EXPLANATIONS

TO ACCOMPANY

SHEET 135 OF THE MAPS

OF THE

GEOLOGICAL SURVEY OF IRELAND,

ILLUSTRATING PARTS OF THE

COUNTY OF TIPPERARY AND OF KING'S AND QUEEN'S COUNTIES.

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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, or in preparation.

Condensed memoirs on particular districts will also eventually appear.

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

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EXPLANATIONS

TO ACCOMPANY SHEET NO. 135

OF THE MAPS OF THE

GEOLOGICAL SURVEY OF IRELAND,

ILLUSTRATING PARTS OF

TIPPERARY, AND OF KING'S AND QUEEN'S COUNTIES.

General Description.

The district included in this sheet of the maps comprises a large part of the North Riding of Tipperary, and smaller parts of the King's county on the N., and Queen's county on the N.E.

The only town within its limits is Templemore; the principal villages are Borrisoleigh, Templetuohy, Moyne, Toomyvara, and Moneygall.

1. *Form of the Ground.*

There is a large, irregular, almost circular, group of hills occupying the ground included in the parts of Sheets 145, 144, and 134, which are adjacent to Sheet 135.

These hills, on entering the limits of Sheet 135, assume more of a linear arrangement, and run from S.W. to N.E. right across the area of the map. They have no general name, but we have spoken of them as the Kilnamanagh Hills when describing the district of Sheet 145. Further to the S.W. they are called the Bilboa and Slieve Phelim Mountains. The Keeper Mountain, 2,278 feet, is their loftiest point. The part within Sheet 135 might perhaps be called the Devil's Bit range.

They are generally remarkable for their want of any definite direction in their crests, presenting a number of isolated round-topped summits, with irregularly confluent bases, separated by many open winding valleys. They preserve the same character on entering Sheet 135. There is one hill of 1,334 feet, without a name, close to the S.W. corner of the map. Two or three miles to the north of it are Ballincurra Hill, 1,333 feet, and Knockadigeen, 1,323 feet. For six miles N.E. of the first-mentioned point the ground never attains a height of 1,000 feet; but farther in that direction we get Knockanora, 1,429 feet, and Kyraun Mountain, 1,521 feet. Two miles N.W. of Knockanora is Latteragh, 1,257 feet, and two miles E.N.E. of Kyraun is the Devil's Bit Mountain, 1,583 feet, the loftiest point within the limits of Sheet 135. From this point there is a continuous ridge of

more than 1,000 feet in height for three miles to the northward, having on it Kilduff, 1,462 feet, Borrisnoe Mountain, 1,471, a nameless point of 1,519, and ending in Benduff, 1,399 feet, which looks down on the village of Moneygall. There is one point of 1,012 feet N.E. of Benduff, but beyond that the ground is lower, and of a very different form, the high lands being broad undulating rocky moorlands rather than hills. There is a point near the northern margin of the map 779 feet high, and another of 754 feet, known as Bawnadrum, in the N.E. corner of the map, the two having a wide flat valley between them.

Fig. 1.

The Devil's Bit from the North.

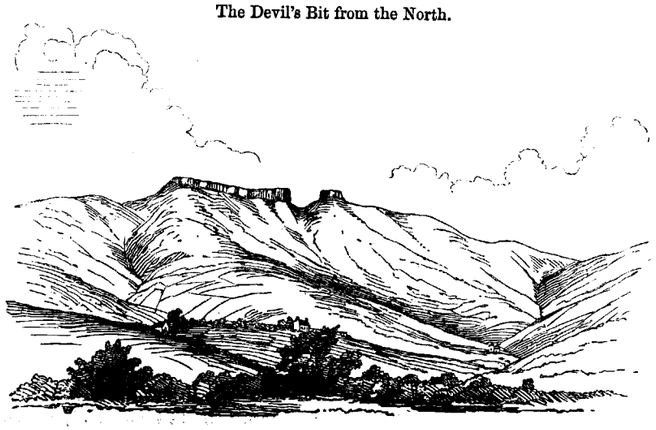

Fig. 2.

The Devil's Bit from the Southward, distant about 5 miles.

The hills have a very different aspect according as they are viewed from the N.W. or the S.E. From the N.W. they seem, as they do farther S., a number of rounded, isolated hills, separated by winding valleys of greater or less width. Looked at from the S.E., however, they have a more definite outline, and a steeper and more unbroken slope. Their aspect here is striking and picturesque, Knockanora forming a flattened irregular cone, Kyraun an indented hog's back, and the Devil's Bit a table top, the thick slab which forms the table having a slight tilt towards the S.E., and a gap or notch near its southern end, in shape like a large bite out of a thick slice of bread.* North of this is a long flat-topped ridge, with a steep slope to the east.

The watershed of these hills is part of the main watershed of Ireland, which here separates the basin of the Shannon from that of the Suir, Nore, and Barrow. It is much nearer to the eastern than to the western boundary of the hills, entering the map precisely at its S.W. corner, and then running with an undulating line over Knockanora, Kyraun, the Devil's Bit, and Benduff, and thence to the point of 779 feet, mentioned before as occurring near the northern margin of the map. The lowest ground crossed by this line of watershed is in the little pass through which the road runs from Borrisoleigh to Nenagh, a little to the S.E. of Cullahill Castle, where it is not more than 450 feet above the sea. This pass leads into a wide valley, with branches spreading for some miles among the hills, and forming the upper basin of the Nenagh River, which issues from it by another little pass above Garrane Mill on to an alluvial flat between Knockacraheen and Latteragh Hills. Between Knockanora and Kyraun is another pass, leading into the broad valley of the Ollatrim River; but the watershed in this pass does not sink below a level of 600 feet. The point where the road from Templemore to Moneygall crosses the watershed, near Honeymount House and the old Castle of Ballynamoe, probably exceeds this altitude, but there are no heights marked near it on the Ordnance Maps.

The width of the Devil's Bit range is about six miles, and it has on each side of it a low, gently undulating country, part of the great central plain of Ireland. The part to the N.W. (sometimes called the Plains of Ormond) has a mean altitude of probably about 320 feet, the Nenagh River being 270 feet where it leaves the district on its way to the Shannon. The plain to the S.E. may have a mean level of 400 feet, the main street of Templemore being 380, and the water of the Suir, where it issues from the district, being 330 feet above the sea. Some detached hills rise here and there from this plain, of which we may mention College Hill, 612 feet, three miles north of Templemore, and Knockhahaw, 656 feet, four miles N. by E. of Templetuohy.

The little River Nenagh, a tributary of the Shannon, and its own tributary, the Ollatrim, have already been spoken of as rising in the heart of the hills, and flowing through them towards the west.

Two rivers of more importance, however, spring from the eastern flank of the Devil's Bit range. Three little brooks run down the eastern slope of Borrisnoe Mountain, and uniting at its foot form the River Suir. Two miles north of that two or three other little brooks

* The popular saying about this gap is, that the Devil was once driving a herd of mountain cattle from the N.W. across the ridge, and one young one becoming fatigued and unable to cross it, he bit out this gap to facilitate her passage, and forgot to drop the piece till he got about 20 miles to the southward, and that this mouthful formed the rock of Cashel. The geologist without at all impugning the literal truth of the story, may be permitted to add to the popular admiration of the size of the Devil's mouth, his own peculiar wonder at its metamorphic action, since it appears in this case to have transformed red sandstone and conglomerate into good gray limestone.

similarly unite to form the commencement of the Nore River. These two rivers, thus springing so close to each other, and having at one point but a very slight rise of ground between them, diverge so that the Suir flows S. to the foot of the Knockmealdown mountains, while the Nore runs N. to the neighbourhood of Mountrath, places full 50 miles apart, only to unite their waters at last in Waterford Harbour.

J. B. J.

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2. *Formations entering into the Structure of the District.*

AQUEOUS ROCKS.

		Name.	Colour on Map.
		Bog, Alluvium, and other Superficial Deposits,	*Sepia.*
		Drift (Limestone gravel),	*Engraved dots.*
Carboniferous.	d^4	Upper Limestone,*	*Prussian blue.*
	d^3	Middle Limestone,	
	d^2	Lower Limestone,	
	d^1	Lower Limestone Shale,	
Old Red Sandstone.	c	Old Red Sandstone,	*Indian red.*
Silurian.	b	Lower Silurian, probably Caradoc and Bala Beds,	*Purple.*

IGNEOUS ROCKS.
None.

b. *The Silurian Rocks.*—These rocks, as a mass, are argillaceous and slaty, but true roofing slates are seldom found among them; coarse grits and siliceous sandstones of considerable thickness, and with a massive appearance, are frequently met with; the predominating rocks, however, are sandy shales, sometimes thick, and having a concretionary structure, but very frequently thin and regularly bedded, when they might be more properly called a fine-grained flagstone. These rocks are generally bluish or gray, and sometimes dark gray, many of them effervesce with acids, and most of them are slightly ferruginous. Under the action of the weather they all assume for some depth a yellowish or brownish colour different from that which they have when broken into, and they may be often recognised from a distance by their peculiar rusty tinge.

Several of the more massive grit beds exhibit, where they are laid open by large fractures, a conchoidal fracture on a large scale, causing these blocks sometimes to assume rather fantastic looking forms.

In the flags and hard grit beds, particularly in those most liable to change under the action of the atmosphere, graptolites, orthoceratites, and other fossils have been found; they will be more fully noticed further on.†

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* It has been found impossible in this district to separate the limestone into these subdivisions with sufficient accuracy to allow of their being drawn and coloured.

† The Silurian rocks of this district seem to be much more fossiliferous than those of the adjoining country lying to the S.W., and represented upon Sheets 134, 144, and 145.

A. B. W

There seems to be no division of the Silurian rocks indicated by the stratigraphical position of the different beds, and it can only be said that the hard grit rocks appear to occur more frequently in the S.W. part of the district.

At several places where the Old Red sandstone rocks are visible near the Silurian, the latter seem to be altered, perhaps, by infiltration from it, and here they have commonly a reddish tinge.

The thickness of the Silurian rocks is unknown, but it must be very great, as they form very considerable hills and large masses of ground, with the beds often at very high angles, and none of the sections expose any lower rocks, nor any thing which we can look upon as either the top or the bottom of the formation.

The following is a list of the localities where fossils were observed in the Lower Silurian rocks:—

List of Places in the Silurian where fossils were observed to be locally numerous or peculiar.

Army Hill.—About a mile south of Moneygall, near the height marked 821: corals and crinoids in coarse grits or fine conglomerate beds; dip N. 40°.

In Stream passing by Whitefield.—Close to the name BORRISNAFARNEY: chiefly graptolites, in flaggy beds.

In Stream from Kilduff, westward, passing by a ruined church: chiefly graptolites, with some shells, in flaggy beds.

Between Kilduff and Curraghbristy.—On the high ground near the latter: crinoids and shell fragments in weathered grit; dip N. 35°.

In Stream leaving Kyraun, running S.W. towards Ballyhoul, one of the head waters of the Ollatrim River: Graptolites abundant in places in flaggy beds; dip N. 40°.

North of the o and South of the s in Killoskehan.—Orthoceratites, graptolites, and bivalve shells, in flaggy beds; dip. N. 70°.

North of the G in Barnagee.—Curious markings on beds (? organic).

At W. extremity of Killoskehan Parish.—Graptolites in flaggy beds; dip. S.E. 70°.

N.W. of Glenkeen Glebe, on old road to Killanafinch.—Graptolites numerous, with some shells in flaggy beds, and beds of gray thin calcareous grit; dipping N.W. 55°.

Near the top of Knockanora.—Crinoidal fragments abundant, in weathered gray grit; dip, N.W. 35°.

S.W. of the name Knocknabrogue, and S. of the E in LATTERAGH.—Crustacean (?) tracks on surfaces of fine greenish gray hard shaly beds; dip. N. 30°.

W. of the name Knocknabrogue, and S. of the R. in LATTERAGH.—Graptolites abundant, thickly accumulated on surfaces of fractures, parallel to bedding planes, in weathered gray flags.

E. of Latteragh Hill. Orthoceratites and tubular (?) annelidan tracks in flaggy beds; dipping N. by W. 65°.

By the road side and in stream, S.E. of Garrane Mill, graptolites, large orthoceratites in concretions, and shells; all in shaly, slaty, and flaggy beds; dips various.

In Glen, S. of Knockadigeen; Graptolites in flags, dipping S. 25° and 60°

Near the n in the name of the Monaha Glen River.—Graptolites in flaggy beds.

Where the main road to Borrisoleigh, S.E. of Cullahill Castle, turns NE.—(?) Organisms, appearing like small punctures on faces of finely laminated flaggy beds.

c. *Old Red Sandstone.*—This group is represented by certain beds of coarse red and whitish sandstone, with conglomerates in its lower part. Some red shales also appear, but hard whitish sandstones are more frequently met with. Associated with these are some cornstones, and in one place a thick deposit of this kind is so highly calcareous as to have been burned for lime.

The thickness of this group can be but imperfectly ascertained, and it appears to vary in different parts of the district. Near Borrisoleigh it is probably about 500 feet, but in the north-eastern part of the district it seems to have a considerably greater thickness, though this appearance may be due to mere accidents of position, such as the beds undulating gently over the ground.

d. *The Carboniferous Rocks* are represented by a great series of beds of the characteristic limestone, usually pale or dark gray, with beds or partings of black shale, interstratified with many of the more earthy kinds of limestone. Some of the beds are distinctly oolitic, almost as much so as Bath or Portland stone, but with small crystals of calcite dispersed among the little concretionary grains.

d^1. *The Lower Limestone Shale* has not been observed anywhere within the district. It is, therefore (although probably represented by a few beds of shale) not coloured on the map.

d^2. *The Lower Limestone*, or that which is nearest to the Old Red sandstone, consists of a quantity of dark-coloured, earthy, shaly, and crinoidal limestone. Paler and more massive limestones are sometimes associated with it, and some of its beds are fine examples of oolitic limestone; but even these, although possessing a marked appearance, it has been found impossible to trace connectedly through all their flexures. As the inclinations of these rocks are nearly always at low angles in various directions (although generally a tendency to dip from the mountains may be observed) it is not improbable that in a country so much acted upon by denudation, lower beds may often reappear amongst the higher ones; and we can only say that generally the limestones most distant from the mountains seem to have a paler appearance, and slightly different aspect from those nearer to their foot; but no cherty zone or band was observed marking a separation between any of the limestone beds appearing upon this map. Magnesian limestone occurs in some localities, but no large space is occupied by it, and its occurrence, on the whole, is rather rare. The thickness of the limestone must be very considerable, certainly many hundred feet, but no accurate measurement of it can be made, nor any more precise estimate given.

A. B. W.

3. *Palæontological Notes.*

The following is a list of the species collected at the several localities by Mr. Wynne:—

Army Hill, King's county, Sheet $\frac{46}{3,4}$.

Stenopora fibrosa, *Goldfuss.*
Favosites Gothlandica, *Linnæus.*
Petraia sp. ?
Fenestella ?

Cloncannon, county of Tipperary, $\frac{22}{4}$.

Graptolithus priodon, *Bronn.* ×
Cucullella angulata, *n.s. Baily.* Fig. 2.

Borrisnafarney, county Tipperary, $\frac{22}{4}$.

Graptolithus priodon.

Castle Otway, county Tipperary, $\frac{27}{4}$.

Graptolithus priodon. ×
Orthoceras elongato-cinctum? *Portlock* sp.

Big Park, near Latteragh, county Tipperary, $\frac{27}{4}$.

Graptolithus priodon. ××
Cardiola ?
Orthoceras elongato-cinctum?

Knocknabrogue, county Tipperary, $\frac{28}{3}$.

Orthis sp. ?
Orthocerus elongato-cinctum?

Knockanora, county Tipperary, $\frac{28}{3}$.

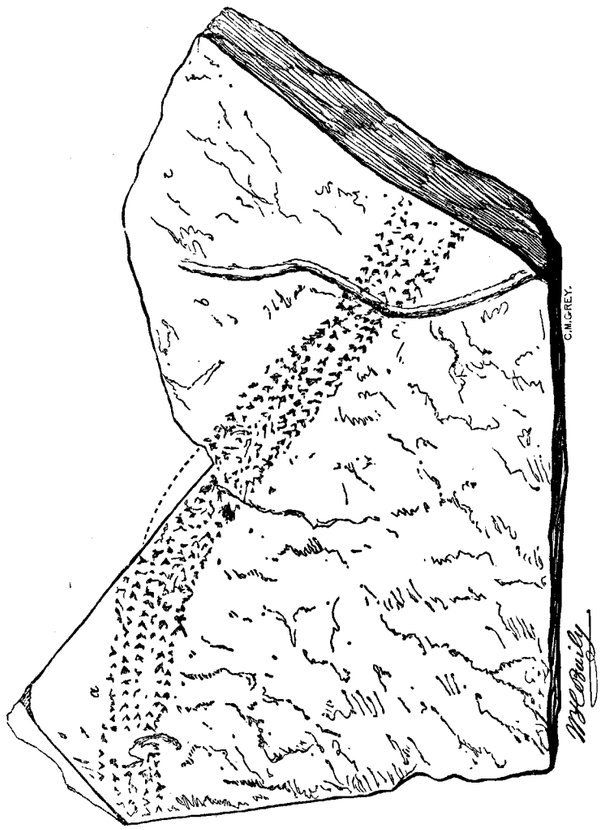
Crinoidal fragments abundant in weathered gray grit.

Townland of Glenmore, county Tipperary, $\frac{28}{4}$.

Crustacean (?) tracks and annelide markings. Fig. 1, p. 11.

At this locality the fragment of a slab was collected of a very interesting character. Fig 3 represents this specimen of the actual size, the surface showing about five inches of a continuous gently curving band of the casts of a series of impressions or tracks made by some marine animal, perhaps a small crustacean. These markings are very numerous and closely arranged, forming about six rows, and occupying a space of about half an inch in width. They are but about the twentieth of an inch broad, and of an angular character (*a*). At one part of their course they cross a long, rounded, and slightly curved furrow, which was probably an annelide burrow (*b*). The surface of this slab, which is a very fine-grained indurated calcareous mud,

Fig. 3.



Natural Size. *a.* Tracks of marine animals, probably crustacean. *b.* Annelidan. Lower Silurian, townland of Glenmore, $\frac{2}{4}$, County of Tipperary (S.W. corner of the map).

of a dark olive green colour, although apparently uniformly even, presents on close inspection various little channels, as if caused by a receding tide.

N.W. of Killoskehan, county Tipperary, $\frac{28}{4}$.

Annelidan (?) tracks.
Orthoceras pseudo-regulare, *Portlock*.

Near Gortagarry, county Tipperary, $\frac{28}{4}$.

Orthoceras elongato-cinctum? ×

Killoskehan, county Tipperary, $\frac{28}{4}$.

Greenish flags, with impressions of rain prints, and burrows of Arenicolites (?) on the surface.

Rossmulteeny, county Tipperary, $\frac{34}{1}$.

Graptolithus Sedgwickii (?) *Portlock*.

Garrangreen, county Tipperary, $\frac{34}{1}$.

Graptolithus priodon.
Graptolithus tenuis, *Portlock*.
Cardiola interrupta, *Sowerby*.

As a group, these fossils are of a similar character to those noticed in the explanation to Sheet 145, and evidently belong to beds of the same Lower Silurian age. The prevailing forms are those of Graptolites, which are abundant at nearly all the localities examined. Most numerous amongst these is the Graptolithus priodon, a wide ranging species, accompanied by the rarer forms of G. tenius, and the curved terminations of G. Sedgwickii (*convolutus of Hisinger*.)

A very few bivalve or univalve shells were met with. Several specimens of an Atrypa (undetermined), and a new species of Cucullella, were the only ones noticed; the latter I have named C. angulata, fig. 4. This small shell has both valves united and spread out;

Fig. 4.

Cucullella angulata, n.s. Lower Silurian. Cloncannon, Co. Tipperary, $\frac{28}{4}$.

the straight hinge line forming an obtuse angle with the anterior portion of the shell, serves to distinguish it from any other species. It has a gentle depression posteriorly, and a corresponding rise next the hinge line, and the surface is marked by faint lines of growth. The outline of the posterior end, which is imperfect, has been restored with dotted lines.

The other organic remains consist of crinoidal fragments, a few small corals, and an abundance of orthoceratites, mostly smooth and tapering species (identical with that figured on p. 12, fig. 3, Explanation to Sheet 145), and doubtfully referred to Orthoceras elongato-cinctum, *Portlock*.

Surface markings, showing what appear to be the tracks of annelides, ripple marks of a peculiar character, and impressions very similar to the rain prints figured by Mr. Salter from the Cambrian Rocks of the Longmynd,* are accompanied, as in the specimens he describes, by small orifices, occurring in pairs, like those he believes to be the burrows of Annelides, and names *Arenicolites*.

With respect to the evidence derivable from these fossils as indicative of their position in the Silurian series, it would appear from the majority of the species being identical with those from the rocks at Desertcreat, county Tyrone, described by Colonel Portlock, that the rocks of the two districts must be nearly or quite contemporaneous.

The Tyrone slates are stated by Sir R. I. Murchison, in his last edition of Siluria (1859) to be of the same age as the Bala and

* Journal of the Geological Society of London, vol. 13, 1857.

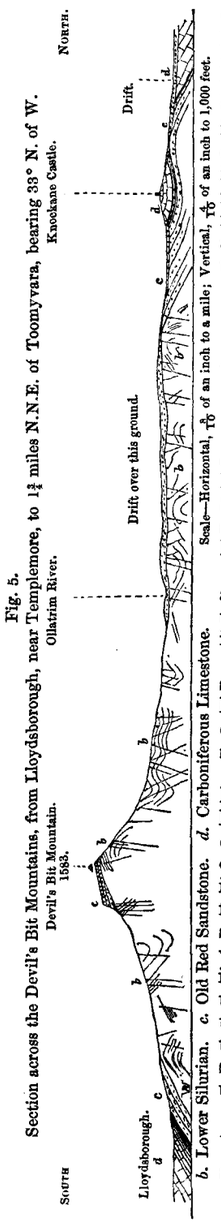


Fig. 5.

Caradoc beds. From the wide range in geological time of such species as Stenopora fibrosa, Favosites Gothlandica, Graptolithus priodon, Orthis elegantula, Orthoceras Ibex, O. tenuicinctum, and Cardiola interrupta, all included in this collection, no more definite conclusion can be drawn, than that as all occur in strata of the Caradoc and Bala period, we may be safe in considering the beds in Tipperary from which these fossils were obtained as most probably belonging to that division of the Lower Silurian series.

W. H. B.

June 14, 1860.

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4. *Relations between the Form of the Ground and its Internal Structure, and general account of the latter.*

The hilly ground which crosses the map diagonally, and which we may designate the Devil's Bit range, is composed partly of Lower Silurian rocks and partly of Old Red sandstone. The plains on each side of it are underlaid by the Carboniferous limestone.

The rocks of the low ground, and the flanks and valleys of the hills, are, to a certain extent, covered and concealed by great but irregular accumulations of drift.

It does not follow, however, from the above statement, that there are no hills formed of limestone, and no low ground having immediately beneath it Lower Silurian or Old Red sandstone.

The detached hills called College Hill and Knockahaw, previously mentioned, consist of limestone. The first is gently and symmetrically rounded, its base being smoothed and concealed by deep drift. The latter, however, is much more bare, and has the characteristic form of a limestone hill, a steep, rounded, but slightly terraced brow on the side towards which the beds rise, and a long gentle slope in the direction of their dip.* This characteristic form would be much more frequently to be observed in Ireland if it were not for the general lowness and flatness of the limestone ground, and its being so largely buried under the drift.

The rounded, gently swelling outlines of

* See the Sketch of Killough Hill in Explanation to Sheet 145.

the hills formed of the Lower Silurian beds show that they do not contain any bulky trap rocks, or other large parts, of such a different constitution from that of their general mass as to offer greater resistance to the action of denudation, and, therefore, to stand out as prominent features.

The peculiar table-topped outline of the summit of the Devil's Bit, on the other hand, at once arrests the eye, and shows that it is of a different constitution from the surrounding rocks. (*See* figs. 1 and 2, p. 6). We accordingly find on examination that it is composed of a thick isolated or outlying slab of Old Red sandstone, consisting of thick beds of red sandstone and conglomerate, resting quite unconformably on the upturned and denuded edges of the Lower Silurian slates (or indurated shales) and grits. A similar outlier of Old Red caps the summit of Kilduff. (*See* Detailed Description, p. 26).

The remarkable change that takes place in the form of the ground north-east of Borrisnoe and Benduff is likewise coincident with a change in the nature of the subjacent rock. In the comparatively lower ground towards the N.E. the Old Red sandstone sweeps completely across the range from one side to the other, and forms the broad, craggy, heathery moorlands that prevail there, instead of the loftier and more grassy hills and deeper valleys of the Lower Silurian* country.

From this part of the range where the Old Red sandstone sweeps over it, a narrow band may be traced south-westwards on both sides of it, along which the Old Red occasionally shows itself between the Lower Silurian rocks and the Carboniferous Limestone. In each case it dips from the hills beneath the limestone of the plains, and seems to form a coating upon the uptilted and broken edges of the Lower Silurian beds, as if to form a floor for the reception of the Carboniferous Limestone.

There are, indeed, several spaces along these two bands of Old Red sandstone where the ground sinks so low, and is so much covered with drift, that no portion of that rock is to be seen sometimes for two or three miles. There is, however, no known instance within the district of any total thinning out and termination of the Old Red sandstone—no place, that is to say, where the Carboniferous Limestone can be seen in direct junction with the Lower Silurian rock. It is therefore most natural to suppose that these bands of Old Red sandstone are continuous, especially since whenever any rock at all is to be seen in their line of strike the Old Red is found in its proper place. On the N.W. side of the range, about Toomyvarra, the Old Red sandstone, after dipping from the hills, rises again in a low undulation, spreading for nearly two miles to the west, and including a little outlying basin of limestone upon it.

There is one remarkable conclusion to be drawn from this apparent persistency of the Old Red sandstone, from its stretching conti-

* The great induration of the Old Red sandstone of Ireland, its sandstones being hard quartzose grits, and its clays made into hard shale, and often cleaved into slate, makes it contrast singularly with the soft fertile Old Red of South Wales and England. In South Wales the Silurian hills are the more barren ones, being often covered with heather, while those of Old Red, as in the Brecon Vans, wave with grass up to their summits.

J. B. J.

nuously across the range of hills where these sink below a certain level, and from the existence of the outlying patches of it, which rest upon the summits of Kilduff and the Devil's Bit, and that is the probable former continuity of it over the whole area of Sheet 135.

As in all the parts of Ireland, south and west of this district, the Old Red sandstone always makes its appearance wherever the base of the limestone rises to the surface, we may feel sure that it is continuous beneath the limestone over all that area. Now, as wherever the Old Red sandstone rises to the surface, its beds end abruptly at the surface, their termination being evidently the result of the action of denudation that produced that surface, it is clear that they once continued for some distance, at least, above the present surface, and the considerations just referred to lead us directly to connect all its outlying patches and broken outcrops into one originally continuous sheet.

The same arguments, moreover, hold good with respect to the limestone itself, so that we cannot escape from the conviction that the beds of that formation were once continuous over the whole area of the Old Red sandstone; and again, that the Coal Measures spread over the whole limestone. This, however, would lead us beyond the limits of the area we are now describing.

We may feel sure that when these Upper Palæozoic beds were thus continuous, the surface of the ground (whether above or below the present level of the sea), was very different from its present surface. The Carboniferous rocks and subjacent Old Red sandstones must have spread originally in horizontal layers across the whole country, resting unconformably upon the uneven surface of the edges of the Lower Palæozoic beds. That old surface thus deeply buried in the earth had itself been produced by long past actions of elevation and denudation, which had been succeeded by a period of depression, during which it sunk beneath the sea and had the Upper Palæozoic rocks deposited over it. How long this period of depression and deposition endured, or what pause may have taken place at its close, we have no means of determining. Some time subsequently, however, elevation and consequent destruction and denudation again resumed their activity, operating under and over the whole of the British Islands apparently at the same time. The once horizontal beds were thrown into great undulations, long ridges and troughs running parallel to each other often for many miles, but sometimes changing their direction, or being interrupted by areas of dome-shaped uplifting, or basin-shaped depression.

It would naturally happen in the majority of cases that the ridges and domes would be the first parts brought within the reach of the destructive action of the sea level, and, consequently, be the parts where the denudation was commenced. As these parts continued their slow and gradual rise, they would be as gradually worn down, and coat after coat denuded off them. But as the rise went on it is clear that the denuding action would spread further and further, so that ultimately the whole area would suffer from it, more or less.

The Devil's Bit range was probably one of the ridges we have supposed above, the beds being bent up over a line running nearly N.E. and S.W. across our area, and the beds denuded off it till at last

the old Lower Silurian surface was brought to light again in places by the entire removal of the Old Red sandstone, and even an additional excavation carried out beneath some parts of that surface to produce the present valleys in the Lower Silurian rocks.

We have in this area no direct evidence to show us the geological period when this great denudation of the Upper Palæozoic rocks took place. Judging by analogy, however, from the age of similar denudation in other parts of the British Islands, it was probably before the period when the New Red sandstone was deposited.

Additional denuding action may doubtless have taken place at subsequent periods, and some little trifling effect may have been produced by the currents and icebergs of the Pleistocene Sea, which flowed over Ireland in the age immediately preceding our own.* Even if we attribute, however, to this comparatively very recent period, such an amount of denudation as would suffice for the production of the loose superficial blocks, gravels, sands, and clays, which we speak of collectively as the Drift, it is at once obvious that such an effect sinks into the most utter insignificance when compared with that much vaster and more ancient denudation, which has removed beds of rock many thousand of feet in thickness, not only from the area we are now describing, but from almost all Ireland and large parts of England and Scotland.

After what has been said we need use but few words in order to give a general notion of the relative position of the rocks. Any one looking at the map, and recollecting that the purple colour represents the lowest group of rocks called Lower Silurian, the blue colour the highest group the Carboniferous Limestone, and the Indian red the Old Red sandstone lying between them, will see that the rocks have been brought up in an arched or anticlinal form, the imaginary central line or axis of which runs N.E. and S.W. across the map. From this line the upper rocks dip, or incline downwards, on either hand towards the N.W. and S.E. respectively. While this is the true general position and lie of the rocks on the large scale, there are also a number of minor undulations in different directions, which ride as it were on the backs of the larger one, as the ripple roughens the surface of the larger slopes of the swell of the ocean.

J. B. J. and A. B. W.

Detailed Description.

[The whole of this district was surveyed by Mr. A. B. Wynne.—J. B. J.]

5. *Position and Lie of the Rocks.*

Lower Silurian Rocks.—The detailed description of the district will be commenced at the S.W. corner, proceeding thence towards the N.E. through the hilly country occupied by these rocks. In this neighbourhood, generally speaking, more hard and massive grit rocks are to be met with than in the localities lying to the northward. Good examples of them may be seen along the Clodiagh River on both banks projecting from the higher grounds, and frequently appearing along the new line of road which runs beside the

* It must be understood that the expression, "the age immediately preceding our own," does not, to my mind, preclude the notion of its having been many millions of our years ago. J. B. J.

river up the valley. They are always of either a pale or dark gray colour, and are sometimes cleaved in a direction bearing about 10° S. of E. The inclination of the cleavage planes being either about 70° to the N. or nearly vertical.

In a small quarry on the new road, opposite to where a stream falls into the River Clodiagh, near the final r in the word "river," a set of planes resembling a coarse cleavage were observed to strike nearly through N. and S. with an inclination to the W. of 80°; and this structure was again observed with a strike of 30° E. of N. on the roadside, between two small plantations south of the first E in Glenkeen, and nearly in line with the strike of that first alluded to, but the inclination is different, being here to the E at an angle of 85°. In the neighbourhood of the place where the latter observation was made, and indeed in many other places along the high ground, immediately N. of the Clodiagh, gray and dark gray shaly and flaggy beds occur, but with inclinations and directions so various that a better idea of these will be formed from an examination of the map than could be conveyed by describing them more in detail.

In the vicinity of the name Templederry, a number of arrows will be observed upon the map, most of them being situated to the N. of it; and where these occur, dark bluish gray strong grits and gritty shales, with some flagstones, will be found. They are sometimes cleaved in a direction bearing 20° N. of E.; the planes inclining to the N. at different angles up to 60°. Some of the thin flaggy beds amongst these contain fossils consisting chiefly of graptolites or fragments of crinoids; their positions are indicated on the map by asterisks.

North of the latter part of the name Templederry a large vein of quartzose breccia occurs probably occupying the space between the sides of a fault or fissure.

On the high ground, S.E. of Cloghinch old bridge, some thick bluish gray grits, associated with flaggy beds containing fossils, were observed; and on the roadside near a farm-house and two little patches of wood S. by W. of the height marked 717, the exposed thickness of one of the hard grit beds measured twelve and a-half feet, without exhibiting any separation that could be called a line of bedding. Close to the bridge some slaty flags appear in the river; and a little further down, between this and the new bridge, some vertical flags, containing graptolites, cross the river at right-angles to its general course.

In the wide valley through which the Moanaha Glen River runs a quantity of drift conceals the rocks, except in the river itself near Latteragh, and in some few other places where some knobs of gray flaggy or gritty rock approach the surface or project through the drift. Where these occur, symbols will be found upon the map. Where the high ground that rises behind Castle Otway is crossed by the pass called Ormond Stile, near the W. margin of the map, some hard thick grits, containing strings of quartz, with fine bands of striped flagstone, and some slaty beds, are well exposed. These and similar rocks dip at high angles to the N. or N.W. on the top and south side of the ridge running from Ormondstile to the narrowest part of the glen through which the Nenagh River finds its way into the plains of Ormond. This dip may be observed particularly south of Knockadigeen. Near Killavella wood, and upon Knockacraheen hill, gray grits, shales, fine grained flagstones, and slates are frequently seen at the surface of the ground; they appear to be much contorted on the sides of the hills overlooking Castle Otway, where the flaggy beds contain graptolites; but on Knockacraheen Hill a dip to the west of from 15° to 40° was taken, and part of a bold convolution in these beds projects from the end of the ridge over Lacken Bridge, near the summit marked 736 Cleavage was observed here dipping to the N. at 40°, and striking E. 25°, N.

Some dark gray flagstones, hard grits, and concretionary shales are exposed by the Nenagh River, near Garrane Mill and the Halfwayhouse, between Nenagh and Borrisoleigh; they dip in various directions at various angles, and are in places nearly vertical; some of them have an east and west vertical cleavage, and fossils have been observed in many of the beds. Those occurring in the finer flagstones and flaggy shales were most commonly graptolites; but some concretionary shales with soft weathered nodules, in the centre of some of which an orthoceras was occasionally found, contained also bivalve shells.

Near the ruins of Cullahill Castle, and in the glen through which the road from it to Borrisoleigh passes, as well as upon the high ground on each side of it, dark bluish gray (and sometimes brownish) grits, shales, and slates, with occasional flagstones, containing graptolites, may be frequently met with; as usual they undulate, so as to have no marked general dip or direction. In one small quarry under the hill upon which Cullahill Castle stands, the surface of a bed is exposed, upon which the cross section of a set of nearly N. and S. vertical joints, with a curious undulation crossing them was observed.

Near Glenkeen Glebe House and all about that neighbourhood the Silurian thinly laminated gray grits, dark gray shaly flagstone, and hard grits with peculiar wrinkled surfaces frequently occur; and in some platy shales, and dark blue flagstones, N.W. of the glebe and ruined church, fragments of shells were found, as well as numbers of graptolites of different kinds. Along the lower boundary of the Old Red Sandstone about Borrisoleigh and northwards to the back of Killoskehan Demesne, and even on further, nearly to Barnane, almost every stream which crosses the boundary exposes both the Silurian and Old Red rocks close to each other. The bedding of the former is often very apparent; but as neither their strike nor inclination follows any fixed direction, it is unnecessary to enter into further particulars concerning them. The Silurian rocks along here consist largely of thin flaggy and sandy shales; but gray grits also occur here and there. Some of the beds nearest to the sandstone appear to have taken a red tinge in two or three places, which is perhaps the result of an infiltration of iron from it.

A connected but irregular ridge of hills stretches from this locality to the N.W. across the Silurian part of the district, from Knockanora to the Latteragh Hills. All over this high ground the Silurian rocks are frequently seen near the tops of the hills, and in some part of almost every stream course which traverses their valleys. Some bands of thick gray grit, near the top of Knockanora, just beneath the tower, which dips N. by W. at 35°, seem to be calcareous, and contain numerous fragments of crinoids, which can be best seen in the weathered portion of the rock; gray shales and flaggy grits occur near them, but lower on the hill side; and gray flaggy beds with some shales and grits are the predominating rocks over the part of the ridge lying to the N.W. At one place, about a mile due S. of a height marked Latteragh 1,257, some curious crustacean (?) tracks were found on the surface of a bed of smooth, hard, olive gray flaggy shale, associated with some gray gritty beds, all of which dipped N. at 30° (see fig. 3, p. 12). Between this place and where the R of the parish name LATTERAGH is engraved, another northerly dip of 30° occurs in gray shales and flags, and some of the latter which had been weathered to a rusty brown, upon being split parallel to the lines of deposition, exhibited a mass of graptolites thickly crossing each other like a number of compressed and matted blades of grass.

N.W. of this place the Latteragh Hills frequently expose gray grits and shales, most of the beds appearing to be flaggy; and in one quarry near a house, and W. of the second O in the name ORMOND, some of these having a dip to the N.W. of about 60°, were perforated by small tubular passages, about one-tenth of an inch in diameter. They also contained impressions of different sized orthoceratites.

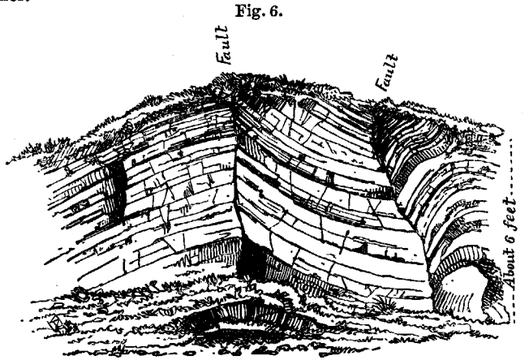
Near Killanafinch, greenish gray flaggy grits and shales, with a dip of 60° to 80° to the northward, crop out at Carrick wood and on the hill above it.

West of Knockahilligan, somewhat similar beds were observed about an elevation marked 928 feet; they contain here graptolites and two kinds of orthoceratites, where the beds dip to the S.E. at 65° and 85°. Near the first letter of AGHNAMEADLE, some nearly vertical thin shaly beds by the side of a road contain similar fossils, and what appeared to be small fragments of plants.

Northward of the first part of the name AGHNAMEADLE, gray grits appear near the height marked 720; and splintery shales occur in the road near Blean House, and again where another road is crossed by a stream N. of Aghnameadle House. The country about here is thickly covered with drift; and the form of the undulations, together with the very occasional occurrence of some small exposure of the shales, such as those just now mentioned, is the only evidence upon which to say that the underlying rock is Silurian.

Returning towards Killoskehan, the fine grained gray flagstones, shales, and hard grits, with very various dips, may be frequently seen near Knocknabrogue, Ballyhoul, Baranagee, and all over Kyraun Mountain. The beds are much twisted, and along the road from Gortnagarry to Killoskehan four or five small local faults may be observed. Subjoined is a sketch taken in a quarry opened to procure road metal, where two roads meet, near the place where the final letter of the name Ballyhoul is engraved upon the map. In this two cracks, producing but a slight dislocation of the beds, ran nearly parallel (about N.E. and S.W.), within the distance of a few feet from each other.

Fig. 6.



N.E. of Barnagee and Lagg some thick gray grits, of a dark colour, project from the hill side, dipping S.W. at 10°; some of these show no separations parallel to their planes of deposition for distances vertical to their bedding of more than six feet; and their fractures in this direction assume in places an exaggerated conchoidal form, probably the result of a latent concretionary structure.

Fossils are to be found in many places here as indicated on the map. Where the two asterisks are engraved N. of the parish name Killoskehan, graptolites, orthoceratites, and bivalve shells were observed; and the flaggy beds in a stream flowing westward from Kyraun mountain towards the place at which the above observations were made, seemed to contain an unusual quantity of graptolites.

The Silurian rocks can also be seen in a number of places upon the Devil's

* Near this place some rounded granitic boulders were observed.

Bit Mountain. On the road from Barnane to Moneygall, close to the Constabulary Barrack near Barnane, concretionary dark blue flaggy shales and thick grits have undulating dips to the N.S. and E.; and further N., where the road crosses the water-shed between the basins of the Suir and the Shannon, at an elevation perhaps somewhat less than 800 feet; some more thin gray grits and hard shales dip to the S.W. at from 10° to 40°. Projecting knobs of shaly grit and flagstone appear at many places on the higher parts of the ground between this road and the Devil's Bit; and round the outliers of Old Red Sandstone, pale and dark gray weathered splintery grits and flaggy shales, some of which contain graptolites, are frequently seen. Their angles of inclination are very irregular, both in amount and direction; but underneath the S.W. corner of the largest outlier, some gray grits and red shales dip to the W. at from 50° to 60°. In other places near this the Silurian rocks dip N.W. at 40° and 60°; and at nearly the highest part of the mountain they have a slight dip to the S.E. Near the junction with the overlying conglomerate, the softer beds appear to have been altered, and rendered harder by something depending upon the contiguity of the Old Red Sandstone. Red, pale, greenish, and variegated hard, compact, and softer sandy shales are often seen, and some of the red beds when broken into, show a greenish tinge.

The ridge of high ground upon which are the summits called Kilduff Mountain, Borrisnoe Mountain, and Benduff has many small streams flowing down its sides; and the courses of all of these give sections in the Lower Silurian rocks, and show them to be as usual more or less contorted. As many of the channels, however, coincide with the direction of the beds, they exhibit a general tendency in these to strike about 15° N. of E., but their inclinations are various; in one stream they dip N., in another S., and in some, have inclinations in other directions as well. Between the Devil's Bit and Kilduff Mountain gray flaggy grits and hard shales appear in many places, chiefly in the streams and near a mountain track, leading from Kilduff House to Whiteville. The streams on the west side of the ridge expose a quantity of dark gray flaggy shales and some grit beds. Many of the flags contain fossils, usually graptolites, orthoceratites, and bivalve shells, with some of the same kind of tubular cavities stated to occur near Latteragh Hill. Some very hard quartzose breccia was observed where a stream, from Borrisnoe Mountain, crosses the road S. of Whiteville House; it resembles somewhat a similar rock already stated to occur near Templederry. E. of Barnagrotty, near the height marked 756, a quarry exposes some hard gray grits and thin shales, dipping to the N. at 83°.

In a wood between Laughton House and the church, some splintery shales were observed; and upon Army Hill, S. of Moneygall, where the name CASTLETOWNELY is engraved, some gray, splintery, flaggy, and slaty shales occur. In an old quarry here, close to the height marked 821, some grits of a much coarser texture than usual occur, they dip to the N. at about 40°; and upon a close inspection were found to contain fragments of small corals and crinoidal fragments.

To the eastward of the height last mentioned, another marked 919 (feet), will be observed. Between this and the road to Lisduff, some much jointed, vertical, thin, gray grits and greenish shales occur, striking about E. 25° N.; the joints cross the bedding of the grits at more or less nearly right-angles. Some undulating ground on both sides of the valley of a little stream which passes close to Lisduff is much covered by drift; but in the roads from the place just now described to the ruined church of Castletownely, and from thence to Honeymount, in the little river close to Lisduff House, on the high ground, both to the north and south of the latter, and in a glen between Benduff and the elevation marked 1,012 on the map, gray, flaggy, and splintery shales, and thin gray grits were observed.

At the tops and in the courses of the streams which join below Borrisnoe to

form the River Suir, gray grits and flaggy shales are seen; and where these streams unite close to the boundary of the Old Red Sandstone, gray and red flaggy grits dip to the S. at 45° and 60°.

Near the top of Curraghbristy (1,295 feet) are some strong gray grits and shales, weathering bright red in places; the former containing numbers of crinoid fragments and small parts of shells. A small stream (not engraved on the one-inch map) runs down the N.E. slope of Curraghbristy, and then turns E. through the townland of Kilballyhemikin, exposing in its bed a quantity of gray flaggy grits and hard splintery shales, most of which appear to dip to the N.W., at angles of from 40° to 70°; and where the stream passes a little north of the junction of two roads, a-third of a mile N.E. of Tober North, graptolites were observed in thin flaggy beds. Hard gray shales and grits were observed in the bed of the brook for 300 yards below this.—A. B. W.

The ground is there very low and flat for some distance, and no rock is to be seen *in situ* till we come upon a quarry of limestone, dipping E.S.E. at 25°, about 500 yards to the E.S.E. of the lowest exposure of Silurian shale. There is, therefore, only this space for the occurrence of the Old Red Sandstone. Not only is there none of that rock to be seen just here *in situ*, but the ground is covered with the debris of the Lower Silurian rocks. This, however, is of the less consequence here, since it is in the lower part of a valley of which the upper portion runs altogether through the lower Silurian rocks, so that we may expect to find it covered with their debris. On the rising ground to the northward of the rock now described is a height marked 770 feet. Just 330 yards S.E. of this point there is a cabin by the roadside, in the yard of which the ends of some decomposed brown and yellow coloured Lower Silurian shales and grits, dipping to the westward at high angles, show themselves. Similar beds are seen in the ditch of the field below the house, and in some new drains now being dug in the lower part of the field (May 1860). Dark gray Silurian slaty shales were exposed in the ditch of the field, just above the little wood that grows on the side of a steeply sloping bank, about 500 yards E. of the cabin just mentioned. At the eastern termination of this wood is an old lane, now closed, and in the hollow of the lane, just above an old limekiln, is a rather large exposure of blue and gray slaty shales, with some brown calcareous sandstones, all dipping to the N.W. at 60° or 70°.* J. B. J.

Some gray grits are exposed in the stream close to Tober South, near the letter E in the name Killea; and in the streams above and below Kilduff House, thin gray grits and shaly beds, with a generally high dip to the N.W., are seen.

All the principal places where the Silurian rocks appear have now been more or less accurately pointed out, and their varieties in each place described; but their angles of inclination are so numerous and different in amount and

* Old Red Sandstone *in situ* may be seen within 200 or 300 yards on three sides of this latter locality, namely, on the S.E., the E., and the N.W., so that it seems to be a tongue-like projection, running N.E. for some little distance into the Old Red Sandstone.

The appearance at the surface of the Silurian rock in this triangular piece, N.E. of Curraghbristy, seems to be due partly to a slight anticlinal flexure in the Old Red Sandstone, which dips rather to the N. on the north side, while it must have its usual S.E. dip on the south-east side, and partly to the form of the ground as modified by the denudation. The Lower Silurian rocks show themselves on the rather steep slope of a bank that pitches down into some flat ground at its foot, so that the Old Red Sandstone has been cut through for about half a mile further to the N.E. than it would have been, if the slope of the ground had been regular and equable, and the bend in the dip of the Old Red, from S.E. to N.E., been a little more gentle than it seems to have been. In that case the boundary of the Old Red Sandstone would have run nearly straight from above Ash Park, under Tober South and Tober North, to its present boundary at the corner, which is about 150 yards west of the point 770.
J. B. J.

direction, that it has not been thought necessary to give a more minute account of them.

The Old Red Sandstone enters the map near the centre of its south side, and a narrow belt of it may be traced almost continuously by Borrisoleigh and Killoskehan. Southward of Borrisoleigh, whitish conglomeritic sandstones, with disseminated particles of copper, and here and there some red and purple beds, appear on the high ground, immediately above Glaskyle and Fort William, they all dip to the E., or E. by S., at angles varying from 10° to 25°. In the stream which passes through the village near Millmount Cottage, some Red Sandstones occur in the river—probably *in situ;* and N.W. of Summer Hill, and thence towards Killoskehan and Barnane, red, gray, and white sandstones, with beds of red shale, frequently appear along the courses of the streams, all dipping to the E.S.E. or thereabouts, at angles varying from 10° and 15° to 20°, 30°, and 35°. Between the point north of Killoskehan Castle and Killea, where they are next seen, there is an interval of three miles with no rock at all appearing at the surface near their line of strike. It is, however, worthy of remark, that if the dip of the outlying patch on the summit of the Devil's Bit were prolonged till it took the ground, it would come in just where the Old Red Sandstone has been drawn in the map, in the line of strike of the beds seen at the two above mentioned places. At Killea some red sandstones and shales may be seen behind the cottages opposite to the old church, dipping E.S.E., and two or three old quarries in speckled brown grit were opened in the high ground, W. of the road; the beds apparently dipping E.S.E. at 5° or thereabouts. A. B. W.

In the wood just west of these is a little quarry showing beds of gray and brown Silurian shale and grit, dipping N.W. at 70°, forming, with the beds just described, a conspicuous instance of the unconformability of the two formations. Silurian rocks may be seen in the bed of the brook just N. of this; and a little lower down, bright red clay, looking as if it were the debris of the red shales of the Old Red Sandstone, decomposed *in situ*. Immediately north of this brook, on the east side of the road, is a line of excavations running across the field, exactly in the strike of the line of old quarries to the S.W. They were all grassed over, and no rock seen *in situ*, but several square blocks of the cornstone conglomerate presently to be described were observed. We then come to the valley previously mentioned, when describing the Silurian rocks, where, for the space of a mile, no rock is to be seen in the place where the Old Red Sandstone could occur, and where Silurian debris was observed on the surface over that space. After passing that distance, however, we reach a quarry of Old Red Sandstone, about forty yards west of the high road to Moneygall, in the townland of Kilballyhemikin. This is a thick, pale yellow, speckled sandstone, weathering brown, the stratification of which is not well exposed. It seems to dip a little N. of E., at about 3°, or at least that is the dip of what seems most to resemble bedding.

Precisely similar sandstone, the exposure of which is equally obscure, may be seen 400 yards N. of this, just S. of the end of a lane running at right-angles from the high road to the W. Here, however, the sandstone seems to dip N. or N. by W., at 3°. In the same field with this, but a little more to the west, may be seen a band of a peculiar cornstone conglomerate, quartz and other pebbles being embedded in a gray compact siliceous limestone base. This certainly dips N. by W., at 5°, and strikes, so as to lie above the sandstone just named. It dips underneath some beds of coarse yellowish white sandstone and conglomerate, which occupy the N.W. corner of the field, dipping N. by W. at 5°, in which direction, in the lane immediately beyond, may be seen beds of red shale.

Proceeding up the lane towards the W. at the corner of another lane that branches off to the N., along the side of Skehanagh Demesne, thick beds of yellow sandstone are visible, apparently horizontal.

200 or 300 yards W. of this, in a field above the lane, beds of the yellowish white conglomerate, precisely like that first mentioned, as over the cornstone, may be seen dipping N.N.W. at 5°. Farther W. still, and just S. of the point 770, beds of the same conglomeritic sandstone show themselves largely, with a possible dip to the N. of about 3°; and from underneath these another band of cornstone conglomerate makes its appearance. This is precisely like that first described as seen down below, and may indeed be the same bed; since in each case it appears close to the base of the Old Red Sandstone.

The actual boundary of the Old Red Sandstone here has been drawn along a little rise in the ground that makes a marked feature all along this part of the boundary.

The cornstone is here better developed than below; and becomes, as we follow it to the W., round the corner of a little wood 700 yards W. of the point 770, a variegated red and gray splintery limestone, which has even been burnt for lime, and is spoken of by the peasantry as a limestone. Some of the beds contain no pebbles, while others contain them abundantly. It attains a thickness here of twenty-five feet. It was carefully searched for fossils, but none were observed in it. By the little wood it curves round, so as to dip E. at about 5°; passing in that direction under some beds of pale sandstone and conglomerate, and these apparently being covered by red shale, which may be seen in the field opposite the end of the lane that comes down from the wood.

Indications of Old Red Sandstone may be observed at two or three places in the fields N. of this wood, for nearly a mile, when we come to the brook which is considered to be the head-water of the River Suir.

J. B. J.

In the Suir, from where it cuts into the Old Red Sandstone to the road below Garrett's Mill, whitish, pale, purplish, gray, and red conglomeritic sandstones, with occasional shale beds, dip to the eastward at from 10° to 15°. The lowest of these beds are calcareous, and a thick band of red shales, where the river bends from the road between Borrisnoe and Mount Frisco at a small plantation, contains irregular veins of compact and crystalline, dark gray and red limestone, the width of which varies from four to about nine inches.

If we now proceed to the N.E. in order to trace the upper boundary of the Old Red Sandstone, we shall find between two bogs, one of which is on the road from Templemore to Roscrea, and the other N. of Foxborough Lodge, a low rising ground upon which are seen blocks of gray, yellow, and purplish obliquely laminated sandstones.

A. B. W.

One of these is certainly *in situ*, and dips to the S.E. at 5°; the others have perhaps fallen over in place, and may be taken as a good indication of the rock being below. South of this rising ground are some craggy bosses of limestone, the bedding of which dips at first S.E. at 15° or 20° but then curves round so as to dip E. and strike directly towards the sandstone, thereby indicating the existence of a fault, which is better proved farther on.

Pale purple flaggy sandstone, nearly horizontal, may be seen on the road side W. of Loran Park, and strong whitish speckled sandstones to the E. of it, on ground which rises to 580 feet, in which there is a bed of siliceous cornstone.

Beds of pale sandstone and conglomerates seem to dip N. here at 5° or 6°, and may be seen on the side of the high road which runs towards Borris-in-Ossory. One exposure of this rock is to be seen S. of the road dipping N.E. at 10°, and 250 yards S.S.W. of that, and in lower ground are quarries of dark gray crinoidal limestone likewise dipping N.E. at 10°. The boundary

between the Old Red Sandstone and the Carboniferous limestone must of course run between these, and there is a little step or terrace in the ground which seems to be the actual edge of the sandstone. This runs N.E. and S.W., certainly in the same direction as the boundary, as is shown by evidence both ways. These two quarries then show beds dipping along the boundary, and of course striking at it, the sandstone within thirty yards of it and the limestone within 100. These facts certainly seem to render a fault probable, and taken in conjunction with the lie of the beds in the surrounding country, may be held to prove it. N.E. of this place the ground rises into hills, known as Knockseefin, 687 feet, and Bawnadrum, 754 feet, over which pale whitish and yellowish speckled sandstone and conglomerate, sometimes becoming purple, undulate in different directions at low angles, and are well exposed.

To the S.E. of the main road by the side of a lane, in the townland of Boolareagh, dark gray limestone may be seen dipping E. 30° S. at 12°, and farther to the N.E. in the flat ground, S. of the large woods, there are several quarries in black shaly limestone that would answer very well to the character of Lower Limestone shale, may be seen with their beds dipping S.E. or E.S.E. at from 10° to 30°.

The Old Red Sandstone on the hills above, about the woods just mentioned, may easily dip at a gentle angle to the S.E. beneath these beds, so that here there appears no reason to suppose the fault to continue, and a band of Lower Limestone shale might have been very well introduced into the map.

J. B. J.

In the neighbourhood of the cross-roads eastward of Carricknabrock wood, and about that wood itself, red, gray, and whitish sandstones project in many places from the surface of the ground, and red shales with whitish sandstones are seen at the southern edge of the other larger wood close by the cross-roads.

On the hill above Curragunneen Roman Catholic Chapel, some more yellowish and speckled sandstones, which are in places calcareous, appear; and good yellowish flags have been raised from the bed of the Nore, where a stream falls into it which comes from the N., after passing the Church of Bourney and the road from Templemore to Roscrea.

The open valley of the Nore W. of this, exhibits an undulating country covered with drift, which conceals the underlying rocks. These, however, must lie in the form of a basin, since dark gray limestone is seen *in situ* just E. of the Roscrea road, a little N. of the limit of the map, showing that here we have passed beyond the upper boundary of the Old Red Sandstone in this direction, as we had just now in the low ground to the eastward of it.

No rock *in situ* is visible to the S. or S.W. of this, until we come back to that already described as seen on the rising ground between the two bogs, or in the bed of the Suir. If we start again from that towards the N.N.W., we come in about a mile to some high ground which runs thence past Summerhill House to Honeymount House. Over that ground and on the hill of Rathaveoge, and in the less elevated but somewhat rocky country about the Fourteen Roads, white and yellowish, often conglomeritic sandstones, with some brownish and speckled beds, are often seen, having a general dip to the eastward, at angles of from 2° to 5°. They may be observed near Longford Wood and Summerhill House, and to the N.W. of Honeymount House, and some yellow sandstones and red shales occur a little E. of the ruins of Ballynamoe Castle. Speckled and brownish purple sandstone is seen in two quarries near a little pine wood, overlooking Finglas grave-yard, but to the W. and S.W. of these, towards Moneygall and beyond it, the country although hilly does not expose the rocks, owing to its being covered by a vast quantity of boulder and gravelly drift.

In the neighbourhood of Toomyvara, some undulating ground of a slightly different aspect from that which is usually formed by the action of denudation upon the limestone rocks of this country, was found to be covered in many places by angular fragments of the Old Red Sandstone; and further observation led to some of these being discovered *in situ* near Killeisk House, Pallas House, and in the road from Knockane Castle to Silverhill, as well as on the higher ground at each side of Toomeyvara, and between Kyleroe Wood and Grenanstown House. In all these places the rocks consisted of yellowish gray speckled sandstones and red shales, with low dips usually to the N., and at the place first mentioned the sandstones were observed to be highly calcareous. Flagstones were said, by a man named Michael Hart, to have been raised a little S. of the road, half a mile to the E. of Lismore House.

In the centre of this low undulating tract of Old Red Sandstone, are some quarries of Carboniferous Limestone opened in a small outlier of that formation, which will be described farther on. A. B. W.

No other exposure of Old Red Sandstone is to be seen to the S.W. of Toomyvara than that already mentioned, for upwards of five miles; but as it then makes its appearance exactly in the strike we should expect, and the whole intermediate district is so thickly buried with drift as to conceal every thing, no reasonable doubt could be entertained of its continuity somewhere about the band coloured to represent it on the map.

J. B. J.

Outliers of the Old Red Sandstone.—Three of these occur, two at the Devil's Bit and one at Kilduff mountain to the N. of it.

A tracing of the two former from the six-inch map is subjoined.

Fig. 7.

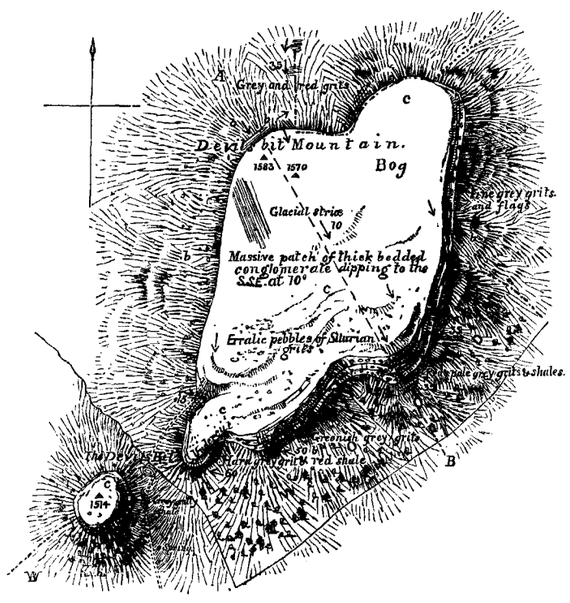
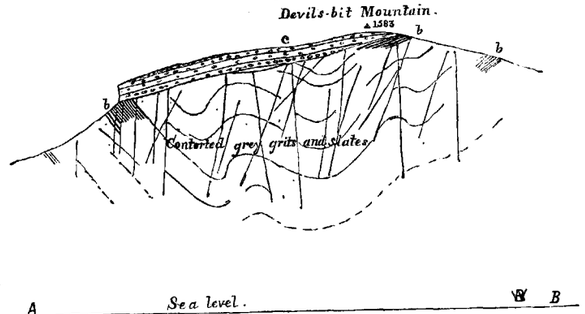


Fig. 8.

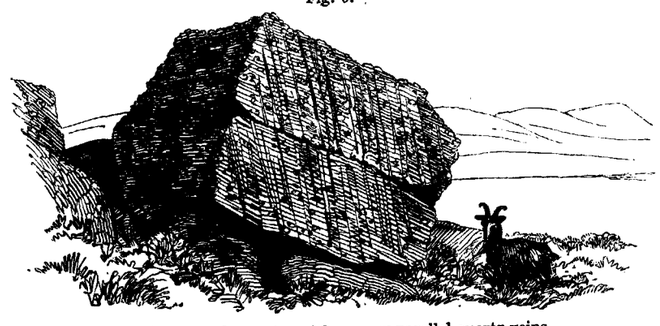


Section on line A.B.—Scale for length and height, 6 inches to a mile.

These isolated remnants of a larger deposition of the Old Red Sandstone, are two parts of an evidently once continuous group of conglomerate beds, the largest having an area of about fifty acres, while that of the other is only about two acres. The thickness of the rocks exposed is on an average about forty feet—it is made rather too great in the sketch. The beds all dip to the S.E. at low undulating inclinations of from 2° to nearly 10°. The conglomerates are massive and thick bedded, consisting of a hard red sandstone base enclosing pebbles of white quartz, jasper, greenish grit, reddish quartzite, red grit, black slate, and black hornblendic trap, many of these average from one to three inches in diameter, but some are larger.*

On the N.W. side of the smaller outlier, a large square fallen block of the conglomerate was observed to be full of thin quartz veins, which traversed both the pebbles and the paste regularly, obliquely to the lines of deposition, as if a cleavage had taken place in the rock, between the planes of which quartz had been infiltrated.

Fig. 9.



Block of conglomerate, with narrow parallel quartz veins.

Junctions of the sandstone with the silurian are seen in many places, as described already.

* Several pebbles of Silurian grit, some of considerable size, were observed scattered over the surface of the conglomerate bed. As they appear to be too numerous to have weathered out of the conglomerate rock, they are supposed to have been left by the Drift which has scratched and grooved the upper surface of the beds composing the tabular slab. A. B. W.

The Kilduff outlier is situated at a distance of less than a mile due N. of the Devil's Bit mountain, and forms the summit marked 1,462. It is somewhat larger but thinner than the least of those just now described. A few beds of pale yellowish obliquely laminated sandstone have been here spared by the denuding agency, and form an outlier of a less marked, but still the same character as those at the Devil's Bit; the beds incline to the eastward at an angle of about 2° or 3° in that direction, forming a small cliff, while on the other side, where they crop out towards the W., the patch has been worn down so thin, as to consist in places of but one or two beds.

The projecting ends of some of these at this side of the outlier, exposed a section showing the oblique lamination remarkably well.

The Limestone Districts.—We have now to describe the districts under which the Carboniferous limestone lies, and will commence with the smaller one on the N.W.

The Lower Limestone Shale has not been found within this district in a sufficiently characteristic form for it to be described as such. The beds are doubtless there, but they probably consist more purely of limestone, and have fewer shales than usual.

The Lower Limestone.—Some of the dark crinoidal beds belonging to the lower part of the carboniferous formation appear at the N.W. corner of the map, on the road from Nenagh to Borrisoleigh, just S. of Lisrathdine. Their inclination is low, being about 10° or 15° towards the Silurian hills to the S.E., and exactly in an opposite direction to that which it might have been expected to take. This dip towards the mountains is continued close up to their foot, where an anticlinal convolution in these crinoidal beds, with the axis sloping slightly to the N.E., seems to occur. Dark gray, and black shaly, and nearly horizontal beds are seen near Grenanstown Chapel and to the N. of Lisrathdine. Similar limestones, with inclinations of dip diverging from the rising ground near Lismore, may be seen near the bridge S. of Lismore House, by the road between Lissanisky and Shanbally; and in the Ballintotty river below Norwood, where some slabs of flaggy limestone were found thickly studded with the broken joints of crinoids, amongst which some good casts of the calyx or head, were observed.

In the neighbourhood of Ballymackey, on both sides of the road from Lissanisky to Knock cross-roads, the limestone is seen in several quarries. In some places it is dark gray and in others pale or variegated, and it frequently contains a great number of Fenestellae. A large tract of the country N. and N.E. of this, is covered with drift so as to conceal the rocks; but one quarry to the S.E. of Silver hills (and that the only one for miles around), has been opened in dark gray and black thick and thin bedded crinoidal limestones, which dip S.E. at about 3°.

Knockane Outlier.—North of Toomeyvara and E. of Pallas House, the old castle of Knockane is a conspicuous object, and underneath it is some black and dark gray earthy limestone, containing crinoids and other fossils such as Strophomena crenistria, Spiriferæ, Rhynconnellæ, &c. It is well seen in a couple of quarries and in the road near the castle; but owing to the prevalence of the drift, no good feature nor any band of shaly debris exists, whereby to determine accurately the latteral extent of this patch of limestone rocks.

The Eastern Limestone District.—In the neighbourhood of Borrisoleigh, dark gray and black earthy limestone of very much the same character as that first described appears in many places, dipping at low angles from the hill. Inside the demesne wall of Barnane, similar limestone is again seen; and between this and Knockagh House (in ruins), grey oolitic limestone occurs in several quarries. A band of this limestone,* seems to stretch

* Probably on nearly the same horizon as that at Ballagh, in the map to the S., Sheet 145.

by Templemore through the country towards the N.E. Near Lloydsborough dark or bluish gray, and sometimes variegated limestone, containing Fenestellae in places, occurs in and near the demesne, and close to the supposed boundary of the Old Red sandstone in an angle between two roads at the N. side of it, bearing N. by W. from the house. At the place last pointed out a quantity of massive gray compact and variegated limestone is traversed by numerous N. and S. joints, and full of the remains of Fenestellae; but although a good deal of it is seen the bedding is not exposed, and it has a different aspect entirely from that of the thin dark crinoidal limestone which might have been expected to occur so near to the base of these rocks.

To the E. and N.E. of Ash Park, in the neighbourhood of College Hill, on the road from Templemore to Roscrea, black and dark gray flaggy shaly, cherty, and crinoidal limestone appears in several quarries upon the hill, and close to the boundary of the Old Red sandstone, where a number of roads intersect each other, between Killough Bridge and Ash Park. In the latter locality, the beds dip at angles varying from 10° to 25° to the S.E., or from the high ground towards College Hill, and consist of hard dark gray and black crinoidal limestone, most of the beds being thin, and all of them more or less fossiliferous. At a distance of less than half a mile from the summit of College Hill, marked 612, and bearing from it W. 10° N. a pit or quarry sunk by the side of a by-road exposed some limestone, containing so much peroxide of iron, that under the action of the atmosphere it assumes a brilliant brick-red colour. Old iron mines are stated to have existed here formerly, and the soil about is so red that the sheep grazing upon it become dyed of that colour. The name of the townland too, Craiguedarg,* seems to have a connexion with the colour of the ground.† To the N. of Killough Bridge, near the height marked 478 feet, dark bluish gray crinoidal limestone occurs; and at a little distance S.E. of the bridge, some dark gray and variegated limestone projects from the ground in the townland of Clontaffe. Eastward of this near a wood upon the Roscrea road, and along that leading from it to Knockane Bridge, a quantity of pale gray compact and variegated limestone in places full of Fenestellae appears at the surface of the ground, and some apparently low angles of inclination lead to the supposition that it undulates above and below a horizonal plane. Some black limestone is seen beside the road to Roscrea N. of this; and near Foxborough Lodge black and dark gray shaly and crinoidal limestone dips to the E. and S.E. at from 10° to 20°, close to the boundary of the Old Red sandstone. From this place in a north-easterly direction, black and dark gray crinoidal limestone, associated with shaly beds in some places, frequently appears within the distance of about a mile of the Old Red sandstone, upon the slightly rising grounds which separate a large tract of bog in this neighbourhood from some which are smaller.

Upon the hill of Dromard N. by W. of Dromard House, some thickly bedded oolitic and crinoidal limestone dips S.W. at about 5°; and upon Knockahaw Hill similar but, perhaps, less thickly bedded oolitic and crinoidal limestones, sometimes exhibiting oblique lamination by the arrangement of the crinoidal fragments, are seen to dip to the south at 5° and 10°. They appear in many places about the hill, and give to its surface a much steeper slope where they crop out to the N., forming small cliffs, than on the S., where the slope of the hill nearly coincides with their inclination. Near Dromard and Sorrel Hill Houses dark gray beds appear in some quarries. In one, lying to the E. of the former; in another, on the other side of a bog, lying to the W. of it, and near the road in three places at Sorrel Hill. On both sides of the road from this to Templetouhy pale gray and variegated limestone con-

* "Darg" or "Darrig" is an Irish word for "red."—A.B.W.

† Trials (which were of course unsuccessful), were made a little to the N. of this place, in search of coal or culm, which was expected to have been found in some of the black limestone shales.

taining Fenestellae is generally met with, although some darker kinds were also observed. The rock is seen in a number of quarries, and also in some natural exposures, as on the hill over Tullow Castle, marked 535, and also to the S. of an elevation marked 466, both lying to the N. of Templetouhy. N. by S. of the latter place, near the margin of the map, the letters "$\mu\delta$" will be found, indicating the occurrence there of a projecting knob of yellowish sandy-looking dolomite; and this is one of the few places where that rock occurs within the district.

Near Long Orchard, and beside the roads leading from Templetouhy to Crannagh and Lisheen, pale and dark gray limestone occurs in several places; the former predominating, appearing sometimes to be slightly magnesian, and caves being stated to occur in it near a fort south of the Templetouhy National School, and beneath the lands of a farmer named Everrard.

In the parish of Templeree, to the E. of Templemore, the limestone appears in several quarries. It is here almost always black or dark gray, as to the westward of Strogue, where black limestones dip S. at low angles, and about Castleleiny and Washpin Bridge, where they have a somewhat similar dip, but less regular and varying to the eastward.

Some large quarries have been opened near Templemore in black and dark gray, sometimes oolitic-looking limestones, which dip to the E. of S. at from 8° to 15°; and similar beds were observed to dip in the same direction between Cloone Bridge and the railway, and at the distance of about a mile S. of the Washpin Bridge. At the latter place red hematitic partings were observed between the beds, and vertical fissures or large funnel-shaped hollows crossing the bedding were filled with a kind of ochrey clay, which appeared to result from a local decomposition of the rock.

In the neighbourhood of Loughmoe (or Loughmore) and near Moneenascythe Lough some more dark gray or black limestones occur, and similar beds were observed south of Ballinlonty House to the S.W. Paler beds occur in the demesne of Dovea, and on the other side of the railway to the E., near Brownstown House, and in that neighbourhood as far to the N. as the name Loughmoe, East.

To the N. of the latter name the black beds which were observed to occur near Loughmoe appear to come towards Fortfield, near Crennagh, dipping S. at low angles; and where the letter M is engraved upon the map N.E. of the height 412, some magnesian limestone occurs.

In the vicinity of Fortfield House, near Lisheen Castle, some pale gray limestone is seen, and also near Killoran and in the village of Moyne; while between this and Brownstown some darker beds appear.

Between the two limestone districts now described, and along the northern margin of the map, a small part of what appears to be a bay of limestone, coming from the N.E., is supposed to terminate N.W. of Curragunneen Bridge; but, although the limestone is seen outside of the Sheet, it does not appear here within its limits.

6. *The Drift.*

The drift which is distributed over a large portion of this district is composed chiefly of a yellowish clay, with beds of sand, containing a great quantity of more or less rounded fragments and blocks of limestone, with some of sandstone or slate, and also many well rounded pieces of granitic rock, such as is known to exist *in situ* in Galway. The latter may be observed frequently scattered over the low ground at the N. of the map. This drift occurs in greatest quantity at the northern side of the map, there concealing for miles the geological structure of the country; while at the S.E. part of the district, although it is also widely spread, it has been penetrated in a number of places by quarries, and at the tops of the hills or rising grounds the limestone rocks project through it. In the part of the district first

named coarse and fine gravel and sand predominate; but in the latter it consists more largely of clayey deposits. In the Moanaha Glen, in which Castle Otway is situated, the drift has been largely deposited upon the Silurian rocks, and a curiously shaped escar-like deposition of it occurs near the ruins of a church S.W. of Grange Lough. A terrace-like escarpment of it extends for some distance along the Moanaha Glen river, and where this passes through a picturesque defile at Latteragh the drift becomes stratified, and, being in places cemented by carbonate of lime, forms beds of conglomerate, which, having a considerable power to resist the operation of the weather, stand out from the rest like masses of consolidated rock. The stratification of the gravel in a small wood S. of the M in ORMOND is well exhibited, dipping towards the interior of the glen at 30°, and the deposit consists of mixed limestone and silurian pebbles.

North of Curragraigue House the limestone drift was recognised at considerable elevations, and it covers the north slopes of the hills about Killanafinch. Large blocks of granite were observed south of Toomeyvara; and in the glen of the Ollatrim River the drift is frequently very conspicuous, spreading over the lower part of the valley, reaching into the higher coombs and smaller glens, and forming here and there rather abrupt escarpments, having a height of about thirty or forty feet.

Along the high ground which rises S. of Moneygall large boulders of limestone may frequently be observed scattered over the hills, as about Bushers-town, where they occur at heights of nearly 500 feet; and one very conspicuous block, which rests at a height of about 890 feet above the sea, nearly on the top of Loyer Hill, S. of Moneygall, measuring 9 feet by 21 feet by 7½ feet, is figured below:—

Fig. 10.

v Knockanora. vv The Devil's Bit.

Perched boulder of cherty Limestone, resting on Lower Silurian slate, near Moneygall, at an elevation of about 890 feet.

It is difficult to account for the transfer of these drift deposits and masses of limestone and granite from the N. southwards, unless the agency of ice is admitted, an agency the existence of which is proved by the occurrence of glacial striae, running in a direction at 10° E. of S., which have been observed upon the upper surface of the conglomerate at the top of the Devil's Bit Mountain. (See fig. 7, p. 26.)

Considerable spaces on this map are occupied by bogs and alluvial deposits; the latter occur along the courses of the rivers, and the former generally fill up slight depressions in the low country.

Other superficial deposits conceal the rocks in some places on the higher

grounds. When composed of fragments of the local rocks they have been generally assigned to atmospheric action and not to that of the Glacial Drift. Upland bogs also conceal the underlying deposits in many localities on the high ground, and these as well as those of the low ground appear to have been formed in the vicinity of forests. Large roots, stems, and branches of trees occur frequently in the bogs of the low country, and in a small remnant of an apparently once larger boggy deposit, which seems to be rapidly in course of removal by the agency of rain from the slightly sloping upper surface of the Devil's-bit outlier, some fragments of bog-timber were observed.

The large bog at Dromard seems to be in some places very deep, and great expense was incurred in making the Great Southern and Western Railway over a small portion of it, underneath the steep northern face of Knockahaw Hill. In this bog, too, large cavities are stated to exist, into which considerable streams flow and disappear beneath it.*

7. *Mines and Minerals.*

The minerals found in this district are chiefly those usually associated with the kinds of rock of which it is composed, such as quartz and carbonate of lime.

Copper.—An old copper mine existed E. by N. of Rathnaveogue Old Church at the N. side of the map. A lode bearing about E. 10° N. was traced here chiefly by means of some old shafts; and in one, near the mouth of it, a hard quartzose breccia, containing galena and copper pyrites, was observed.

In the townland of Garrane, N. of Killanafinch, and about a mile S.W. of Toomyvara, close to where the height 308 is marked upon the map, some spoil banks at the mouths of a couple of old shafts were found to contain fragments of Silurian grits, in which small veins of galena were observed; but, although copper is stated to exist here also, no traces of it were found.

Lead is stated by Sir R. Griffith to occur in the townland of Cooleen near Borrisoleigh.

One old shaft was found in this townland, which was said by an old man living near it to have been sunk in expectation of finding coal.

A. B. W.

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* This information was communicated by Captain Lidwell, of Dromard.

A quagmire or wet vein is said to run like a river all through the bogs which stretch from this towards the N.E., and it is supposed that the railway crossed this wet vein under the northern brow of Knockahaw.

No bones of Megaceros or other extinct animals are known to have been found within the limits of Sheet 135, though they have been discovered in the adjacent grounds to the west, and also under a bog, near Thurles, to the eastward.

A. B. W.

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