. Limestone similar to the last is imperfectly seen in a field on the north side of the esker, half a mile east of Long Hill in the townland of Newtownlow. In the neighbourhood of Ballynagore, and thence to Tyrrellspass, the underlying rock is entirely concealed by drift and bog.

On the road one mile to the N.E. of Tyrrellspass, massive thick-bedded crinoidal gray limestone may be well observed in some large quarries; the beds are nearly flat, and the limestone magnesian in places. These beds, which belong to the Lower Limestone, are again visible in the by-road south of where "School" is marked on the map, and in some quarries south of Toor House.

Proceeding to the east the character of the limestone becomes very different, and the massive gray beds disappear, being replaced by black, earthy compact beds, with shale partings and chert. The junction between the two is very well seen in the above-mentioned by-road—the dark beds resting on the gray at an angle of about 15° to the east. The black limestone is again visible near the road a third of a mile south of West House, where it consists of black thin-bedded limestone with shale bands and chert, the beds dipping east at 15°.

Commencing at the S.W. corner we shall now proceed to enumerate the localities where the rocks are exposed along the southern portion of this sheet. Dark gray compact limestone is visible in a quarry on the south side of the canal at Ballincloghan bridge; these beds are probably near the base of the Lower Limestone; the dip is to the east at 2°. Thick and thin bedded gray limestone with some dark gray beds, may be seen in a quarry a little north of Rahan College, the beds inclining to the south at a low angle.

Massive thick-bedded gray crystalline limestone is exposed on the west side of the road half a mile north of Ballycowan bridge; the bedding is here obscure, but may be seen in similar limestone half a mile to the S.E., where the beds dip S.S.E. at 5°. This gray limestone may be traced in several quarries for two miles to the E.N.E., the beds striking about E. 15°, N. and W. 15° S., and dipping S. 15° E. at 5°. Very extensive quarries are open in it at Ballyduff, one mile N.W. of Tullamore, where the stone, which is of very superior quality, and can be obtained in large blocks, is much worked. It takes a fine polish, and is much used for tombstones and other purposes where cut stone is required.* Farther to the N.W. at Ballyduff bridge, thick-bedded gray limestone may be seen on the road a little north of the bridge, and in a quarry at the corn-mill.

To the S.W. of Tullamore, the lower limestone is exposed in a few quarries. At the farmyard at Charleville Castle, it is bluish gray, regularly bedded, with some dark beds, containing layers and nodules of chert; these beds dip S.E. at 20°. Similar beds having the same dip may be seen in two quarries farther to the S.W.

Bluish gray crystalline limestone is exposed three-quarters of a mile east of Charleville Castle, and in the railway cutting west of the gaol at Tullamore. Similar limestone is visible north of the barracks and near the bridge south of the Union Workhouse.

To the N.N.E. of Tullamore the gray limestone is exposed at Derrygolan bridge, and in several places to the S.W. of it, where it appears to be near the surface for some distance; the beds are here either horizontal or dipping gently to the S.E.

The Middle Limestone, which occupies the principal portion of the S.E. corner of this sheet is, like the Lower Limestone, only exposed in a few

* For prices see page 35.

scattered quarries. It may be observed in two places three-quarters of a mile south of the railway station at Tullamore, where it consists of thin-bedded black compact limestone, with shale partings, in which fossils are rare; the beds seen on the west side of the road dip S.E. at 10°, while those on the east side undulate to the S.E. and E. at 20°. Similar beds may be seen in some quarries about two miles east of Tullamore near the road south of the canal, where the rock is said to be near the surface over a small area; the beds here dip south at from 25° to 30°. These beds are again seen on the by-road 300 yards north of Odlum's Bridge, where they dip S.S.E. at 20°. Dark gray and black, earthy, impure, thin regularly bedded limestone, with layers and nodules of chert, is exposed in the hill N.N.E. of Aghabrack, near the trignometrical point 441, where the beds dip E. and S.E. at 30°. Similar beds are well exposed in a hill half a mile to the east, and again to the north, about the trignometrical point 457, also in a quarry farther east, west of Tinker's Bridge. The boundary between the Middle and Lower Limestone probably curves round to the east, north of the last locality, as the Lower Limestone appears in some crags in the island in the bog north of Kilduff House.

To the south the black limestone is exposed W. and N.W. of Clonearl House, also in some quarries about Philipstown, one 300 yards N.W. of the gaol, another half a mile due north of Snugborough, and another one-third of a mile east of the Roman Catholic Chapel, where the beds dip west at 60°, consisting of black and dark-gray compact limestone with gray and white chert.

The Lower Limestone occurs at Mount Briscoe, and in the hill south of it; at the latter locality it is dolomitic in places. It is again visible at the S.E. corner of the sheet, a little north of Rathfeston House, while the Middle Limestone appears in a quarry one mile and one-third to the north of it, and again on the road three-quarters of a mile west of the same locality. The latter is also exposed one-third of a mile E.S.E. of Ballymooney House, and in a brook S.S.W. of Ballinagar, to the north of which village it is also visible, in a quarry, in the townland of Knockballyboy, where the beds dip N.W. at 8°, and again one mile E.S.E. of Byrnestown, where the dip is N.E. at 30°.

*Croghan Hill.*—This hill is remarkable as being the only feature of any importance over a large area of this portion of Ireland.

If we now proceed to examine the rocks of which it is composed, we shall find some of them distinct from any we have hitherto met with in this district, a great portion of the hill being composed of trap and trappean ash. Unfortunately, from the scanty exposures of the rocks, and the total absence of any connected section, it has been found impossible to arrive at any definite conclusion as to the relations existing between these traps and ashes with regard to each other, or to the surrounding limestone. Probably a great portion of the trap of Croghan is intrusive, and the intruded masses may have occurred at different intervals, also forming beds of contemporaneous trap and ash. On account of the imperfect manner in which these rocks are seen, all that has been attempted on the map is to separate the solid trap from the ash, the boundaries of course being quite provisional, as is also the boundary between the ash and limestone.

The trappean ash is well seen in a farm-road three-quarters of a mile E.N.E. of Boston, where it consists of coarse brecciated ash, containing fragments of trap and limestone; at one point lines like bedding were observed in it, the dip being apparently N.W. at 45°. This ash is not again visible farther to the N.E., but gray limestone, in which the bedding is nearly horizontal, is exposed a little less than a mile in the same direction, close to the edge of the bog.* The two patches of greenstone coloured on the map E. and N.E. of Boston are very imperfectly seen, the most northern one being only scantily exposed in a drain. Some of this trap was compact dark-blue greenstone, while other portions of it were vesicular and amygdaloidal. In a well sunk in this patch, 22 feet deep, greenstone is reported to have been the only rock met with. In the other patch to the east of Boston, the greenstone was only observed at one spot, consisting of very compact tough blue trap with crystals of hornblende.



The ash was met with in sinking a well on the side of the road a little south of Boston; it was similar to that in the farm-road to the east; the well was sunk 27 feet deep, and the rock is reported to have been the same for the entire depth. Green ash is also visible at the surface on the road side a little further south, and again one-third of a mile S.S.W. of Croghan Castle. Compact and rudely columnar greenstone is seen overlying thick and thin bedded dark-gray and black limestone with shale partings, in a quarry half a mile north of Clonearl House; the limestone dips to the east at 15°, and does not appear to have been altered by the trap. The ash marked on the map here is merely drawn on the supposition of the ash at Boston extending south beneath the bog, as neither the ash nor any other rocks are visible here.

On Croghan hill the ash is visible in several places, forming crags and bosses of rock which may be seen all round the top of the hill, and in several places south of it, and about the trigonometrical point 516. It is all of the same character, being generally of a greenish hue, with a highly calcareous paste, containing embedded fragments of trap and limestone; it often contains specks of iron pyrites, and at times assumes a spheroidal concretionary structure, lines of bedding are rarely visible in it, and when they do occur are generally very obscure. The band of limestone between this ash and that at Boston is exposed in a few places. It is seen east of Croghan Castle where it consists of pale gray limestone, much jointed, the beds dipping east at 5°, and similar limestone is reported to have been met with in sinking a well (22 feet deep) at Croghan Castle. Dark-gray and black shaly limestone may be observed dipping beneath the ash at a low angle, near a well, on the north side of the road, close to where the name Gorteen is marked on the map. Similar dark shaly beds are visible in a farm-road, and a little south of it, half a mile due north of the summit of Croghan, the beds here dip N.W. at about 30°, apparently dipping beneath the ash to the north. Black shaly and cherty limestones are again seen a little farther east, south of a farm-house, where the beds appear to undulate and dip N.E. at 30°. Gray limestone, similar to that east of Croghan Castle, in which the bedding is very obscure, is exposed a little less than half a mile N.N.W. of the summit of Croghan. This limestone as well as that east of Croghan Castle, has very much the character of the Lower Limestone and may possibly belong to it, the base of the Middle Limestone being represented by the black earthy beds which are well seen in the farm-road to the N.E., and which certainly appear to lie above the gray limestone and dip beneath the Boston ash, while the black beds visible at Gorteen dip beneath the Croghan Hill ash, and are above the gray limestone east of Croghan Castle. From this scanty evidence it would appear that the band of limestone between the two ashes forms an anticlinal, and that the Croghan Hill and Boston ash are actually the same bed, the continuity being broken by denudation which subsequently carried away the ash and some of the black limestones which form the base

* The limestone seen in this quarry has all the characteristics of the Lower Limestone.

of the Middle Limestone, leaving the Lower Limestone exposed in a few places. Owing, however, to the difficulty in distinguishing between the Lower and Middle Limestone, when the rocks are so complicated and imperfectly exposed, we have not attempted to separate the gray limestones which appear to belong to the Lower Limestone by any boundary on the map.

Hard compact cherty limestone with shale partings is exposed near the holy wells to the N.E. of Croghan, and black compact cherty limestone may be observed dipping beneath the trap close to the margin of the map north of the height 516. Similar limestone, with the ash resting on it, is well seen farther east, in the adjoining Sheet 110, the beds undulating and dipping south at a low angle.

The patch of trap marked on the map immediately north of the summit of Croghan is well exposed and may be observed in several places, it is hard and compact, of a dark-purple or bluish-gray colour, at times becoming slightly vesicular and amygdaloidal. The patch farther north is imperfectly seen, the rock being only exposed in two places, it is similar to the last but more amygdaloidal. To the S.E. of Croghan the trap is likewise only exposed in a few places. It consists of dark purple compact trap, and may be observed in the road cutting where it is exposed for a short distance, also in a few places to the north of the road. The small patch of trap marked on the map to the S.E. of Gorteen, is of a different character, it is very hard and tough, difficult to fracture, granular and crystalline, with green and yellow glassy crystals; it is only exposed at one place, in a quarry north of a farm-house close to the road.

At Castle Barnagh, N.E. of Philipstown, a small exposure of trap occurs, it is only visible at one place where it forms a small crag which can be seen from some distance. The trap is compact, of a dark-blue colour, with crystals of hornblende, it is slightly calcareous, lines like bedding occur in it, the direction being N.N.E. and S.S.W., and the dip E.N.E. at 70°.

J. O'K.

## V. *Drift and Superficial Deposits.*

As before stated, the rocks of this district are much obscured by drift. This drift may be divided into two kinds, namely—1, the boulder drift, and 2, the esker drift.

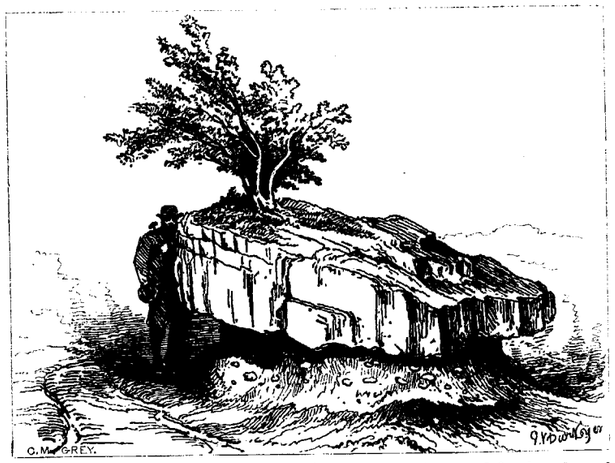
1. *The Boulder drift* is generally composed of the angular or rounded debris of the subjacent rock, but also contains blocks and boulders of foreign rocks, such as sandstones and conglomerates, and occasionally trap, and also of limestone, differing in character from that which would be found beneath the surface; these latter are frequently much worn and rounded, and often have their surfaces scratched and striated. These blocks and boulders either occur loose and separate from each other or bound in a matrix of coarse clay and gravel. This drift was probably formed when the country was enveloped in a sheet of ice, which slowly but constantly moving towards the sea from higher grounds, wore away the surface of the rocks. Though most of the harder boulders in this drift are scratched, no striæ have been observed within the limits of these four sheets on the surfaces of any rock *in situ*. Very few smooth surfaces however are laid bare, and long exposure to the atmosphere, rain, &c., has probably obliterated striations which once existed before the protecting covering was washed away.* During this period, or subsequently to it, the country was probably slowly submerged beneath the sea. While the bed of the sea was again being elevated,* the waves and currents washed and remodelled the drift. In some cases the rock was laid bare, in others, under favourable conditions, the drift was left *in situ*, while in others, conflicting tides and currents may have modified the materials of the old drift into knolls and esker ridges.

* To the north of the present district many striated surfaces occur, to be hereafter described in the explanation of Sheets 78, 87, 88, &c.



The climate was milder than heretofore, but still there were glaciers on the higher hills which often descended to the sea; and the sea itself was frozen round the shore, and icebergs floated off, laden with debris and blocks often of great size. When the ice melted, these would be dropped on the sea bottom, and accordingly we occasionally see large angular blocks resting on the boulder drift or sometimes on the eskers. A good example of this may be seen on the south side of the road leading from Clonmacnoise to Ballynahown, about three miles east of the former, where a large block of gray limestone rests on boulder drift. See fig. 3.

Fig. 3.




Block of gray limestone, about eight feet long by three deep, and five broad, resting on a patch of boulder drift on S. side of road, three miles east of Clonmacnoise. Ord. Sheet 8, King's County.

2. *The Esker Drift.*—The esker ridges which form such remarkable features throughout this district, and are traceable for many miles across the country, vary considerably in their composition, the same ridge being in some places made up of the coarsest materials, large and small, angular and rounded fragments occurring huddled loosely together, sometimes bound together by a calcareous cement, and sometimes imbedded in a matrix of coarse gravelly clay, while at others a transverse or longitudinal section exhibits fine sand and gravel, beautifully stratified and obliquely laminated. Sometimes seams and cakes of very fine yellow clay occur. The beds are often curiously contorted. Such sections may be seen in the railway cutting near Athlone and Ferbane. Though to all appearance these sands and gravels look most promising, no shells or fossils of any

* See "Memoirs on Glacial Drift of Scotland," by A. Geikie, F.R.S.

kind have been found in them within the limits of this district or anywhere in the neighbourhood.

These eskers were most probably formed, as has been said above, during the emergence of the sea bed, the sands, fine gravels, and clays having been deposited over the boulder clay and re-arranged, sorted, and obliquely laminated by opposing currents, &c., when brought near the surface. Where coarse materials form the esker, many of the harder boulders exhibit striæ and scratchings on their surfaces. It is probable that atmospheric causes, after elevation, greatly modified the form of many of the eskers.—F. J. F. and J. O'K.

We shall now proceed to describe them in detail, commencing with the *Athlone Esker*.

The town of Athlone stands on an esker, part of which has been taken advantage of for purposes of fortification.* To the westward of Athlone, the ridge runs in a continuous chain for four miles, when its continuity is somewhat broken, but the esker can be distinctly traced for three miles further to the north-west corner of Sheet 108, and into the adjoining Sheet 107, in the Explanation of which it will be again mentioned. Many interesting sections in beds of sand and gravel are exposed in this part of the esker.

From Castlesampson, six miles west of Athlone, a rather broken esker runs off to the north by Cam Lodge to Curraghboy, which is five miles north of Castlesampson. From Rooskagh, which is about four miles W. of Athlone, another beautifully marked chain runs almost due north for five miles by Miltown Pass to the southern end of Lough Funshinagh. The remains of other north and south ridges may be seen a little further to the east, about Toornafulla and Foxborough. Another well-marked chain, parallel to these, leaves the main esker near Larkfield House, two miles W. of Athlone, and runs N. by Hodson's Bay House to Ballybay, at Lough Ree, a distance of three miles. The numerous little ridges and hillocks N. of Athlone, towards Carberry Island and Coosan Point, may also be considered as branches of the Athlone esker.

To the east of Athlone it runs in an unbroken ridge for two and a half miles, when it spreads into the broad undulating drift ground of Moydrum. In the cuttings of the Tullamore railway, E. of the town, a fine section is shown in this esker in beds of fine sand and gravel, and thin seams of indurated clay. In many places the beds are obliquely laminated, curved, contorted, or even faulted; N.E. of Moydrum, about Twyford, the esker again appears in the form of ridges and hillocks, which soon again merge into the high undulating drift about Belville, which is five miles E. by N. of Athlone. It again appears in the form of a ridge at Mount Temple Old House, two miles and a half E.S.E. of Belville, whence it takes a south-easterly course for five miles, running about half a mile N. of Moate to the neighbourhood of Marchbrook House, two miles east of Moate.

Immediately S. of the town of Moate, and close to it, are numerous abrupt drift hills, which are probably a branch of this esker; some of them show fine sections in stratified sand and gravel. F. J. F.

The esker is well marked as a single ridge along the southern shore of Ballinderry Lough, but, just N. of Marchbrook House, spreads out and divides into two ridges, with some curious hillocks, and cup-shaped hollows between them. One of these branches turns to the S.E., crossing the road at the "Gap of the wood," and ending abruptly at the bog half a mile further in the same direction. Some very remarkable hollows occur

* This is not peculiar to modern times, as on many of the eskers, raths, which were evidently intended for fortification, may still be seen.



on the summit of this esker S. of the "Gap of the wood." The other branch spreads out into undulations to the E. of Marchbrook House, which continue without forming a regular ridge as far as Primrose Lodge, a mile to the eastward of Marchbrook, where the esker again becomes more clearly defined, running in an irregular line with a steep slope to the north. Its southern side is not so well marked, and is lost a mile or so farther in the undulations west of Springfield, beyond which the esker cannot be distinctly traced for a mile or two. Between Marchbrook and Springfield this esker appears to be in a great measure composed of fine sand, more or less stratified. About one mile to the E. of Springfield House, a curious small drift hill rises abruptly from the bog; it is principally composed of fine sand, a good section of which is seen in a sand-pit at its western end. To the north of this, about a mile, is Templemacateer, from which to Horseleap, about one mile and a half to the S.E. of it, a very remarkable system of eskers sets in, at times forming regular embankments for short distances, with slopes of about 30°, and varying in height from 30 to 100 feet above the low ground. These embankment-like ridges sometimes divide into branches, which either end abruptly, or join again, enclosing curious hollows of various forms. Many angular blocks of gray limestone, from three to five feet across, rest on the eskers about here. At Horseleap the esker is cut through by a small brook called the Gageborough river, but continues as a well-defined ridge for another mile to the S.E., the northern slope being much more abrupt than the southern, as far as Coolalough House, a little east of which the esker is lost in the undulating drift ground which stretches along by Meldrum towards Kilbeggan. J. O'K.

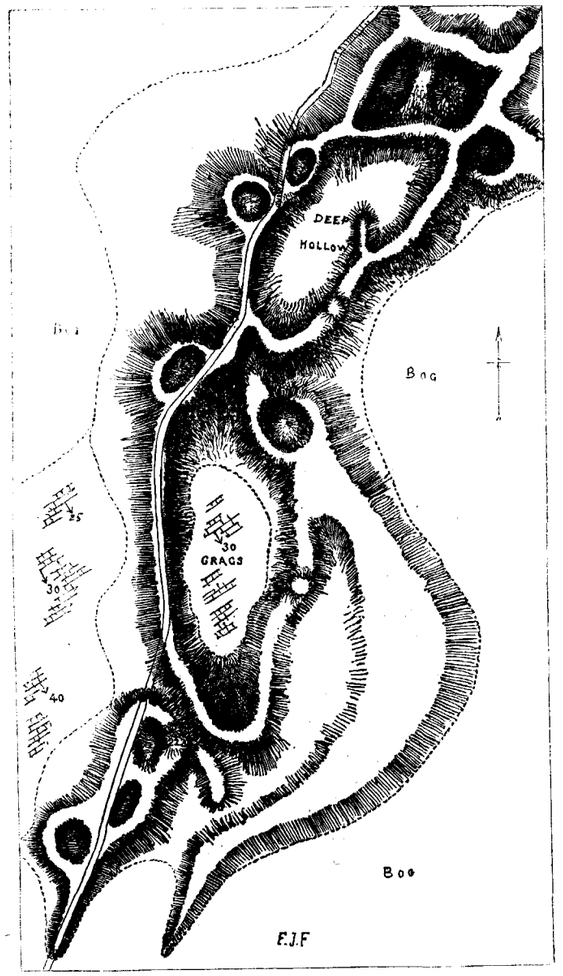
*The Seven Churches' Esker.*—This great esker, coming from the west, enters the limits of Sheet 108 near its south-west corner by two branches, which may be seen marked on the map S. of Kidlawn. One of these runs by Newtown police barrack, continuously, to a point a little north-west of Devenish Island, where it terminates in a mound, surrounded by bog. The other branch is broken just where it enters Sheet 108. It runs at first east and west for about three miles, the first two of which are parallel to the River Suck, which there falls into the Shannon. The other mile is on the east of the Shannon, and is occupied by the little town of Shannon Bridge. This esker ridge is indeed almost the only dry land hereabouts, great bogs spreading all along the courses of the rivers here for some miles on each side of them.

It is remarkable that the River Shannon cuts through this esker by a gap only just wide enough to admit of the passage of the river, while the ridge would apparently have easily been turned by the river running either east or west of it.

To the N.E. of Shannon Bridge the esker is broken at two places by flats, half a mile wide, now occupied by bogs, and then runs continuously to the N.E. for three or four miles past Creevagh and the Seven Churches of Clonmacnoise.

About a mile south of Creevagh the esker is seen to rest upon bare limestone, which makes its appearance not only on the outside of it, but in a broad hollow space in the middle of it, surrounded on all sides by a continuous ridge. (See figs. 4 and 5).

Fig. 4.




Plan of the esker near Lough Naneg, between Shannon Bridge and Creevagh.
Scale, 6 inches to 1 mile.



Fig. 5.

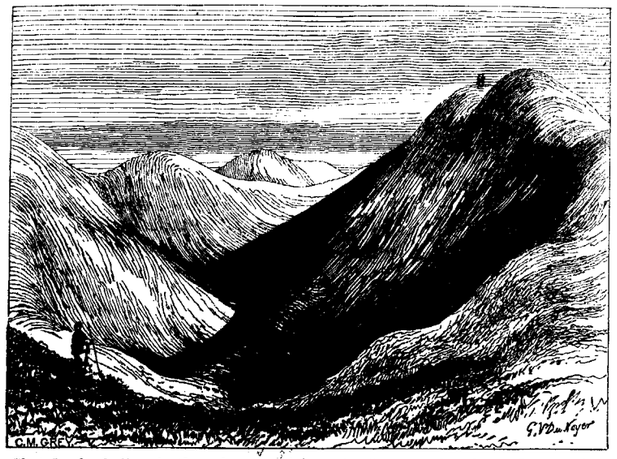

Sketch of the esker near Lough Naneg, looking north, showing limestone crags in a hollow of the esker, taken from a point two miles N.E. of Shannon Bridge, on the ridge just E. of the trigonometrical point shown in fig. 4, marking an altitude of 223 feet above the sea.

Many other curious deep hollows occur in the esker here, similarly closed in by continuous ridges, one of which has been sketched by Mr. Du Noyer, and is given in figure 6. (See fig. 6).

The general appearance of this part of the esker may be learned from figs. 5 & 6. At Clonmacnoise the esker again turns to the east and bifurcates. The southern branch runs by FinLough and terminates in about three miles in a mound called Fighting Hill, near Ballaghurt. The main ridge, after running a little farther to the N.E., turns due E., and is continuous for five miles past Darcy's-street and Hind's-street. The crest of the ridge hereabouts, as is so often the case with these eskers, is occupied by an old road, called the Pilgrim's road. The general appearance of this part of the esker ridge, when viewed from an eminence a little at one side of it, may be learnt from the two sketches given in figures 7 and 8, which form parts of a semi-panoramic view of it taken by Mr. Du Noyer from a point about two and a half miles east of the Seven Churches of Clonmacnoise, looking north.

In fig. 8 the spire of Athlone R.C. Chapel is seen in the distance, which is, however, too

Fig. 6.




Sketch of a hollow in the esker, looking south, from a point situated one and a quarter miles S.S.W. of Seven Churches, at the northern end of the "Deep Hollow," marked in fig. 4.

great to show the esker on which that town is itself built. Parts of the Pilgrim's road esker have a singularly artificial appearance, looking exactly like a railway embankment, if it were not for its occasional sinuosities.

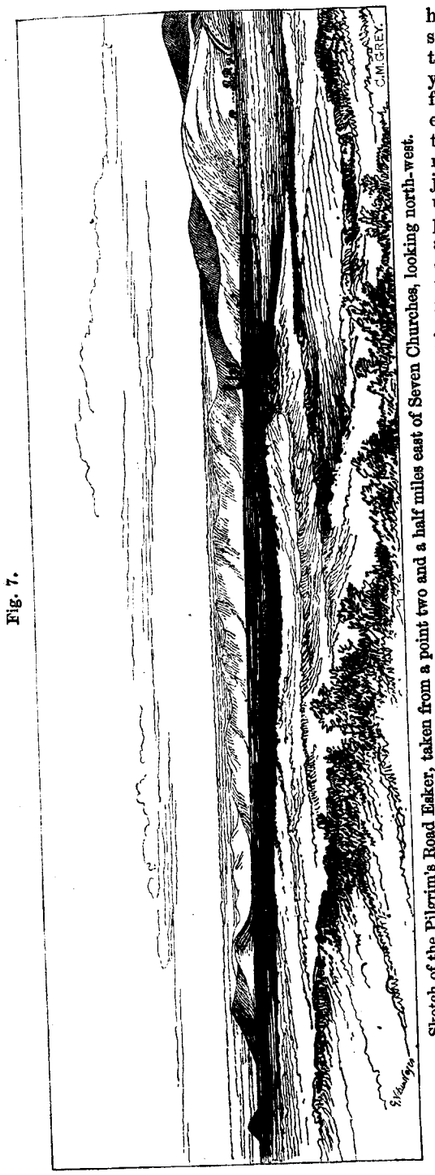
About five miles east of Clonmacnoise the ridge is interrupted for about half a mile by the bog that runs south of Ballynahown, but on the east of the bog it re-appears again, running by Doon and south of Eskerbreague, till, in a few miles farther east, it is lost for a time in the irregularly undulating drift ground S.W. of Bellair.—F. J. F.

Proceeding to the east, towards the village of Ballycumber, which lies at the eastern edge of Sheet 109, no regular eskers are met with at first, but the boulder drift appears to be thickly deposited about Hollybrook and Grogan. To the east of Ballycumber commences a system of very remarkable eskers, which can be traced for twelve miles to the east. The first of these commences a short distance east of Ballycumber, west of the trigonometrical point 238, it extends three-quarters of a mile to the N.E. and is broad topped with well marked slopes, sending out a spur to the west.

The narrow strip of land in the bog east of Ballycumber is the commencement of an esker which is low at first but gradually increases in elevation as we proceed eastward till it becomes a well marked ridge. It spreads out, a little farther to the eastward, into a wide tract of high drift land, some of which is nearly one hundred feet above the bog. This high land is composed of variously formed ridges and hillocks, having steep slopes, with corresponding deep and sometimes broad hollows, in which patches of bog occasionally occur. Some well marked ridges occur in it south of Clara. One of these commences west of Lough Cuith, and extending along the southern side of the lough may be followed as a distinct and well marked ridge, of from 50 to 80 feet high, narrow at the top, and with slopes of about 30°, for one mile to the S.E. where it spreads a little,



Fig. 7.




Sketch of the Pilgrim's Road Esker, taken from a point two and a half miles east of Seven Churches, looking north-west.

having a broad and sometimes undulating top of from 200 to 300 yards in width. A little farther to the S.E. the esker curves round to the N.E. becoming narrower at intervals till it joins in with a broad undulating esker, composed of several hillocks and minor ridges with corresponding hollows, which stretches S.E. from Lismoyny. At the junction of the two eskers are numerous undulations which gradually coalesce towards the east, and form a regular broad-topped esker north of Durrow. The northern slope of the esker between Lough Cuith and the junction with the Lismoyny esker is particularly well marked. Two-thirds of a mile S.E. of the same lough, on the southern slope of the esker, is an immense block of gray limestone which roughly measured 18 × 15 × 12 feet. (*This is somewhat similar to that drawn in fig.* 3, *but is much larger.*) Large blocks of similar limestone were also observed on the esker near where the tower is marked on the map south of Lismoyny, one of them is at least ten feet square.

On the northern slope of the esker due north of Durrow Abbey are some gravel pits in which coarse gravel and stratified sand may be observed, and the stratification appears at this place to coincide with the slope of the ridge.

To the east of Durrow the esker continues to form a broad high ridge, making quite a feature in the country. North and south of the main ridge are occasionally small ridges running parallel to it, and some drift hills occur south of it. Due east of Durrow Abbey is a small esker which forms a regular ridge for half a mile, but is lost in the irregularly undulating ground farther east. Another small esker occurs at the glebe farther south. Two miles to the east of Durrow the esker spreads out and divides into numerous and variously shaped ridges and hillocks, with some very remarkable deep cup-shaped hollows, which are particularly well seen west of Lowertown. These irregular hillocks and ridges extend for two miles to the N.E. of Lowertown, and spread over a large area of country south of Ardnaglew.

Fig. 8.—*continuation of fig. 7, looking north.*

The spire of Athlone R. C. Chapel in the distance.

North and north-east of Clara is some high undulating drift land, bounded by steep and regular esker-like slopes. A spur of this high land forms a short esker on which Clara Church is built. The southern slope of this esker continues well marked for more than half a mile to the N.W. forming the boundary of the high drift land in this direction. Good sections of the drift are seen in gravel pits along this slope; it is chiefly composed of sand of various degrees of coarseness, which is often rudely stratified, the stratification sometimes having a tendency to coincide with the slope. This high drift land extends to the north towards Ballicknahee, and east to near Lismoyny, to the S.E. of which it sends out a branch forming a broad and high esker ridge a mile in length, round which the River Brosna makes a remarkable bend.



Good sections of the drift are exposed in the Clara and Streamstown Railway cutting a little north of Clara, where numerous large angular blocks of gray limestone were observed in it.

A little S.E. of Clara and on the south side of the River Brosna, east and west of Sallybrook House, is a very well marked esker, which at one place a little S.W. of the house, attains an elevation of 80 feet above the bog.

*The Ballyduff and Newtownlow Esker.*—This remarkable horseshoe-shaped esker can be traced for nearly twenty miles, forming quite a feature in part of the area included in Sheet 109. Commencing in the bog one mile N.W. of Rahan College, where it forms a small esker, it gradually increases in breadth and elevation as we proceed eastward till it becomes a broad topped ridge, N. and N.E. of the College, ranging in height from 70 to 100 feet above the bog. The northern slope of this ridge is very regular and steep, while that to the south is long and gradual. Still farther to the east, the esker becomes narrower, sending off short branches in different directions, and having occasional detached short eskers on either side. There are also some very curious deep hollows in the esker east and west of where the railway cuts through it. The railway cutting exposes a good section of the esker which is made up of rudely stratified sand and gravel, with numerous rounded and subangular blocks of limestone and occasionally sandstone. The lines of stratification appear to coincide in some measure with the undulations of the esker. At Ballyduff bridge the underlying rock is exposed at the northern base of the esker, the summit of the latter being here 111 feet above the river, and over 100 feet above the surrounding low ground. To the east of Ballyduff several hollows again occur in the esker, and it sends off spurs along its southern side while the northern slope continues steep and regular. Proceeding farther to the east, south-east of Gormagh bridge, which is two miles and a half north of Tullamore, the esker is made up of a series of ridges and hillocks of various forms, separated by deep and curiously shaped hollows. Some of the crests of the ridges rise to a height of at least 90 feet above the low ground. To the south and east of the esker hereabouts, and at various distances from it, are numerous small detached eskers and hillocks of drift. The main chain now begins to contract, forming itself into a narrow well defined embankment-like ridge south of the old castle, and curving to the north-east continues in a slightly sinuous line for about six miles, with few modifications, by Murphy's bridge, New Mill bridge, and Kiltoher Castle to near Judgeville. The underlying limestone is exposed close to the esker near Derrygolan bridge, and south-west of it. There is a very curious natural gap in the esker at New Mill bridge, about five miles N.E. of Tullamore, through which the head waters of the Silver River flow. (See fig. 10, p. 31). A little to the N.E. of the gap on the northern slope of the esker, is a gravel pit in which the lines of stratification in the gravel and sand coincide with the slope of the ridge. This gravel pit is likewise shown in fig. 10 just to the left of the gap. A short distance to the north is a large mound of drift on the top of which is a fort, known as Rahugh Moat, looking from which the adjoining esker forms a remarkable feature. (See figs. 9 and 10.)

To the N.E. of New Mill bridge the esker is very narrow on the top,

with steep slopes on either side, and from forty to sixty feet high, which character it maintains to within a quarter of a mile north-east of the R.C. chapel, where it begins to become more irregular, sending out a spur to the east, which is however soon lost in the irregularly undulating ground north-west of Judgeville. The main esker here begins to curve sharply to the N.W., spreading however at first into numerous hillocks and irregular undulations, which continue as far as the road to the north, where they again combine to form a single ridge. This at first runs westward for more than half a mile, when it turns sharply to the north-west towards Cornagher Lough.

Many large angular blocks of limestone and sandstone rest on the esker where it passes along the road south of the lough. It is narrow and low, with occasional small breaks, south-west of the lough, but gradually increases in elevation as we proceed towards the north-west, till at Newtownlow it attains an elevation of at least seventy feet above the surrounding drift country. To the north-west of Newtownlow, two and a half miles N. of Rahugh Moat, the esker

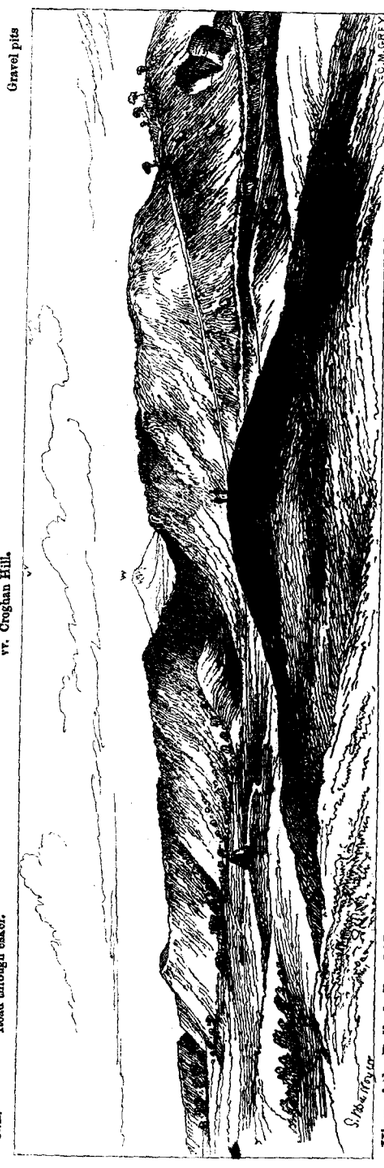



Fig. 9.

View of the Ballyduff and Newtownlow esker from the isolated drift mound of Rahugh Moat, looking due east, with the trappean hill called Croghan visible through a gap in the esker, and some gravel pits opened in it on the right.




Fig. 10.—*continuation of fig. 9.*

View of esker from Rahugh Moat, continuation of the view in fig. 9. On turning to the south the gap south of the gravel pit near the left of the sketch is the gap by which one of the head waters of the Silver River escapes.

is beautifully defined, being narrow on the top, with slopes of about 30° on either side. (See fig. 11.) It is here known by the name of the Long Hill. The north-eastern slope is unbroken for more than a mile and a half, but at Newtownlow and west of Long Hill some piles of drift occur on the south-western side.

The limestone, as before stated at page 17, is exposed near the base of the northern slope a third of a mile north-west of Newtownlow.

The esker continues to be well defined, having however occasional banks of drift at either side, till we arrive at the gap formed by the River Brosna, which is not much greater than is necessary to allow of the passage of the river. West of the Brosna the esker again forms a well defined narrow ridge for three miles to the west, to near St. David's Lodge. For a short distance east of the latter place it is a narrow and low ridge. Another parallel esker extends between the two roads east and west of Loughnagore. Other high and remarkable short detached eskers, with some curious hollows, occur at Split Hill. These eskers appear to rest directly on the

limestone, as a large area of it is bare of drift hereabouts.

Returning to the main chain north of St. David's Lodge, it curves to the north-west, forming a narrow but well marked ridge for more than a mile to the north-west, where it is lost in the irregularly undulating ground east of Donore bridge, which is only about one and a half miles from Templemackateer, already mentioned in describing the Athlone esker. J. O'K.

*The Streamstown Esker.*—A chain of eskers commences on the west side of Sheet 99, at a point about one mile N.N.W. of Moyvore, and runs in a south-easterly direction as far as Toberville House (a distance of nearly four miles), where it spreads into high drift land. It again resumes its feature at a point one and a half miles to the south-east, and half a mile south-east of Killare House, at the cross roads. Thence it runs continuously in a general southerly direction by Streamstown into Sheet 109. This latter part of the chain runs in a valley, having the high stony ground which stretches from Killare House by Killeenbrack Castle to Streamstown on the west, and that about Stremmingstown Castle and Jamestown on the east. About Streamstown the esker

Fig. 11.

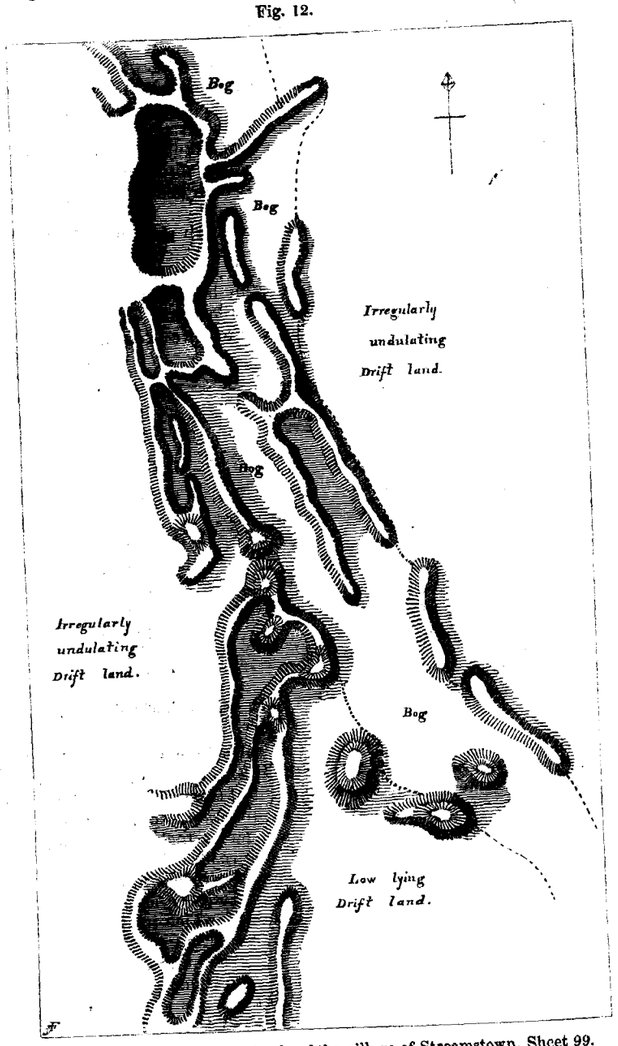
View of the Ballyduff and Newtownlow esker, looking north, from a point a little west of Newtownlow, three miles E. of Kilbeggan.

C.M.GREY.



assumes the most fantastic forms, dividing into steep-sided parallel ridges and knolls, with several curious trough-shaped hollows (see fig. 12), the spaces between the ridges being occupied by perfectly flat bogs. On entering the north edge of Sheet 109 this esker soon

Fig. 12.




Plan of eskers on the west side of the village of Streamstown, Sheet 99.
Scale, 6 inches to 1 mile.

spreads out and is lost in the undulating drift north-west of Donore bridge, and thus shows itself to be a continuation of the Ballyduff and Newtownlow esker.

West of the Streamstown esker, traces of another ridge may be seen at intervals, commencing in the bog at the trigonometrical point 385, less than a mile east of Winetown, two miles N. of Ballymore. Here it may be traced for about three-quarters of a mile, and it forms rather a conspicuous object in the bog. It is again traceable for a short distance at the southern end of Lough Sunderlin; and again, south of Ballymore, and a little west of Clare Castle, it runs along the edge of the bog for about one and a half miles. Commencing again at Rose Mount, it runs southward into Sheet 109, when it turns to the south-east, forming a well-marked ridge for about one mile, and ending abruptly east of Ballynabarna, within a mile or two of Marchbrook and Templemacateer, already mentioned.

In a direction nearly parallel with the northern portion of the Streamstown esker there runs a small chain, in Sheet 98, starting from the high rocky ground near Cartron House, one and a half miles south of Ballymahon, running by Keel bridge and Baskin bridge to a point one and a half miles south of the latter; hereabouts the chain splits into parallel ridges and knolls, and in one point appears to have been cut across by an ancient river. (See fig. 13.)

Fig. 13.

Eskers cut through by ancient river, half a mile S.W. of Ballymore.
Ord. Sheet, W. Meath, $\frac{2}{3}$.

A small ridge, extending for nearly two miles in a southerly direction, may be seen a little east of Sonna House, in Sheet 99. F. J. F.

An esker commences about one mile north of the village of Ballynagore, on Sheet 109. It first has a south-easterly direction, soon, however, curving to the south, and running due south as far as the road, where a gap occurs. It is very well marked north of the road, being very narrow on the top, with steep sides. Several large angular blocks of limestone rest on it hereabouts. To the south of the road the esker again turns to the south-east, as far as the River Brosna, south of which it continues in a small but well-marked ridge, which can be distinctly traced for about half a mile to the south, where the drift begins to spread out, forming numerous hillocks and ridges, with corresponding trough-shaped hollows. This remarkable undulating character of the drift extends over a large area of country east and south-east of Ballynagore, and thence to New Forest. Some of the hillocks are over 100 feet above the bog, and may be seen from a great distance.



A very well-marked esker occurs south of New Forest. It appears to be a branch from the Newtownlow esker, commencing in a series of hillocks near where the corn-mill is marked on the map, north-west of Long Hill. These hillocks extend for half a mile to the south-east, where a gap occurs, a little beyond which, and due south of Forest House, the esker again commences, and continues eastward and unbroken for about one mile and a half, when it spreads out and is lost in the undulating ground south-west of Tyrellspass. The Ballynagore and Tyrellspass road is carried along the top of this esker.

Large accumulations of drift occur in the neighbourhood of Tyrrellspass, which, however, are not of sufficient importance to require special notice.

A chain of small eskers also runs along the south-east margin of Sheet 109, commencing about three miles E.S.E. of Tullamore. They run in an easterly direction for about four miles along the verge of the bog, curving to the south of the village of Ballinagar, and entering Sheet 118.

J. O'K.

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## PRICES OF BALLYDUFF LIMESTONE.

"The price of best Ballyduff limestone delivered in Dublin would be about 1*s.* 6*d.* per cube foot in the rough. Strongly chiselled ashler about 2*s.* 6*d.* per superficial foot, and tombstones, four inches thick, about 2*s.* per superficial foot, delivered in Dublin.

The tracery, windows, and dressings at St. Patrick's Cathedral are done with the above stone, and the columns and cornice of the Club House, Kildare-street, are also done with the same material. The weight per cube foot is 168 lbs."

The above information was communicated by Messrs. Fitzpatrick and Molloy, the proprietors of the above quarries, who have erected many handsome monuments of this stone in Prospect Cemetery, Glasnevin.

J. O'K.

# INDEX.

DUBLIN: Printed by ALEXANDER THOM, 87 & 88, Abbey-street,
For Her Majesty's Stationery Office.