Memoirs of the Geological Survey.

EXPLANATIONS

TO ACCOMPANY

SHEET 133 OF THE MAP,

OF THE

GEOLOGICAL SURVEY OF IRELAND,

ILLUSTRATING A PORTION OF THE

COUNTY OF CLARE.

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

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

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

Condensed memoirs on particular districts will also eventually appear.

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

In referring to the sheets of the six-inch map, they are commonly supposed to be divided into quarters, 1 being the N.W., 2 the N.E., 3 the S.W., and 4 the S.E. quarters: so that $\frac{25}{3}$ means the S.W. quarter of sheet 25 of any county.

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EXPLANATION

TO

ACCOMPANY SHEET 133 OF THE MAPS

OF THE

GEOLOGICAL SURVEY OF IRELAND.

[The western half of the district comprised in this Sheet of the Map was surveyed by Mr. Foot; the eastern half by Mr. Kinahan. They have jointly drawn up this Explanation, Mr. Baily furnishing the Palæontological Notes.—J. B. J.]

General Description.

The district included within the limits of this Sheet of the map is a portion of the county of Clare, in which are situated part of the town of Ennis, and the small towns or villages of Tulla, Newmarket-on-Fergus, Sixmilebridge, Clare, Quin, Kilkishen, and Broadford.

1. *Form of the Ground.*

A line drawn from Sixmilebridge to Bodyke divides the district into two parts—a high mountainous district called Slieve Bernagh on the east, and a low, comparatively flat country to the west. The Slieve Bernagh* range, which runs eastward from Sixmilebridge to the valley of the Shannon, on the N. of Killaloe, forms the principal feature of the district, the remaining portion, to the north and west, being low and broken ground, the highest undulations of which only strike the eye when in their immediate vicinity.

The loftiest peaks of the Slieve Bernagh range are situated in the district to the east of that which is now being described, Cragnamurragh (1729 feet) being nearly at the junction of the two. That part of the Slieve Bernagh Hills which comes within the limit of Sheet 133, is divided by a remarkable valley called Glenomra, which, beginning at Bridgetown, in Sheet 134, runs by Ballyquin House and Broadford down to Doon Lough, its entire length being about eight miles. The slopes of the hills towards this valley are peculiarly steep, especially those on the southward, to the S.W. of Kilbane, where the ground rises, in less than half a mile, from 140 to 798 feet.

To the southward of Glenomra the hills, which are sometimes called the Broadford Mountains, have, on their southern faces long gradual slopes, while on the north they are very steep. Their highest peaks are Knocksnaghta (1,018 feet), Knocksise (851 feet), and Knockaphunta (843 feet).

On the north of Glenomra the hills rise suddenly, as before remarked,

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* This name is taken from the Railway Commissioners' map, which Sir R. Griffith has taken as the basis of his Geological Map of Ireland.

from the glen, while towards the north, the slopes, although still steep in a few places, are generally gradual.

The country to the W. and N. of the Slieve Bernagh Hills, although low, is not without variety, as it is broken by low hills and studded over with lakes and bogs. It has a mean elevation of about 150 feet; its highest point being to the N.W. of Tulla, and attaining to upwards of 300 feet, while its S.W. corner is at the level of the sea.

The western side is drained by the river Fergus and its tributary, the Rine or Ardsollus river. The Fergus enters the map at its western edge, at the town of Ennis, being tidal up to that point, and leaves it at its S.W. corner. The Rine rises in Sealmagoron, one of the hills north of this district, and enters the part included in this Sheet north of Kiltannon House, at an elevation of about 350 feet above the sea. It flows thence under the names respectively of the Toomeen and Boolyree rivers, by Quin, and falls into the Fergus, three miles S. of the village of Clare.

Nearly the whole of the eastern part is drained by a number of small rivers that flow into Doon Lough, the principal of them being the Ballymacdonnell river, which rises on Crag and Cragnamurragh, in the district to the east. From the south end of Doon Lough flows the Owengarney, which, after passing through Castlelake and by Sixmilebridge, leaves the map at its southern edge, at a height of twenty-two feet above the sea level.

A small portion at the N.E. is drained by tributaries of the Scariff river, which empties itself into Lough Derg (in Sheet 125), while the S.E. part discharges its drainage through the headwaters of the Blackwater River that flows into the Shannon, a little to the eastward of Limerick (*in Sheet* 143).

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2. *Geological Formations or Groups of Rocks.*

Aqueous Rocks.

	Name.	Colour on Map.
	Bog, Alluvium, &c.,	*Pale sepia.*
	Drift,	*Engraved dots.*
Carboniferous.	d⁴. Upper Limestone,	*Prussian blue (dark).*
	d³. Middle Limestone,	
	d². Lower Limestone,	*Prussian blue (light).*
	d¹. Lower Limestone Shale,	*Prussian blue and Indian ink.*
Old Red.	c. Old Red Sandstone,	*Indian red (dark).*
Lower Silurian.	b. Grits and Slates,	*Purple.*

Igneous Rocks.

None.*

* No rocks of an igneous origin were found *in situ* in this district, but in the lower or stratified part of the Lower Limestone, to the W. of Knocksnaghta, there may be a bed of *trappean ash*, as angular blocks, that seem not far removed from their native beds, were observed in various places between Belvoir House and Doon Lough. The nature of the country, which is either covered with drift or bog, prevents the bed, if it exists, from being seen.

b. *Lower Silurian.*—This formation consists of variously coloured grits and slates, with some fine conglomerates and olive and red clay rocks. On the S.W. of Knocksnaghta black, olive, and red grits and shales are exposed, in which there is rarely any cleavage. On the S. of Knocksnaghta hard purple grits abound, which are usually thin-bedded and imperfectly cleaved. Between the beds there are shale partings. The rest of the Lower Silurian consists of grits and slates; the latter are often arenaceous to such an extent as to make them unfit for roofing slates; they are also affected with numerous joints.

Fossils are locally abundant, except in the cleaved rocks where the cleavage has obliterated all the traces of organic remains.

Fossils were found in the following localities—

In the stream that divides Crag and Belvoir (*Sheet* $\frac{4,5}{4}$), *graptolites*, &c.

In the stream that bounds Ballyvorgal South (*Sheet* $\frac{4,5}{4}$) on the S.E., *trilobites*, *bivalve shells*, &c.

In the townland of Ballykelly (*Sheet* $\frac{4,5}{4}$), *graptolites*.

By the side of the road from Limerick to Kilkishen (Sheet 52), and a little W. of Trough Cottage (Sheet 53).

c. *Old Red Sandstone.*—The Old Red sandstone in this district is all supposed to belong to the upper division or *Upper Old Red sandstone*. It consists of yellow and red grits, sandstones, and flags, and red, green, and greenish shales and clay rocks. The flags are usually of a red colour, and were formerly extensively worked. Between the yellow grits and sandstone beds, greenish, sandy, and micaceous shale partings are often found. In this district the Old Red sandstone is rarely if ever cleaved, and is supposed to be about 1,300 feet in thickness.*

Fragments of *fossil plants* were found in this rock at Anamullaghaun river, in the townland of Caherhurly (*Sheet* $\frac{2,3}{4}$), and bivalve shells were got in the grits at the top of it, in the small outlying exposure of it, two miles S.E. of Newmarket.

d^1. *Lower Limestone Shale* consists of yellow thin-bedded grits and clay rocks, black and blue shales and grits, and shaly, arenaceous, fetid, dark blue exfoliating limestones. The yellow grits are only found among the lower beds. Between this division and the lower part of the Lower Limestone there is no natural boundary, as there are shales and shaly limestones in both, from which it appears that the boundary marked on the map must be in a great measure arbitrary.

The rocks considered to belong to this division are about 140 feet thick.† Fossils abound in some of the beds. In the Anamullaghaun River, townland of Caherhurly (*Sheet* $\frac{2,3}{4}$), *bivalve shells and corals* are in great abundance, with a few *univalve shells*, *trilobites* (?) &c.; fragments of *plants* were also found in the shale partings in the lower part of this group.

In the Gourna River, a mile E. of Sixmilebridge (*Sheet* $\frac{5,2}{1}$), similar fossils to those just mentioned were collected.

d^2. *Lower Limestone.*—As in the country to the south (Sheets 143,

* Calculated from a section at the N.E. of the district.

† This thickness is calculated from a section that is exposed in the Anamullaghaun River, to the N.E. of the map.

144, 153, and 154) this division of the Carboniferous formation is capable of a twofold subdivision, by its containing a band, about forty feet thick, of thin limestones, full of layers and nodules of chert. Below these cherty beds the limestones are of a dark blue, sometimes nearly black colour, emit a fetid odour when freshly broken, and are inclined to exfoliate when weathered. Occasionally the mass of the rock is traversed in every direction by veins of indurated clay, of a red, black or blue colour, and nearly always shale partings occur between the beds, the stratification of which is clearly defined. Above the cherty beds the limestones are of a gray or light blue colour, and in certain localities assume the character of red or pink marble.

They are usually more or less magnesian (m d), and near the top of this division of the limestone they occasionally become good dolomites ($\mu\,\delta$) of a yellowish gray or whitish colour, and are then destitute of fossils. In this upper portion (viz., above the cherty beds), bedding is rarely if ever seen.

The Lower Limestone in this district seems to be much thicker than to the S. in the county of Limerick, as it is at least 1,600 feet thick, the lower stratified part being about 600 feet.* In the upper part of the Lower Limestone fossils abound, while in the lower part they are comparatively rare.†

The following are the principal places in which fossils were remarked:—

Lower Limestone.—In the townlands of Cragroe, Craggaunkeel, and Fortanemore, Sheet $\frac{2}{7}$—Bivalve and univalve shells, corals, and encrinites.

In the townlands of Annagh, Ross, and Clonmoher, $\frac{2}{8}$—Bivalve and univalve shells, corals, and encrinites.

In the townlands of Garruragh, Fortanebeg, and Clogher, $\frac{3}{5}$, and Ahardaun and Fox and Geese, $\frac{3}{6}$—Univalve and bivalve shells, corals, &c.

In the townlands of Killanena, Killeen, and Lakyle, $\frac{4}{5}$, and Enagh East, ditto.

d^3 and d^4. *Middle and Upper Limestone.—As no line of demarcation can here be drawn between these divisions of the Carboniferous formation, they will be described together.*

They are separated from the Lower Limestone by some thin dark gray beds, having bands and nodules of chert, and varying in thickness from ten to fifty feet.

They consist of dark blue and black limestones, more or less argillaceous, often fetid when freshly broken with the hammer, and generally having shale or clay partings between the beds.

Some beds have an oolitic structure, while others are dolomites of an orange or yellowish gray colour, and very saccharoidal texture; fossils are locally abundant. The thickness of as much of the Upper and Middle Limestone as is seen on this Sheet, is probably about 1,500 feet.

* The thickness of the upper part is calculated from a section that is exposed about a mile to the S.E. of Kilkishen, near Killeen House, while the lower part from a section at the S.W. of Castlelake, two miles N. of Sixmilebridge.

† A fish-tooth was found in some dark blue limestone, at a limekiln near Sixmilebridge. The stone must have been quarried somewhere in that vicinity.

3. *Relations between the Form of the Ground and its Internal Structure.*

All the low country in this district consists of rocks belonging to the Carboniferous formation, which are either limestones or shales, while the high ground is formed of grits, slates, and shales, of the Silurian and Old Red sandstone formations. (See Section, Fig. 1.)

The fact of the latter or older rocks occupying a higher elevation than the former and more recent ones, is due to the elevating forces having acted with greater intensity at the eastern than at the western side of the district; but as there can be little doubt that at one period the limestone covered the older rocks, they would not now be exposed to our view were it not for the forces of denudation, viz., the action of the waves and breakers, which eat away the limestone while the beds were being elevated above the sea. To the east the Old Red sandstone, also yielding to the denuding action, was removed by it, and thus the Silurian rocks were laid bare.

The general subterranean relations of the rocks will be seen by reference to the section, fig. 12, p. 21, and also to those given in Sheet 9 of the engraved sections, on the scale of six inches to the mile.

G. H. K. and F. J. F.

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4. *Palæontological Notes on the Silurian and Old Red Sandstone Fossils, collected within the area included in Sheets* 133, 134, 135, 143, 144, *and* 145.*

The Silurian fossils obtained from the district comprised within these Sheets, were collected at sixty-nine localities, and consisted of more than 1,000 specimens.

Only one locality within this area can, with certainty, be referred to the Upper Silurian division; it is that numbered *55* in the townland of Ballycar, South, in the Cratloe Hills, about four miles N. of Limerick, the fossils from which have already been noticed in the Explanation to Sheet 143, pp. 10 to 12, as indicating beds of Upper Llandovery age.†

The fossils from all the remaining localities are believed to belong to the Lower Silurian division: three of these localities deserve special notice, as differing in lithological character and fossil contents from any of the others.

The first of these is locality 7, in the townland of Kilmoculla, distant about a quarter of a mile north of the Upper Silurian locality of Ballycar, South; but in Sheet 133 the rocks there exposed in an old road-cutting consist of greenish gray shales, and contain a number of Trilobite remains, all, however, belonging to one species, *Phacops conopthalmus*, a Crustacean peculiar to the Caradoc or Bala beds. Specimens in good preservation were collected, consisting of detached heads, showing the prominent eyes with their numerous lenses, and tails terminating in a point like that figured by Angelin,‡ a peculiarity alluded to by Mr. Salter in his account of this species.§

* Palæontological notes were inserted in the published Explanations to Sheets 135, 143, and 145; a large collection of fossils having, however, since been made by Mr. C. Galvan from many other localities on those Sheets, they are now included in these general remarks upon the whole series.

† An additional series of fossils since obtained at this place by Mr. Galvan, has added two species to the list there given, viz., *Stenopora fibrosa* and *Illænus Bowmanni*.

‡ Palæontologia Scandinavica (1852), pl. 7, figs. 5, 6.

§ Memoirs of the Geological Survey of the United Kingdom. Decade 7, first article, p. 11.

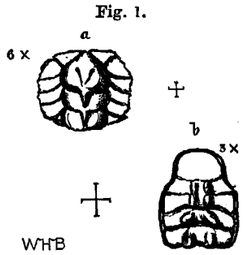
The associated fossils were a small turbinated coral, *Petraia elongata*, small bivalves—probably a new species of *Ctenodonta*, and two species of *Orthoceras*, doubtfully referred to *O. Brongniartii* and *O. subundulatum*.

The next locality deserving special notice is No. 1, on the same sheet, situated in the townland of Ballyvorgal, South, at the western extremity of the Slieve Bernagh mountains, where, from a very small exposure of soft brown ochrey shales in a stream, some peculiarly interesting fossils were obtained. They consisted mostly of small Trilobites, principally *Æglina*, a genus remarkable for the large size of its eyes, the majority of the specimens collected appearing to be identical with *Æglina rediviva*, Barrande;* the *glabella*, or central part of the head, is shorter than in *Æ. mirabilis*, the species found at Portraine, being broader than long, the eyes, showing their numerous lenses, are beautifully preserved; the tail (*pygidium*) is precisely like that figured by Barrande of this species: no body or thoracic segments have been observed.

Associated with it was another small Trilobite of which two or three specimens only were collected, one being the entire head, having two of the thoracic segments attached; this I have referred to *Dindymene Haidingeri*, Barrande,† a species with which it appears to agree in every particular, so far as the upper portion is concerned, the tail not having been here met with. Both this and the preceding species are new to Britain.

The collection of fossils from the above locality includes the head of another uncommon Trilobite, which is considered to be identical with *Staurocephalus globiceps*, Portlock, sp.‡ as well as a very perfect curved eye, and other fragments presenting the characters of *Remopleurides;* also the head of *Agnostus trinodus*, a little Crustacean peculiar to the Caradoc or Bala beds, and parts of the head, perfect tails, and other portions of *Trinucleus concentricus*, a characteristic Lower Silurian Trilobite. Other small and peculiar Tribolite remains in this collection are provisionally referred to the genus, *Olenus;* fig. 1 *a, b*, represents two of the forms of these singular little Crustacea, which are, however, too imperfect for determination; they bear some resemblance to the small species *O. humilis*, &c., from the black schists of the Malvern hills, described and figured by Professor John Phillips.§

Fig. 1.



It will be seen, from the foregoing observations, that this locality is remarkably rich in the remains of small and peculiar Trilobites; most abundant amongst them being species of the genera *Æglina* and *Dindymene*, hitherto only found in Bohemia, and included by M. Barrande in the second zone, D, of the Lower Silurians in his vertical table of distribution of the species of Trilobites in Bohemia.

The only other fossils observed at this place were a few small examples of the common Brachiopods, *Orthis calligramma*, and *O. elegantula*, and a Pteropod, *Theca triangularis*, Portlock.

The remaining fossil locality to be specially noticed is No. 2, which was discovered by Mr. G. H. Kinahan, and is also situated on Sheet 133, in a stream forming the boundary of the townlands of Belvoir and Crag, on the western flank of the Slieve Bernagh mountains. The rocks consist of black

* Système Silurian du Centre de la Bohême, par Joachim Barrande, 1852. Plate 34, figs. 3–13.
† Système Silurian, &c., pl. 43, figs. 25 and 26.
‡ Geological Report of Londonderry, Tyrone, &c., plate 1, fig. 7 *a, b*.
§ Memoirs of the Geological Survey of Great Britain, vol. 2, p. 55.

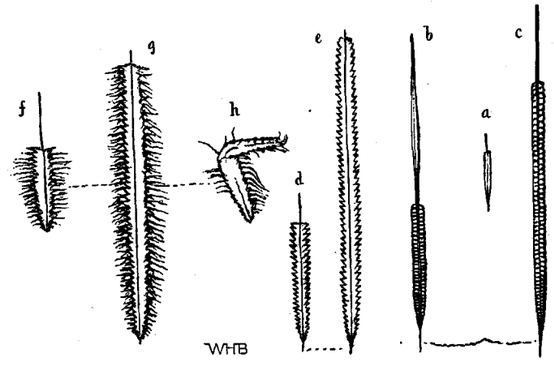
slates which dip at a very high angle, and are remarkably full of Graptolites, accompanied by groups of a new species of Pteropod hereafter mentioned; from the dark colour of these slates, which separate readily into laminæ, the fossils appear in strong contrast, and although subjected to much pressure, the characters are well defined. The most abundant species is that generally known as *Diplograpsus pristis*, the majority being of the variety *scalariformis*, a form, the peculiarities of which, so apparently distinct from the usual serrated appearance of *D. pristis*, are attributed to lateral pressure. It appears very singular, however, that this so-called variety should be in so great a majority over the serrated form both at this and other localities examined by me. On a small fragment of this slate, measuring five inches by two, I counted as many as thirty of these remarkable little fossil bodies crossing each other in all directions, and all exhibiting precisely similar characters identical with *Prionotus scalaris*,* or *scalariformis*, which Dr. Geinitz, in his fine work on the Graptolites of Saxony,† considers to be a synonym of *D. pristis*.

Some confusion having arisen respecting the species *Diplograpsus pristis* and *D. foliaceus*, in consequence of their apparent similarity of characters, and my own difficulty in distinguishing between them, would suggest the probability of their being synonymous. The figures of the latter species in the "Silurian System," and since repeated in "Siluria,"‡ representing small fragments only, are necessarily imperfect, although sufficiently like Hisinger's original figure of *D.* (*Prionatus*) *pristis*, to have caused the difference of opinion with regard to its correct identification, held by some authors who have treated on the subject.

The examples of the variety *D. scalariformis* from this locality are very perfect, although, as usual in slates of this character, much compressed; they show a more or less elongated polypidom, composed of cells arranged on each side of a central axis, which extends beyond it for some distance at one end, and at the other terminates in a much shorter and more filamentary prolongation. Several varieties are shown at fig. 2 *a, b, c*.

The serrated forms of *D. pristis* are, as before mentioned, much less numerous; a small example, with its extended and very fine axis, and a more

Fig. 2.



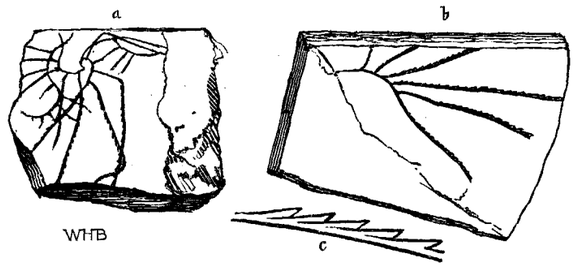
* Hisinger—Lethæa Suecica, Suppl. 1837, pl. 35, fig. 4 *a, b*.
† H. B. Geinitz. Die Graptolithen, and 1852, p. 22.
‡ Murchison, "Silurian System," pl. 26, fig. 3; and "Siluria," pl. 1, fig. 2.

lengthened specimen, are shown at fig. 2 *d*, *e*: they appear to be identical with Portlock's figures of this species and *D. foliaceus*.*

In addition to these are other serrated forms much broader in proportion, and having remarkably long filaments proceeding from the cells. These Graptolites I have referred to *D. mucronatus*, Hall,† with which they appear to agree very well. Our specimens are, however, in better preservation, and have the filaments more produced. Fig. 2 *f* represents a small example of this species, with its very fine axis extending for some distance beyond the cells. Fig. 2 *g* is a larger, and 2 *h* a bent or twisted example of this species.

Abundant in these slates is another and very peculiar branching Graptolite which I believe to be identical with *Graptolithus gracilis*, Hall ;‡ it appears to have been spirally curved, sending off long slender branches which are distinctly serrated on one side; see fig. 3 *a*, *b* (and *c*, which is a portion of *b* enlarged to show the serratures).

Fig. 3.

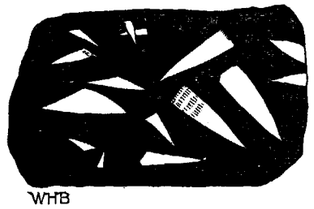


Not being certain at present as to the genus to which this singular form should be referred, I have retained it provisionally under the generic name given to it by Mr. Hall. Dr. Geinitz, however, appears to consider it to belong to the group of Sertularidæ.§

Graptolithus priodon and *G. Nilssoni* are more sparingly distributed at this locality, and complete the list of Graptolites found there.

The only other fossils observed at this place were some remarkable impressions of small Pteropod shells, occurring occasionally in groups, and scattered over the surface of the different laminæ into which these slates so readily separate. Considering this to be a new form, I have named it *Theca cometoides*, of which fig. 4 represents a group of the natural size.

Fig. 4.



These very thin, conical little shells, belonging to the genus *Theca* (*Pugiunculus*, Barrande), of which six species were previously known from Silurian rocks, were considered by Professor E. Forbes to be very closely allied to *Creseis*, a genus of Pteropods common in the Mediterranean.

The species I have named occur in these slates of various sizes, from the

* Geological Report on Londonderry, &c., pl. 19, figs. 9, 10, and 11.
† Natural History of New York, part 6, Palæontology, vol. 1, pl. 73, fig. 1.
‡ Palæontology of New York, vol. 1, p. 274. pl. 74, fig. 6.
§ Die Graptolithen, p. 19.

tenth of an inch to half an inch in length, the largest having a diameter of about the eighth of an inch; commencing from a point they gradually increase in diameter, the impressions becoming less distinct, and fading away without any very definite outline. The point of this little cone is, in some cases, bent, and the shell slightly curved, thus indicating its membraneous character.

At all the other Silurian localities in this district from which fossils were collected the rocks appear to have been very similar in lithological character and fossil contents to those described in the Palæontological notes to Sheet 145, pp. 10–14; they consist mostly of dark gray or bluish shales, or flags, weathering brown, with a few interstratified grit beds.

The grit beds occurred at localities 11, 15, 19, 29, 45, 52, containing a few scattered fossils similar to those alluded to in the Explanations already published to 135, p. 11, as having been observed at Army Hill and Knockanora, and 145, pp. 10 and 11, at Dooree, Roan, &c. The fossils are mostly small corals, as *Petraia elongata*, and *Stenopora fibrosa*, the latter being the most numerous; *Crinoid* joints and small Brachiopods, mostly fragmentary—principally *Orthis calligramma*. The shales contain a much greater variety of fossils, some of them, such as the Graptolites and Orthoceratites, being particularly abundant.

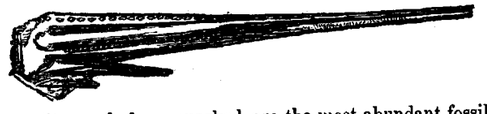
On reference to the list of species it will be seen that remains of plants were obtained at several localities: one of these a large and straight stem, is of considerable size, being twelve inches long, with a diameter of three quarters of an inch; it is coarsely fluted lengthwise, with the surface carbonized, some of the fragments show a distinctly reticulated vegetable structure. One of these large plant fragments collected at locality 59, in the same beds with *Graptolithus priodon*, is two inches in diameter, having an irregularly tuberculated surface not very unlike *Stigmaria ficoides*, and was probably an aquatic root: others again are distinctly fucoidal.

The corals in this collection are few, as regards the number of species, and generally of small size: *Stenopora fibrosa*, *Petraia elongata*, and *Favosites Gothlandica*, are the principal species.

Crinoid joints are plentiful in the grit beds, as before alluded to, and at some localities heads and other portions of the species of Encrinite I have named *Actinocrinus Wynnei*, are tolerably abundant in the shales.

No Trilobites occurred at any of the localities except those specially noticed; at locality 64 was found the remarkable fossil, fig. 5, which appears to be Crustacean, and is probably the tail spines of a species of *Ceratiocaris*.

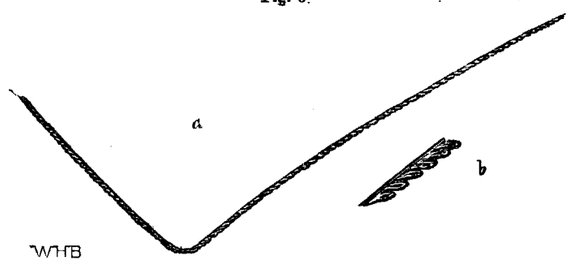
Fig. 5.



The Graptolites, as before remarked, are the most abundant fossils in these shales. On reference to the list of species it will be seen that *Graptolithus priodon* occurs at fifty-three of the localities examined in this district, being very much compressed in the shales, but in the grit beds preserving its original form; some specimens showing the structure very clearly; others in the shales, are remarkable for length; one specimen, and that not perfect at either end, measuring fourteen inches. At some localities they are met with in masses, and uncompressed, in calcareous nodules, which are sometimes decomposed, exposing them to view in relief and with great distinctness. *Graptolithus Nilssoni* (*tenuis*, Portlock), and *G. Sedgwickii*, are found accompanying the common form at most of the localities from which they were collected.

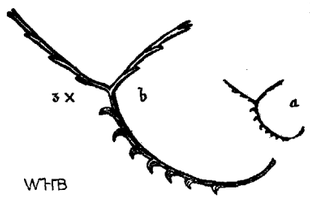
Another and rarer species, of which one specimen only was collected, but that a very perfect one, at locality 4, resembles so distinctly the figure of *Didymograpsus* (*Cladograpsus*), *Forchhammeri*, Geinitz,* that I have unhesitatingly referred it to that species, which has hitherto, I believe, not been known to occur in the United Kingdom. In this specimen, fig. 6 *a*, the branches diverge at an angle of between 25° and 30°, one branch measuring three inches long, the other being imperfect: they are provided with numerous closely set cell denticles, of a somewhat rounded character, arranged upon each branch in a single series, of which fig. 6 *b*, represents an enlarged portion.

Fig. 6.



In addition to these, a beautiful little branching species was found at three localities, 28, 47, and 49, which appears to me distinct from any described form; this I have named *Didymograpsus hamatus*, fig. 7 *a*, *b*. This species, one portion of which is curved, after proceeding for about half its length, with a single row of distant, prominent, and much recurved cell denticles, branches off on either side; the branches bearing cells more distant, and of a less prominent character. Fig. 7 *a*, represents it of the natural size; *b*, enlarged three diameters.

Fig. 7.



The species of Brachiopoda from these deposits are very few; one of them only being rather abundant; it is probably new, and is referred provisionally to *Atrypa*, although it may, perhaps, belong to some of the smooth forms of *Rhynchonella*; from its bad state of preservation, all the specimens being crushed, I am at present undecided as to the genus in which it should be included. This small shell, of which two examples are sketched, fig. 8 *a*, *b*, is about a quarter of an inch in height, with a diameter of $\frac{8}{10}$ths of an inch; its surface is marked by irregularly distant lines of growth, corresponding with the curvature of the outer edge of the valves. This species, although so imperfect, I have thought it necessary to notice, as it serves to identify the beds, being found at fourteen localities, often occurring in groups, and sometimes aggregated round an Orthoceras.

The well known species, *Orthis elegantula*, was found to occur at only a few of the localities; the small variety of *O. calligramma*, was also sparingly distributed, those collected being principally met with in the grit beds, in which deposit the specimens were generally fragmentary.

A few bivalve shells belonging to the *Lamellibranchiata* were collected; the

* Die Graptolithen, &c., pl. 5, fig. 28.

Fig. 8.

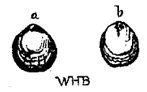


Fig. 9.

Fig. 10.

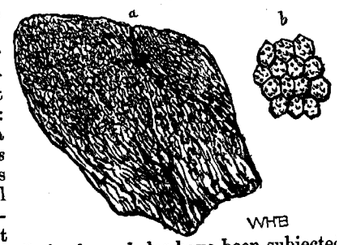
most important amongst them being the well-marked species, *Cardiola interrupta*, which was found at several localities; the other common species, *C. fibrosa*, only occurring at one locality, No. 21—I have no doubt, however, about its correct identification: the only others were two specimens of the genus Ctenodonta, fig. 9 *a*, *b*, which are probably new species, both from the same locality, No. 7, and a Cardioid shell, possibly identical with *Pleurorhynchus calcis*, a new species noticed and figured by me in the Explanation to Sheet 145; this specimen, which was found at locality 37, is accompanied on the same slab by *Graptolithus priodon*, one valve only being exposed to view, which is covered by faint radiating ribs; no indications of the siphonal tube, characteristic of this genus, can be observed; the general form of the shell, however, is well preserved, and agrees with that of the genus. The truncated or posterior end only is shown in the specimen previously figured; that now given, fig. 10, is a view of the right valve. A very perfect example of the small aviculoid shell, *Pterinea asperula*, M'Coy, completes the list of bivalve shells in this collection.

Gasteropoda, or Univalve, shells are still more scarce in the Lower Silurian rocks of this district. There are, however, some large *Euomphali* of a very important character; one of these, from locality 65, is nearly two inches in diameter, and sufficiently perfect to show the rugged lines of growth so characteristic of the two Upper Silurian species—*E. discors* and *rugosus*, from the former of which I am unable to distinguish it. The only other Univalve shell is a very small species of *Murchisonia* found at locality 6.

The small Pteropod, *Theca triangularis*, Portlock, was found at locality No. 1; one specimen only having been collected, its occurrence at locality No. 8, is considered doubtful.

The Cephalopoda are represented in this collection by one genus only, that of *Orthoceras;* these, however, of which there are several species, next to the Graptolites, are the prevailing fossils in the Lower Silurian rocks of this district. All the species but one are believed to be identical with those described by General Portlock, as occurring in Tyrone.

Fig. 11.



A remarkable specimen found at locality 25, resembles so much one of the peculiar fish allied to *Cephalaspis*, such as the cephalic buckler of *Auchenaspis*, that I have felt considerable hesitation in rejecting it altogether from the list of species: on the same slab is a fragment of a striated plant stem and *Graptolithus priodon;* this specimen, fig. 11, is considerably distorted, the unequal expansion it exhibits, being probably caused by the great amount of compression to which all the fossils in these shales have been subjected; fig. 11 *a*, represents the specimen of the natural size; *b*, is a portion of the surface enlarged; fragments of an irregular polygonal cell structure, with granulations and markings very similar to that described and figured as characteristic of this fish, was found at several localities. As the discovery of fish remains in Lower Silurian strata, if well established, would involve some important considerations, it is deemed advisable to wait for more

perfect or additional specimens before deciding with certainty as to its true relations.

Having thus given a sketch of the general character of this collection of fossils, I will now proceed to show the evidence they offer as to the particular subdivisions of the Silurian rocks to which they should be referred; first, taking the special localities mentioned at the commencement of these notes, I would observe that No. 2, Belvoir, offers undoubted evidence of being equivalent to the Llandeilo flags, from the characteristic Graptolites of that subdivision which are so abundant in these slates.

The next locality specially mentioned, No. 7, Kilmoculla, is characterized by the prevalence of one kind of Trilobite, *Phacops conopthalmus*, a form hitherto described as being peculiar to rocks of Caradoc or Bala age; the associated fossils, which were few, afford but little additional information; the presence, however, of this peculiar Trilobite, in the absence of negative evidence, is sufficient to enable us to arrive at the conclusion that these deposits were of similar age.

The third and last locality specially alluded to, No. 1, Ballyvorgal, supplied a set of fossils of a very peculiar and unusual character: they consist principally of the remains of Trilobites, the most abundant belonging to species hitherto not noticed in British Silurian rocks, such as *Æglina rediviva*, and *Dindymene Haidingeri*, described by M. Barrande; the other Trilobites, of which there were two species, and the few fossil shells, would appear to indicate beds of the Caradoc or Bala age.

The group of fossils from the remaining sixty-five localities are, as before stated, of the same character as those alluded to in the Palæontological notes to Sheets 135 and 145; in this large additional collection, however, some important considerations arise with regard to the occurrence of some peculiar fossils in rocks so low in the series as these are believed to be:—

1. The occurrence of plant remains of apparently a higher character than any previously noticed in Lower Silurian deposits, some of which may have belonged to succulent marshy plants, allied to Sigillaria.

2. The discovery of the remains of a Branchiopod Crustacean, probably *Ceratiocaris*, a genus hitherto met with only in Wenlock and Ludlow rocks.*

3. The occurrence of the characteristic bivalve shells, *Cardiola fibrosa* and *interrupta*, the former species never having been hitherto observed in rocks older than the Wenlock series; the latter, which is not uncommon in this district, being hitherto only doubtfully referred to rocks of the Caradoc or Bala age, together with the large *Euomphalus*, which appears to me undistinguishable from *E. discors*, a species hitherto believed to be confined to Wenlock rocks.

4. The presence of fish remains, which are doubtfully alluded to, if proved to be correct would lead to a modification of the opinions expressed as to their earliest appearance in Silurian strata.

The peculiarities presented by the combination in this collection of undoubted Lower Silurian fossils with species hitherto believed to have been confined to Upper Silurian deposits, associated with land plants of a higher character than any before observed, even in the uppermost Silurian beds, are sufficient to show the important character of this series of fossils; the examination of which tends to confirm the conclusion I had before arrived at, as to the great probability of the deposits in which they occurred being the equivalents of the Tyrone schists of the North of Ireland, which are acknowledged to be of Lower Silurian age, their position in the series being at present referred to the Caradoc or Bala subdivision.

* Since writing this I have seen that Mr. Salter alludes to the probable occurrence of the genus in the black shales of Dumfries, believed to be of Lower Silurian age. See "Annals and Magazine of Natural History, 1860," p. 161.—W. H. B.

List of Localities from which Silurian Fossils were collected.

Some of these localities are already mentioned in the published Explanations to Sheets 135, 143, and 145.

No. of Locality.	Quarter Sheet of the 6-inch Maps.	Townland.	Sheet of the 1-inch Map, and situation of Locality.
	Co. Clare.		Sheet 133.
1	43/4	Ballyvorgal South, .	Western end of the Slieve Bernagh Mountains; about 3 miles from Sixmilebridge.
2	43/4	Belvoir, . . .	About ½-mile south of Cragbridge, western flank of Slieve Bernagh Mountains.
3	43/4	Ballykilly, . .	West flank of Slieve Bernagh Mountains; about 2 miles from Broadford.
4	52/4	Kilnacreagh, . .	Cutting on road, about 1 mile from Troutstream Bridge.
5	52/4	Glennagross, . .	Cross-roads north of Troutstream Bridge.
6	53/3	Ballycar, North, .	About 1 mile east of last locality.
7	53/3	Kilmoculla, . .	About 1 mile west of Trough.
8	53/1	Trough, . . .	A little N.W. of Trough cottage.
9	53/3	,, . . .	N.W. of R.C. Chapel.
	Co. Tipperary.		Sheet 134.
10	29/4	Aughinish, . .	About ¾ of a mile from Aughinish point.
11	25/2	Gortlassbrien, . .	South flank of the Arra Mountains; 2 miles N.E. of Ballina.
12	31/1	Gortbrigane, . .	New road cutting a little north of Glenview cottage, near Bird Hill.
13	25/2	,, . .	½-mile S. of Ballycahane village.
14	32/1	,, . .	Mulkear River, S.E. of Killoscully R.C. Chapel.
15	32/1	Ballynanoose, . .	North of the Keeper Hill.
16	32/2	Bauraglauna, . .	In stream east of Keeper Hill.
17	32/3	,, . .	In River Doonane, about 3 miles E. of Doonane.
18	26/3	Gorteenadih, . .	In stream, Silvermines Mountains, 2 miles S.W. of Silvermines.
19	32/2	Bauraglauna, . .	East of Glen Coloo lodge; south flank of Silvermines Mountains.
20	32/2	Mucklin, . .	In stream south of Mucklin.
21	33/1	Bollinbrook, . .	Quarry, about ½-mile W. of Anglesey-road; S.E. of Silvermines Mountains.
22	33/1	Poulanass, . .	In Nenagh River.
23	33/3	Curreeny, . .	Quarry and road cutting ½-mile S.W. of Muingatunna Bridge, Nenagh River.
			Sheet 135.
24	22/4	Curreeny, . .	West flank of Borrisnoe Mountain.
25	22/4	Cloncannon, . .	In stream, about ½-mile S.W. of last locality.
26	22/4	Cloncannon and Knockaunroger,	About ½-mile S.E. of last locality; W. flank of Borrisnoe Mountain.
27	22/4	Borrisnafarney, .	About ¼-mile from the church W. of Kilduff Mountain.
28	23/3	Kilmacuddy, . .	About ½-mile S.E. of Borrisnoe.
29	23/3	,, . .	Summit of Carraghbristy Mountains; about 3½ miles N.W. of Templemore.
30	27/2	Tiermoyle, . .	Knockacraheen Hill; about 1 mile and ¼ W. of Killanafinch.
31	27/4	Lackenavorna, .	½-mile N. of Oatfield house.
32	27/4	Garrane, . . .	Quarry, near road, east of Garrane mill.
33	27/4	,, . . .	Moanaba River, between old and new Cloghinch Bridges.
34	27/4	Loughane, . .	A little S. of Ormond stile; W. of Castle Otway.

LIST of LOCALITIES from which SILURIAN FOSSILS were collected—*continued.*

No. of Locality.	Quarter Sheet of the 6-inch Maps.	Townland.	Sheet of the 1-inch Map, and situation of Locality.
	Co. Tipperary —*con.*		SHEET 143.
35*	27/4	Ballincurra, . .	Road cutting near Ballincurra Hill.
36	28/1	Ballinlough, . .	About 2 miles S.E. of Toomyvara.
37	28/1	Knocknagoogh, .	E. of Latteragh Hill.
38	28/1	Latteragh, . .	About ½-mile E. of Latteragh Church.
39	28/1	Gortagarry, . .	½-mile N.E. of Ballyhoul.
40	28/2	,, . .	In stream, W. side of Kyraun Mountain; about ½-mile N.E. of last locality.
41	28/2	,, . .	W. side of Kyraun Mountain; about 4 furlongs S. of last locality.
42	28/2	—	S. of Devil's Bit; 1 mile N.W. of Barnane House; about 4 miles W. of Templemore.
43	28/3	Knocknabrogue, .	About ½-mile N.W. of Knockanora Mountain.
44	28/3	Glenmore, Upper, .	1 mile S. of Latteragh.
45	28/3	,,	Knockanora Mountain.
46	28/4	Killoskehan, . .	About 1 mile N.W. of Killoskehan Castle.
47	28/4	Garrangrena, . .	2 miles N. of Borrisoleigh.
48	33/1&2	Garryglass, . .	1 mile S.W. of Mount Kennedy.
49	34/1	Glennariesk, . .	Road cutting 2 miles N.W. of Borrisoleigh.
50	34/1	Glentane, . .	1 mile N.W. of Cullahill Castle.
51	34/1	Cullahill, . .	Old road cutting a little W. of Cullahill Castle.
52	52/4	Glennagross, . .	In stream, a little E. of Troutstream Bridge.
53	52/4	,, . .	Rocks in same stream, a little further E. of last locality.
54	52/4	Boundary of townlands Glennagross and Cappateemore,	Quarry, W. of road; a little S. of last locality.
55†	53/3	Ballycar, South, .	About 1 mile S.W. of Trough cottage,—Upper Silurian.
			SHEET 144.
56	32/3	Boundary of townlands Bleanbeg and Knocknamoheragh,	In stream ½-mile S. of R.C. Chapel.
57	32/3	,,	Quarry by wood; N. side of Knockfune Wood.
58	33/3	,,	Curreeny commons.
59	45/1	,,	2 miles W. of Holyford.
60	45/1	,,	A little to the N.W. of Holyford R.C. Chapel.
61	39/2	Shevry, . . .	1 mile W. of Upperchurch.
62	39/4	Dooree commons, .	About 4 miles N.E. of Holyford.
63	39/4	,,	Quarry by road, about 3 furlongs E. of last locality.
64	45/2	Boulanunane, . .	About 2 miles N. of Holyford.
65	45/2	Reafadda, . .	2 miles N. of Holyford.
66	45/2	,, . .	In stream, near last locality.
67	45/3	Boundary of townlands Reafadda and Reagoulane, . .	In stream, about 1 mile N. of Holyford.
68	45/4	Carrowkeale, . .	Poulanass Waterfall, Aughnaglanny River; about 3 miles S.E. of Holyford.
			SHEET 145.
69	40/1	Gortnaskehy, . .	A little S.E. of Upperchurch.

* This locality has been inadvertently included in the above list, the only specimen collected there being surface markings of a peculiar character, but such as might have been caused by a pebble or other obstruction to the course of a gentle current.—W. H. B.

† See page 9.

LIST of SPECIES of LOWER SILURIAN FOSSILS collected from the preceding localities:—

The numbers opposite each specific name, refer to the localities where they were found, and the mark ×, when placed before them, denotes their comparative abundance.

	Localities.
PLANTS.	
Plant stem (large), longitudinally ribbed,	15
—— fragments,	? 37, ? 44, 62, 64
—— showing reticulated structure,	39, 48, 52
—— with tuberculated surface (like Stigmaria), probably an aquatic root,	59
—— with large and more regular raised surface markings,	47
—— Fucoid? obtusely lobed frond,	47
CŒLENTERATA.	
ACTINOZOA.	
Favosites Gothlandica,	10, 21, × 37
—— alveolaris?	43, 45
Halysites catenularius,	45
Petraia elongata,	7, 10, 19, 29
Stenopora fibrosa,	4, 8, × 10, × 11, × 19, 45, 66, 67
MOLLUSCA.	
POLYZOA.	
Didymograpsus Forchhammeri, *Geinitz*, sp. fig. 5, p. 14,	4
—— hamatus, *Baily*, fig. 7, p. 14,	28, 47, 49
Diplograpsus pristis,	× × × 2
—— mucronatus,	2
Graptolithus? gracilis, *Hall*, fig. 3, p. 12,	× × 2
Graptolithus Nilssoni,	2, × 4, × 9, 16, 27, 29, 32, 36, 44, 49
—— priodon,	2, 3, × × 4, × × 5, × × 8, 9, × × 12, 13, 14, 17, 18, × × × 20 × × × 21, × × 22, × × 23, × 24, × × × 25, × × 26, × 28, × 29, × × 30, 31, 32, × × 33, 34, × × 36, × × × 37, × × × 38, × × × 40, 41, × 42, 43, 44, 45, × × 46, × × 47, × × 48, × × 50, × 51, × × 52, × × × 53, × × 54, × × 56, × × × 57 × × × 58, 59, × 60, × 63, 64, × × 65, 66, × 67, 68
—— Sedgwickii,	4, 27, 32, 36, 46, × 47, 51, 67
BRACHIOPODA.	
Atrypa? n.s. fig. 8, p. 15,	4, 30, 32, × × × 38, × × 41, × 43, 44, × 49, × × × 51, 52, 53, × × 62, × × × 64, 65
Leptæna sericea,	45
Orthis calligramma (var. virgata),	1, 7, ? 11, × 19, 29, 37, × × 45
—— elegantula,	1, 11, ? 21, ? 37, 42, 64, 69
—— testudinaria,	29, ? 45
—— species undetermined,	15, 30, 46
CONCHIFERA.	
Cardiola fibrosa,	21
—— interrupta,	5, 6, 20, 37, 43, ? 44, ? 45, 47, 52, 56, 57
Ctenodonta, n.s.? fig. 9, p. 15,	7
Pleurorhynchus calcis?* fig. 10, p. 15,	37
Pterinea asperula,	40
GASTEROPODA.	
Euomphalus discors?	65
—— species undetermined,	21, 42, 57
Murchisonia, small species,	6

* Explanation to Sheet 145, page 11, fig. 2.

PTEROPODA.

Theca cometoides, *Baily*, fig. 4, p. 12, . .	× × × 2
—— triangularis, ...	1, ? 8

CEPHALOPODA.

Orthoceras angulatum, ...	56
———— Brongniartii, ...	? 7
———— elongato-cinctum, . . .	4, 13, 25, 26, 28, 30, 32, 33, 34, 37, 39, 43, 46, 47, × 49, 50, 51, 52, × 54, 57, 62, 63, 64 ? 65, 66
———— lineatum, ...	6, 21, 46
———— subundulatum, . . .	? 7
———— tenuicinctum, . . .	37, 38, 42, 69
———— species undetermined, . .	6, 9, 21, 36, 41, 42, 44, 48, 53, 67, 68

ANNULOSA.

ECHINODERMATA.

Crinoid joints, Actinocrinus? . . .	× 11, 19, 24, 25, 27, × 29, 37, 38, × 45, 48, 52, 61, × × 66
Actinocrinus Wynnei, n.s.* . . .	× 4, × 8, × 21, × 37

ANNELIDA.

Tentaculites Anglicus, ...	37
Trachyderma, sp.	54

CRUSTACEA.

Æglina rediviva, *Barrande*, . . .	× × 1
Agnostus trinodus, ...	1
Ceratiocaris, sp. tail spines? fig. 5, p. 13,	64
Dindymene Haidingeri, *Barrande*, . .	× 1
Olenus? undetermined species, fig. 1, p. 10,	1
Phacops conopthalmus, ...	× × 7
Remopleurides, sp.?	1
Staurocephalus globiceps, *Portlock*, sp. .	1
Trinucleus concentricus, ...	× 9
Ceratiocaris?	64

? FISH.

Auchenaspis? fig. 11, p. 15, . . .	25
———— ? polygonal cell structure, . .	26, 43, 45, 59, 63, 66

LOCALITIES in OLD RED SANDSTONE, from which fossil plants were collected.

No. of Locality.	Quarter Sheet of the 6-inch Maps.	Townland.	Sheet of the 1-inch Map, and situation of Locality.
	Co. Clare.		SHEET 133.
70	28/4	Caherhurley, . .	In River Anamullaghaun.
			SHEET 134.
71	45/1	Killerty, . . .	Ballyteige River, 1 mile S.E. of Killaloe.
			SHEET 143.
72	52/3	Brickhill, . .	Railway cutting at Poulavoura Cross Roads.

The fossil plants from localities No. 70 and 71 consist of longitudinally striated and branching stems; that from locality 72, is a single specimen, with stems of Sagenaria 2½ inches in diameter.

Fossils were also collected from seventy-two localities in the Carboniferous Limestone within the district comprised in these Sheets. They are of a similar character to these described in the Explanation of Sheet 153.

March 11, 1862. W. H. B.

* Explanation to Sheet 145, page 10, fig. 1.

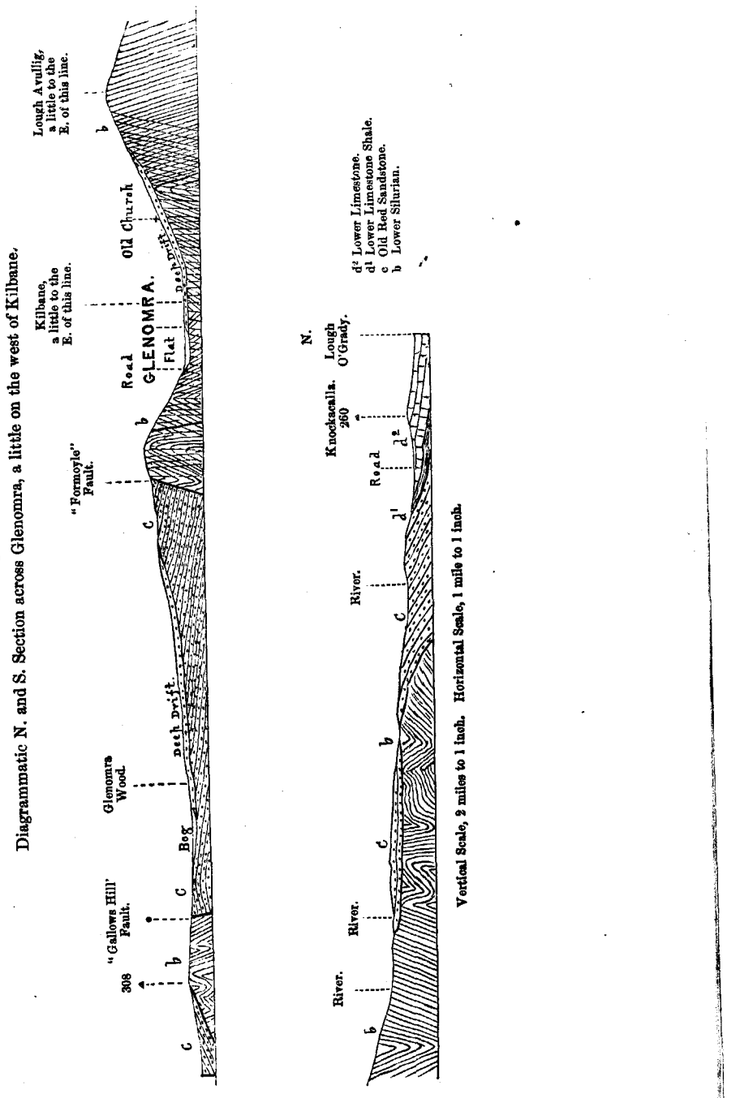


Fig. 12.

5. *Position and Lie of the Rocks.*

Outlying exposure of Old Red Sandstone, S.E. of Newmarket.—Commencing near the S.W. corner of the map, a patch of Old Red sandstone and Lower Limestone shale, protruding through the Lower Limestone, will be observed a little more than two miles S.E. of Newmarket. It is partly situated in the district included in Sheet 143, and partly in that which is now being explained. The Lower Limestone shale, consisting of grits, flags, shales, and shaly limestone; while the only rocks belonging to the Old Red sandstones which are exposed, are yellow grits and sandstones. Some of the rocks of the Lower Limestone shales in this place are highly fossiliferous.

Lower Limestone ground between Newmarket and Sixmilebridge, and thence to Doon Lough.—On the west of the Old Red sandstone, and one mile and a half S. of New-market-on-Fergus, near Mogullaan House, are beds of dark gray exfoliating limestone, thin-bedded and very cherty, dipping N.W. at 10°. These are the beds mentioned in page 8, as forming a remarkable horizon in the Lower Limestone. Eastward, at Feenagh House, and between it and Sixmilebridge, beds of dark gray shaly limestone (below the cherty beds), are well exposed in crags and railway cuttings, lying nearly horizontal or undulating to the N. and S. at low angles. West of Sixmilebridge similar dark gray beds may be seen lying horizontal in several quarries; and northwards, along the Owenogarney River, a continuous section extends for nearly a mile in length, from S. to N., in beds of thick and thin dark gray limestones, which have an average dip of 15° to N. The uppermost beds in this section are cherty exfoliating limestones, similar in character to those above mentioned, near Mogullaan House, and they appear further N.N.E. at the northern end of the Castle Lake and at Enagh Castle, lying horizontally or dipping N.W. at 5° beneath, and in conjunction with pale gray limestone, which is occasionally of a pink colour, and would polish into a marble. From thence the beds above the Lower Limestone shales are traceable in a N.E. direction to the N.E. corner of the map, and thence westwards along the north of the district. The cherty beds that divide the stratified and unstratified limestones are well exposed near Killeen House, where they dip N.W. at 45°, and in the neighbourhood of Ballynahinch, where they are undulating, but have a general slight dip to the W.S.W. The dark blue bedded limestones are well exposed in numerous places in this strip, especially in the vicinity of Bodyke, where they are quarried.

About half way between Ballynahinch and Fortanebeg Houses, there is a quâ-quâ-versal dome, which brings up the cherty beds through the upper or unbedded part of the Lower Limestone.

Proceeding westward dark gray crystalline limestones, having shale partings which are full of fossils, may be seen lying horizontal in quarries on the roadside N. of Ardbooly.

On the road side S. of Marble Hill, and in the bed of the river E. of Kiltannon House, are dark gray somewhat cherty limestones, appearing below and in conjunction with the unbedded gray limestone, and having a slight dip to S. of 5°. The lower beds are freely exposed in craggy knolls to the W. of Tyredagh Castle, forming a low anticlinal curve, and S. and W. of Maghera Cottage, having a general dip to S. at 5° or 10°; also round Crowhill Mine, one mile N.N.W. of the Hurler's Cross-road, where they lie horizontal.

At Newgrove and Fomerla bridges these, as well as the cherty beds over them, appear nearly horizontal or undulating at low angles to N. and N.E. S. of Fomerla loughs, and also a little N. of Sandhill Bridge, two instances occur of these cherty beds forming shallow troughs, in which lie outliers of the upper unbedded portion of the Lower Limestone. They may also be distinctly and almost uninterruptedly traced from Sandhill Bridge, southwards, for a short distance; then bending westwards, by Clooney Church and Castle, and thence taking a N.N.W. direction, along the E. side of Clooney Lough, to the Roman Catholic Chapel, the general dip being S.W. at 5°. At the chapel they bend round again, and dip N. at from 5° to 20°. North of this they are seen lying nearly horizontal beneath the pale gray limestone at Craggana-weer Lough, and also between this and O'Brien's Big Lough, where they dip W. at 10°. Lower beds may be seen eastward, at Ballyvergin Mine, dipping S.W. at from 5° to 10°. Similar dark gray thin limestones lie horizontal in quarries W.N.W. of Attycuil, and further N.W., near the northern edge of the map, with a dip S.W. of 10°.

On the N.E. of Attycuil, and about four miles N.W. of Tulla, there seems to be a tract of Old Red sandstone, with a belt of Lower Limestone shale. In this place no rocks appear at the surface of the ground, but the country is covered with large angular blocks and fragments of yellow and red grits and sandstones which seem not far removed from their natural bed; and from the way that rocks of these formations, which are seen *in situ* immediately north of this district, dip and strike, it is evident that they must occupy the whole of the portion supposed to be occupied by them, if not more.

Again starting from the S.W. corner of the map, the upper or unbedded part of the Lower Limestone forms an extensive tract of crags around Urlaunmore Castle, one mile and a half S.W. of Newmarket-on-Fergus. The rock is of a pale gray colour, in places magnesian, and contains fossils, but shows no planes of stratification. Rocks similar in character also appear at the S. side of the road leading to the railway, about half a mile E.S.E. of Newmarket-on-Fergus, and S. of this, in patches along the roadside, N. and N.E. at Mogullaan House. They are also well exposed E. of Rathlaheen House and S. of Rosroe Lough, where they form a rocky knoll sloping down to the lough.

The amorphous character of the rock may be well seen here and in the railway cuttings. Similar rocks also occupy a considerable area between Knockalappa Lough and Ballysheen House, fossils being locally abundant.

North of this, at the N.E. end of Rosroe Lough, large patches of yellowish or whitish gray amorphous dolomite (μ δ), may be seen underlying the cherty limestones which divide the Upper and Lower Limestones; here there is a N. and S. fault causing a downthrow to the E., which will be further mentioned in the description of the Upper Limestone.

Eastwards, around the hamlet of Kilmurry, and along the N. shore of Castle Lake, extending to Enagh Castle, the pale gray limestones occupy a large area of nearly bare rock, apparently quite amorphous, but containing fossils in abundance. In the latter locality they may be seen resting on the cherty limestones which divide them from the lower beds.

One mile to the N.E. of Enagh Castle, N.W. and N.E. of Killeen House, there are blue and gray unstratified limestones; and also further north-east, near Lakyle House, where they are magnesian.

Immediately S. of Lough Avoher there is the debris of dark blue argillaceous bedded limestones, and half a mile N.E. of Lakyle House, on the N. and S. of the graveyard there situated, are similar rocks which have been quarried a little. They either lie horizontal or dip W. at a low angle (5° to 10°).

In the neighbourhood of O'Callaghan's Mills gray limestones are quarried. Between Kilgorey, Fortanebeg, and Fortanemore Houses, there is a large area free from drift, the limestones coming everywhere to the surface. A similar patch, but of a smaller extent, is found on the W. of Mary Fort, and another to the S. and S.W. of Garruragh House. These rocks also crop out in large tracts to the W., N.W., and S.W. of Tulla, being magnesian in many places and abounding in fossils. One mile and a half W. of Tulla a mineral vein occurs, which will be described hereafter.

Two miles S. of Tulla, near Carrowroe, and a little S. of Dangan Villa, the dolomite (μ δ), appears in a large irregular mass lying immediately below the cherty beds, which have been described above as forming the boundary between the Upper and Lower Limestone, and which have a general dip here to S. at 10° or 15°. From this the dolomite is traceable (except when bog occurs), along this cherty horizon westward, as far as Wellpark Cottage. The pale gray limestones are freely exposed a little north of this, cropping out in crags around Corbally House and Toonagh House, and also at Ballyhickey Mine. Here the dolomite is again seen, and can be almost uninterruptedly traced hence to Castletown Lough, a distance of two miles. For the same distance also, at the north side of the dolomite, the gray amorphous limestone forms a tract of nearly bare rock, more or less abounding in fossils. Another extensive tract occupied by it is that lying northwards, around Cranagher House and Kerney's cross-roads.

The dolomite is next seen in an irregular mass below the cherty beds at the W. side of Holaun Lough, and also further N., between Ballymacahill Lough and Spancelhill. A little W. of Spancelhill the pale gray limestones show planes like stratification dipping N.W. at 25°. At a distance of a little more than a mile N.W. of Spancelhill, where they form craggy knolls, they also appear to dip W. 10° N. at 10°; here is another patch of dolomite. Northwards to the edge of the map the gray limestone occurs as a bare tract of rock lying to the east of the overlying cherty beds.

The Upper Limestone.—The western and central portion of this district is composed of the beds of this division of the limestone, and excepting the extensive alluvial flat of the river Fergus, and some patches of bog in the neighbourhood of Kilkishen, is almost all a tract of bare rock. The beds undulate in different directions, but have a general tendency to form a synclinal fold, spreading out widely at the west side of the map, and becoming narrow towards the east, and terminating there in the form of a U. The basal cherty beds of this division are traceable almost continuously round both the north and south sides of the synclinal, except where their continuity is occasionally broken by intervals of bog or drift.

Valley of the Fergus.—They are well exposed at the N.W. corner of the map, both N. and S. of Chipfield House, undulating considerably, but having an average dip to W. of 20°. A large area, extending towards Drumconora and Barefield, is occupied by the superincumbent dark gray compact limestones, containing productæ and corals in abundance. A small patch of brownish crystalline dolomite (μ δ), occurs at the S. end of Stonepark Lough. Further S.E. at the W. side of Holaun Lough, the cherty limestones again appear, having an average dip W. at 15°, and from this to the edge of the map, at the town of Ennis, and around the latter the upper beds crop out in large patches of bare rock, the general dip being W. 20° S. at 10°. These are similarly exposed south of Ennis, W. of the river Fergus, and W. and S.W. of the village of Clare, the general dip being W. at 10°; and also N.E. of Clare, between it and Castletown Lough.

At the W. and S. sides of Castletown Lough the cherty beds may again be seen forming a small anticlinal curve, dipping on the east side of the lough W. 10° N. at 20°, and on the south side of it S.W. and S. at 15°. From this they may be traced running almost continuously in a wavy line across the country eastwards, as far as Liskenny Lough, a distance of more than six miles, the general dip being S. at 10°.

Dolomite.—A narrow and rather irregular band of yellowish gray dolomite, overlying the cherty beds, runs without interruption from a point on the road half a mile S. of Castletown Lough to within a quarter of a mile W. of Hazelwood House. It again makes its appearance at the E. side of the road, a little S.E. of Hazelwood House, and can be traced thence for half a mile to the east.

Upper Limestone in the neighbourhood of Quin.—To the east of a line drawn N. and S. from Liskenny Lough through the village of Kilkishen, a large amount of bog and rounded hills of drift conceal the cherty beds; they again appear S. of Kilkishen, quarter of a mile N. of Enagh Lough, dipping N.W. at 50°. Their next exposure is westward, at Lough Nanillaun and the N.E. side of Rosroe Lough; here, at the W. side of the former (as has been observed in page), is a N. and S. fault, giving a downthrow to the W.; the reasons for supposing the existence of this fault are, that at the S. side of Lough Nanillaun, overlying dolomite, the cherty beds may be seen dipping N. 10° W. at from 5° to 30°, and abutting eastward against a mass of dolomite which lies between the two loughs over which, at the northern corner of Rosroe Lough, the cherty beds again appear, dipping N. at from 5° to 10°; southwards, at the E. side of Rosroe Lough, near the ruined castle, and between Rosroe Lough and Finlough, the cherty beds are strongly developed, and attain a considerable thickness (probably fifty feet); for half a mile between the two loughs, they dip W. 20° N. at angles varying from 40° to 51°. Further west they may be seen near the Ballycar railway station, and a little east of Newmarket-on-Fergus, dipping N.W. at 35°; lastly, they are well exhibited at the ruined castle, a quarter of a mile S.W. of Newmarket-on-Fergus, having a dip of N.W. at 55°. The upper beds are well seen N. of Newmarket-on-Fergus, in the hilly tract of bare rock to the east of Dromoland Castle, and also in the large area of crags of which the country between Quin and Lough Cullaunyheeda consists. The beds undulate at low angles, but, as has been before said, they have a general tendency to form a synclinal fold, those at the N. side dipping S., and those at the south dipping N. Besides, at the base of the Upper Limestone chert occasionally occurs in bands and nodules in other places, as at about one mile E. and S.E. of Quin, at Ballymacloom Lough, where a considerable thickness of cherty dark gray thin-bedded limestones occur, and also S.W. of Quin, between Ardsollus Bridge and Lough Ataska, but their occurrences are only local, as the chert cannot be traced for any considerable distance.

Oolitic Limestone.—A little south of Jasper's Bridge, which lies between the villages of Quin and Clare, and at a distance of two miles E. of the latter, is a conspicuous tract of crags, consisting of beds of gray limestone, having a very perfect oolitic structure, and which undulate to the W. at from 5° to 25°. This oolitic structure may also be seen in the rocks near Lough Girroga, one mile N. of Ennis, and on the roadside at the N. side of Ballymacahill Lough, which is situated two miles N.E. of Ennis.

Derrymore.—Dark blue limestone beds are seen at the N. and S. of Derrymore House, which lies two miles N.E. of Kilkishen; at the S. side they dip N.N.W at 10°, and at the north, S. at 10°. The debris of these limestones is seen in other localities.

The S.E. corner of the District.—At the extreme S.E. corner of the district there is supposed to be some limestone and Lower Limestone shale, but no rocks appear at the surface, as the S.E. slope of this hill is covered with deep drift, which conceals all the rocks except the lowest beds of the Old Red sandstone. These are seen in various places along the line that is marked on the map as the lower boundary of the Old Red sandstone. They consist of yellow and red sandstone, dipping S.S.E. at angles varying from 2° to 20°.

Silurian ground S. of the Gallows Hill Fault.—Lying unconformably under the Old Red sandstone are Silurian rocks, which occupy a long narrow strip that is bounded on the N.N.W. by a fault—the continuation of the "Gallows Hill Fault"—that is a downthrow to the N., cutting off the Silurian rocks and replacing them by the Old Red sandstone (see Section, fig. 12, p. 21). Between the eastern margin of the map and the alluvial flat that lies half a mile to the W. of Harold's Cross-roads, green and

gray shales are exposed in numerous places; among these shales there are a few grits, and along the outcrop of the Old Red sandstone, at the S. of the Silurian, the rocks are of a red or purple colour. These rocks all dip southward at angles varying from 45° to 88°. At the W. of the alluvial flat just mentioned, by the road side, gray grits, with black shale partings are quarried; they are very hard, and make excellent road metal, for which they are extensively used. They dip S.S.E. at 85°. On the road from Trough to Broadford are green, greenish, and blue shales, near where the Roman Catholic chapel is marked on the map,* they dip N. at 55°, while to the N. of Trough they dip S.S.E. at a high angle. A little to the S.W. of Trough Cottage are green calcareous shales and finely laminated argillaceous grits.† They dip N. at 60°, and N.E. at 65°. To the N.W. of Trough Cottage, along the fault, are green and gray grits, slates, and shales, that dip W.S.W. at 65°, E. at 70°, and S.W. at 30°. In the part of the parish of Kilseily that lies a little to the W. of Trough Cottage, there are similar rocks that dip W. and W.S.W., at angles varying from 30° to 85°, S.W. at 65°, and N.W. at 60°. The cleavage strikes E. and W., and either dips N. at 80° or S. at 70°. In one place the slate was quarried to a slight extent, but the works were abandoned as the arenaceous character of the slate rendered them coarse and heavy.

In a N. and S. stream that lies half a mile on the S. of Cappananagh,‡ a section is exposed in green and blue shales, grits, and flags. In this stream the beds all dip S. near the S. of the district at a high angle (80° to 89°), which gradually decreases towards the N., and where the stream joins the road the angle is only 45°. A little to the N. of this, on the road, the beds are vertical, while further N. they dip N.E. and N. at 5°. Between the section just described and the barony boundary that lies six furlongs on the W., are blue, gray, green, and ribboned shales and slate, and gray and green grits. Many of the shales are calcareous, and some of the slate was formerly quarried, but all the works have been for a long period abandoned. Some of these rocks are fossiliferous. The beds dip S.S.W. at a high angle (80° to 89°), except on the barony boundary, at the south margin of the map, where, in yellow and green shale, the dip is W. at 75°.

On the W. of the barony boundary, where the trigonometrical point 848 is engraved on the map, there occurs a remarkable mass of rock, consisting of a green grit, apparently unstratified, and occupying a surface area 1,000 feet long by 250 feet wide.§ A little to the S.S.E. of the trigonometrical point there is a detached piece of this grit, 500 feet long by 100 feet wide, cut off from the large mass by a fault that runs N.W. and S.E. This fault is well seen a little to the E.S.E. of the trigonometrical point, where there are blue shales that dip S. at 60°, and strike E. and W. at the grit. All the rocks in the neighbourhood of these grits, between the barony boundary and the road that lies a little to the W. of the trigonometrical point, are similar to those at

* There is no chapel now where marked on the map, it having been razed to the ground. Trough Roman Catholic chapel is now situated about a mile to the N. of its former site.

† A little to the southward of these beds, in an old bohereen, of which only a very small portion is in this district, it being principally situated in the district contained in Sheet 143, red, yellow, purple, and green shale, with thin veins of siliceous hematite were observed; they seem to strike towards these beds, and they dip S.S.E. at 80°. Between them and the beds just mentioned there appears to be a fault, but unfortunately enough of rock *in situ* is not exposed to enable a correct conclusion about them to be arrived at.

‡ This stream is not marked on the one-inch map.

§ This grit weathers and forms crags very like an igneous rock, but on careful examination small pebbles will be found in it. It is very remarkable, as nowhere else in the Silurian of this district are similar grits found.

the east of the barony boundary, and dip S. at angles varying from 35° to 85°. Due west of the trigonometrical point, at the road, there are greenish slates that dip nearly S. at 75°. In these the cleavage is somewhat singular, as it strikes S. 34° E., and dips S.W. at 87°. A little to the S.W. of this place, in a by-road, are greenish and gray thin bedded grits and shales, that dip nearly E. at 55°. A little further W. on the same road are red shales that dip S. at 55°, which would seem to point to a fault between these two sets of beds. Along the road that runs nearly W. from the trigonometrical point, are green and gray shales, slates, and grits, in which excellent specimens of graptolites were found. They dip S.E. at angles varying from 60° to 88°. A little to the S. of this there is a patch of Old Red sandstone, which consists of yellow grits and conglomeritic grit, that seem to lie horizontally. To the N. and W. of this patch, in some of the streams and roads, olive green and gray Silurian shales and grits are exposed.

Old Red Sandstone of the Slieve Bernagh Hills.—To the north of this strip of Silurian rocks there is a tract of Old Red sandstone, which is bounded on the southward by the continuation of the "Gallows Hill Fault," and on the north partly by the "Formoyle Fault," which has a downthrow to the S., and partly by an irregular line of *basset*, or outcrop of its lowest beds. It stretches from the eastern limits of the district to near Sixmilebridge, when it assumes a N.E. direction, and occupies a narrow strip of country along the base of the hills as far as Drimmeen Castle, that lies a mile and a half N.E. of Doon Lough. After this castle is passed the Old Red country widens considerably, as the rocks undulate in gentle curves, forming a rough broken, hilly country. On the east margin of the district it splits into two, one narrow tract along the Inchalughoge river running for about two miles into the district on the E., and another going in a N.E. direction, forming a belt between the Silurian rocks and the limestone.

Old Red Sandstone between Glenomra and the Gallows Hill Fault.—Returning to the S.E. of this area of Old Red sandstone, we shall find, a few yards to the E. of Ballydaw, yellow grits that dip S. at 15°. To the south of Glenomra Wood yellow grits are also exposed. Between Ballyquin House, which lies two miles on the N.N.E. of Glenomra Wood, and the new road from Limerick to Broadford, the rocks are well exposed, and consist of yellow and red sandstones and grits, red flags, and red, purple, yellow, and greenish clay rocks and shales. All these rocks dip N. at angles varying from 5° to 20°, but usually at an angle of 8° or 10°. From this it is seen that the nearly east and west fault that runs through Formoyle must be rather a large downthrow to the S.* Half a mile to the W. of Formoyle, and to the N. of the *Formoyle Fault*, are red shales, with a few grits, that dip S. at 25°. From the place last mentioned, for more than two miles to the west, along where the boundary between the Old Red sandstone and the Lower Silurian is engraved on the map, there are red and yellow sandstones, grits, shales, and clay rocks. These all have a southerly dip, but sometimes at so low an angle as to be nearly horizontal. Along this line the junction between the Old Red sandstones and the Silurian is often exposed, the lowest bed of the former being sometimes a rusty reddish yellow soft sandstone, at other times a soft reddish flag, while often it is a red shale or clay rock. To the W. and S. of this the boundary marked is only provisional, as no rocks are seen, the place being covered with bog and drift, but in the place marked as Old Red sandstone, at the N. of Knockaphunta, numerous crags of yellow sandstone appear through the bog. About a mile to the S.W. and S. of

* As all the rocks for more than a mile on the south of the Formoyle fault dip N. at about 7°, it would make the thickness of the Old Red at the S. side of the fault at least 600 feet, which must necessarily be the amount of the downthrow to the S.

Formoyle, between the new and old roads from Limerick to Broadford, the rock is very flaggy and highly micaceous, especially some beds that are of a red colour. These latter beds, twenty years ago, were quarried extensively for flags, but the works are now abandoned.* All these rocks dip N. at angles varying from 2° to 10°.

A mile and three quarters on the S.W. of Formoyle, in a quarry situated between the trigonometrical point 651 and the old road from Limerick to Broadford, the junction between the Old Red sandstone and the Silurian is exposed, the lowest bed of the former being a reddish ferruginous soft sandstone.

Nearly a mile S.W. of the last mentioned quarry, in the stream called Sruffaunnageeragh, there is another junction, red breccia being the lowest rock of the Old Red sandstone. A little to the S. of this, in the same stream, are flaggy, red, and yellow sandstones and greenish shales, that dip S. at about 5°. Further S.S.E., in the Mountrice river, near Mountrice House, yellow grits, with thin gray and greenish shales are quarried, that dip S. at 3°. To the S.W. of Mountrice House, in and to the S. of Trough river, are yellow and red sandstone grits, shales, and clay rocks, that dip N. at angles varying from 2° to 10°. In the stream over which was built Aughnagourney bridge, that lies a mile and three quarters on the W.N.W. of Mountrice House, the lowest bed of the Old Red sandstone is exposed in five places, and is a soft red coarse-grained sandstone; this kind of rock being seen round the small patches of Lower Silurian that are here exposed, and at the junctions of the Old Red sandstone with the Lower Silurian, a little to the N.E. and N.W. of Corlea. All the Old Red rocks exposed in these streams, as far to the southward as the patch of Silurian rocks that lies a little N. of Aughnagourney bridge, dip southward at angles varying from 3° to 15°, while at the N. and S. of the bridge the angles vary from 25° to 45°. In that part of the Old Red sandstone that lies to the N.W. of Corlea, and runs up nearly to the peak of Knocksnaghta, the rocks are principally yellow grits, although there are a few red beds, and red and greenish shales. In one place, where the new road crosses the boundary between the Lower Silurian and Old Red sandstone, six furlongs to the N.W. of Corlea, the latter rocks seem to lie against an old cliff of the former; as they are perfectly horizontal, lie at a lower level than the Lower Silurian rocks that are in juxtaposition, and there is no appearance of a fault anywhere at the boundary hereabouts. The beds here generally incline southward, although there are a few local undulations. A mile on the W. of Corlea there is a small outlying patch of Old Red sandstone. From Corlea to the west, towards Mount Prospect, similar rocks are seen, that dip S. at angles varying from 10° to 45°. Due S. of Lough Coolmeen, at the fault, the beds dip S.E. at 25°, S. at 30°, and S.W. at 20°; they are yellow and gray grit and yellowish green clay rock in appearance, very like the uppermost beds of the Old Red sandstone formation, or perhaps the basal beds of the Lower Limestone shale. To the W. and S.W. of Lough Coolmeen there are yellow and white grits and sandstones, some of which are flaggy. They all have a westerly dip at angles ranging from 2° to 20°.

Old Red Sandstone and Lower Limestone Shale seen near Sixmilebridge.—Two miles due W. of Lough Coolmeen, in the Gourna River, a good section is exposed, that shows the gradual change from the Old Red sandstone, through the Lower Limestone shale, into the Lower Limestone. The uppermost beds of the former being yellow and olive flaggy thin bedded grits, some of which are highly micaceous, with greenish shale partings, while the lower beds of the Lower Limestone shale have black, gray, and blue shales,

* These works were called the *Glenomra Flag Quarries.*

interstratified with similar grits; over these are shales with a few grits; these shales, with a few limestone beds which give place to shaly limestones with a few shaly beds, and at the top of the section, are good dark blue limestones. The beds in this section form an undulation which makes the Lower Limestone shale occupy a larger space than usual, but they have all a general dip towards the W.S.W.

Castlecrine.—To the N. of the Gourna river, near the castle that lies a mile on the N.E. of Castlecrine, the lowest bed of the Old Red sandstone is well exposed, where it is always a red soft breccia with imbedded angular and semi-angular jasper and red grit pebbles, having few or no white quartz fragments. The beds here undulate in almost every direction at angles varying from 10° to 40°, but have a general inclination to the S.W.

Castlecrine to Doon Lough.—East of the castle, half way between it and the trigonometrical point 873, there is a small outlying patch of Old Red sandstone. To the N. and N.E. of the castle, and a mile due E. of Glenwood House, the basal bed is also exposed, having a N.W. dip of 10°. Yellow grits occur in quarries and crags on the S. and S.W. of Belvoir House. In the stream to the E. of Belvoir House a good section is seen of the lower beds, where the following rocks were noted:—

Section No.

					Ft.	In.
11.	Reddish coarsely cleaved grits and shales,	N.N.W.	at 60°	*about*	50	0
10.	Yellow sandstones with thin yellow and	,,	45	,,	105	0
9.	reddish shales,	,,	30	,,	100	0
8.	Yellow grits, interstratified with flaggy beds,	,,	45	,,	175	0
7.	Yellow sandstones, interstratified with red flaggy argillaceous sandstones,	,,	45	,,	96	0
6.	Yellow sandstones, interstratified with greenish yellow sandy clay rocks,	,,	45	,,	0	11
5.	Red sandy clay rock,	,,	45	,,	2	0
4.	Red sandstone,	,,	45	,,	0	7
3.	Red and yellow sandy clay rock,	,,	45	,,	0	9
2.	Soft purple sandstone,	,,	45	,,		
	Unconformability.		vertical			
1.	Altered Silurian shales and grits,					
					530	3

To the N.E. of this the basal bed, a red jasper breccia can be traced through where the K in Kilseily is engraved on the map, and then N. to Poulnalecka Wood, where it forms a waterfall over fifty feet high, from which the wood takes its name; here it dips nearly N. at 40°. From this it runs E.N.E., and is again exposed in the stream that flows through Ballykelly Wood, where it dips N. at 50°. Half a mile on the N.E of this, at the old road from Sixmilebridge to Broadford, are yellow flaggy sandstones and red clay rock, which seem to dip N.W.

Doon Lough.—In the vicinity of Doon Lough the geology of the country is very obscure, as few rocks are seen *in situ*. Immediately south of the lough no rocks are seen; on the west of it there are dark blue limestones in the vicinity of the *Castle* near Mountallon Bridge; on the N. there are Lower Limestone blocks, which seem to be nearly *in situ;* to the N.E., near the Glebe House, in a cliff by the road side, there is Lower Limestone shale debris; on the E. immediately south-east of Doon House, and on the south, in a small grove by the road side, are Silurian rocks; and on Doon Island are shaly dark blue limestone and shale, which may be *in situ;* but on account of the nature of the island, it being covered with timber and brushwood, their exact relations are undeterminable.

Old Red Sandstone N. of Doon Lough.—From this to the east of the district, the Old Red sandstone rocks are principally yellow sandstones and grits, with,

in places, red, greenish, and yellow clay rocks and shales, and a few conglomerate beds. Partial sections of the beds are seen in the Killuran, Ballymacdonnell, and Anamullaghaun Rivers, where the strata are found to be undulating in sharp and gentle curves and flexures, bringing up to the surface the same beds in different places, and thereby occupying a large tract of country. The angle of dip is usually low (from 1° to 20°), although in some places it will suddenly rise to 50° or 60°, and in a few places to as much as 70°.

Old Red Sandstone and Lower Limestone Shale in junction.—In the Anamullaghaun River, a remarkably good section is exposed in the upper beds of the *Old Red sandstone*, and the whole of the *Lower Limestone shale*, of which the following is a measured section, the inclination of the beds being northward, at angles varying from 20° to 45°.

Section No.

		Ft.	In.
17.	Black and blue shale, with beds and bands of shaly limestone,	52	0
16.	Black and blue shale, with an occasional limestone band and nodules,	35	3
15.	*Break in which no rocks are exposed,**	7	0
14.	Black shales,	20	0
13.	Olive sandy shales,	3	0
12.	Shaly limestone, very fossiliferous,	1	6
11.	Flaggy yellow sandy shales, in which are grass-like plants,	3	0
10.	Yellow sandstone,	2	3
9.	Greenish yellow argillaceous grit,	2	0
8.	White sandstone,	1	8
7.	Flaggy arenaceous clay rock, *about*	9	0
6.	Blue shales, with sandy layers, in which are plants,	0	6
5.	Yellow calcareous grits,	2	6
4.	Flaggy greenish yellow clay rock,	1	10
3.	Calcareous sandstone,	0	6
2.	Arenaceous clay rock, *over*	3	0
1.	Yellow and red grits, and clay rocks, with a few shale partings, in which there are plants, *about*	283	0
		428	0

The beds from 14 to 17, inclusive, are highly fossiliferous, containing bivalve shells, encrinites, and corals in abundance. Those from No. 6 to the top of the section are considered to be the *Lower Limestone shale*, while the rest are part of the *Upper Old Red sandstone*. By this section the local gradation from the Old Red sandstone through the Lower Limestone shale into the Lower Limestone, is well exposed.

This section is the only place on the N.W. slopes of Slieve Bernagh that any Lower Limestone shale is seen, as all the country that it should occupy from this to Sixmilebridge (twelve miles on the S.W.), is covered with drift, especially on the S.W. of Bodyke, where it forms esker-like hills.

That the Lower Limestone shale would be found in this strip, if the rocks were exposed, is nearly certain, as the beds near Sixmilebridge, are identical with those at Anamullaghaun; and besides the debris of the shales is found in various places, especially near Doon Lough, where, as before-mentioned, it is considered to be *in situ*.

The Silurian Rocks of the Slieve Bernagh.—The Silurian rocks now to be described are bounded by the Old Red sandstone on the N.W., W., and S. They occupy an irregular triangular shaped tract of country, which is about four miles wide at the east margin of the district, which may be taken as its base, the apex of the triangle pointing towards the S.W.

Knocksnaghta and Knockaphunta.—The rocks in the eastern part of this area are usually well cleaved, while toward the west the cleavage is not well defined, as it generally does not appear. All the beds here exposed

* The thickness is of course calculated from the dip of the rocks on each side of the break.

are twisted and contorted by various flexures and undulations to such an extent, that their relative positions are uncertain; but the rocks that are seen a mile to the S. of Knocksnaghta, seem to be the oldest or lowest down, as an anticlinal curve occurs in them, the northern side of which seems to dip under the rest of the Silurian rocks. They consist of purple and reddish grits, that have usually shale partings between the beds; often there are beds of shale interstratified with them, and some of the grits are green. Those near the Old Red outcrop on the south, dip nearly S. at about 30°, while the rest of the beds have a general dip N.N.W., at angles varying from 65° to 85°. Similar rocks are exposed in the stream (one of the head waters of the Trough River), that runs a little to the west of the hamlet of Corlea, about a mile S.E. of Knocksnaghta. In this section the rocks seem to be undulating in sharp curves over the axis of a large anticlinal curve, and in the stream at the west of Corlea, the apex of the curve is exposed, as the beds in one place dip nearly E. at 45°, and in another S.E. at 65°. None of these purple grits were remarked in the tract of Silurian country that lies to the E. of Knockaphunta, except at the outcrop of the Old Red formation, where they are exposed in the Mountrice River and Sruffaunageeragh. A good junction of the Old Red sandstone and the Silurian is seen in Sruffaunageeragh, and in a quarry by the side of the old road from Broadford to Limerick. There are also good junctions exposed in the three small Silurian outliers that are marked in the streams that flow by Corlea.

The rocks that seem to be above the purple grits just described are black, green, gray, and blue shales, among which are a few purple beds, and a few grits. Many of these rocks are altered by some unknown agency.* The shales are changed into a rock like felstone or a jasperized rock, and the grits into a rock like quartzite or a silicified rock. These altered rocks are well exposed in the vicinity of the old castle that is situated about two miles N.E. of Sixmilebridge, and extend from that in an E.N.E. direction for about two miles. The alteration sometimes affects masses of rock, at other times beds, and often only parts of beds. In the unaltered black shales, fossils abound, especially in the stream that flows from Knocksnaghta to Crag Bridge. These rocks are in general nearly vertical, but some of them dip N. and N.N.W., at angles varying from 50° to 89°, and others S. and S.W. at from 70° to 89°, and in a few instances at about 40°.

On the N. of Knocksnaghta cleavage is found to affect some of the rocks, which consist of gray, green, blue, black, and reddish shales and grits, with a few slates; one bed of fine quartzose conglomerate, seven feet thick, was also remarked.† These rocks are nearly always vertical. The cleavage strikes nearly east and west, and dips S. at 80°.

Knocksise.—Further N.E., at Knocksise, there are hard purple grits, which weather with an imperfect cleavage. Through these are *flying veins* or strings of quartz with micaceous iron ore. At the N. of Knocksise, there seems to be a fault, where marked on the map, which runs S.W. and N.E. On the north of this fault are green grits, and fine quartzose conglomerates, interstratified with which are a few beds or *veins* of slate that were formerly quarried.‡

* Some of these rocks are very like the altered Silurian rocks along the boundary of the granite, in the county of Kildare.—(*See Explanation of Sheet* 128.)

† These conglomerates are very peculiar, being generally composed of equally sized pebbles, about the size of mustard seeds, large pebbles being of rare occurrence. The contained fragments are usually white quartz. They are locally called *porphyries*.

‡ The local terms used in the slate quarries, are as follows:—*Bellies*, curved joints; *cleave*, the cleavage; *concealed joints*, lines in which the slates are inclined to break, but are not conspicuous; *ends*, vertical joints; *poles*, oblique joints; *ribbon*, the lines of lamination; *slant*, the face of a bed; *soles*, horizontal or nearly horizontal joints; *vein*, a bed of slate. When a fault occurs, they say that *the vein of slate is cut out*. Faults and bedding are sometimes called *joints*.

Between Knocksise and the Old Red sandstone, there are green and blue gritty slates and slaty grits. In one place, which is situated about a quarter of a mile due south of Knocksise, and a little W. of a farmstead, they are altered into jasperized and silicified rocks, and stand up in a remarkable conical hill, called Croaghaun, which is surrounded by unaltered rocks.

From Croaghaun eastward to Formoyle along the Old Red sandstone outcrop, the rocks are generally of a purple or reddish colour; a good junction of the Silurian and Old Red sandstone is seen along the new road from Broadford to Limerick.

Knocksise and Huddlestone Slate Quarries.—Between Knocksise and Broadford, many small slate quarries are situated. This locality is all cut up with faults, which prevent any large works from being carried on, the good slate being only found in small patches, locally called *pockets*. In good slates, the strike of the cleavage has a bearing of about E. 25° N., with a vertical dip.* These quarries are, at present (March 1860), worked only on a small scale, four or five hands being employed in each.†

Hill S. of Glenomra.—In the hill between Glenomra and Formoyle fault, there are blue, green, and gray slates, gritty slates, and cleaved grits. They seem to have a general dip of about 50° to the N., although in some places they are found to dip S., S.W., and W. In this hill numerous trials have been made in search of good slate, but without success, although in one place, nearly a mile S.W. of Kilbane, there is a quarry which was formerly worked. The rock in this quarry was very gritty, and could not have been a good slate. The cleavage bears N. 45° W., and dips southward at 60°. The bed of slate is cut off at the north by a fault which gives a downthrow to the N. Above the slate is a line of calcareous nodules that are elongated by the cleavage; at the N. side of the fault there is also another line of nodules that are similarly affected; at the downthrow side of the fault the cleavage dip bends to the fault.

Silurian Rocks N. of Glenomra.—To the north of Broadford, at each side of the old road to Tulla, rocks are exposed. They undulate in sharp curves, and consist of green and gray grits and slates, with a few purple beds. On the east of Broadford, slates were formerly quarried rather extensively. The cleavage strikes from E. 20° N. to E. 30° N., with a dip to the southwards at angles varying from 60° to 65°. A large fault is found where marked on the map, besides which there are numerous other small ones exposed in the different workings for the slate. To the W. of the fault that is marked on the map, the rocks dip N.W. at from 55° to 85°, while on the east of it they undulate to the N. and E., at angles varying from 30° to 70°.

Between this and the east margin of the district there are other sections seen in the mountain streams, the rock exposed being grits, slates, and slaty shales, of a green, gray, and blue colour; fine conglomerates are also found, but these are more plentiful still farther to the east than here. The strata undulate, the strike or dip being rarely found the same in any two sections, although the streams in which they are exposed may only be a quarter of a mile apart. (See Section, fig. 12, p. 22.)

6. *Drift and other Superficial Coverings.*

Drift.—The drift, which is principally limestone gravel and clay, is found scattered over the low country at the north and west of this district, in

* In this range of hills, in the good slates, the dip of the cleavage is vertical, or nearly so, as just stated; while at the Valencia quarries, the cleavage of the good slates has always a low angle (about 20°) of dip.—(*See Explanation of Sheet* 182.)

† The slates are generally classed under two heads, *mosses*, eighteen to twenty inches, by ten to sixteen inches, and *quarters*, twelve inches by six. These are sold at the rate of from ten to twelve shillings per cwt. for *mosses*, and six shillings per cwt. for *quarters*.

patches and elongated hills; while on the slopes and in the valleys of the hills it is always made up, more or less, of either Silurian or Old Red sandstone debris. That all this drift is of the same age seems likely, as it is found to contain numerous syenite pebbles and fragments, and in some places among the hills *running limestone* is found in such quantities that it is collected by the inhabitants for burning into lime. In places in the Ballymacdonnell and Killuran Rivers, which join and empty themselves into Doon Lough, rounded fragments and boulders of limestone are found in great profusion in an Old Red drift; the grits belonging to the latter formation being nearly always angular, or only partially rounded, and some of them over three feet in diameter. In Glenomra there are mounds and ridges, some of which might be called *Eskers*, composed of gravel. The gravel is nearly always made up of Silurian and Old Red sandstone debris, with a few limestone and syenite pebbles; but particles of the Silurian rock are the principal ingredients. In this valley the local drift appears to be part of the regular drift; but as a general rule, all local drift may be taken as aerial, the winter torrents carrying it down and spreading it on the plains and hill slopes.*

The drift on the southern slopes of the Broadford hills is principally Old Red debris, and is of a considerable depth. On some of these hills there are large perched blocks of limestone, one, which must have been about two tons in weight before it was broken, was observed near the old flag quarries at the S. of Broadford, at a height of 650 feet. Small syenite boulders are also found on these hills.

Ice scratches were remarked in numerous places; on the south slopes of Knocksnaghta they run nearly N. and S.; on the hill at the S.W. of Hurdlestown House they bear N. 20° W.; and on the mountain which is crossed by the old road from Broadford to Limerick, they are very numerous, and have a similar bearing. On the hill between Formoyle and Glenomra, the bearing of the ice scratches that were observed ran N. 20° E.

At the northern edge of the map, and N.W. of Tulla, the geological structure of the district is obscured by a considerable amount of drift occurring in rounded heath-clad hills. It consists of reddish-brown clay, and angular blocks of red and yellow sandstone, which are evidently from the Old Red sandstone formation. In the neighbourhood of Spancelhill, to the N.E. of Ennis, are numerous rounded hills, composed of the debris of the limestone of the immediate neighbourhood mixed up with rounded blocks of red and yellow sandstone and conglomerate, and large masses of the cherty limestone, which have been above mentioned as forming a horizon in the Lower Limestone.

Bog and Alluvium.—On the high ground at the S.E. and E. of this district there are mountain bogs which, in some places, obscure the geology of the country; but they are generally very shallow, and only in elevated positions. In the marl under one of these bogs that occupies a small valley, in which the village of Formoyle was built, the skull and horns of an Irish elk (*Megaceros Hibernicus*) were found by Mr. W. Q. Going, of Violet Hill, who informed us that the rest of the skeleton seemed to be there, but on account of the water rising in the marl hole, they were unable to extricate any of it except the parts just mentioned.

On the low ground bogs are of frequent occurrence. They are usually mixed with alluvium, and occupy irregular valleys, which run through the low country with a general bearing of about S.W. and N.E. Bog and allu-

* It is remarkable what a small stream will carry down tons of debris in the course of a single winter. One stream in this district that I specially remarked was, during floods, only 2 feet 6 inches wide, and not 1 foot 6 inches deep, and yet in three or four days of heavy rain, it covered about an acre of a meadow on an average three inches deep, with the debris it carried down. Some of the stones that were carried into the middle of this meadow were nearly a foot in diameter.—G. H. K.

vium occur along the river that flows in the valley of Glenomra. At the west end of this valley, near Violet Hill, some remarkable skulls and bones were found by Mr. Going, of which he gives the following descriptions:—"A skull about twelve inches long, and the shape of the skull of the *Ursus Arctos*. (Fig. No. 1 in the paper read by Mr. Wilde before the Royal Irish Academy, May 9th and 25th, 1859 *see* '*Natural History Review*' *January*, 1860, *Proceedings of Societies, p.* 52) was found about two years ago on the townland of Violet Hill, while opening drains in a boggy hollow. It was in blue clay under the bog, and half or more of the under jaw was with the head. Two large tusks and several teeth were also dug up with it, and several bones lay near it, resembling the bones of an immense dog or some animal of that description. Three or four skulls, about seven or eigth inches long, but rounder, or more like a cat's skull than the figures Nos. 2 and 3 in the paper of Mr. Wylde before referred to (*see page* 54, *ibid*), were found a few years since on the same townland, in a bog under a wood, while raising some very large oak trees; several bones were also got with them, of which unfortunately none were preserved."

In the alluvial flat along the tidal part of the River Fergus, marine shells occur, and the marl found beneath most of the other alluvial flats of the district is chiefly composed of shells, all of the same species as those now existing in it. There is a great waste of the raw material in all the bogs hereabouts, as none of them are properly drained or systematically cut.

7. *Minerals and Mines.*

The minerals occurring in the district included in this map are:—Ores of *iron*, *copper*, *lead*, *zinc*, and *antimony*.

The ores of *iron* are:—*Iron pyrites*, *specular iron ore* (red hæmatite and micaceous iron ore), and *brown iron ore* (brown hæmatite and brown and yellow ochre).

The ores of *copper* are:—*Copper pyrites*, *red copper ore* (?), and *malachite*.

The ores of *lead* are the *sulphide* and *carbonate* (galena and white lead ore).

The ores of *zinc* are also the *sulphide* and *carbonate* (blende and calamine).

The ore of *antimony* is *kilbreckanite* or *geocrinite* (sulphide of antimony and lead).

All the above minerals, except the specular iron ore, are found associated together in the limestone on two geological horizons, one of which is immediately below the Upper Limestone, and the other in the bedded, dark blue limestone, near the base of the Lower Limestone.*

Besides these there are numerous veins of *quartz* and *calc spar*, and rarely veins of *heavy spar* (sulphate of baryta) and *fluor spar* (fluoride of calamine or fluate of lime).

Ballyvergin Mine.—This mine is situated at the north side of the townland of Ballyvergin, and four miles N.N.W. of Tulla, in the lower or stratified part of the Lower Limestone. The lode—which bears N. 10° E., and *underlies* or *hades* to the west at from 45° to 70°—can be traced for 300 yards. It is cut off to the northward by a clay dike or flookan course about six yards thick, which is supposed to bear E. and W., and *underlies* or *hades* N.

The N. and S. lode contains the ores of lead, copper, and sulphur, a little baryta and zinc (*galena, copper pyrites, iron pyrites, sulphate of baryta, and blende*).

* The miners' names for these ores are as follows:—Iron pyrites, *mundic* or *sulphur ore*; brown iron ore, *gaussen* or *gossen*; copper pyrites, *yellow ore*; red copper ore, *red ore*; malachite, *green ore*; blende, *jack*; white lead ore, *cat's-tooth ore*.

We may here also mention that the carbonates of copper, lead, and zinc (*malachite, white lead ore*, and *calamine*), as also the *brown and yellow ochre* and *red copper ore*, seem to be due to the decomposition of the sulphides of iron, copper, lead, and zinc.

The flookan course or clay dike contains blocks of mineral matter, in which are found the same minerals as in the main lode, with the addition of the carbonates of lead, copper, zinc (?), and the oxides of iron and copper (*white lead ore, malachite, calamine, brown and yellow ochre or gossen, and red copper ore*).

This mine has been hitherto worked by the Ballyvergin Mining Company,* who carried their operations down to ten fathoms. At a depth of about six fathoms the lode divides into two parts—the western branch being from three to nine feet thick, and the east from two to four; the portion of limestone rock between them being called by the miners a "*horse*." From the main level side workings or *stopes* have been made successfully. Occasionally small veins springing from the main lode occur, interstratified with the limestone, and are called by the miners *lay under lay*.

About one mile due S. of Ballyvergin mine, near Classagh House, large fragments or *tumblers* of galena were found in the drift, and a trial-shaft was sunk, but no lode being discovered, the work was abandoned. This shaft is known in the neighbourhood as Carrahin mine.

Miltown Mine.—This mine lies on the south side of the road leading from Newgrove to Tulla, about a mile and a-half from the latter. It occurs at the junction of the stratified and unstratified beds of the Lower Limestone.

There is here a large irregular mass of calc spar, with the ores of zinc, lead, and sulphur (*blende, galena, and iron pyrites*) occurring in patches and pockets scattered through the mass of the spar. The workings have been carried on to a considerable extent in the open daylight, in a wide, deep, irregular hole, and the large dimensions and whiteness of the mass of spar present a most remarkable and picturesque appearance.† Similar spar, with associated minerals, has been proved at a point about a quarter of a mile N. of the present workings, as if they formed parts of a N. and S. irregular lode, though the part worked does not at all resemble a true lode.

A nearly E. and W. vein of calc spar can also be traced from the Milton works to a point a little S. of Tulla, a distance of a mile and a-half, but no minerals have been observed, and no trials have been made on it.

Crow Hill Mine.—This mine is situated nearly two miles due W. of Miltown mine, in the townland of Knockaphreaghaun. The lode bore E. and W., and contained galena, mundic, and blende. It was worked to the depth of twenty-two fathoms and all the ore taken, in consequence of which the work was abandoned.

Ballyhickey Mine.—This mine lies two miles S.S.W. of that last mentioned, and one mile and a half N. of Quin. It occurs a little below the junction of the Upper and Lower Limestones. There appears to have been an elongated bunch or pocket of calc spar, containing galena, blende, and iron pyrites, having a bearing nearly E. and W., with a small N. and S. cross course. Open works were carried on to a depth of thirty feet, with a width of fourteen feet from N. to S., and a length of from twenty to thirty yards. The mine is now abandoned, as all the profitable ore was extracted.

Kilbreckan Mine.—This mine lies one and a-half miles N.W. of Quin. There appears to have been here a nearly vertical main lode, varying in thickness from one to three feet, and running N. and S.; and also a cross-lode or course, nearly vertical, having a direction N.W. and S.E., and varying in thickness from fourteen inches to four feet. Shafts were sunk as follows:—One on the main lode, to a depth of fourteen fathoms; two on the cross-course, at the respective depths of twenty-two fathoms and thirty

* They are now abandoned (November, 1861).

† In the mass of the spar at the open work of this mine there are small patches of limestone which are often fossiliferous.

fathoms. The richest ore was got by the latter; sixty tons of ore were obtained in a month by thirty miners.*

The minerals occurring in Kilbreckan mine were argentiferous galena, iron pyrites, copper pyrites, blende, calamine, and Kilbreckanite, besides calc spar in abundance. This mine was abandoned on account of the works being inundated.

About half a mile to the N., in a craggy field, strings or small veins of galena and blende occur in the limestone. This may be an indication of the continuation of the main lode. The indication at Kilbreckan, before the shafts were sunk, was the occurrence of numerous large blocks or "tumblers" of galena in the drift. Besides the worked mines, indications of ore have been observed at the following places :—

At the east side of Moyriesk Lough stains of lead occur.

At the edge of a small bog half a mile N.E. of Newmarket-on-Fergus are veins of calc spar containing galena and mundic.

On the south side of the road, about half way between Rosroe Lough and Kilmurry, is a small vein of spar with stains of lead. This may be the continuation of a fault which appears to the north, between Rosroe Lough and Lough Nanillaun.

At Rathlaheen West, about one mile S.E. of the Ballycar Railway Station, is a small vein of calc spar, in which lead and sulphur ore was proved.

In the Lower Silurian rocks mineral indications were observed in the following localities, but none of them seem to be of much, if any, promise.

Two and a-half miles N.E. of Sixmilebridge, and a little to the N.W. of the trigonometrical point 875, there is a trace of *copper and iron pyrites*. On the northern slope of Knocksnaghta there is a *flookan course*, with strings of spar, in which specks of copper and iron pyrites were observed. Two miles to the N.E. of Knocksnaghta, in the townland of Ballykelly, there is micaceous iron ore in *flying veins of spar*.† Near the centre of the eastern margin of the district there is also a *flookan course*, in which are strings of spar that contain specks of iron pyrites and a trace of copper. A shaft, as I was informed by the proprietor, C. Naish, Esq., was opened on this lode about 100 years ago, and since it has gone by the name of the *Shannaknock Mine*. Other small veins are seen on the south of this, which afford peroxide of iron. About three and a half miles due north of the Shannaknock Mine there is a lode about two feet wide, that bears S.W. and N.E., and *hades* southward at 88°. It seems to have been driven on a little, and is remarkable for the quantity of peroxide of iron that runs from it.

G. H. K. and F. J. F.

[Since the Explanation of Sheet 134 was printed off, Mr. Wynne has received from Mr. Garvey, agent for Lord Bloomfield's property, some additional information respecting the mine formerly worked at Ballyhourigan, about a mile to the E. by S. of Kimalta Lodge, on the west side of the Keeper Mountain.

It is said that two shafts were sunk to the depth of forty feet and thirty-five feet, and a level driven thirty yards in one direction and eleven yards in the other, along the course of a lode running E. and W., which was said to contain a vein of copper ore four inches wide.

Some old workings for copper were also made on the lands of Aughavahier, or Coolrunther, in Glen Colloo, N. by E. of the above-named place, two small shafts being sunk a few feet, and a small driving made.—J. B. J.]

* This information, as well as of Ballyhickey mine, was received from an intelligent man named John Conlan, who formerly worked in Kilbreckan mine.

† At the first-mentioned place there were trials and opencasts made unsuccessfully. At Knocksnaghta the proprietor, Mr. George Samson, opened a trial shaft, and informed me that he found specimens of *galena*. At Ballykelly there was a trial opened, under the supposition that the veins contained lead ore.—G. H. K.

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