# EXPLANATIONS

TO ACCOMPANY

## SHEET 143 OF THE MAPS

OF THE

# GEOLOGICAL SURVEY OF IRELAND,

ILLUSTRATING PART OF THE

## COUNTIES OF CLARE AND LIMERICK.

DUBLIN:
PRINTED FOR HER MAJESTY'S STATIONERY OFFICE.
PUBLISHED BY
ALEXANDER THOM & SONS, 87 & 88, ABBEY-STREET;
HODGES, SMITH, & CO., 104, GRAFTON-STREET.
LONDON:
LONGMAN, GREEN, LONGMANS, AND ROBERTS.
1860.

THE

# GEOLOGICAL SURVEY OF THE UNITED KINGDOM

IS CONDUCTED UNDER THE POWERS OF THE

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

---


DIRECTOR-GENERAL OF THE GEOLOGICAL SURVEY OF THE UNITED KINGDOM:

SIR RODERICK IMPEY MURCHISON,

D.C.L., F.R.S., G.C.ST.S., &C., &C.

*Geological Survey Office and Museum of Practical Geology, Jermyn-street, London.*


---

## IRISH BRANCH.


*Office in the Museum of Irish Industry, 51, Stephen's-green, Dublin.*

LOCAL DIRECTOR:

J. BEETE JUKES, M.A., F.R.S., &C.

SENIOR GEOLOGISTS:

G. V. DU NOYER, M.R.I.A.; W. H. BAILY, F.G.S. (*Acting Palæontologist*).

ASSISTANT GEOLOGISTS:

G. H. KINAHAN, Esq.; F. J. FOOT, Esq.; J. O'KELLY, Esq.;
A. B. WYNNE, Esq.; J. KELLY, Esq.

COLLECTORS OF FOSSILS, &C.:

Mr. C. GALVAN; Mr. ——.


---

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, or 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;
Messrs. Alex. Thom & Sons, Abbey-street, Dublin.

# EXPLANATIONS

TO ACCOMPANY SHEET 143, OF THE MAPS

OF THE

# GEOLOGICAL SURVEY OF IRELAND.

---

## General Description.

The River Shannon runs with a general bearing E. and W. through the northern part of the district included in this map, dividing it into two portions. The southern and largest of these is a part of the County of Limerick; while the other division belongs to the County of Clare, except a small tract to the N. of the City of Limerick, which is a portion of the former county. The places of most note are the City of Limerick, and the villages of Askeaton, Adare, and Pallaskenry.

### 1. *Form of the Ground.*

All this area is drained by the River Shannon and its tributaries, the largest of the latter being the tidal river Maigue. This enters the district a little to the south of Adare, and flows nearly due N., emptying itself into the Shannon, about seven miles to the W. of Limerick. The spring tides affect it as far up as Adare Manor, while they influence the Shannon to Athlunkard Bridge, above or to the eastward of the City of Limerick.

The country south of the Shannon is one large undulating plain, which gently slopes to that river and the Maigue. It is here and there broken by small rocky or abrupt hills. A similar plain also extends north of the Shannon for about two or three miles, when the ground rises to form the Cratloe Hills, attaining, in the farther space of four miles, an altitude of 996 feet above the sea. Large alluvial flats, locally called *callows* or *corcasses*, run along the margin of the Shannon and its feeders. These flats are generally below the high water mark of spring tides, but those to the N. of the Shannon, especially those W. of Bunratty, are studded over with islands, if we may so call them, of drift; some of which rise abruptly to over 100 feet in altitude, and give a peculiar aspect to this part of the district.

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

### Aqueous Rocks.

| | Name. | Colour on Map. |
|---|---|---|
| | Peat Bog, Shell Marl, and Alluvium, | *Pale Sepia.* |
| | Drift, | *Engraved dots.* |
| *Carboniferous.* | $d^4$. Upper Limestone, | *Prussian blue (dark).* |
| *Carboniferous.* | $d^2$. Lower Limestone, | *Prussian blue (light).* |
| *Carboniferous.* | $d^1$. Lower Limestone Shale, | *Prussian blue and Indian ink.* |
| *Old Red Sandstone.* | $c^3$. Upper Old Red Sandstone, | *Indian red (dark).* |
| *Upper Silurian.* | $b^3$. Llandovery beds, | *Purple.* |

### Igneous Rocks.

| | | |
|---|---|---|
| D. | Greenstone, | *Crimson.* |
| B. | Basalt, | |
| P. | Porphyry, | |
| Am. | Amygdaloid, | |
| Ds. | Trappean Ash, | *Crimson, with dark dots.* |

$b^3$. *Llandovery Beds.*—The oldest rock formation appearing at the surface of the ground in the area contained in this map, belongs to the group called the Llandovery beds, or lowest part of the Upper Silurian formation. It here generally consists of green and gray, highly calcareous, shales and grits, interstratified with a few red beds and clay rocks. Some of the shales are cleaved into coarse slates, and were formerly quarried to a slight extent for roofing slates. In the calcareous beds fossils are locally abundant; they will be particularly spoken of in the *Palæontological Notes* (see p. 10) by Mr. W. H. Baily.

$c^3$. *The Upper Old Red Sandstone* in this district is usually a coarse yellow quartzose grit, sometimes conglomeritic, and sometimes calcareous, and often having greenish sandy shale partings between the beds. The bottom beds are reddish, or yellow, ferruginous, quartzose grits or conglomerates; over these are coarse, sometimes flaggy, grits and conglomeritic grits, with a few red and purplish beds. The next beds in an ascending order are purplish red and yellow sandy shales, clay rock or indurated marls, and a few grits, in which there are nodules and lenticular calcareous patches (*cornstones*), which are sometimes nearly a pure limestone. Above these are quartzose grits, usually of a yellow colour, very quartzose, and sometimes calcareous, with, in places, greenish sandy shale partings. All the Old Red formation in this district seems to belong to the *Upper Old Red Sandstone*. On account of the great accumulation of drift on the southern face of the Cratloe range of hills, no exact estimate of the true thickness can be formed, but it cannot be more than 500 or 600 feet.

The Carboniferous formation has been divided into five, viz.:—$d^1$. *Lower Limestone Shale,* $d^2$. *Lower Limestone,* $d^3$. *Middle Limestone or Calp,* $d^4$. *Upper Limestone,* and $d^5$. *Coal Measures.* Of these, the highest, viz., the Coal Measures, is wanting in the district included in this sheet of the map; and the Middle and Upper Limestones are not distinguishable from each other, and will be therefore described together.



$d^1$. *Lower Limestone Shale.*—Between the Old Red sandstone and the Lower Limestone shale there is no regular boundary, since there are beds of yellow quartzose grit in places calcareous, which as we descend begin to alternate with red beds, while as we ascend they alternate with black shales. Even below the black shales the calcareous parts of these grits are generally fossiliferous, often abounding in bivalve shells, though the fossils are usually not perceptible, unless when the rocks are weathered. Above these are alternations of yellow quartzose grits and ribboned black and blue shales.* Over these are grits, shales, and argillaceous fetid limestones. The next rocks in an ascending order are black and blue shales, very fossiliferous. These pass up into calcareous shales and highly argillaceous shaly limestones. The portion which may be assigned to the Lower Limestone shale is about 50 feet in thickness.

$d^2$. *The Lower Limestone.*—This division in the district now under examination, is again divisible into two parts: the lowest being dark blue, sometimes nearly black, argillaceous, fetid, thin-bedded limestones, that are usually shaly, but sometimes are good compact stones. When weathered they are inclined to exfoliate. These beds are capped by gray and black shales, alternating with thin beds of chert and limestone. The thickness from the top of the Lower Limestone shale to the top of these cherty beds, is about 300 feet; the cherty beds being generally about 20 feet thick.

The upper division of the Lower Limestone over the cherty beds, is massive limestone of a gray or blue colour, and usually destitute of bedding. In it there are thin bands that are either red or purple, or variegated.†

The upper part of the Lower Limestone is generally full of an oblique coarse cleavage, which might easily be mistaken for bedding, The strike of which varies from E. 20° N. to E. 35° N. It is also much jointed, the principal joints running N. 20° W., and E. 20° N. The variegated and red beds are often well developed, being thin-bedded, with red argillaceous shale partings. A red bed is generally found nearly immediately under the cherty beds that have been made the boundary between the Lower Limestone and the argillaceous beds of the Middle and Upper Limestones. The Lower Limestone is often magnesian, the magnesian limestone occurring in beds, parts of beds, or dykes: it is seldom a true dolomite. When magnesian it is of a yellowish gray or brown colour, the weathered portions having a sandy aspect. The dykes generally run between the principal joints, and therefore N. 20° W., and E. 20° N.

---

* In these shales there are the remains of grass-like and other plants.

† These variegated red and purple beds are sometimes quarried for marble, and they have been extensively used in the building of Adare Manor, the seat of the Earl of Dunraven. The colouring matter seems to be derived from iron in some form or other, as in that part of the Manor that is longest built, some of these limestones have become marked with iron stains. From this it would appear that they are better adapted for internal ornamental purposes than for use where exposed to the atmosphere. The colour may itself be due also to atmospheric influence, as sometimes in the same quarry, and seemingly in the same bed, the limestone is red or purple near the surface of the ground, and when followed down is of the ordinary gray colour. My attention was first directed to this latter fact by George Fosberry, Esq., and the Rev. H. H. Jones, of Adare.—G. H. K.

At the north of the Carrigogunnel igneous district, there is a large mass of true dolomite of a very saccharoid aspect and orange gray colour.

$d^3$. and $d^4$. *The Middle and Upper Limestones* are undistinguishable in this district. The limestones above those just described are full of layers and nodules of chert. These cherty beds vary in thickness from 20 to 50 feet. Over them the limestones are argillaceous, fetid, granular, and thin-bedded, with shale partings between the beds. They are occasionally cleaved into a coarse slate, and sometimes the beds are so thin as to form good flags. It is often magnesian, sometimes a true dolomite. Immediately W. of Limerick, it has an oolitic structure, and is magnesian to a greater or less degree. When magnesian it is of a yellowish brown, or whitish gray colour; and in the oolitic limestones the alternate globules are magnesian, giving it a marked appearance. The partings between the beds are black shales and yellow clay; some of the black shales have all the appearance of coal smuts.

*Igneous Rocks.*—Associated with the Upper and Middle Limestones are *Greenstones, Basalts, Porphyries, Amygdaloids,* and *Trappean Ashes.*

The *Greenstones* and *Basalts* are usually a glistening, finely crystalline, green, bluish, purplish, or reddish trap, being scarcely distinguishable from one another. They blend imperceptibly into Porphyries and Amygdaloids, being always amygdaloidal at the top, and sometimes at the bottom of the beds. These traps have often scoriaceous patches in them. When amygdaloidal and porphyrytic they contain almond-shaped pieces and crystals of Felspar, Calcspar, Hornblende, &c., &c, the almond-shaped cavities being usually filled with the calc spar. On the weathered surface of the Amygdaloids and Porphyries will be seen empty cavities, but on breaking the rock these are found to be full of a white mineral; and on going farther in, few or none of the white minerals will be seen, but their places are taken by pink, green, or red minerals—some of the cavities being filled with a substance marked like an agate. Specks of a greenish mineral are numerous in some of these traps; also veins and crystals of quartz.

The *Ashes* are of a blue, green, or purplish colour, and vary from a coarse breccia or conglomerate to fine trappean grits. The latter are often porphyrytic or amygdaloidal, especially when of a purplish colour. When blue the ash is highly calcareous, sometimes nearly a limestone, and it might sometimes be called an Ashy Limestone or Limestone Ash.* Green, however, is the prevailing colour for most of these rocks. In these ashes are fragments of grit, slate, limestone, trap, and ash, the pieces of limestone being most abundant, and some of them of considerable size, their diameter being over 8 inches. Beds of limestone and ash are often found alternating with each other in the district, as will be seen in the *Detailed Description.* Fossils, chiefly encrinite stems, are sometimes seen in the mass of the ash, and are abundant in the embedded limestone fragments.

*Drift.*—The principal drift in this district is usually composed of

* These ashes were extensively used in building the New Terminus at Limerick, of the Waterford and Limerick Railway.



limestone fragments and gravel, although to the N. of the Shannon, there is a large accumulation of Old Red debris and sand lying above the limestone drift.*

The Old Red drift in places is over 200 feet in thickness, and is often fine ferruginous sand.

The *Shell Marl, Bog, and Alluvium* need no general description.

G. H. K.

*Note on the Igneous Rocks.*—The igneous rocks interstratified with the Carboniferous Limestones of the County Limerick, described above by Mr. Kinahan, are a very remarkable series of varieties.

Some of the hard purple porphyritic traps seem as if almost entirely composed of feldspar, and the embedded crystals are certainly all feldspathic. I am, however, unable to say to what species of feldspar they belong.

The mass of the rock and the embedded crystals would be well worthy of an accurate chemical and mineralogical investigation, which I regret that I have not hitherto succeeded in inducing any one to undertake. It seems difficult to suppose that the rocks can be composed of a trisilicated feldspar, such as orthoclase, when they have come through and have been poured out upon such a basic substance as the thick Carboniferous Limestone, still less likely does it seem that they should contain any free silica mingled with the feldspar in a state of paste. We are, therefore, precluded from applying the term "Felstone" to them, since that is already applied to a rock consisting of a pasty mixture of a trisilicated feldspar and uncombined silica; yet the feldspathic crystals do not appear to be Labradorite.

Other varieties of these traps of dark green, sometimes almost black colour, might easily be supposed to be varieties of basaltic or doleritic and dioritic rocks, yet they seem to pass by insensible gradations into the red porphyries (which would be commonly called feldspar porphyry), and scarcely to differ from them except in colour.

The vesicular or scoriaceous structure of some parts of these traps is very remarkable, and appears in some cases to form irregular bands alternating with compact rock, as if marking successive flows of molten matter in the way described by Sir C. Lyell, in his Paper on Ætna, in the Phil. Trans.

The ash beds (or Tuffs, as many geologists would call them) are also very remarkable. Some are coarsely conglomeritic or brecciated, as described by Mr. Kinahan, and there is every gradation from these through finer and finer grained materials, to a perfectly compact rock of which the particles are indistinguishable even by the lens. Different beds in the same quarry, and sometimes different laminæ in the same block, show alternating layers of coarse and fine grain arranged with the utmost evenness and regularity, the coarse made up of rounded grains of finely vesicular trap, varying from the size of a pea to that of a pin's head, while the finer are made of smaller and smaller particles till we get the materials of impalpable powder. Among the coarse conglomerates large blocks of trap and limestone occur, and little rounded fragments of limestone may be seen now and then in the finer layers.

The compact green stone which seems to have been made of consolidated trappean powder, often blends insensibly with layers of gray limestone, so that hand specimens may be got containing alternations of the two substances. The evenness of the layers of the rather coarser sorts is so remarkable, that they have been likened in the quarry to a pile of boards in a timber yard.

I was often struck by the exact similarity between these accumulations and those in the volcanic islands of Erroob or Darnly Island and Murray Island, in Torres' Straits, where there were equally regular layers of volcanic ash and scoriæ, likewise containing lumps and pebbles of limestone, torn apparently from the coral reefs through which the volcanic orifice had forced its way. Neither were the black heavy cindery lavas of some parts of these islands at all unlike some of the traps of Limerick.

The difference in the two cases lies in the arrangement of the materials, since the beds of ash, &c., in the Torres' Straits islands were highly inclined, while the adjacent coral reefs were horizontal; the Limerick traps and ashes being on the contrary parallel in position to the beds of the interstratified limestones.

This difference, however, may be the result of our comparing different parts of the two structures. In the Torres' Straits islands the only parts that can be seen are the subaerial cones, and it is quite possible that beds of cinders and ash, and even flows of lava might be concealed under the adjacent sea, interstratified perhaps with layers of coral limestone. In Limerick, on the other hand, the old cones, if ever they existed, and whether they were submarine or subaerial, have of course been long ago destroyed

* The limestone drift is known to lie under part, if not nearly the whole, of this drift, as in places where the mountain torrents and railway cuttings have penetrated the former, the limestone drift appears below it.

and their materials strewed over the adjacent seas, making, perhaps, many of the thick deposits of the present trappean ashes and conglomerates. We may, perhaps too, suppose that the eruptions were more entirely submarine, and doubt whether any cones were ever formed over the orifices.

In some of the adjacent Sheets of the Map, we find what are with great probability some of the volcanic foci from which some of these igneous matters have proceeded, as will be found in the explanations of those Sheets.

J. B. J.

---

### 3. *Palæontological Notes by Mr. Baily.*

At Ballycar, in one particular locality (a ditch separating two fields) are sandy shales, abounding in fossils, the most numerous being the peculiar casts of small simple turbinated corals, formerly called Turbinolopsis, now Petraia; these eminently characteristic corals serve with the other fossil evidence to determine the geological horizon of these beds, proving them to belong to that division of the Upper Silurian which is now called the Upper Llandovery rocks.

Two very distinct forms of this typical genus were obtained, the one most abundant I have referred to Petraia elongata, *Phillips*, a species which Sir R. Murchison alludes to as being more common in the Upper than the Lower Llandovery beds.* Of this species as many as thirty-six specimens were collected, which although presenting a considerable variety of form had evidently all the same specific character.

The majority of the corals which have been referred to this genus are preserved in the state of internal casts, and therefore present an unusual appearance, which has probably induced them to be considered by some palæontologists sufficiently distinct to form a separate genus. On an examination of the mould, however, from the external surface, which we are enabled to make in several instances in the series from Ballycar, there appears to be nothing to distinguish them generically from the small detached corals of the genus Cyathophyllum, which are so common in the Wenlock limestone. This tends to confirm the observations made by Professor Milne Edwards in his work on the fossil corals of Great Britain, published by the Palæontographical Society, that he did not consider "such casts as had been referred to the non-characteristic genus Turbinolopsis or Petraia," as presenting any material difference in structure to warrant their removal from the genus Cyathophyllum. It may therefore be a matter for future consideration whether they ought not to be included in that genus, or whether, as they are now so well known by the name of Petraia, and are so peculiarly characteristic of the Llandovery rocks, it may not be considered advisable still to retain them under that generic name. It does, however, appear to me that the list of recorded species requires revision, and that some of them have been established upon fossils which might have been referred to previously described species.

I would therefore propose the following amended list of the species of the genus Petraia (including a new form from the above locality), with their range in geological time, as given in Sir R. Murchison's Appendix to Siluria:—

| | Caradoc or Bala. | Llandovery Rocks. | Wenlock. |
|---|---|---|---|
| Petraia? æquisulcata, *M'Coy*, | * | * | |
| ,, bina, *Lonsdale*, | | * | * |
| ,, ? Du Noyeri, n.s. *Baily* (fig. 1, p. 11), | | * | |
| ,, elongata, *Phillips*, | *? | * | |
| (synonyms) P. rugosa, *Phillips*. | * | * | |
| ,, P. subduplicata, *M'Coy*, | * | * | |
| ,, P. uniserialis, *M'Coy*, | * | * | |
| ,, Ziczac, *M'Coy*, | | * | |

* Siluria, 3rd edition, p. 228.



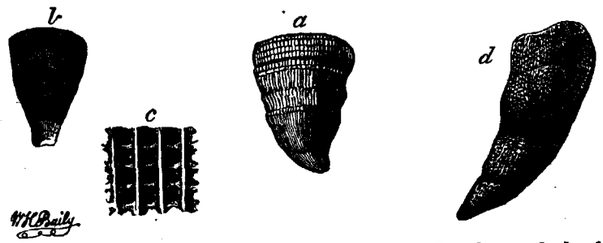
By the above list it may be seen that Petraia rugosa, *Phillips*, P subduplicata, and uniserialis, *M'Coy*, are considered to be synonyms of P. elongata *Phillips*, species all occupying the same geological horizon.

The additional species, Petraia? Du Noyeri (fig 1), included in that list was found, associated with those I have referred to Petraia elongata, in the same sandy shales at Ballycar, but in smaller numbers. I have named it after Mr. G. V. Du Noyer, of the Geological Survey. Its internal cast, having a regularly reticulated surface, presents so different an appearance from that species that it appeared doubtful whether it ought not to be considered generically distinct. The mould of its external surface and general form, however, do not exhibit any marked difference from those of the accompanying species of Petraia, and may also be referred to Cyathophyllum, or probably Cystiphyllum, a genus with which, in its internal structure, it would, perhaps, better agree.

Fig 1*a*, represents the external surface as copied from a mould taken in gutta percha, from one of the cavities in which the casts of these corals are suspended; it bears a considerable resemblance, externally, to corals of the genera Cyathophyllum and Cystophyllum, such as Cyathophyllum pseudoceratites, *Milne Edwards*, Brit. Fossil Corals, tab. 66, fig. 3, or Cystiphyllum Grayi, Ibid. tab. 72, fig. 3, showing it to be a simple turbinated coral, variable in height, its epitheca having well marked and closely arranged longitudinal striæ, irregularly crossed by concentric lines of growth.

Fig. 1*b*, represents the internal cast suspended in its cavity; the beautiful reticulated appearance of its surface distinguishes it from the species with which it is associated, and from all others. Its longitudinal septæ being united by transverse divisions at nearly regular distances cuts the whole surface into regular square cells; a portion of this surface is enlarged at *c*. A large specimen is shown at *d* in which the internal cast has been separated into three portions, which, unlike the others, fill up the whole of the cavity to the extremity. The costæ in this cast appear to have been more flexuous and to have radiated from a central axis somewhat similar to that in P. elongata.

Fig. 1.




The following is a list of species from the Upper Llandovery beds of the Upper Silurian, at Ballycar, South, county Clare, $\frac{53}{3}$:—

ZOOPHYTA.

Heliolites interstinctus, *Wahlenberg*.
Favosites alveolaris, *Blainville*.
Petraia elongata, *Phillips*. × ×
,, Du Noyeri, *Baily*, n.s. ×
Cyathophyllum.

ECHINODERMATA.

Crinoid stems.

ANNELIDA.

Cornulites serpularius, *Schlotheim*.

CRUSTACEA.

Encrinurus punctatus, *Brünnich.* ×
Phacops caudatus, *Brongniart.*
Proetus latifrons, *M'Coy.*
Sphærexochus mirus, *Beyrich.*

MOLLUSCA, *Brachiopoda.*

Athyris tumida ? *Dalmann.*
Atrypa marginalis, ,,
,, reticularis, *Linnæus.*
Orthis elegantula, *Dalm.* ×
Rhynchonella Wilsoni, *Sowerby.*
Spirifer elevatus, *Dalm.* ×
Strophomena depressa, *Dalm.* ×
,, euglypha, ,, ×
,, funiculata, *M'Coy.*
,, pecten, *Linn.*

*Gasteropoda.*

Euomphalus funatus, *Sow.* ×
,, lautus, *M'Coy.*
Murchisonia Lloydii, *Sow.*

The mark × indicates the abundance of the species.

Many fine Carboniferous fossils were also collected from the Lower Limestone in the western part of the district included in this sheet, which will be described with others of the same character in the Explanation of Sheet 153.

December 24th, 1859.

W. H. B.

---

4.—*Relations between the form of the Ground and its internal Structure.*

The plain which spreads over the greater part of the district has almost everywhere the Carboniferous limestone either immediately below the vegetable soil, or covered with a greater or less amount of the loose sand, gravel, and boulders which are called "the drift."

The level or gently undulating surface of the ground, however, is by no means the result of the horizontality of the beds below it, which often undulate or "dip" in various directions much more steeply than the surface does, the beds having been all worn down by denudation to one general level, and the irregularities of their surface still further smoothed over by the deposition of the drift.

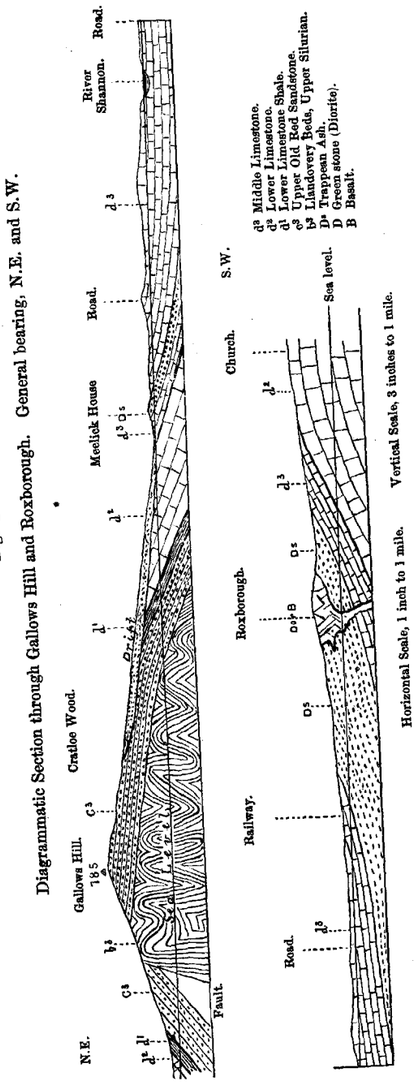
Some of the low hills south of the Shannon are formed of knolls of limestone rising above the general level of the ground, and this often happens where the beds are more highly inclined than usual. Others of them, and those generally the most striking in feature and abruptness, are formed of trap or trappean ash, materials which, from their toughness, have resisted the action of denudation to a slightly greater degree than the more jointed and more decomposable limestone.

One district, that towards Pallaskenry, which rises rather higher than usual, is composed of gently inclined beds of Old Red sandstone, rising gradually from beneath the Carboniferous limestone.

The Cratloe Hills also are composed partly of Old Red sandstone rising out to the northward, the beds having a rather steeper inclination than the ground, so that we come upon lower and lower beds as we ascend the slope of the hill. We thus arrive at the base of the formation in some places before we reach the summit of the hill, in some places at the summit, and in others on its northern slope, according to variations in the height of the ground, or the angle at which the beds incline.



Fig. 2.




The rocks which appear from underneath the base of the Old Red sandstone are the Silurian shales, slates, and grits, which, from their fossils,

appear to have been deposited during the same geological period as the Llandovery Rocks of Wales.* These beds, in the Cratloe Hills, are often very highly inclined, sometimes even vertical, and strike in various directions, so that their position has no relation whatever to the form of the surface of the ground composed of them. Moreover, on examining the relation between these rocks and the Old Red sandstone, it is perceived that the Silurian rocks had been tilted into their present highly inclined positions, and had been worn and denuded down so as to form a surface very little different from their present one, even before the deposition of the Old Red sandstone.

This ancient surface would be found everywhere still unaltered underneath the base of the Old Red sandstone, while in those parts from which the Old Red has been removed by subsequent denudation, that denudation has effected but little change in the Silurian rocks compared with that much greater erosion by which they had previously suffered. The little gap, for instance, worn in the Silurian rocks, below the base of the Old Red sandstone, to form the valley of Glennagross, is but a slight loss from their mass compared to the bulk of the Silurian rocks that must have been removed in order to produce the surface on which the Old Red sandstone was deposited.

We have, then, within the district evidence of the following operations having taken place :—

1st. The formation of the Silurian beds as horizontal strata beneath the waters of the sea.

2nd. The elevation and tilting of those beds in various directions, and the erosion of vast quantities of the bent and broken beds, so as to produce a new surface across their edges.

The time required for this operation must have been enormous, and it is most probable that during part of this time the surface of the Silurian rocks formed dry land.

3rd. The deposition on this new surface, probably during a great period of depression, of horizontal beds of Old Red sandstone, covered by thick deposits of Carboniferous limestone and Coal Measures ; volcanoes breaking out in the bed of the sea during part of the period, and contributing flows of submarine lava and great beds of ash to the mass of the other deposits.

4th. Another action of elevation and denudation by which these latter rocks were tilted and largely worn away, so that the Coal Measures were removed from off the whole of the district, all the Carboniferous limestone from some parts of it, and from one portion even the whole of the Old Red sandstone, so as to re-expose the Old Silurian surface, and even in some small parts to excavate down below that, and make fresh gaps into the mass of the Silurian rocks themselves.

The extent to which this denudation proceeded depended very largely on the elevation which the rocks attained, so that commonly, but not invariably, the spaces under which the force of elevation had acted with greatest local intensity still retain something of their original comparative altitude, and rise as hills above the low grounds.

J. B. J. and G. H. K.

* It is remarkable that even on the higher parts of the Cratloe Hills the ground formed of the Silurian rocks is in a state of cultivation, while that composed of Old Red sandstone is wild and desolate at lower levels.



## Detailed Description.

[The district included in this sheet of the map was surveyed by Mr. G. H. Kinahan, by whom also the following detailed descriptions have been drawn up.—J. B. J.]

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

$b^2$. *Llandovery beds.*—The rocks of this group are only found along the north of the district. At the old church, in ruins, that lies to the N.W. of Heathmount Lodge, are gray flaggy shales. In the stream that flows by Heathmount Lodge, immediately due west of that place, are gray grits and shales, with a thin vein of red hematite. A little higher up the stream are flaggy shales that are vertical. Due E. and E.S.E. of these, in the same stream, are gray and greenish grits and shales, that dip N. at 88°. Higher up the stream are variegated shales and grits, the first met with are very much contorted, but farther up they dip S. at 80°. A little to the S. of this, near an old lime-kiln, are indurated grits and shales, that dip nearly N. at 75°. Due west of these last named rocks, in the lane leading up from Heathmount Lodge, are green shales.

On going back to Heathmount Lodge, and proceeding a short way up the road that leads to Gallows Hill, there are found alternations of grits and variegated shales, purple beds are frequently seen, and thin veins of red hematite ; the beds are nearly vertical, but with a slight dip to the S.E. Over these are strong purplish red grits, interstratified with purplish red, and a few green shales ; they dip S.E. at 85°. These seem to underlie purplish red shales and grits, in which there are thin beds of yellow clay, they dip first at 85° to the S.E., and then at 80° to the N.W. A little to the south of this, at the north of the cross-roads, are purplish red and variegated grits and shales, greatly twisted and contorted To the south of these, in the centre of the cross-roads, are silicified grits and shales, which dip N. at 70°. In the field to the W. of these, there is a mass of purple red and white quartzose rock, which in places has the appearance of a breccia. Its relation to the surrounding rocks is obscure, and it is not easy to determine to what it owes its peculiar aspect. To the east of the cross-roads are purple red and gray silicified grits and shales, some of the grits appear as if they are nearly changed into quartzite. These peculiar rocks continue for 800 feet to the E. of the cross-roads. Leaving these peculiar beds and going E., there are red and olive sandy shales, much twisted, but with general dips to the W.N.W. at 80°, and to the N. at 60°. The next rocks seen are olive shales, dipping N. at 88°. Further E. are red grits, that dip to the E.N.E. at 80°. Where the parish boundary crosses this road, green grits and shales alternate ; the grits are extremely hard.* The beds dip N.W. at 85°. A little to the E. of these, along the same road, is a red clay rock. To the S. of this, there are gray and olive grits and shales, at first much twisted and contorted ; but at the boundary of the Old Red sandstone, they have a steady E. 20° N. strike, the dip being nearly vertical. About half a mile to the S. of this, near the source of the Cratloe river, there is a small island of Silurian rocks exposed by the denudation that formed the ravine in which that stream flows. In it are green and purplish shales and grits and olive clay rocks, all dipping to the N.E. at 70°. In a stream a little to the W. of where 998 is marked on the one-inch map, there are green grits, flags, and shales, some of them calcareous, and all dipping nearly S. at about 85°.

A hill capped with Old Red sandstone, of which the point marked 998 is the highest summit, divides the Silurian rocks at Gallows Hill from those in Glennagross. Glennagross is the little valley in which the head waters of the Crompaun river rise. The denudation having removed the Old Red sandstone from the upper part of the valley, the boundary of that formation is deflected to the south of its general course a distance of two miles, with a

* These grits and also the quartzite at Gallows Hill are excellent road materials.

corresponding exposure of the Silurian rocks. In the mountain road that runs E. and W. to the north of Troutstream bridge, there are green olive blue and gray shales, all calcareous in a greater or less degree; interstratified with these are a few grits and clay rocks. The shales are fossiliferous. To the W.S.W. of Troutstream bridge the same beds are seen; near the Old Red sandstone, they dip E. and E.N.E. at 80°; a little lower down they are vertical; nearer the bridge they dip to the S.W. at 50°, and at Troutstream bridge, W. at 80°. In the stream at the E. of the bridge the rocks dip south at 65°, while at the hamlet a little to the north-east, they dip N. at from 65° to 70°. To the E.S.E. of this bridge where Troutstream joins another stream, there is a thick yellowish green indurated marl, which dips N.E. at 88°, and N. at 10°. Under it are blue shales with nodules of a sort of impure siliceous clay ironstone; in some of these nodules there are fossils. Here there is an anticlinal curve, the southern side of which dips S. at 60°. 500 yards to the S.W. of this, there are blue and greenish shales, full of nodules of impure siliceous ironstone; they dip S. at 80°, and S.W. at 45°; in some of the nodules there are fossils. To the south of this, where the parish boundary meets the Old Red sandstone boundary, there are green shales and clay rocks that dip E.N.E. To the N. of the wood which lies at the W. of Cappateemore, there are olive clay rocks and shales, striking E. and W. with a nearly vertical dip. A little to the north of these in the same stream are green, blue, and olive shales, clay rocks and calcareous shales; the first met with are vertical, higher up they dip N. at 80°, and afterwards at 30°. Due north of these at the point of the barony and parish boundary are green shales and grits that dip S. at 80°. To the N. of the barony boundary olive green and blue shales are seen, the most western of which dip S.S.W. at 75°; the others that are calcareous and fossiliferous at 80° to the N. At the margin of the map, due N. of the O in O'Brien's bridge, there are blue and green shales. Between the O and the B there are green calcareous shales, that are highly fossiliferous; under them are sandy green shales or finely laminated argillaceous grits, and over them is a bed of fine green conglomerate, in which there are also fossils; these beds dip N.N.E. at 60°. This locality is in the townland of Ballycar, and is that from which the fossils described by Mr. Baily were procured. To the east of these there are shales, some of which are very arenaceous, they dip N.E. at 40°. To the north of the latter are green sandy shales that are dipping N.W. at 75°. In the lane that runs through where the N in O'Brien's bridge is printed on the map, are seen purple red and yellow shales, with thin veins of red hematite. They strike nearly E. and W. These beds are very like those before spoken of, that lie to the E. of Heathmount Lodge, and N.W. of Gallows Hill cross-roads. To the E. of the lane there are green sandy shale or finely laminated argillaceous grits, which are slightly calcareous, and seem to be the continuation of the rocks that lie below the fossiliferous beds at Ballycar, as the debris of the fine green conglomerate that overlies those shales is found a little further to the east.

*Upper Old Red Sandstone.*—Beginning at the N.E. corner of the map and going W.S.W. along this formation, the first rocks seen *in situ* are found where the second R in O'Brien's Bridge is engraved on the map. Here are yellow grits that are slightly calcareous, and that dip S.S.E. at 20°. About a quarter of a-mile to the W. of this, and a little to the N. of where three roads meet, there are red conglomeritic calcareous sandstones lying unconformably on the Silurian rocks, and dipping S. at 20°. These rocks can be followed for about half a-mile to the west along where the boundary between these formations is marked on the map. They dip S. at about 20°. The rocks are found in the following ascending order at the road that runs nearly N. and S. between the first B and R in O'Brien's Bridge. Red conglomeritic grit, soft red sandstone, red grit and yellow flaggy grit, the latter in places being conglomeritic. They dip S. at 25°.

Similar rocks are found in numerous places on the hill that separates this



valley from Glennagross, some of the yellow beds are conglomeritic and calcareous; they all dip S.; at the top of the hill from 2° to 5°; and on the south slopes, at from 10° to 25°. In the stream that flows N. and S. at the W. of Cappateemore, above where the two streams join, a good section of the beds that lie immediately above the Upper Silurian rocks, are seen, and computed to be about the following thickness:—

*Section No.* 1.

| | | | | Ft. | In. |
|---|---|---|---|---|---|
| 6. | Red flaggy highly micaceous, sandy grits, on which are tracks like fucoids, | dipping S. at | 15, about | 15 | 0 |
| 5. | Red grits, | ,, | 15° ,, | 40 | 0 |
| 4. | Conglomeritic and flaggy yellow grits, | ,, | 20° ,, | 171 | 0 |
| 3. | Thin micaceous shaly red grits, | ,, | 15° ,, | 43 | 0 |
| 2. | Olive grits, | ,, | 15° ,, | 12 | 0 |
| 1. | Red Sandstones, | ,, | 15° ,, | 53 | 0 |
| | | | | 334 | 0 |

Near the north of Glennagross, in Troutstream, the lowest bed of the Old Red sandstone is seen, which in this place is a soft highly ferruginous yellowish flaggy sandstone.

On the hill to the W. of Glennagross and N.E. and N. of the rifle practice ground, rocks are seen in numerous places. They are principally yellow grits, that are either flaggy, conglomeritic or calcareous, with here and there a few red beds; the latter are generally sandy shales or clay rocks. At the sharp turn of the road, about two furlongs to the north of the encampment, there is a bed of yellow sandy clay rock lying under yellow flaggy grits, and above red sandy shale and clay rock. On the top of the ridge of the hill, near where the boundary is marked between the Upper Silurian and this formation, the beds are lying nearly horizontal; while on the south slope of the hill the strata dip to the S. generally at an angle of from 5° to 10°. At the place where the road crosses the stream that lies about half a-mile to the W. of the camp, there are pale yellow and whitish sandstones with green shale partings. Some of the grits have a spheroidal concretionary structure, while others are conglomeritic. They all dip to the S. at angles ranging from 10° to 25°. To the N. of this bridge, and immediately N. of the detached piece of Upper Silurians, are fine quartzose conglomeritic grits, which dip N.N.E. at 5°. To the north of these, near where the boundary of the bog is engraved, are yellow and greenish grits and shales that are lying nearly horizontal, but with a slight dip to the N. Between this and Gallows Hill and Ballintlea Lough the rocks are seen scattered over the ground in crags and escarpments. They are principally yellow flaggy and conglomeritic grits, and dip S. and S.S.W. at angles varying from 2° to 10°. To the north of Gallows Hill, lying unconformably on the Upper Silurian, are soft red sandstones and sandy shales. Similar rocks to those just described are seen to the N. and W. of Heathmount Lodge. At the N. they dip N.W. at about 15°, while at the west they generally dip W., at angles varying from 15° to 30°. A little to the N. of where the old castle stands there is a slight undulation, and the beds are seen to dip S. at 15°. To the N. of Heathmount Lodge, where marked on the map, there is a fault* which is a downthrow to the N. or an upthrow to the S. It runs nearly E. and W.

At Poulavara cross-roads, which lie about two miles to the W.S.W. of Gal-

* This is a most extensive fault, as it can be traced for more than twenty-four miles to the E.N.E (*see sheets of map, Nos.* 133 and 134). In some places the downthrow to the N. is rather considerable, bringing down the Lower Limestone shales, or the Lower Limestone, against the Silurian. It could not be traced to the W., through the limestone, although a little to the E. of Ballynacally, which lies near the N.E. corner of Sheet 142, the boundary between the Coal Measures and the limestone is suddenly deflected for more than three miles to the W.; and although a fault could not be proved in that place, it appears as if it was a fault, and the continuation of the "Gallows Hill fault" to the W.

lows Hill, at a new cutting for the road the beds are well exposed, being an alternation of grits and indurated marls, in which there are large lenticular cornstones. In the cutting, which is about 100 yards long, some of the beds seen at the south end die out, and other rocks take their places at the north. These beds dip to the W. at 10° under strong yellow grits.

A mile to the south of this, a section is seen in the railway cutting, of which the following are the measurements :—

*Section No. 2.*

| | Ft. | In. |
|---|---|---|
| 8. Yellow quartzose grit, | 6 | 0 |
| 7. Purple clay rock, top of bed, for about nine inches of a yellowish green, | 10 | 0 |
| 6. Purple grit, calcareous in parts, | 6 | 6 |
| 5. Purple sandy clay-rock, | 4 | 0 |
| 4. Purplish gray argillaceous grit, | 1 | 9 |
| 3. Yellowish gray sandy clay-rock, | 2 | 0 |
| 2. Grayish green grit, | 2 | 3 |
| 1. Light green grit, calcareous in places, over | 5 | 0 |
| | 37 | 6 |

A mile due west of Cratloe cross-roads, at the boundary of the alluvial flat, there is a very superior building-stone seen in an old quarry. It is a massive whitish yellow grit, and dips nearly W. at 5°. To the south of Cratloe cross-roads, in the railway cutting, are red sandy shales and yellow grits, which dip S.S.E. at 20°. A little to the E. of Cratloe cross-roads, where marked on the map, there is a N. and S. fault, which is a downthrow to the E. To the N. and N.W. of this place rocks are seen *in situ* in numerous crags and quarries; but as they are similar to the rocks already spoken of they do not require a special description. No rock is to be seen *in situ* on the slopes of the Old Red sandstone hills hereabouts, except at the W. of Cratloe woods; and therefore the boundary between the Old Red sandstone and the Lower Limestone shales has been drawn entirely by the physical features of the ground.

At the S. of the Shannon a small area of *Upper Old Red sandstone* is seen exposed along the shore of that river, extending for about three miles to the W. of the mouth of the River Maigue. At the point which lies nearly due S. of Way Rock are spotted yellow grits over red sandy shales, which lie above greenish yellow clay rock. These dip S., but at so low an angle as to be nearly horizontal. Similar rocks are found on all the small headlands from this to Mellon Point. A mile to the S.W. of Mellon Point, at a farm-house, there are coarse yellow grits exposed in two places. They dip nearly S.W. at 3°. Nearly S. of these, and at a short distance to the S. of the road, in a trial that was opened on a lode, there are yellow grits nearly horizontal. A mile to the W. of this, and a little to the N. of the Charter School-house, there are coarse yellow and calcareous grits that dip S.S.W. at 10°. Half way down the road to Ringmoylan Quay, at the old windmill, are thin bedded yellow grits and blue shales under calcareous grits nearly horizontal. In the shales are the remains of grass-like plants, and bivalve shells are found in the grits. A few perches to the W. of these, at the cabins, are yellow and gray grits and blue shales. One of these grits is conglomeritic and calcareous, and contains bivalve shells. They dip W.N.W. at 10°. To the N. of these, by the Shannon, are coarse yellow grits, which underlie a calcareous bed, in which bivalve shells were also found. They dip N.W. at 10°. To the S. and W. of Ringmoylan Wood are yellow grits, one bed of which contains a few bivalve shells. They dip S. at 3° and W. at 7°. There are no other localities in this area in which the rocks are exposed.

*Lower Limestone Shale.*—Very few rocks belonging to this formation are seen *in situ*, as generally the ground where they ought to appear is covered with deep drift. A good section, however, is seen of them at the W.S.W. of Ringmoylan Wood, S. of the Shannon, while to the N. of the Shannon a few



are seen in the road that runs N.W. from Heathmount lodge, which lies to the N. of Cratloe Wood.

On the W.S.W. of Ringmoylan Wood the lowest beds seen are yellow grits and black argillaceous limestone. They dip first S.S.W. at 10°, then S. at 3°. Over these are yellow calcareous grits, some of which are flaggy and are marked with numerous fucoid tracks. Over these are black shales, highly calcareous shales, and shaly argillaceous limestone, which dip S. at 10°, and are highly fossiliferous. Three miles to the E. of Ringmoylan Wood, and a little to the N.W. of Mellon House, the following section may be seen in a quarry :—

*Section No. 3.*

| | Ft. | In. |
|---|---|---|
| 6. Black shales, | 4 | 0 |
| 5. Yellow sandy shales, *on an average,* | 1 | 6 |
| 4. Black argillaceous limestone, | 3 | 6 |
| 3. Shales and thin grits, | 2 | 0 |
| 2. Blue argillaceous limestones, | 0 | 6 |
| 1. Black and gray shales, *over* | 4 | 0 |
| | 15 | 6 |

No. 2 is a mass of bivalve shells, "Modiola Macadami;" it weathers into a yellow-brown clay. No. 3 are calcareous to a greater or less degree. No. 4 is very fetid and seems to have shells in it. No. 5 is an irregular bed full of what seems to be the rootlets of plants; in some places it is only six inches thick, while in others it widens out to two feet. Part of it is affected by an oblique lamination when it can be split into flags. The upper portion contains more rootlets than the bottom of the bed, and in the part exposed in the quarry there are a few large calcareous nodules, which always occur in a thick part of the bed. In them are found the same shells as in bed No. 2. No. 6 is an ordinary black shale with calcareous nodules. The beds in this quarry dip S.S.W. at 10°.

North of the Shannon and half a-mile E. of Ballintlea Lodge, which is situated in the centre of the north side of the map, in a small stream, there were seen the following rocks, in ascending order:—thin green grit and blue shales, blue and black shales, blue shales and thin dark blue argillaceous limestones. These all dip N.W. at 15°. Due north of Carrigogunnel, on the north bank of the Shannon, to the W. of the N. and S. fault before-mentioned, are some shaly limestones and black shales, that dip S.E. at 30°. No other rocks belonging to this sub-group were exposed in the district now under examination.

*Lower Limestone.*—The lowest beds of this sub-group that are exposed are seen at the S. of the Shannon, at the S. and S.W. of the small area of Old Red sandstone before-mentioned. They shall be first described.

A little to the W. of Mellon House, which lies on the W. side of the mouth of the River Maigue, there are dark blue limestones, which dip nearly S. at 5°. Half a-mile to the S.W. of Mellon, where the road crosses the stream that flows between Cartown and Mountpleasant, are the same kind of rocks nearly horizontal, or with a slight inclination to the S. At the W. and S. of Cartown House similar limestones are seen; those at the W. dip S. at 5°, while the others are undulating, dipping S. at 10°, E. at 10°, and S.S.E. at 5°. These dark blue scaly limestones are exposed in various quarries and crags from this place to the west of the map, and roll over the country in gentle undulations; the angle of dip being about 10°. A good section of them may be seen along the coast line. Near the little lake, lying half a-mile to the N.W. of Ballystein R. C. Chapel, there was a mineral deposit of some kind in some shaly beds, which is now said to be worked out.

The shales and cherty layers which divide the dark blue shaly limestone from the overlying gray limestones are well exposed south of the Shannon,

and can be easily traced. On the western side of the district they are first seen a little to the E. of Hogan's bridge, which is situated about two miles to the N. of Askeaton, where they dip S. at about 5°; and about two miles nearly east of the same bridge, where the parish and barony boundaries join, they again appear undulating and dipping under the overlying gray beds at angles ranging from 5° to 15°. Six furlongs farther E., at a by-road, they are well exposed, dipping S. at 10°, and S.E. at 30°; while a mile to the east of the above, N.E. of the small alluvial flat, they dip S. at 20°. From here they can be traced to the eastward for nearly two miles, their outcrop appearing a little to the N. of the trigonometrical point, 131, along the east side of the road to Carriganea Castle, and N. of the rock on which the castle stands. They then disappear under the drift S. of Pallaskenry, but half a-mile further to the N.E. they again appear, being exposed at the S.S.W. of the R. C. Chapel. From that they run along the south side of the parish boundary to an old castle, then up to Rockfield House; and they are last seen two miles to the N.E. of Rockfield, and a little to the E. of Ballynacarriga House.

The space that lies between the outcrop of these cherty beds, the south and west borders of the map, and the alluvial flat along the River Maigue, is occupied by the upper gray beds, except where basins of the Upper Limestone come in over it. Rocks *in situ* are found in abundance everywhere, the beds undulating over the country for miles. They are generally of a gray or bluish gray colour, cut by two or three systems of joints, a coarse cleavage, and have sometimes a structure which has the appearance of oblique lamination. Red, purplish, or variegated beds are found in the following places:—At Clorhane, which is situated two and a-half miles to the N. of Adare; on the W. and N.W. of the old church, which lies a mile to the W. of Stonehall; at the by-road half a-mile due W. of the same church, and half a-mile to the S. of the last place, where the "vi" in Ballinvirick is engraved on the one-inch map; and in the railway cutting to the south of Askeaton, where the L in Deel is engraved. At the second place mentioned above the limestone is thin-bedded, and has red argillaceous shale partings between the beds.

Beds and dykes of Magnesian limestone are found in many places as marked on the map, a bed, which is nearly a dolomite, being generally found round the basins of Upper Limestone. There are mineral deposits found in these limestones to the N. and S.W. of Nantinan Church, which is situated in the S.W. corner of the map, and at Ballinvirick. They will be hereafter mentioned under the head of *Minerals*. The whole of the area just described abounds in fossils.

At the east of the River Maigue, and to the N.W. and W. of the *Carrigogunnel Trap district*, the Lower Limestone is also seen *in situ*. There are gray limestones that appear to be undulating, but in such a manner as to be nearly horizontal, to the N.E. and S. of Newtown Hall, at Carrigbeg Old House, and half a-mile to the S.E. of it adjoining the trap district. Bounding the trap on the W.N.W. there is a mass of dolomite, which is well seen a little to the N. of the police barracks. It is of an orange-gray colour, very saccharoidal in aspect, and highly crystalline, and is apparently destitute of fossils. It seems not to extend further than where it is marked on the map, and is the only mass of metamorphic limestone observed in the district. To the W. of the traps, and N.N.E. and S.E. of Carrigview House, limestones are seen, being of a gray or blue colour, and dipping E. or E.S.E. at angles ranging from 5° to 25°. At the road due N. of Carrigview House the limestones are nearly white.

Half a-mile to the S.E. of St. Patrickswell there is a dome of Lower Limestone appearing through the Upper Limestone.

Besides the areas now mentioned the Lower Limestone occupies a portion of the S.W. of the map. To the E.S.E. of Adare, and to the W. of the road



that runs south from St. Patrickswell, gray limestones appear in numerous quarries and crags. At the boundary of the Upper Limestone, due south of the E in Adare, there is a bed of magnesian limestone. To the E. of the road similar rocks are seen. A little further E., and at the S. of Shanaclogh House, cherty blue limestones are found dipping nearly W. at 15°. These beds are part of those cherty beds that have been described as dividing the Lower Limestone into two portions. To the E.N.E. of the beds just mentioned, and S. of the alluvial flat which lies to the W. of Rockview, there are dark blue, nearly black limestones, which may belong to the Upper Limestone, but have been allowed to remain in the Lower, as they might be part of the lower portion of that sub-group. They dip N. at 35°. To the S. of these, where the road leaves the map, there are limestones quarried, which are partly magnesian. In one place there is a thin vertical dike of dolomite which runs E. and W. At and to the N. of the old church that lies about a mile and a-half to the N.E. of Rockview there are gray limestones; those seen in the cutting for the road are magnesian more or less, and one bed seems to be a dolomite. At the old church that lies to the N.E. of Cloghane bridge, there are also beds that are slightly magnesian. A little to the east of this, where marked on the map, there is a tract of magnesian limestone, nearly a dolomite; a few fossils are found in it, but all traces of bedding are obliterated, and it is affected by one system of parallel joints which run N. 10° E. The joints are nearly vertical, with a slight underlie to the westward. Bounding this magnesian limestone on the E. are red, white, and yellow variegated limestones, which dip E. at 5°. This stone takes a good polish, and would make a handsome marble.

To the W. of Edwardstown House gray limestone appears in a cliff. To the W. of Glenview massive bluish gray limestone is quarried. It underlies the cherty limestones, the lowest beds of the Upper Limestone. To the W. of Ballynagarde House, under where the N in that name is engraved, there is gray slightly magnesian limestone under cherty limestone. To the E. and S.E. of Williamstown Castle there are gray limestones, which are all partially magnesian. In one place, about 500 yards to the S.S.E. of the castle, there are two nearly N. and S. dikes of dolomite, ten and twelve feet wide. Under the old castle that lies to the N. of Rockstown House are chert beds. The strata here are nearly horizontal, but with a slight dip to the S.

To the north of the Shannon, the Lower Limestone is found in the flat country round the Old Red sandstone hills. At the east, near the River Fergus, are gray limestones, which are partially magnesian. They seem to be nearly horizontal, but with a slight general dip to the W. or W.N.W. There are some red beds among these limestones; and one of these beds, which is situated about half a-mile to the E.N.E. of the trigonometrical point 70, has been quarried for marble.

From Stonehall to the Bunratty River, the Lower dark blue exfoliating Limestones are found rolling about in gentle undulations. To the N.E. of Stonehall, under the second O in Clonloghan, there are shaly cherty beds, which dip N.W. at 20°. To the W. of Knockaun House, the beds dip N.W. at 10°, and S.E. at 20°. To the south of the same place, they dip N. at 10° and S. at 30°. To the west and south of Firgrove House, they dip E. at angles varying from 5° to 15°. To the N. of Ballycunneen House, they roll in sharp and gentle curves, and dip every way. At Deerpark House they are dipping S. at 15°. At Rossmanagher, the beds run regularly and have a dip of about 3° to the N.W. To the S.S.W. of this, at Bunratty, the limestone has a general dip of 10° to the N.W.* To the E. of the Bunratty River, the limestone is cut by the N. and S. fault before

* In building part of the wall that bounds the road from Bunratty to Newmarket-on-Fergus, a flaggy ashy-looking limestone was used. It could not be discovered anywhere *in situ* in the neighbourhood.

spoken of. On the east of this fault, near the coach road, are dark blue shaly limestones, dipping S.S.W. at 10°. South of this, by the Shannon shore, are found gray limestones, brought down by the fault to the level of the Lower Limestone shales, with which they are found in juxtaposition. To the E. of this, between Cratloe Woods and the road, the gray limestone is seen in numerous crags and escarpments; there is no undeniable bedding to be seen, but it is much cut up with joints, and in places it is slightly magnesian. To the N. of the road, all along the boundary of the alluvial flat and Upper Limestone, for three miles, the gray limestone is exposed; it is always slightly magnesian, and often nearly a true dolomite. To the N.E. of this, N. and S. of Ballycannon House, there are gray limestones exposed; those to the S. are very fossiliferous. To the N.E. and E. of Castlebank House, there are gray magnesian limestones. At Newbridge, on the River Blackwater, yellowish gray magnesian limestones are exposed. In the N.E. corner of the map, under and to the S. of Cloonlara, there are gray, slightly magnesian, limestones.

$d^3$ *and* $d^4$. *Middle and Upper Limestone undistinguishable in this District.*—Three miles due S. of Askeaton, at the N. and W. of Nantinan Church, there is a basin of this sub-group. To the S. of Nantinan House are blue cherty limestones, that dip N.W. and W. at 45°; while, to the west of the same house, at the railway, are black and blue argillaceous fetid limestones. To the W. of Wellmount House are black and dark blue argillaceous fetid limestones, which undulate under the farmstead that lies half a-mile to the W. of the last mentioned house. The rest of the limestones dip N.W. at 30°, and N.N.E. at angles varying from 20° to 40°.

Two miles to the N.E. of Nantinan Church there is another basin, which is affected by three N. and S. faults. The most western of these is a downthrow to the E. The next met with, going E., is a downthrow to the W.; and the third is also a downthrow to the W. These three faults, taken in the aggregate, are one compound step fault. These could not be traced to the N. or S. (although they, most likely, are continued) on account of the nature of rock, it being all gray limestone, with no bedding seen. To the southward of this, there is a small basin of Upper Limestone, hereafter mentioned, through which one of these faults most likely runs. The rocks found in the basin that is now being described, are all partially magnesian, being sometimes nearly a pure dolomite. Here the cherty beds are very well developed, and are nearly always dolomitic. Under the "v" in Ballinvinick, there is a junction seen of the Upper and Lower Limestone, where the beds are found in the following order:—

*Section No. 3.*

4. Blue cherty limestone, with minute encrinite stems.
3. Magnesian limestone.
2. Red limestone, with shale partings.
1. Gray limestone.

A little to the north of Ballinvinick House, the junction of the limestones are also seen in two places, where the beds lie as follows:—

*Section No. 4.*

3. Blue cherty limestone.
2. Magnesian limestone.
1. Gray limestone.

To the southward of the basin just described, at the R. C. Chapel, there is another small basin, in which the limestone is also magnesian. Through the centre of it runs N.N.E. and S.S.W., a fault, which is a downthrow to the northward. This fault is likely to be the continuation of one of those in the



basin last described, as it lies in the direction which they would have taken if continued (*see map*).

The Upper Limestone is also found in the trough, of a compound synclinal curve, which extends from Cappagh, in the S.S.W. of the map, to Limerick, in the E.N.E.; its main axis running N.E. and S.W. Between Cappagh and Hollywood House, black and dark blue limestones are exposed in various places: at Cappagh Castle they dip E. at 40°; to the S. of Cappagh House they dip N.W.; while, to the E. of the same place, they are nearly horizontal. Where the Limerick and Foynes Railway enters the map on the S., the beds are dipping at 40° to the N.W., and at 35° to the N.N.W. To the N.E. and E. of Ballincurra Bridge, some of the limestones are cleaved; the strike of the cleavage running E. 15° N., and with a nearly vertical dip, or slightly inclined from the vertical towards the N.W. The beds dip W. at from 35° to 45°.

About 600 yards to the W. of Hollywood House, there is a small boss of Lower Limestone appearing through the cherty beds of the Upper Limestone, brought up by a curve with a quaquaversal dip; the cherty beds dipping N. at 15°, W. at 25°, and S. at 25°. To the N. of Hollywood House there is also a protrusion of the Lower Limestone, with cherty beds round it and a farmstead situated nearly in the centre of it. At the S. end of this oblong mass the following sequence of beds is seen:—

*Section 5.*

4. Black limestone.
3. Blue cherty limestone.
2. Magnesian limestone.
1. Gray limestone.

Three-quarters of a-mile to the N. of this, and due S. of Farm Lodge, the blue cherty beds are exposed. There are two hills of Lower Limestone about half a-mile each from Farm Lodge, one to the W.N.W., and the other to the S.W., coming up through the Middle Limestone, under similar circumstances to those just described. These islands of Lower Limestone prove that the Upper Limestone is very thin in this neighbourhood.

In the railway cutting to the south of Hollywood, are cleaved black limestones. Due S. of Hollywood the cleavage strikes nearly N.W. and S.E.; while, half a-mile to the E., it strikes E. 15° N., and hades northward at 85°. To the N. of this last place, where the D in Hollywood is engraved, there are good black limestones quarried, which dip E. at 30°. There are black and dark blue limestones exposed both E. and W. of Tuogh Bridge; those on the W. dip E. at 15°; while those on the E. are nearly horizontal. To the south of Tuogh Bridge, a sharp synclinal and a gentle anticlinal curve are exposed in the railway-cutting in black argillaceous cleaved limestones; the strike of the cleavage runs about E. 15° N., and hades northward at 80°. This cleaved limestone is also seen in the railway on the E. of the stream that flows from Tuogh Bridge. Between the last-named place and Curragh Bridge, there are black and dark blue limestones quarried and exposed in crags. In many places the limestones are cleaved, but they are all similar to those previously described.

Three and a-half miles to the north of Adare, near Cullum Castle, are blue cherty limestones, that, at the north of the Castle, dip E. at 10°; while, to the south of it, they dip E. at 40°, and N.W. at 20°. On the east side of the River Maigue the rocks are exposed in many places; they seem to roll in gentle undulations, dipping in nearly every direction, and generally at low angles, rarely exceeding 10° or 15°. At Carrigogunnel there are igneous rocks, which will hereafter be described. Some of the limestones over the igneous rocks are oolitic; and, in one place, where the C in Clarina is engraved on the map, there is massive gray unbedded limestone. A gray unbedded limestone

here is remarkable, as in the county of Limerick it is never found associated with the Upper Limestones, except in the igneous districts, and there it is not of frequent occurrence. *See Explanation of Sheets* 142, 144, *and* 154.

The limestones about Conigar House, which lies about two miles to the E. of Carrigogunnel, are cut up by two systems of nearly vertical parallel joints that strike N. 35° E., and N. 25° W. About half way between Adare and St. Patrickswell, a little to the N.W. of Ballycarrane House, the limestone dips S. at 45°. In this quarry it is so thin-bedded as to form good flags; and, on the surfaces of the beds, are a few large tracks (annelidan or molluscan) like those on the Coal Measure flags at Money Point. This is the only place in the limestone where they were remarked. To the S.E. of this, in the railway-cutting, are similar beds. Some of the black limestone exposed in the railway-cutting would take a polish, and could be used as marble.

Where the railway crosses the road at the E. of Patrickswell, there are thin black limestones, and reddish gray dolomites alternating; they dip N. at 25°. A mile and a-half to the S.E. of this there are igneous rocks seen, interstratified with the Upper Limestones. These rocks are again met with further to the eastward, near Kilpeacon Glebe, and continue from that through Cahernarry to the east of the district contained in this map. They will be described presently.

A little to the N.W. of Cahernarry, in two places, as marked on the map, there are magnesian limestones; they are of a dull blue colour. At the old castle that stands about a mile to the N.W. of Cahernarry Church, there is dark blue limestone, all shattered and broken up into angular fragments. Between the beds are partings of yellow clay and shales, from three to six inches thick. In the centre of one of these clay partings there is a black decomposed shale, two inches thick, that has all the appearance of a coal smut. The limestone seems to be magnesian.

A mile and a-half to the N.W. of this, and a little to the N. of Rathbone House, in a quarry of dark blue limestone, there is a bed of dolomite, five inches thick; a black shale, four inches, and two beds of yellow sandy decomposed shale (? trappean), being severally about three inches thick. A little to the east of this quarry, at the mail-coach road, there are thin-bedded dark blue limestones, with black shales. One of the latter, which is three inches thick, has the appearance of a coal smut.

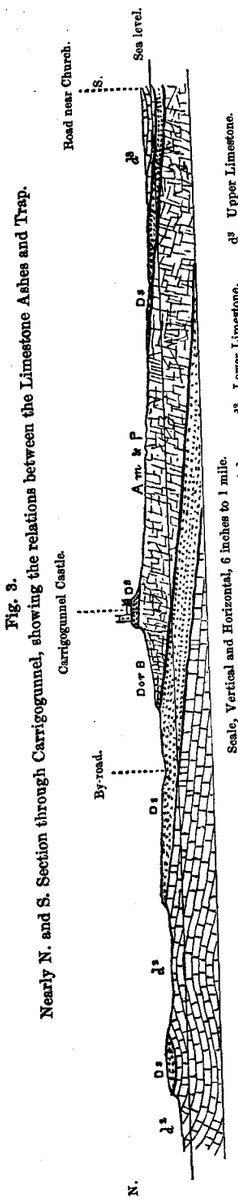
To the east of the town of Limerick there are also igneous rocks. Some of the limestones over them, as seen in the quarries in the western suburb of Limerick, are oolitic and magnesian. These rocks undulate at such a low angle as to be nearly horizontal.

To the north of the Shannon the Upper Limestone is also exposed in numerous places, and it seems to roll in low undulations over the tract occupied by it. Three miles to the N.W. of Limerick, at Meelick House, there are trappean ashes associated with the limestone. About 500 yards to the S.S.E. of the Union Workhouse, near the Shannon, there is a large quarry, in part of which the Messrs. Russell have now built a factory, out of which stones from 20 to 30 feet long can be taken: the beds dip S.W. at 15°. A little to the north of the Workhouse the limestones are slightly oolitic. To the S. of the Glebe House, that lies half a mile to the N.E. of the Workhouse, the limestone is affected by vertical N. and S. parallel joints. In the railway cutting half a mile to the N. of the Glebe House, there are dark blue limestones, in places nearly black, with shale partings from one to four inches thick, and layers of plastic yellow clay, from five to nine inches between the beds. In the limestones hereabouts there are geodes, the outer envelope of which is gray dolomite; incrusting the inside of the cavity is a frost-like white mineral (? bitter spar), and in the centre crystals of calcspar, quartz, or fluor spar. Two and a-half miles to the N.E. of Limerick, at Gilloge Lock, there is a limestone quarry in which three thin beds of trappean ash were observed; some of the limestone burns into a good



Fig. 3.

Nearly N. and S. Section through Carrigogunnel, showing the relations between the Limestone Ashes and Trap.




hydraulic lime, and was used extensively in building the new dock at Limerick*.

In the Upper Limestone, to the westward of this district, fossils are scarce, but on going eastward towards Limerick they become more plentiful, and in the neighbourhood of that place are locally abundant. In a few places a whole bed was observed to be made up of fossils, all broken shells, and single valves of one variety. Bivalve shells and corals are the usual fossils found in the Upper Limestone of the county of Limerick, but about Limerick many univalve shells were observed; Trilobites are also common in some localities.

Near the south-east corner of the map, there are two small basins of Upper Limestone, the cherty beds being exposed at the N. of the basin on which Ballynagarde House stands: and dark blue nearly black limestone, with shale partings between the beds, are seen half a-mile to the west of Ballynagarde House. In the basin that lies more than a mile to the west of the same place, black limestones are exposed in the stream that flows through the centre of it.

*Carrigogunnel Igneous District* is situated four and a-half miles to the W. of the town of Limerick, and is an irregular tract, extending about two and a-half miles long, with a general bearing of N. 15° E. The geological position of the trappean beds is at the junction of the Upper and Lower Limestones, and they consist of two compound beds of *trappean ash*, and an intervening bed of *trap*. Towards the north of the area there is no bed of trap, and therefore the ashes cannot be separated; while towards the S., the uppermost ash seems to have died out.

The lowest ash must have been ejected at two different periods with a long interval between them, if there were not more periods of ejection, as at about two furlongs to the E. of Carrigview,† the ash and limestone are interstratified, which could not have been the case if all the ash was ejected and deposited at the same time, and as it is a thick bed of limestone, at least twenty feet, there must have been a long period of rest between the ejections to allow time for the limestone to be deposited. The junction of the ash and limestone is also seen about a quarter of a mile to the N.N.W.

---

* Communicated by C. Bagnell, Esq., of Castleconnell.

† There are two Carrigviews; one to the S.W., and the other to the E. of Carrigogunnel; that which is at present referred to lies to the S.W. of the rock.

of the castle, where fine calcareous ash lies on the blue limestone. Half a mile due N. of the castle, there is a compound curve formed of an anticlinal and synclinal, at which place the ash and limestone are seen in juxtaposition. In the northern part of the igneous district, near the police barracks, the ash lies on a dolomite of an orange gray colour. The lower ash has either a red, purple, green, or purplish green base, and embedded in it are pebbles of white, gray, and blue limestone, which are often fossiliferous, and yellow, purple, and gray grits and slates. It varies from a fine porcelain looking ash to a coarse breccia or conglomerate, fine and coarse layers lying so close together that a hand specimen can be broken off, showing three or four different textures. A few encrinite stems were found in the base of this ash.* This ash is about 150 feet thick, *see fig. No.* 3.

Above the lower ash, as previously mentioned, lies the trap, which is usually very compact, but sometimes has vesicular or scoriaceous patches in it. It is generally of a dark blue colour, and becomes porphyritic and amygdaloidal at the top of the bed. The almond-shaped vesicles are now usually filled with calcspar. To the south of the castle, near the boundary of the upper ash, the trap is in angular fragments, that are now joined together by a calcareous cement; it has a very brecciated appearance, and might easily be mistaken for an ash.† This trap seems to be either a diorite or a basalt, but its composition cannot be determined by inspection, and no analysis has yet been made of it so far as is known to us. The bed is about 170 feet thick, *see fig.* 3. Under the castle it is nearly horizontal, or dipping at from 5° to 10° to S.S.E. To the S. and S.E. of the castle, a considerable quantity of the upper ash has been denuded away, exposing a large portion of the trap.

The upper ash is apparently a thin bed, about fifty feet thick, and seemingly it diminishes in thickness, and finally dies out, as it is followed to the S.S.W. From the Model Farm, which lies to the E. of the castle, down to the point where it disappears, it always has either a red or purplish base, and contains fragments of limestone, trap, amygdaloid, grits, and slates. It is generally a coarse ash, often a breccia or conglomerate. The castle is built on a detached portion of this ash, which was left, while the surrounding parts were carried away by denudation. On following this ash to the northwest of the Model School, where the bed of trap no longer separates the ashes, the colour of the base seems to change to a green or a purplish green. It is also not so regularly stratified, the bedding in places being undistinguishable.

There was only one actual junction of the ash and the overlying limestone seen, which is situated about a quarter of a mile to the N.N.E. of Meelick House (which lies about a mile and a quarter to the S.W. of Carrigogunnel), where the rock which rests upon the ash is a dark blue, nearly black argillaceous fetid limestone. A section of the limestone over that just mentioned was seen at the junction of three roads, a little to the N.N.E. of Meelick House:

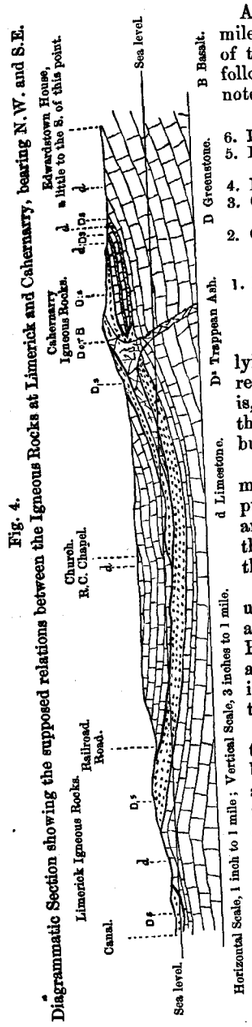
*Section No.* 6.

4. Dark blue argillaceous limestone.
3. Blue oolitic limestone.
2. Ferruginous oolitic slightly magnesian limestone.
1. Gray granular limestone, with minute pieces of trap embedded.

* Mr. Weaver, in a paper read before the Geological Society of London, mentions these rocks as fossiliferous (*see their* "*Transactions*" *A.D.* 1821, *vol. v. page* 117). This trap is also mentioned in papers read before the Geological Society, Dublin, by Drs. Apjohn and Scouler, and Messrs. Ainsworth and Hamilton. *See the Journal of Geological Society, Dublin, vol. i., pp.* 24, 112, 185, *and vol. iii., pp.* 52, 145.

† This peculiar form of trap was also remarked at Boughilbreaga (*see Explanation of Sheet* 144); but in that place it is at the bottom, while here it is at the top of a flow. I also remarked the same thing at the end of a dyke of felstone, in Bear Island, county Cork, *see Explanation of Sheets* 197 *and* 198. In Bear Island, the angular fragments did not seem to be cemented together.






Diagrammatic Section showing the supposed relations between the Igneous Rocks at Limerick and Cahernarry, bearing N.W. and S.E.

Fig. 4.

A little to the W. of Cooper Hill, which lies a mile to the N.E. of Carrigogunnel, where the tail of the p in Cooper is engraved on the map, the following section of the overlying limestones was noted :—

*Section No.* 7.

| | | Ft. | In. |
|---|---|---|---|
| 6. Dark blue limestone, thick bed, | *over* | 13 | 0 |
| 5. Dark blue limestone, with minute particles of trap, | | 3 | 0 |
| 4. Bluish gray limestone, | | 4 | 0 |
| 3. Gray oolitic limestone, with minute particles of trap, | | 2 | 9 |
| 2. Conglomerate of egg-shaped pieces of trap; the largest about the size of beans in a gray oolitic limestone base, | | 2 | 0 |
| 1. Dark blue argillaceous limestone, | *over* | 5 | 0 |
| | | 29 | 9 |

No. 1 in this section seems to be the limestone lying on the ash; but its base is not exposed. A remarkable fact in this and the preceding section is, that the pieces of trap are not found at all in the bed of limestone immediately above the ash, but in each case in higher beds.

The trap rock at Carrigogunnel is an excellent material for road metal, and if it was used for that purpose on the streets in the town of Limerick, and on the public roads in its neighbourhood, their condition would be greatly improved, and the repairs required much less frequent.

The Carrigogunnel ash appears to be continued under the Shannon and the alluvial flats which run along it, as to the north edge of them at Meelick House,* in county Clare, there is a bed of similar ash, which seems likely to be part of that which is so well seen at Carrigogunnel. It also contains fragments of encrinite stems.

To the S.E. of Carrigogunnel, and about a mile to the N. of Patrickswell, where the L in Pubblebrien is engraved on the map, trap and trappean ash were observed; and on the alluvial flat along the Barnakyle River there are large angular blocks of trappean ash, which seem not far removed from the parent rock. It was at first proposed to mark in a small trap district in this place; but the evidence was not considered conclusive enough, as none of the rocks are undeniably *in situ*, and they may have come from the trap district at Carrigogunnel, as they are exactly the same kind of rock.†

*The Limerick Igneous District* runs due east and west from the new railway terminus at Limerick to the eastern margin of the map, being three miles

* This Meelick House is not that which was previously mentioned, as that lies in the county of Limerick, while this is in the county of Clare, and about three and a-half miles to the N.W. of the city of Limerick.

† Since I examined this district I found in a paper read by Mr. Ainsworth, and before referred to, *see note, page* 23, that he speaks of trap rocks between Limerick and Patrickswell, and, I think, must refer to this place.

long, and of an average width of one mile. The geological position of the beds is not exactly determinable; but it seems likely to be nearly the same as that of the Cahernarry igneous rocks hereafter spoken of, which are known to have about 300 feet of the Upper Limestone underneath them. The Limerick trappean rocks are altogether ash, varying from porcelain-looking ash, through shales and grits, to coarse unbedded breccia and conglomerates. The ash is frequently calcareous, sometimes passing insensibly into limestone.

It consists of a series of beds of ash that were deposited at different periods, which is proved by the ashes near the termination of the mass being interstratified with beds of limestone. Its greatest thickness is supposed not to exceed sixty feet; but it extends over a large space, as it is horizontal to the E. of Limerick.

At and near the western termination of this ash, both the under and overlying limestones are seen. In the quarry that was opened at the new railway terminus the beds over it are exposed, and the following section was noted:—

*Section No.* 8.

| | | Ft. | In. |
|---|---|---|---|
| 5. | Very compact black limestone, | 3 | 0 |
| 4. | Chert bed, with encrinite stems, | 0 | 6 |
| 3. | Impure limestone, very cherty, and full of corals, | 1 | 0 |
| 2. | Rotten limestone, very ferruginous, | 0 | 6 |
| 1. | Green laminated ash, *over* | 13 | 0 |
| | | 18 | 0 |

There is limestone under the ash; but as the quarry was full of water when the section was examined the thickness of the ash could not be measured, or the beds under it specified.

A little to the S.E. of this, in the railway cutting to the W. of the bridge which crosses the railway at the old terminus, the following excellent section is exposed of the limestone under, over, and interstratified with the ashes:—

*Section No.* 9.

(In the railway cutting, and in the quarry at the S. of the Artillery barracks.

| | | Ft. | In. |
|---|---|---|---|
| 14. | Dark bluish gray limestone, with shaly partings, | 7 | 0 |
| 13. | Fine green calcareous ash, | 1 | 6 |
| 12. | Dark blue crystalline limestone, | 1 | 9 |
| 11. | Fine green calcareous ash, | 0 | 9 |
| 10. | Very compact fine ash, porcelain-like, | 0 | 3 |
| 9. | Highly ferruginous crystalline limestone, | 3 | 0 |
| 8. | Very fine ash, | 0 | 3 |
| 7. | Green flaggy ash, in fine and coarse layers, | 2 | 6 |
| 6. | Fine ash, | 0 | 6 |
| 5. | Dark blue limestone, ferruginous and magnesian, *about* | 8 | 0 |
| 4. | Shaly, ferruginous, dark blue limestone, | 2 | 0 |
| 3. | Bedded ash, made up of alternations of fine shaly flaggy and calcareous beds. One of the latter, seven inches thick, is nearly a pure limestone. All the rest, except one reddish purple shale three inches thick, are of a greenish colour, | 5 | 6 |
| 2. | Green brecciated ash, *over* | 25 | 0 |
| 1. | Dark blue limestone with layers of calcspar, to the bottom of quarry, | 10 | 0 |
| | | 68 | 0 |

Beds 1 and 2 are seen in the quarry to the south of the Artillery barracks, just beneath the spot where the word "jail" is engraved on the one-inch



map; the rest of the beds are seen at the back of the new goods' stores in the cutting.*

To the S. of the last section, at the other side of the railway, the overlying limestones are exposed, the lowest of them being flaggy; and the upper beds contain a few yellow clayey sandy beds, which may be decomposed trappean ashes.

To the E.S.E. of this, where the Ennis and Limerick Railway crosses the mail-coach road from Limerick to Tipperary, in the bottom of the cutting, are dark blue limestones under bluish calcareous ash. This limestone seems to be under all the ash; but it may be a bed contained in it. A mile to the N.N.W. of this, over the M in Limerick as engraved in the map, limestones and ashes are seen in a quarry, on the N. side of which the following beds were noted:—

*Section No.* 10.

| | | Ft. | In. |
|---|---|---|---|
| 7. | Green shaly ash, | | |
| 6. | Dark blue limestone, | 0 | 6 |
| 5. | Green shaly ash, | 0 | 6 |
| 4. | Dark blue ashy limestone, | 0 | 9 |
| 3. | Green shaly ash, | 0 | 7 |
| 2. | Dark blue limestone, | 0 | 5 |
| 1. | Ash, *over* | 2 | 8 |
| | | 2 | 0 |
| | | 7 | 5 |

At Willow Bank, which is built on the River Shannon, about two miles to the N.E. of the last section, very fine compact calcareous blue ash, with shaly layers, and interstratified with dark blue limestone, is exposed in the river bank, at the mouth of the mill-race. What seems to be the continuation of this ash is seen also on the north bank of the river.

A mile to the N. of Willow Bank, at Gilloge Lock, in a quarry there situated, and called the *Gilloge Lock quarry*, are three or four thin beds of ash, which seem to be connected with the Limerick igneous district; but their exact relations cannot be shown on account of the paucity of rock seen *in situ* in the intervening country.†

Nearly a mile to the S. of Willow Bank, on the road from Limerick to Nenagh, are purple and purplish green ashes. About 500 yards down the by-road that runs to the southward from the Nenagh road, are green and purple brecciated ashes, which dip S.E. at 10°. To the S.W. of this, at the trigonometrical point 182, are green brecciated ashes, which dip E. 15°, N. at 15°. To the N. of this, and at about 250 yards to the E. of Newcastle Cottage, are green ashes, fine and brecciated, in thick and thin beds, with shaly partings. To the N. of Newcastle Cottage, from the castle in ruins to Newcastle, green and purplish ashes, fine and brecciated, are exposed, the beds of which are seen to roll in gentle undulations. At the old castle they dip N.W. at 15°; on the road at the corner of the plantation at 10° to the E.; while at Newcastle they are dipping E.

To the W. of the alluvial flat, and at about 900 yards to the W. of Groody bridge, there are green brecciated ashes which dip S.W. at 3°. In the cutting for the Nenagh coach-road under the Ennis and Limerick Railway the ash is well exposed, having a green matrix, and containing blocks and frag-

* In the bottom of the quarry last mentioned large blocks of black limestone were formerly raised; they could be got of nearly any required size, and were worked for marble thirty years ago.—*Communicated by C. E. Baynell, Esq, on the authority of Cloha, an old quarryman.*

† They are supposed to be connected with the ashes at Limerick through the ashes to the N.N.E. of Annacotty. *See Explanation of Sheet* 144.

ments of limestone. The limestones are principally gray and blue, the former being most abundant. Some of the blocks are very large, more than twelve inches in diameter. No bedding is perceptible in the ash in this place. To the W.N.W. of this bridge, south of where the "h" in chapel is engraved, there is green ash that dips W. at 20°. In this ash are thick veins of iron pyrites, which are of a remarkable structure, as they have a *botryoidal* surface. Nearly S. of this, north of the first I in Limerick, as engraved on the map, are green flaggy ashes in fine and coarse layers, which lie nearly horizontal, but with a slight dip to the N. To the E. of the place just mentioned, at St. Patrick's holy well, are blue ashes, so calcareous as to be nearly a pure limestone. Due west of the Lunatic Asylum, in the cutting for the Ennis and Limerick Railway, there is thin flaggy ash, that dips S. at 2°. Similar beds to those last mentioned are seen in the same cutting near the Tipperary road. To the N.W. of these beds, and at the W. and E. of the waterworks tank, there are green and bluish calcareous ashes.

The trappean ashes may extend further to the S.W. than marked on the map, and also N.E. towards Corbally. On the S.W., though there is no rock *in situ* that gives evidence of its not extending, the boundary as drawn is likely to be in about the proper place, as there is a marked feature in the ground which it follows; but on the N.E., towards Corbally, there is no evidence of any kind, and it has been thought advisable to draw the boundary a little to the northwards of the last ash seen *in situ*. At the new railway terminus it is known to extend further to the N.E.; but its exact termination is unknown, as it goes under the town of Limerick, where no rock is seen *in situ*, and no information of the underlying rocks could be obtained.

*Kilpeacon, Roxborough, and Cahernarry Igneous District* lies about three miles to the S. of the town of Limerick. It runs nearly north from Kilpeacon Glebe to Roxborough, when it turns and goes due east to the margin of the map near Cahernarry, extending for a short distance into Sheet 144.

The geological position of the beds is about 300 feet above the base of the cherty beds that form the line of demarcation between the Upper and Lower Limestones.*

It consists of ashes and traps, the latter generally seeming intrusive; but no junction of these two kinds of rocks was found, and therefore their exact relation cannot be stated with certainty. The ashes are likely to be on the same horizon as the ashes near Limerick, and to be connected with them under the intervening limestone, as in a pump hole sunk by the side of the old road, a mile to the N.W. of Cahernarry church, the ash was found. The following was the account of the beds passed through as communicated by the proprietor of the ground :—

*Section No.* 11.

(Communicated by Proprietor.)

| | Ft. | In. |
|---|---|---|
| Gravel, | 15 | 0 |
| 2. Limestone, | 4 | 0 |
| 1. "*Greenstone*," green ash,† | 29 | 0 |
| | 48 | 0 |

* This is the thickness of the part of the Upper Limestone which lies under the ash, at about a mile to the E. of Cahernarry church. *See Explanation of Sheet* 144.

† In the sections local names are put in italics. The ashes and traps have numerous local names in this district, viz.: ashes—*greenstone, brownstone, greet, and copperstone*, the latter term being only used at Carrigogunnel; traps,—*brownstone, ironstone, and blackrock*.



Moreover, the Limerick ashes are seen to dip under the limestone towards the S., while the ashes that are now being described dip under it towards the north.

To the south of Cahernarry there are ashes interstratified with the underlying limestones: this is seen in the Carrigmartin quarry, which lies about a mile to the S. of the church, where the following section was noted :—

*Section* 12.

(Carrigmartin Quarry.)

| | Ft. | In. |
|---|---|---|
| 5. Massive green ash, containing fragments of limestone, traps, regularly laminated, but weathering into large globular blocks, &c., *over* | 30 | 0 |
| 4. Very fine green ash, porcelain-looking, | 0 | 9 |
| 3. Compact blue, in places purplish limestone, full of cavities, filled with red clay and sand, the clay horizontally stratified, | 8 | 0 |
| 2. Fine green brecciated ash, the top of the bed for about five inches being very fine and porcelain-like, | 4 | 3 |
| 1. Compact blue limestone to the bottom of the quarry, | 5 | 0 |
| | 48 | 0 |

The lower ashes were also proved in a pump-hole that was sunk at the side of the old road, at about six furlongs to the S. of the church.

*Section No.* 13.

(Given by the Proprietor.)

| | Ft. | In. |
|---|---|---|
| Drift, | | |
| 5. *Greenstone*, green ash, | 20 | 0 |
| 4. *Limestone*, compact purplish blue limestone, | 25 | 0 |
| 3. *Greenstone*, soft oolitic-looking green ash, | 8 | 0 |
| 2. *Limestone*, blue limestone, compact and very ferruginous, | 20 | 0 |
| 1. *Greenstone*, fine compact green ash, | 12 | 0 |
| | 15 | 0 |
| | 100 | 0 |

On the east side of the map, where the parish boundary runs into the alluvial flat, there is purple ash, which is nearly horizontal, but with a slight dip to the W.N.W. A little to the west of this, between the traps at Cahernarry, is green ash, which dips S.W. at 5°. About half a-mile to the S.W. of the church there is also some green ash. Immediately north of the trap there are red and purplish ashes in fine and coarse layers, which dip towards the trap at from 2° to 5°. Half a-mile to the N. of the church, near Tobersenan, are purple ashes, which dip N. at from 10° to 15°. A mile to the W. of the church, on the S.W., S., S.E., E., and N.E. of Drombanny Castle, are brecciated ashes, usually of a red or purplish colour. Although due south of the castle, near the trap, there is a thick green bed. These all dip N. and N.N.W. at from 5° to 10°. Under where the Y in Drombanny is engraved on the map is purple brecciated ash, which dips nearly E. at 15°. To the S. of the beds just mentioned, along the boundary of the trap, are ashes; those on the N. being purplish, the rest green. They seem to be horizontal. To the S.W. of the church, under the Y in Cahernarry, are purple ashes, that dip S.E. at 5°. A little to the S. of these are similar beds which dip N.W. at 3°. From these beds to the quarry before-mentioned, at Carrigmartin, the ash can be traced along the brow of the hill; the colour to the N. being purple, which afterwards gradually change through a purplish green into a green. At the R. C. Chapel, which lies about a mile and a-half to the S.W. of the church, there are green ashes, with a spheroidal concretionary structure. They dip N. at 5° To the N. of the chapel the ash that is in contact with the trap is altered in places nearly into a trap. It dips to the N.W. at 10°. To the N.W. of the chapel, between the trap and the alluvial flat, there are green

ashes, which are usually brecciated, and sometimes amygdaloidal. They undulate in gentle curves, dipping N. at 10°, W. at 10°, E. at 5°, S. at 10°, and N. at 3°. About two miles to the N.W. of these ashes, at Ballysheedy House, there are purple ashes in coarse and fine layers; they generally dip N. at about 5°. The ash is nowhere else seen where it can be said without doubt to be *in situ*: but angular blocks, which seem not far removed from their natural beds, are found scattered over the space marked as ash. The ashes that are found in this district contain fragments and pebbles of limestone, grit, slate, trap, amygdaloid, and ash, the limestone usually being the most abundant.

Associated with these ashes are five masses of trap: two at Cahernarry, one to the south of Drumbanny, one at Roxborough, and one at Kilpeacon Glebe. Those at Cahernarry are possibly parts of the same outburst with a mass of ash caught-up and dividing them, while those at Roxborough and Drombanny castle seem to be connected under the intervening alluvial flat.*

The trap at Cahernarry is of a dark green or bluish colour, with white and greenish crystals widely disseminated through the mass. The greenish crystals are felspar, while the white are usually calcspar, effervescing with acid. In the detached portion most of the trap is amygdaloidal. Amygdaloid is also found in the mass on which the church stands, and good porphyry was noted due east of Cahernarry House. In these porphyries and amygdaloids the crystallized mineral seemed to be calcspar. These traps seem to be either a compact diorite, or a basalt or dolerite; they generally effervesce slightly with acid, and always in the weathered portions, and along the joints. The trap just described appears to be intrusive, as the ashes are found dipping at it, away from it, and obliquely towards it; but its exact relations are undeterminable, as there is no natural or artificial exposure of the junction of the rocks.

The Drombanny trap is similar to that just described, but here the trap seems to be contemporaneous, lying on part of the ash, and under the rest. All the ash to the N. of the trap dips away from it, and is of a purple colour, except one green bed before-mentioned, while the ash to the south is all of a green colour, and seems to dip under it. The ashes to the east seem to be horizontal, and may be under or over it. From this it is seen that this may be a bed of trap between two ashes. If it is, it must die out, as it goes east.

At Roxborough the trap is similar, except in one quarry, which lies nearly due E. of the house, near the road. In this quarry the trap has a most peculiar aspect, being full of crystals and amygdaloidal kernels of white, red, and green minerals, imbedded in a greenish blue base. In the heart of the rock there does not seem to be any of the white minerals, which are only found in the weathered parts, and seem to be the red decomposed. Some of the red kernels in the amygdaloid have an agate-like structure. This rock may be an altered ash, as in places it has a very ashy appearance, and is like the altered ash to the N. of the R. C. chapel at Cahernarry, see page 31.

At Kilpeacon Glebe the trap is well seen at the old church and in the fields to the E. of it. Much of it is amygdaloidal, but the trap seems to be similar to that before described.

To the S.W. of Kilpeacon Glebe, and about a mile and a-half to the S.S.E. of St. Patrickswell, near Jockey Hall, there is a small hill, on the top of which there was an old quarry that is now filled up, but in which an ash was worked. It is very compact, flaggy, and calcareous, of a green colour, and in places highly fossiliferous.

* The traps at Roxborough and Kilpeacon may be connected; but there is no evidence seen to support that supposition.



Besides the igneous rocks described there are some found at the S.E. corner of the map, which will be described in the Explanation of Sheet 144.*

### 6. *Drift and other Superficial coverings.*

*Drift.*—On the north-west of Pallaskenry the drift consists principally of sand and gravel, and lies in ridges that have generally a north and south bearing. The gravel is composed of about equal portions of limestone and sandstone debris, with occasional fragments of syenite; and the sand is often a quartzose "Rabbit Sand."† The rest of the country that lies between the River Maigue and the western margin of the map is partially covered with drift which is generally local and has seldom accumulated to any considerable depth; but all over this space fragments of syenite are often seen. These syenite fragments range from the size of an apple to a foot in diameter, a few being two feet, and are always egg-shaped, as if they had been rolled for a long period by water. They are chiefly of the same kind as the Galway syenite, having large pink crystals of felspar in them. From the Maigue to the eastern border of the map it is principally a drift country. The drift is generally limestone gravel mixed with clay, with here and there small deposits of sand and gravel. In some places it is of considerable depth.

On the north of the River Shannon and to the west of the Bunratty river there is usually only a thin coating of local drift, except in the drift hills which rise from the alluvial flat. East of the Bunratty river and on the N.W. flank of the Cratloe Hills there is deep limestone drift, while on the south flank it is nearly all Old Red debris, which is sometimes of very great depth, especially at the south end of Glennagross. To the south of Cratloe Wood and to the west by Burton House towards Cappateemore the drift is often a fine quartzose "Rabbit Sand." In some places limestone drift is found under the sandstone drift; this was remarked in the Cratloe river to the S.W. of Woodcock Hill House, where the sandstone drift is over fifty feet in thickness; also below and above Cappateemore bridge in the Crompaun river, and in some of the cuttings for the Limerick and Ennis Railway.

*Shell Marl* is found in some of the flats, and is generally covered with a coating of peat, which varies in thickness from four inches to four or five feet. The shells it contains are all of the same species as those that are alive in the lakes and morasses of the county of Limerick at the present day.

*Bog.*—On the hills to the N.E. of the map there are patches of mountain bog.‡

To the S.W. of Ballynagarde there is a good bog of rather wide extent. There are other patches on the low land to the south of the Shannon, which are usually shallow or unprofitable in consequence of a want of drainage.

In the bog to the W. of Curragh bridge, which lies to the N. of Adare, skulls and horns of the Megaceros Hibernicus were found. *Communicated by the Rev. Mr. Beere, of Limerick.* Some of them are now preserved in Adare Manor.

*Alluvium.*—Along the River Shannon and its tributaries there are extensive alluvial flats, beneath which is a calcareous mud, with here and there

* A little to the south of Kilpeacon cross-roads, and from that down to the east at Rockview, there are large angular blocks of ashes scattered about, which may be near their original site. At first it was proposed to put in an igneous district hereabout on the strength of them, but afterwards it was considered advisable not to do so, as they may only be erratic blocks; although at one place a little to the E. of Rockview, the rocks exposed in a new drain have the appearance of being *in situ*, but too little of them were exposed to be able to come to a conclusion about them.

† So called apparently from its being loose enough for rabbits to burrow in it.

‡ None of the mountain bogs unless when geologically important, were marked on the one-inch map, as they would have obliterated the geology of the district.

thin layers of peat. Besides these there are detached flats scattered over the district which generally surround lakes and morasses, with a mud, more or less calcareous, over which is a coating of peat. In all these flats the roots of trees are found, and sometimes the bones of animals. In the flat to the north of the Shannon, in the county Limerick, where marked on the map, skeletons of Megaceros, male and female, were found at about ten feet deep in the marl In places in these flats there is a sort of brick clay which generally runs in veins. None of it is very good, being all more or less impregnated with calcareous matter, and therefore the clay burns into cellular and blotched bricks.

### 7. *Minerals.*

Five minerals were observed in this district, viz.: *Iron pyrites, Copper pyrites, Argentiferous galena, Blende, and Red Hematite.* These minerals, with the exception of the latter, are generally associated together in the limestone.*

The description Dana gives (*see Manual of Mineralogy, by James D. Dana, A.M., page* 261) of the lead mines in the United States would do well for those in the county of Limerick.

"They abound in what has been called 'Cliff Limestone.' . . . Argillaceous iron, iron pyrites, calamine, blende, carbonate, and sulphate of lead are the most common associated minerals, together often with ores of copper and cobalt. . . . The principal indications in the eyes of miners, as stated by Mr. Owen, are the following:—fragments of calcspar in the soil, unless when very abundant, which then indicated that the vein is wholly calcareous or nearly so; the red colour of the soil on the surface, arising from the ferruginous clay in which the lead is often imbedded; fragments of lead ('gravel mineral'), along with the crumbling magnesian limestone and dendritic specks distributed over the rocks."

In the county of Limerick no cobalt ore is recorded, but all the other ores have been met with associated together. The carbonates of lead and zinc seem to be due to chemical decomposition, the sulphates having decomposed, and the metals having taken up some of the carbonic acid from the adjacent limestone, and formed the carbonates. Calamine is generally found associated with the *gaussen* (peroxide of iron; decomposed iron pyrites.) In the county of Limerick the ore is generally in pockets and not regular lodes, and none of it seems to run very deep.

*Pallaskenry Mine.*—A mile nearly north of Pallaskenry, a little above where the first A in Ardcanny is engraved on the map, in the Upper Old Red sandstone there is a lode, in which were seen indications of copper with a trace of lead. In the townland of Ballydoole there was a recent sinking on the lode, but at the time it was visited, *September*, 1856, it was filled up; the pieces of *gangue* (quartz) scattered about had a good appearance. The mineral seems to be principally the gray and purple copper ore. A little to the N.W. of this trial at the Old Charter School-house, in sinking a pump hole, they came on the workings of an old mine, that had previously been unknown, which was said to have contained copper.

*Ballysteen Mine.*—In the townland of Ballycanauna, which lies about three and a-half miles nearly due north of Askeaton, a mineral vein was formerly worked; it contained argentiferous galena, blende, sulphate of copper, and

* A remarkable fact that I have observed about all these minerals that are found in the limestone is, that they are on two geological horizons; the highest being a little below the cherty beds that are taken as the base of the *Upper Limestone*, and the lowest, a little above the top of the *Old Red sandstone* formation. These rules are carried out in all the mines that I know of in the counties of Clare, Limerick, and Tipperary. Another rule which generally, but not always, stands good is, that lodes on the lower horizon generally have lead in them as deep as the limestone and shales go, changing to copper when the sandstones are met with.



sulphate of iron. The lode is said to have run nearly E. and W., and in Ballycanauna to have swelled out into a rich pocket. It is now worked out, and all the shafts closed. At the W. of Ballysteen House, there is a *dead lode*, made up entirely of calcspar, which seems to be the continuation of the lode that was worked. In this place it was driven on, but abandoned, as it was found to contain no metallic *minerals.*

*Graigues Lough Lodes.*—Two miles to the S.E. of Askeaton, S.W. of Graigues Lough, there is a lode running nearly E. and W. which contains the sulphates of lead, zinc, and iron (galena, blende, and iron pyrites) with a trace of copper. This locality was pointed out to us, by the Rev. H. H. Jones, of Adare, who was informed by the tenant occupying the land, that there is a parallel lode a little to the N. of the one marked on the map. On the most southern of these lodes, a small trial shaft was sunk, which proved the existence of the above mentioned ores.

*Nantinan Lodes.*—About three and a half miles to the S. of Askeaton, in the townland of Ardgoul South, which lies to the S.W. of Nantinan Church, a lode of argentiferous galena was discovered in the cutting for the Limerick and Foynes Railway. A specimen of the ore was sent for analysis to the Mining Company of Ireland, by George Leach, Esq., of the Abbey, Rathkeale, and was found to contain 40 oz. of silver to the ton of lead, the lead ore giving 90 per cent of the pure metal. We are indebted to Mr. Leach for the above, as he kindly gave us a copy of the return furnished to him. To the north of the lode just mentioned, two veins of calcspar were opened in the same cutting, one in the townland of Freagh, which had a trace of lead and copper in it, and the other in the townland of Boolaglass, which had a trace of lead. This last mentioned lode does not give any promise of ever yielding any mineral, as the *gangue* is too compact and pure.

*Ballinvirick Mine.*—Three miles to the E. of Nantinan, lies Ballinvirick House. To the S.W. of it, a lead mine was formerly worked, but when visited, all traces of the old workings were obliterated, and none of the inhabitants could tell the exact place where the lode is, but tradition says the shaft was about 500 yards to the N.W. of the cross-roads. In this place a calcspar lode was observed, which seems to have been driven on, and may be part of lead lode.

*Iron Pyrites*, besides the places mentioned, was observed in some of the trappean rocks. Half a mile nearly W. of the Limerick Post Office, at the junction of the townlands of Park and Singland, in green ash, there are two veins of this ore: they are of little or no commercial value, as the stone they are in is of too hard a nature; but they are peculiar on account of the way the ore makes, the surface of the vein that is exposed being *botryoidal.*

*Red Hematite* is found in very small veins in some of the Lower Silurian rocks. It does not seem to be of any value.

NOTE.—A piece of galena, about the size of a man's fist, was found in a field a little to the east of Heathmount Lodge; but whether it was in the drift or the surface soil I could not ascertain. It is mentioned as it might point to a mineral deposit somewhere in that vicinity.

## GLOSSARY OF LOCAL NAMES USED IN THIS DISTRICT.

*Black Rock*—[illegible]
*Brown stone*—[illegible] sandstone.
*Copper stone*—The green [illegible]
*Crag*—When the rock [illegible]
*Flint*—Chert.
*Grandt*—Yellow quartz [illegible] grit.
*Greenstone*—Green sand.
*Greet*—Ash.
*Ironstone*—[illegible]
*Melt*—Applied to a shale when it [illegible]
*Minerals*—The ores of [illegible] in use.
*Pencil of P*[illegible]
*Rabbit S*[illegible]
*Red Pen*[illegible]
*Running L*[illegible]
*Rusty Limestone*—[illegible]
[illegible]—Shale that can be w[illegible] and shovel.
[illegible]—Shale; in this district only used in speaking of the Silurian shales.
*Spar*—Quartz or calcspar.

G. H. K.

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