# DATA AND DESCRIPTIONS

TO ACCOMPANY

QUARTER SHEET 46 N.W.

OF THE

# MAPS

OF THE

# GEOLOGICAL SURVEY OF IRELAND.



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# GEOLOGICAL SURVEY OF IRELAND.

## General Descriptions.

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

The most striking feature of the district included in this quarter sheet is the hill called Slievenaman, the summit of which is 2,364 feet above the sea.

This mountain is at the western extremity of a broad ridge or small table-land, the base of which forms an elongated oval, about eighteen miles long from E. to W., and five miles broad from N. to S. The general summit of the table-land* is not more than eleven miles long, and three and a-half broad, with a mean elevation of about 500 or 600 feet above the sea, rising, however, in occasional eminences to 800 or 1,000 feet.

It is surrounded by a line of craggy heights that generally make small cliffs or escarpments on the inside, overlooking the table-land, and slope smoothly, though rather steeply, down on the outside. Some of these heights have an elevation of 900 or 1,000 feet above the sea; but where the table-land inside sinks to lower levels, the surrounding belt of crags likewise diminishes in height to 500 or 600 feet. Both table-land and boundary crags are higher towards the eastern termination than in the middle; but towards the west the whole ground swells up rather suddenly to form the mountain of Slievenaman, rising from 800 feet to 2,364, in the space of a mile, and then sinking down with a pretty regular and continuous slope on the outside, to the level of the surrounding plain.

(See fig 1, which is an E. and W. section through Slievenaman on the true or natural scale, both horizontal and vertical distances being on the scale of 1 inch to a mile.)

The general level of the plain which surrounds the Nine-mile-house table-land on the north and west, is about 200 feet above the sea, rising towards the north-west into hills of some 500 feet in height. On the south, the land slopes down to the valley of the Suir, the ground along the southern foot of the hills, surrounding the table-land, being nowhere higher than 175 feet above the sea. From the centre of the northern flank of the table land, a small swell of the ground strikes N.E. from the village of Killamery, for a couple of miles,

* Nine-mile-house being the most widely known place upon it, it may be spoken of as the Nine-mile-house table-land.

rising in one part to a height of 317 feet. Towards the east, the table-land slopes down into the valley of Mullinavat, in sheet 46 N.E.

The table-land is partly traversed from E. to W. by the little river Lingaun, which rises on the flanks of Slievenaman, and with its tributaries, drains the greater part of the district included within the belt of heights above alluded to. This river issues out through a deep and picturesque glen at Tinnakilly. One or two other minor brooks escape by similar glens, on a smaller scale. On the N.E. of the map, the King's river runs from west to east by Callan and Kells, making for the river Nore, while round the western foot of Slievenaman, runs the Anner river coming from Mullinahone, and receiving as a tributary the Clashowley river coming from the north by Fethard. The latter rivers, as well as the Lingaun, fall, of course, into the Suir.

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## 2. *Relations between the external form of the ground, and its internal structure.*

Here, as elsewhere in the south of Ireland, the limestone, called Mountain or Carboniferous Limestone, is found only in the plains, valleys, and low grounds. It entirely surrounds the table-land and hills before spoken of, the rocks of which they are composed rising up from underneath it in an inclined position, and rearing themselves to a considerable height above it.

These rocks consist of beds of red sandstone and red shale or slate, belonging to the formation known as the Old Red sandstone. The hill of Slievenaman is entirely composed of these red rocks, except on its eastern slope, where the debris of some dark gray, and green clay slates may be seen appearing from underneath the lowest beds of the Old Red sandstone. These clay slate rocks, with some associated igneous rocks, occupy the whole of the central ground of the table-land, stretching from the eastern foot of Slievenaman to Boolyglass and Redgap. They are believed to belong to the group known as Lower Silurian. The ridge which surrounds this central ground, with its precipitous little crags everywhere facing it and overlooking it, and its more gentle slope towards the outside, is composed of Old Red sandstone, and the crags are formed by the broken ends of the beds, while the outer slope is made of their downward extension.

If we examine the map, and then look at figure 2, which is a north and south section over the top of Slievenaman, and compare it with figure 3, which is a north and south section* across the eastern end of the table-land, we should be at once struck with the fact, that if the hill of Slievenaman had been continued farther and a little higher towards the E., so that the ground over the whole table-land had been, at least, as high as the top of that mountain, we should have had a continuous long oval ridge entirely composed of Old Red sandstone, with its beds in an anticlinal curve over the top of the ridge, dipping N. and S. on its N. and S. flanks respectively, and curving round at the ends, so as to dip E. and W.

The mountain would then have had something the form of a boat,

* These sections are distorted for the sake of clearness, the heights being twice as great as they ought to be, compared with the lengths.



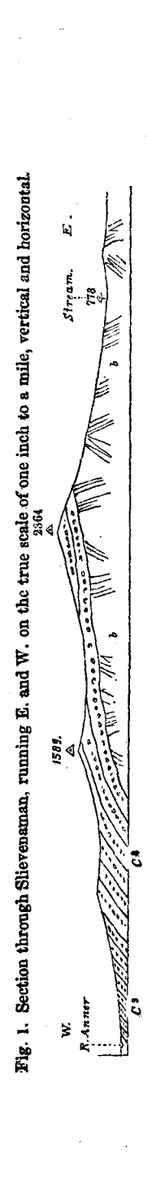


Fig. 1. Section through Slievenaman, running E. and W. on the true scale of one inch to a mile, vertical and horizontal.

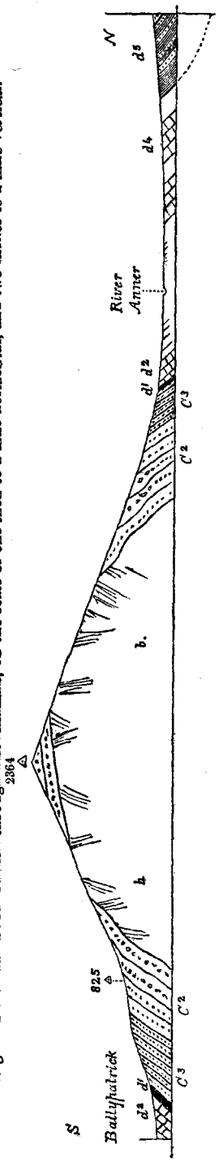


Fig. 2. North and South section through Slievenaman, on the scale of one inch to a mile horizontal, and two inches to a mile vertical.

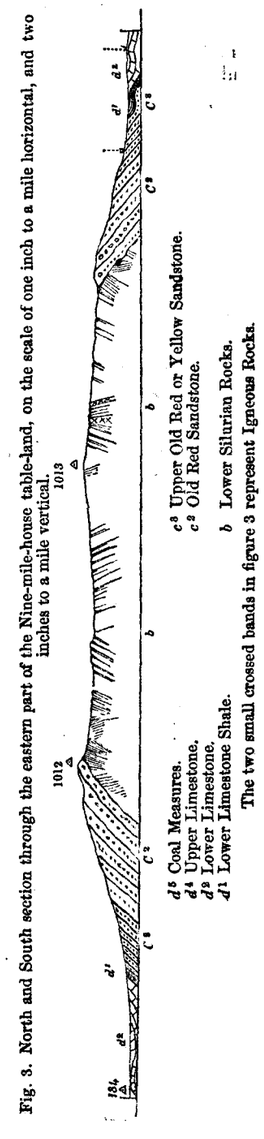


Fig. 3. North and South section through the eastern part of the Nine-mile-house table-land, on the scale of one inch to a mile horizontal, and two inches to a mile vertical.

$c^3$ Upper Old Red or Yellow Sandstone.
$c^2$ Old Red Sandstone.
$b$ Lower Silurian Rocks.
$d^5$ Coal Measures.
$d^4$ Upper Limestone.
$d^3$ Lower Limestone.
$d^1$ Lower Limestone Shale.
The two small crossed bands in figure 3 represent Igneous Rocks.

keel uppermost, and would have been formed of a continuous crust of Old Red sandstone, containing a large central nucleus of Lower Silurian rocks. No one, indeed, can look at the maps and sections, and read the foregoing description of the position and inclination of the beds, as they are now to be seen, without feeling assured that such was once the structure of the mountain; that the covering of Old Red sandstone was once continuous over the whole, and has been broken into and partially removed, and the central mass of the previously existing mountain ridge exposed at the surface and cut down to a table-land. The ground resembles, in fact, a huge half consumed pasty, of which the part coloured pale purple, (Lower Silurian,) in the map, would represent the meat, and the reddish brown colours, (Old Red Sandstone,) would form the crust, all the upper crust having been removed, except at the western corner.

*Unconformability.*—There is another striking geological structure which may be here alluded to, as obvious from a mere inspection of the map and sections. If we look at the eastern end of the table-land, between Tinnakilly and Redgap, we should see on the map certain stripes and dots of red, representing some contemporaneous trap rocks and ash beds interstratified with the slates. These strike nearly N.E. and S.W., and are, generally, very highly inclined. The Old Red sandstone, however, both on the N. and on the S., runs right across these beds, striking nearly E. and W., so that a quarry or cutting along the edge of the Old Red would show the beds having a relative position, like that in the diagram below (fig. 4).

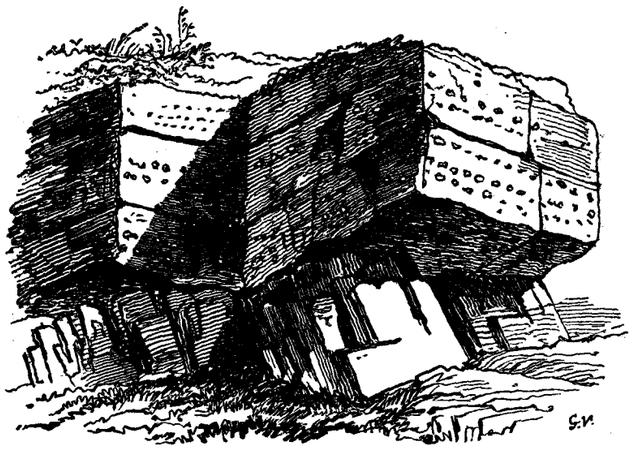

Fig. 4. Diagrammatic sketch, in which the upper massive overhanging rocks, containing layers of pebbles, represent the Old Red Sandstone, dipping at a low angle from the spectator, and resting on the upturned edges of the lower Silurian slates, which are inclined at a high angle in the opposite direction.

This relation of position between two groups of beds is called



unconformity; the upper group of beds being said to be unconformable to the lower. This unconformability, which occurs wherever the base of an upper group rests at different places upon different parts of a lower group, proves that before the deposition of the upper group, the lower one had itself been disturbed, tilted, and partly destroyed by denudation; otherwise, its lower beds would not have appeared at the old surface (or, the old sea bottom), and could not, therefore, have had any part of the upper group deposited directly upon them.

These geological structures are not only important facts in themselves, enabling us to understand the mere physical structure of particular districts, but like footprints on the shore, they serve as records of events. In the case of the district under consideration, we learn that after the horizontal beds of the Lower Silurian series had been deposited at the bottom of the sea, they had not only been uplifted, but tilted and set on edge as just described, and that large portions of them had been cut off and removed by denudation, and a new surface formed across their edges; but also that, at some subsequent period this surface became a new sea bottom, first, a beach, and then a shallow sea, and then a deeper sea, till great beds, first of gravel and shingle, and then of red sand and red clay, had been deposited upon it to a thickness of some three or four thousand feet. We may learn also, by studying the structure of the district, that this depression was continued until the sea became too deep, or too widely spread and too clear, for the introduction of sand and pebbles, and that only occasional beds of fine black mud were deposited, and that then these ceased for a time, and the space became the habitation of millions of marine animals, from whose debris great beds of limestone were formed, varied occasionally by the sweeping in of other beds of mud; and that, eventually, mud and sand began to regain the predominance, forming what is now the lower beds of the Coal Measures. We learn, moreover, that after all this took place, another period of disturbance occurred, during which the whole mass of rocks were elevated, and often tilted and dislocated in different directions; and that a local intensity or continuance of this uplifting force happening under the region of Slievenaman, thrust the rocks there to a much greater height than over the surrounding region. They thus became exposed, both earlier and longer, to the denuding forces which acted on the district either at the same time with those of elevation or subsequently, and removed first the Coal Measures, then the Limestone, and lastly, more or less of the Old Red sandstone, and the Lower Silurian rocks themselves from the region of the table-land. There is no other rational explanation to be given of the peculiar structural facts, which a survey of this and other neighbouring districts discloses.

*The Drift.*—Another very curious set of facts may be here alluded to, in general terms, namely, those connected with what is known as the Drift. The limestone plain is covered with a limestone gravel, consisting of angular and rounded fragments of the rock below. This might not at first appear very wonderful, but when we proceed to trace the boundaries of this drift, we find the limestone gravel

going beyond the limits of the limestone itself, and spreading up above the level of the limestone on to the flanks of the higher ground, both on to that made by the Old Red sandstone rising from below the limestone, and on to that caused by the accumulation of beds of Coal Measures above it. As the ground, however, gets steeper and loftier the limestone pebbles generally cease, and the rocks are covered merely by their own debris. It is, however, most singular that up on the Nine-mile-house table-land, at an altitude of 300 or 400 feet, at least, above the highest piece of limestone in the neighbourhood, the drift is found to be so full of pebbles and large blocks of limestone, that they are collected and burnt for lime. A considerable thickness of this limestone gravel is found here and there in the hollows of the table-land, occurring in large isolated patches, quite unconnected with the limestone gravel of the plains below. It is not very easy to frame an altogether satisfactory hypothesis to account for these facts; but it would seem as if the whole country, except the loftiest elevations, had once been covered with this wreck and ruin of the limestone, and that it had since been removed from all the more steep and prominent portions of the country, while that which occurred in plains or in hollows, at any elevation, was left behind, though even there it has been often removed either completely or in part from the beds and channels of the brooks and rivers.

J. Beete Jukes.

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### 3. *Formations and Groups of Rocks entering into the structure of the District.*

| | | *Colour in Map.* |
|---|---|---|
| | **Aqueous Rocks.** | |
| | Alluvium and Superficial accumulations. | *Pale sepia.* |
| | Drift (Limestone Gravel.) | *Engraved dots.* |
| *Carboniferous.* | $d^5$ Coal Measures. | *Indian ink.* |
| | $d^4$ Upper Limestone. | *Prussian blue (dark.)* |
| | $d^3$ Calp, or Middle Limestone. | *Indigo.* |
| | $d^2$ Lower Limestone. | *Prussian blue (light.)* |
| | $d^1$ Lower Limestone Shale. | *Prussian blue and Indian ink.* |
| *Old Red Sandstone.* | $c^3$ Upper Old Red or Yellow Sandstone. | *Indian red (dark.)* |
| | $c^2$ Old Red Sandstone. | *Indian red (light.)* |
| *Lower Silurian.* | *b.* Green and Gray Slate Rocks of Lower Silurian age. | *Pale purple.* |
| | **Igneous Rocks.** | |
| | E. Quartziferous Porphyry, or Elvan. | *Carmine.* |
| | D. Greenstone, (Diorite). | *Purplish red.* |
| | Ds. Ash beds, made of the detritus of Greenstone, or other igneous rocks. | *Red dots.* |



*b. Lower Silurian Rocks.*—These consist of slates and grits, which are confined to the central portion of the table-land of Nine-mile-house. Over the western half of that table-land their prevailing colour is a dull apple green, sometimes variegated with purple; over the eastern half they are generally blue and gray, sometimes black, and are interstratified with various trap rocks. Whether the green portion destitute of trap rocks forms a different group from the gray with trap rocks, and if so, which is the higher of the two groups, there is not sufficient evidence to determine with any thing like accuracy. It is just possible, perhaps, that the western half may belong to the Cambrian, and the eastern only to the Lower Silurian.

*c. Old Red Sandstone.*—This, as in the adjoining districts, consists of red sandstones and red shales, the sandstones often becoming conglomeritic, especially in the lower beds, and the shales often cleaved into slates. The upper part of the series containing yellow sandstones and green shales, interstratified with the red beds, is separated (though in a very loose and arbitrary manner), as a sub-group, under the derivation of $c^3$,* the Upper Old Red sandstone (or Yellow sandstone, of Sir R. Griffith, as marked in his map of Ireland).

The total thickness of the Old Red sandstone (including the upper beds) will be about 4,000 or 5,000 feet.

*d. The Carboniferous Group.*—This group is capable of a sub-division into four or five sub-groups over one part of the district, though as one of these (the Calp) disappears over another part, there would then be only three sub-groups, and it becomes very difficult then to separate those which lie above and below the horizon of the Calp.

$d^1$. *The Lower Limestone Shale* is a set of black earthy shales, or slates, with impure flaggy limestones, often decomposing into brown, sandy-looking beds.

Its thickness does not exceed 100 or 150 feet.

It is usually full of fossils, but no very good exposure of it is to be seen within the limits of sheet 46 N.W.

$d^2$. *The Lower Limestone.*—Regularly, sometimes thickly, bedded limestone of various shades of gray, sometimes crystalline, sometimes compact; it is, occasionally very magnesian, sometimes becoming a regular dolomite, and contains, where it is not magnesian, a good many fossils, Spirifer, Orthis, Corals, Crinoids, &c.

Thickness, perhaps, 1,000 feet.

$d^3$. *The Calp, or Middle Limestone.*—This is a dark gray, nearly black, limestone, generally very compact, rarely crystalline. Earthy shales occur in it sometimes, but as these disappear towards the S.W., and the dark colour of the limestone is no longer conspicuous, it becomes then no longer possible to distinguish clearly one part of the limestone from the other.

Fossils scarce, small bivalve shells occasionally.

* The Old Red sandstone to which the letter *c* was assigned by the Director-General, Sir R. I. Murchison, is provisionally separated into three sub-groups, of which $c^3$ is the upper 500 or 1,000 feet, $c^2$ is the main mass, and $c^1$ was intended to represent some still lower beds which are found only in the south-west of Ireland.

*d*⁴. *The Upper Limestone.*—This is, generally, a massive, thick-bedded limestone, of a bluish gray colour, generally very crystalline, sometimes fetid, and commonly full of layers and nodules of chert. It is rarely, if ever, magnesian. It is often full of fossils, especially of large Productæ, and large corals, Lithodendron, &c.

It must have a thickness of several hundred feet, though, from want of continuous sections, it is difficult to say how many.

The total thickness of the carboniferous limestone can hardly be much less than 3,000 feet, and that in a part where there is very little else but pure limestone (or dolomite) throughout.

*d*⁵. *The Coal Measures.*—Immediately on the top of the limestone occur black shales, passing up into gray shales and grits, and these into sandy grits and shales of an olive green colour.

No beds of coal or culm were seen.

Thickness of the beds which occur in the district, about 1,000 feet.

## Igneous Rocks.

Various beds, or dykes, of Greenstone and Elvan occur in the Lower Silurian rocks, also some beds of trappean ash. These, however, will be more fully described in the detailed descriptions.

*Drift and Superficial Accumulations.*—The description of these also will be better deferred till the end of the paper.

J. Beete Jukes.

G. V. Du Noyer.



## Detailed Descriptions.

The district included in this map was partly surveyed by Mr. A. Wyley, and partly by Mr. G. V. Du Noyer. These detailed descriptions are accordingly in part by Mr. Du Noyer, and in part taken from the data notes inserted by Mr. Wyley on the six-inch maps, whence they have been abstracted by myself.—J. Beete Jukes.

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

*Lower Silurian and base of Old Red Sandstone.*—We will commence the detailed description at the eastern end of the Nine-mile-house table-land, beginning with the Lower Silurian rocks about Boolyglass.

Gray argillaceous Lower Silurian slates, with gritty layers, are to be seen in the roads in the village of Boolyglass and the neighbourhood, north, south, and south-west of it, dipping at angles of 50°, and thereabouts, to the south-east; while immediately to the eastward, coarse Old Red conglomerate, containing quartz pebbles as much as three inches in diameter, may be observed here and there along the Old Red sandstone boundary. About a mile south by east of Boolyglass is a hill, 1,034 feet in height, covered with a detritus of clay slate, and quartzose grits, and the boundary of the Old Red sweeps immediately to the southward of this summit, forming in one place a rocky escarpment of coarse conglomerate, known as Carricktriss.

To the north-east of the summit, a band of ashy detritus may be traced along the ground, running north-east and south-west; and near its southern termination, strong greenish slates dip north-west at 80°, while immediately to the southward may be seen the conglomerate of the Old Red, dipping south at low angles.

Between this point and Garryduff is a little valley, about 200 feet in depth, giving passage to a small brook. The Lower Silurian slates may be seen in the bottom of this, and on its sides, as far to the southward as the field opposite the angle of the road just north of the cloth-mill, masses of red conglomerate occurring in the field south of that. The position of these Lower Silurian slates apparently induced Mr. Wyley to suppose that the sudden deflection of the boundary of the Old Red was caused by an upcast fall on each side of the valley. It may, perhaps, be doubtful whether the mere fall of the ground is not sufficient to account for the deflection.

Westward of Garryduff the Old Red conglomerate is well seen, forming a rocky escarpment, rising to a height of 1,012 feet, overlooking a slope covered with detritus of blue clay slate; and close to another summit of 1,006 feet the conglomerate may be seen dipping south at 15°, while the slate just below it dips north at 80°.

There is then another valley, in which greenish and bluish gray clay slate may be seen, here and there, north of the boundary, and sandstone and conglomerate to the south of it.

The hill west of this rises to a height of 867 feet, the Old Red boundary being immediately south of the summit, running between rocky beds of Old Red conglomerate, with an apparent dip of 20° or 30° to the south but a real one of much less, and beds of greenish gray Lower Silurian slate, well shown on the sides of the hill, which dip to the N.N.W. at angles varying from 50° to 80°. This north-westerly dip may be seen occasionally in the bed of the brook to the northward in dull gray, argillaceous slate. A quarter of a mile north of the hill last named, some hard, gray, ashy beds and breccias make their appearance, very solid and massive, interstratified with gray slate, and striking north-east and south-west; and these beds are again seen at Brown mountain, three-quarters of a mile to the north-east, being concealed in the intermediate space by drift consisting of gravelly clay, full of pebbles

of carboniferous limestone. They shortly disappear under another patch of similar drift, and are seen again a mile still further to the north-east, on the road, about three-quarters of a mile west of Boolyglass, beyond which they are again concealed by limestone gravel, and clay. These patches of drift lie at heights of 700 to 800 feet.

Following now along the boundary of the Old Red sandstone to the north of Boolyglass, we find the conglomerates sometimes containing a considerable quantity of fragments of slate, striking to the north, in almost unbroken scars, and dipping east at an apparent angle of 15°*; but no Lower Silurian rocks are to be seen near it till we approach Redgap. Gray and greenish slate is then to be seen on the road just north of the houses, while on the road to the west, gray brecciated ash is met with, very tough and solid, and between that and more greenish gray slate is a dyke of quartziferous porphyry or Elvan. This is in some places very beautiful, with a yellowish green mineral disseminated through it. Mr. Wyley describes it as shattering the slates into fragments, and disseminating itself into every crevice, making a breccia-like mixture of the two. It may be traced a little way to the southward, and runs in a curved line northwards through the wood,† being altogether about 700 yards in length. Smooth bluish-gray and greenish-gray slates may then be seen in the fields and roads to the westward, with a vertical cleavage striking north and south.

A quarter of a mile north of Redgap the beds and boundary of the Old Red sandstone begin to curve to the west; and on entering Castlemorris demesne, they at once strike nearly due west, dipping north at 10° or 15°. It consists here of coarse red and white sandstone, rather than conglomerate, and the boundary runs a little south of west till it meets a road running due north down by Rosenarra demesne.

South of the Old Red sandstone boundary, and just east of the road is another dyke of whitish compact feldspar, sub-porphyritic in parts and very massive. This is doubtless another variety of Elvan. It traverses bluish gray slates, which are not much altered. This may be traced about 500 yards to the southward, when it is lost; but going down the road to the south, about 600 yards beyond the cross-roads, another similar dyke (if it be not a reappearance of the same) may be seen. This runs for three-quarters of a mile to the south-south-west, ending apparently in a rocky boss. At its first appearance in the road it is a very fine grained mixture of quartz and feldspar, and is afterwards described as a light-coloured quartziferous porphyry, having a felspathic base with grains of quartz and crystals of feldspar disseminated, but being often without the porphyritic structure, and as being a granite without the mica. Immediately south-east of this, on the road towards Boolyglass, more bands are met with of coarse ashy breccia, very hard and solid, and looking like greenstone externally, interstratified apparently with gray slates. The ashy beds reappear from under the drift at intervals, for at least a mile towards the S.S.W.

About half a mile to the north-west two (or three) other elvan dykes are to be seen in the townland of Newchurch, described by Mr. Wyley, as having yellow crystals of feldspar in a dark base, and as a granite, wanting the mica, dark inside, weathering white outside. Bands of ash are seen near them, and close to Ballygowan are three dyke-like longitudinal masses of coarse Greenstone, traversing ash beds and gray slates. The slates appear to strike N.N.E. and S.S.W., dipping generally to the S.S.E. at 60° or 70°, but sometimes to the N.N.W.

* It is probable that the conglomerates and sandstones were originally deposited with a slight inclination in the direction of their present dip. In calculating their thickness, therefore, allowance must be made for this original slope.

† The name of the townland in which this wood is situated is Coalpit Parks, doubtless from some former abortive search after coal in the Lower Silurian rocks.



About a mile north of Ballygowan, on the road in the valley leading to Kilmaganny, a larger section than usual may be seen in these slates. They are spoken of as yellow and gray soft silty slates, much used in the neighbourhood for hones, and are stated, although soft, to be capable of giving a fine edge to tools. The prevailing dip appears to be to the N.N.W., but the slates are nearly vertical. Immediately to the eastward of this road a small fault occurs, a downcast to the east, shifting the boundary of the Old Red sandstone, which from that point runs nearly due east and west for a mile and a half. The Old Red here consists of red, brown and gray sandstones, very coarse, often conglomeritic, dipping north at 10° or 15°, and forming slight escarpments towards the south.

Near Barnathasona, west of Ballygowan, more beds occur of hard, massive, solid, ash breccias and coarse flaky ash, interstratified with slates, and one broadish band that may possibly be an actual Greenstone. About a mile to the south-west, in the strike of these beds, similar Ash and Greenstone reappear from under the drift, becoming a syenitic Greenstone on the banks of the Lingaun river.

Some strong bands of thick, solid, ash beds and breccias are also to be seen at Curragh and to the southward of it, all having a general strike from north-east to south-west; and the edges of beds of bluish or greenish gray slates are to be seen here and there in the lanes and ditches, all apparently having the same strike, and lying at high angles of inclination.

A little to the east of the glen of the Lingaun river, and at intervals for a couple of miles in that direction, the bottom beds of the Old Red sandstone may be seen, consisting chiefly of red silty sandstone, with occasional bands of conglomerate, resting directly on the gray slates of the Lower Silurian rocks. The Old red dips south at angles of 20° or 30°, while the Lower Silurian dips usually N.N.W. at 60° or 70°.

A pretty good continuous section may be seen in the banks of the river Lingaun, for about two miles above this. The eastern or Kilkenny bank of this stream was examined by Mr. Wyley, the western or Tipperary side, by Mr. G. V. Du Noyer. The latter describes a strong band of crystalline hornblendic Greenstone, near Tinnakilly, as cut through and shifted by a fault, as indicated in the map. He also finds two other dyke-like masses of Greenstone further north, the continuation of those described above as seen by Mr. Wyley. Both observers describe the ash beds at the bend of the river, a mile and a half north of Tinnakilly; Mr. Du Noyer, speaking of them as coarse and fine-grained, sometimes conglomeritic felspathic ash beds, dipping N. 40° W. at 85°, and having hard light gray grits and slates both above and below them.

Both observers, too, mention the strike of the cleavage in the slates as being N.E. or E.N.E., with a north-westerly inclination of 80° or 85°; the slate beds generally having the same strike, and dipping either north-west or south-east at high angles, but sometimes curving round over small spaces and dipping either north-east or south-west at lower angles; the cleavage still preserving its usual strike and inclination.

Beyond the ash beds just described no trappean rocks are anywhere to be seen, either to the north, west, or south. It appears, both from Mr. Wyley's notes on county Kilkenny, and Mr. Du Noyer's on the part in Tipperary, that higher up the river the slate beds more often dip to the south-east than to the north-west, the angle of inclination being always 60° or more. The country, however, now becomes widely covered by drift, containing limestone pebbles, so that except in the valleys of the brooks from which the drift has been removed, or on some of the higher grounds where possibly it may never have been deposited, little rock is to be seen. The higher grounds, again, are often covered to a considerable depth by small angular local detritus which equally obscures our view of the rocks below.

The northern boundary of this part of the Lower Silurian district, for two or three miles on each side of Windgap, is very regular, striking a little north of west and south of east. The bottom part of the Old Red sandstone consists of red sandstones sometimes shaly, with occasional bands of conglomerate, dipping to the north at an angle of about 30°, forming a range of low hills with small escarpments to the south, the summits of which rise to heights of 700 or 800 feet above the sea, overlooking the somewhat lower Silurian ground immediately to the south of them, which is covered with detritus of clay slate which assumes a greener hue as we proceed to the west than it had in the eastern part of the district. The central flat to the south of the ridge, covered with limestone drift, has a mean height a little over 500 feet above the sea.

J. B. J., *chiefly from Notes by* A. W.

To the west of Tinnakilly is a hill 980 feet high, formed of gray and greenish gray slates, immediately south of which may be seen the bottom beds of the Old Red sandstone dipping south at 25°. The dip of the slates is not seen, but they are strongly cleaved in lines striking north 50° to 60° east, vertical. Clay slates, with the Old Red sandstone resting on them, can be traced westerly in an almost straight line for the distance of nearly six miles, and junctions of the two rocks may be observed at intervals along it, as at the crossroads south of Rathclagh, and again on the north of the eminence, 786 feet, in the north side of Curraghadobbin wood, where the basal beds of the Old Red dip southwards at 25°.

In the glen of Glenbower, a short distance north of the barracks, green sandy grits and slates, dipping south-east at from 60° to 75°, are well exposed. Here they are not cleaved, or else the direction and dip of the cleavage coincides with those of the beds; but higher up the stream where it turns sharply to the west, the same beds are reversed, dipping north 50° west, and the cleavage at once becomes developed, striking east 20° north, inclined 75° to the south-east. Between Glenbower and Toor South, the slates are little seen, except along the boundary of the Old Red sandstone; and on the north of Kilcade wood, where the basal conglomerates of that rock form a bold eminence, and the two may be seen nearly in junction.

To the west of Toor South, in a small stream course, greenish gray grits and slates are seen in junction with the Old Red sandstone, the basal beds of which are hard red shales.

For nearly a mile and a half north of that part of the boundary of the Old Red just described, the Lower Silurian slates are rarely seen at the surface, and then merely as subsoil fragments.

To the west of Toor, the ground rises to form the eastern slopes of Slievenaman. On this slope there are two distinct eminences, one on the north, called Sheegouna, having an altitude of 1,822 feet, where hard green subcrystalline grits, slightly micaceous and conglomeritic, are imperfectly seen. The other, about a mile south of this, has an altitude of 1,644, and is likewise composed of hard greenish grits. These are both Lower Silurian rocks. Immediately south of the last eminence, the basal beds of the Old Red sandstone may be seen dipping to the south at 30°.

The small stream which here runs down the southern slope of Slievenaman to the west of the townland of Shanbally, cuts through both the Lower Silurian and Old Red sandstone rocks, and exposes a remarkably good section of the latter. Its base is formed of thin irregular layers of dark red conglomerate alternating with layers of sandstone. Above this is a conglomerate containing well-rounded pebbles of greenish grit, and over it, thin bedded dark red sandstones and shaly beds; the average dip of all being southwards at from 25° to 30°. Proceeding down the stream we pass over hard red sandstones, which frequently contain numerous small pebbles of



quartz and grit, the dip increasing to 55°. Where the mountain track crosses the stream, the rocks are not seen for some distance, but we again meet them lower down. They consist of red sandstones and fine conglomerates, with occasional dark red shaly beds passing up into thin-bedded fine conglomerates and flaggy sandstones capped by conglomeritic sandstones, with hard red shales, having dark red shaly and flaggy sandstones on the top. About here the cleavage in the sandy beds is nearly east and west inclined 85° southwards. Hard red shaly sandstones are then to be observed, and resting on them are yellow quartzose sandstones with greenish shale partings, which may be regarded as the base of the Upper Old Red beds. Above them are other yellow sandstones with red shaly beds, and red sandstones; the last rocks seen in the section being irregularly-bedded yellow sandstones, with thin slaty shale partings. All the beds just described, south of the mountain track, dip southwards at from 45° to 60°, and their total thickness, including the Upper Old Red, may be estimated at 3,500 feet.

If we now return near to the head of the stream just described, we find the basal beds of the Old Red sandstone striking in a nearly north and south direction, but about 560 yards east of the summit of Slievenaman, their boundary is slightly deflected to the west by the fall of the ground. At the head of the stream, between the townlands of Tober and Gurtnapisha, on the north side of the mountain, this line is sharply brought round to the east, and skirts the southern base of the eminence of Old Red sandstone named Knockahunna, 1,639 feet in height. In the streamcourse last named the basal beds of the Old Red are exposed. From the southern base of the summit just named, the green gritty Lower Silurian slates and the basal beds of the Old Red sandstone were observed at intervals striking in an almost straight line E.N.E. to a mile east of the village of Ninemile-house, a distance of nearly five miles, the two rocks, however, being nowhere seen in absolute contact. For a distance of two miles to the west of Nine-mile-house, the basal conglomerates of the old red dip northwards at angles varying from 40° to 60°.

*Old Red Sandstone.*—The detailed description of the Old Red sandstone may conveniently be commenced at Nine-mile-house. The basal beds of this rock, as there seen, consist of pale red conglomerates and sandstones, passing upwards into the yellow sandstones and silty beds, which are recognised as the Upper Old Red. These may be seen at the north-east angle of the wood north of the village. The conglomerates now strike west at high angles, as before stated, and occupy the northern slopes of the mountain of Slievenaman. Just as the ground begins to flatten into the limestone plain to the north, the different stream courses which indent its side expose short sections through the Upper Old Red rocks. These consist of yellow sandstone and red shales, the best sections of which can be observed in the boundary between Tober and Gurtnapisha, where the uppermost beds of the Old Red sandstone proper, consisting of red sandstones, slates, and shales, are also exposed; both sets of beds having a dip to the N.N.W. of from 30° to 50°. The Old Red now, as a mass, curves round so as to dip to the west, and form the west face of Slievenaman mountain, and it also widens or flattens out to a considerable extent. A tolerably good section of some of its upper beds is observed in the stream bounding the townlands of Clashbog North and Clorannew, exposing hard red flaggy sandstones passing down into thin conglomerates, the lowest observed rocks. The Upper Old Red beds do not appear in this stream.

Passing round the west face of the mountain, the beds of Old Red again curve round so as to dip to the south. Of these, good exposures can be seen in the streams which run southwards into the valley of the Suir. That at Killurney, in its upper portion, cuts into thin flaggy brown sandstones and

shales, which pass up into irregularly-bedded reddish sandstones; and near the top of the section, east of Kylebeg wood, there is a bed of fine quartzose conglomerate, having hard dark red flaggy sandstones with shales above it. These pass gradually up into the pale yellow flaggy beds of the Upper Old Red, of which a good section is now exposed, and the rocks are found to consist of flaggy yellow sandstones and hard red shales, which are cleaved (the cleavage planes striking east and west, inclined 70° and 75° to the south,) passing up into flaggy yellow sandstones with shale partings, and red and green earthy cleaved shales, and yellow sandstones with red shales above all. The dip of the beds just described is S.S.E. at 50°, and their maximum thickness exposed is 700 feet.

The same beds as those last described occur in the streamcourse in the townland of Ballyknockane, which need not, therefore, be described; and the section in the stream which lies still further to the east has already been mentioned when noticing the basal beds of the Old Red to the east of the summit of Slievenaman.

North of the village of Kilcash, on the road, a short section of Old Red sandstone is seen, the beds dipping south at 60°; they are chiefly hard red sandstones, with a shale bed cleaved east and west; cleavage inclined 75° to north. This brings us to Kilcash wood, whence in a direct line eastward, as far as the valley of the Lingaun river, a distance of five miles, the Old Red sandstone beds strike along the southern flanks of the Lower Silurian plateau, nearly due east and west, with a steady dip to the south of 30° to 40°.

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On the eastern side of the Lingaun river, just S.E. of the corn-mill of Birchwood, the Old Red sandstone consists of red sandstone, dipping south at 20°, having a cleavage striking east and west, and inclined to the north at 75°. These, near the edge of the wood to the southward, are covered by white sandstones, which are assumed as the boundary of the upper division, or so-called Yellow sandstone, which dips south at 35°.

Between this point and Annfield House, soft, yellowish, fine-grained sandstones (like some of those used in Jerpoint Abbey, near Thomastown), may be seen occasionally in this Upper division, together with white and red sandstones, the highest beds seen being thick brownish white and red sandstones, separated by green slaty partings. The lower division hereabouts consists of red silty and shaly sandstones, more or less conglomeritic. The dip of the whole is about 30°, increasing to 45° as we ascend in the series, or descend towards the plain occupied by the limestones, where, however, scarcely anything but drift is to be seen for some distance from the foot of the hills. A section in the lower beds may be seen in the road coming down by the Druid's altar. In the valley coming down from Garryduff, just at the bottom of the lower wood, is a quarry in the Upper division of the Old Red, in which the beds dip S.W. at 10° to 15°. This, according to Mr. Du Noyer's notes, shows a bed of hard, purplish red shale at top, under which are layers of light yellow, gritty sandstone, and thin bedded brown sandstone; underneath those are light, greenish, yellow, gritty shales, slightly micaceous, with impressions of plants, underlaid by hard, regularly bedded, light yellow sandstone, full of grains of feldspar. The total thickness of the beds seen in this quarry, is about fifty feet. From underneath these beds, as we go up the glen, other yellow sandstones rise out, and then red shales, dipping S.S.W. at 40°, for a space of 500 yards. At one point, Mr. Du Noyer observed these to be traversed by cleavage running E. 10° N., and dipping southerly at 65°. Near Templeorum, hard, red, coarse-grained sandstone dip S.W. at 10°.

While this Upper part of the Old Red sandstone thus descends into the low ground, with a strike to the S.E., and a dip to the S.W., the lower part,



on the other hand, near Garryduff, retains its E. and W. strike, and as it proceeds towards the E., curves round to the N.E., and finally to the N., dipping S.E. and E. at low angles. The consequence is, that the Old Red sandstone begins to spread over a much wider surface towards the E., than the narrow band which it occupies along the southern flank of the Nine-mile-house table-land.

Whitish and yellowish gray sandstones are described by Mr. Wyley as occurring in it occasionally, down even to the basal conglomerates. This conglomeritic portion is the only part seen along the eastern margin of this map, till we come N. of Redgap, when the beds curve round towards the west, and are again gathered up into a narrow belt running along the north flank of the table land, as they were on the south. Near the road north of Castlemorris, Mr. Wyley speaks of coarse white sandstone, as looking at first very like the granite of Glenpipe, with fragments of the same peculiar green feldspar. It dips N. at 15°. Similar whitish sandstones (forming the Upper part of the Old Red) are seen here and there towards Kilmaganny, having nearly the same dip. Beyond Kilmaganny, as far as Windgap, brown and red sandstones, and sometimes whitish brown are mentioned.

Between these upper beds, and the lower conglomeritic part of the Old Red, the beds consist of red, reddish gray, gray, and sometimes even of yellow sandstones. The dip of the whole is steady to the N., at angles varying from 15° to 30°.

A little west of Windgap, however, this steadiness of dip and strike, though continued in the lower beds, towards Nine-mile-house, is interrupted in the upper part of the group by a local deflection over a small anticlinal axis, which strikes out from the foot of the ridge, between Windgap and Killamery, towards the N.E.

In a quarry about 300 yards east of Killamery Church, are some greenish and brownish sandstones, dipping N.W. at 30°, containing impressions of the leaves of Cyclopteris (or Sphenopteris) Hibernica, and another smaller fern, and other plants. Similar beds, together with whitish brown sandstones, may be seen for a distance of three miles to the N.E., dipping N.W. at 20° or 30°, till they curve round and dip N., and N.E., and S.E., over the end of the small anticlinal ridge, which runs from Killamery to Kyle. This little ridge of Yellow sandstone (or Upper Old Red) rises to a height of 529 feet near Knockbritton, forming a very marked protuberance into the low limestone plain by which it is on three sides surrounded.

*c. Carboniferous Series. Limestones of the N.E. part of the map.*—It will be best, perhaps, to commence the detailed description of the Carboniferous rocks of this sheet of the map, on its N.E. side, beginning with the lower rocks north of Castlemorris.

The Lower Limestone Shale may be seen by a farm-house just a mile and three-tenths north by east of Castlemorris House. Mr. Wyley speaks of it as a black slate, with thin limestone bands, full of Carboniferous fossils. Just N.E. of it is blackish gray magnesian limestone, the bottom beds of the Lower Limestone.

At Clene Castle, beds a little higher in the series, are composed of dark and light bluish gray crystalline limestone with many encrinite stems and some shells, dipping N.W. at 7°. Similar beds are to be seen at Shancashlan Castle, north of Kilmaganny, but greatly crushed and broken by many small faults and contortions. Half a mile west of this is a quarry in dark gray impure magnesian limestone, exactly similar to that just mentioned to the eastward. About a mile north of these, are other quarries in bluish gray crystalline limestone, dipping at low angles in different directions.

About a mile and a-half N.E. of Knockbritton are some quarries in blackish gray crystalline limestone with Spirifers, &c., dipping N.E. at 5° or 10°.

Judging from these facts, and guided partly by the form of the ground, the Lower Limestone Shale is supposed to spread to the S.W. over the flat, as drawn on the map, although it is nowhere actually visible. At Coolaghmore House, however, black slates with beds of blackish limestone containing fossils are seen; and, again, at a small spot 700 yards to the N. by W. of that, near the boundary of the townlands of Coolaghmore and Courtnabooley West.

None of these lower beds are seen again, from this point round by Garryricken to Killamery, although there can be no doubt of their presence underneath the Drift.

The Lower Limestone spreads over the plain to the north of the band of country just described, and may be seen in numerous quarries scattered over the country. It is generally described as a bluish or blackish gray limestone, with fossils pretty abundant in some places, generally thick bedded and dipping in different directions, at low angles. Towards the E. and N., however, a great change takes place, the limestone becomes light coloured, often stained yellow or red, and has the glittering sandy aspect which is usual in dolomites. All traces of bedding are often lost, and the rock becomes a porous or cellular dolomite. In a quarry in Chapelizod demesne it is decomposed to a depth of eighteen feet, the crystals being disaggregated and separated into a mere dolomitic sand, which might be taken, at first sight, for a common quartzose sand. This magnesian or dolomitic character seems to be pretty uniform over considerable tracts of ground, but even there is capricious in occurrence, since it contains, sometimes interstratified beds of pure carbonate of lime without any appearance of magnesia.

In other districts, too, which are generally devoid of dolomite, dyke-like masses of it cutting across the beds may sometimes be seen in the quarries, as in a large quarry three-quarters of a mile S.W. of Kells. This occurs in a considerable patch, a mile broad, south of Kells, which is described as blackish gray earthy limestone, and supposed, therefore, to be a portion of the Calp. A still larger patch of similar black limestone may be seen north of Kells; and just to the west of this, about Newtown House and Highrath, there are two bands of black earthy limestone with black shale partings, entirely included in a district, every other quarry in which shows highly magnesian crystalline limestone, with the stratification almost entirely obliterated. Similar light coloured dolomitic limestone surrounds another large patch of pure limestone about a mile and a-half east of Callan. The included limestone is described as thick, solid, bluish-black, ringing limestone, with few fossils. It dips at angles of 10° or 15° in different directions; and one small quarry does contain some dark beds of impure magnesian limestone.

A quarry, about half a mile N.E. of Callan, in which light and dark gray coarsely crystalline limestone dips N.W. at 18° is crossed by a vertical band of highly disintegrated magnesian limestone. On a bye-road again by some houses, three-quarters of a mile north by west of Callan, is a whitish dolomite, highly crystalline, yellow stained, and much disintegrated.

To the west of Callan, along the road leading to Physicianstown, we get a set of quarries which give us a tolerable section from the Lower to the Upper limestone. At about three-quarters of a mile from the town, we have gray and bluish gray, almost compact, limestone nearly horizontal; a quarter of mile beyond that, to the west, is black limestone, compact and solid, over which is more bluish gray, dipping very slightly to the south. Half a mile west of these are dark gray compact limestones, dipping very slightly to the north, and just beyond, some thin earthy black limestones and shales.

A quarter of a mile west of this are a group of quarries running close up to the county boundary, composed of blackish or gray compact and crystalline limestone, the upper beds of which are particularly full of shells and



corals (Producta, Lithodendron, &c.). These dip N.W. and S.W., and are supposed to be the bottom part of the Upper Limestone; the beds between these quarries and Callan, generally destitute of fossils, being taken as the representative of the Calp.

A mile south of the last mentioned group of quarries, just east of Kyleadochir wood, strong beds of bluish gray compact and crystalline limestone are to be seen dipping north, at low angles; and a little east of these, again, in the townland of Ahanure North, is a quarry in a similar limestone, nearly horizontal, traversed by a north and south vertical dyke-like band of magnesian limestone. Lastly, on the road running south of Callan, towards Killamery, two large quarries are to be seen, in the county Kilkenny, in pure whitish crystalline dolomite, in which the bedding is quite indistinct; while a quarter of a mile to the east of these, are quarries of compact gray limestone, apparently without magnesia, well bedded, and containing many fossils.

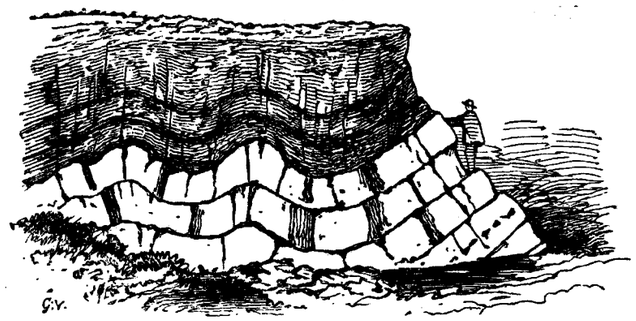
' J. B. J., *chiefly from Notes by* A. W.

*Limestones of the N.W. part of the map.*—If we proceed west from Callan, into the county Tipperary, and to the district which lies immediately to the north-east of Mullinahone, we find various quarries of bluish gray, finely crystalline limestone, often very fossiliferous, the beds dipping, on an average, to the north-west at low angles, or from 5° to 15°. These beds are frequently much jointed in planes running nearly north and south, inclined at 85° to the east.

North of the townland of Jamestown pale gray oolitic limestone may be seen, very fossiliferous; beds somewhat similar occur in the northern portion of the townland of Kyleaglanna.

In the townland of Ballydonnell are two large quarries, the beds dipping north-west and nearly west, at from 10° to 20°, consisting of blue massive limestones, which become thin-bedded and slaty on top. These evidently belong to the Upper subdivision of the Carboniferous Limestone as closely adjoining them to the west are the Coal Measures of Killinaul. South of and adjoining Mullinahone, limestones similar to those just noticed, appear in various quarries; the principal being those east of the village, exposing bluish gray limestones, dipping 10° to the north, but soon becoming horizontal. In the townland of Ballynacloughy the limestone as seen in the quarries dips west at from 5° to 15°, and has the overlying Coal Measures close to it on the west. At Drangan, and on the hilly ground to the north of it, the Upper Limestone is well exposed. It consists of blue and pale gray crystalline and often fetid limestones, which at Drangan dip S.S.W. at 10° to 15°, but turn over to the north in a low arch as they extend northwards, till at the distance of a mile from Drangan they are observed to lie in absolute contact with the black shales of the Coal Measure, and to dip under them at an angle of 10° to the north. A quarry at the north-east corner of Newtowndrangan townland very close to the basal black shales of the Coal Measures exposes some beds of very cherty, coarsely crystalline, and gray limestone, dipping northerly at a low angle. The junction between the limestones just described, and the Coal Measure shales, may be again observed in a quarry on the road-side, near the south-east corner of Langley Lodge demesne. Here the limestones are dark bluish gray, crystalline, thick and thin-bedded. The Coal Measures which rest on them consist of thin bands of purple, sandy, and platy shales, passing up into brownish and gray platy layers, which rapidly decompose into a brown earth. The surface of the limestone is here undulating in gentle contortions, which have also affected the superimposed shales.

No. 5.



Diagrammatic Sketch (looking north) of a quarry on the road-side, near the south-east corner of Langley Lodge Demesne, showing the Junction of the Upper Limestone and Coal Measure Shale.

To the north-west of Drangan, in the townland of Ballylusky, an excellent exposure of the Upper Limestone is obtained, in some large quarries on the Fethard road. The dip of the beds is here northwards at 10° and the limestones are bluish gray, crystalline, and crinoidal, with occasional nodular layers of black chert. Numerous very regular and smooth joints, striking north 10° west, inclined 70° to 80° to the west, cut across these beds, which in their upper exposed portion become lumpy, thin, and shaly, when they are observed to pass beneath the black shales of the Coal Measures which lie to the north. Although the absolute contact of these rocks cannot be seen, they approach so close as to leave no doubt that the following is the correct section of the junction :—

Black shale of the coal measures.
Lumpy, slaty, and shaly limestones, crinoidal, with thin layers of gray shale.
Thick and thin bedded crystalline crinoidal limestone.

To the south of this locality, and distant about one mile, the Upper Limestone again appears at the surface, with the Coal Measure shales resting on it. The dip is here 10° to the southward. On the rising ground which extends in a north and south direction, half a mile east of St. Johnstown castle, the same beds of the Upper Limestone as those previously described are very well seen in some large quarries, exposing a section of half a mile in length, the most remarkable feature of those beds being the very regular manner in which they are jointed. These joint planes have a general strike of north and south, and east and west, varying occasionally 10° in either direction, but always in such a manner as to cross each other at right angles at their intersection. On the north end of this section, where the upper beds are exposed, they dip under the Coal Measures at 10° to the north, flattening to 5° as they recede southwards, and then curve round to the north-west at 5°, and at the branch roads they dip west at 30°, curving round to the south-west at 20°, and eventually disappearing below the Coal Measures on the south end of the section, with a dip to the south of 15°.

If we now proceed towards Fethard we do not find any limestone appearing on the surface till we reach Knockkelly castle. Here it is very well exposed, and is also part of the Upper Limestone. It is bluish gray, irregularly bedded, containing lumpy layers of gray and black chert. Some of the beds are a mass of crinoidal fragments, and others contain large Productæ and corals. The joints in these beds strike north 10°, 20°, and 30° west, crossed by others east and west, and 10° to 20° north of east.



A few hundred feet south of Knockkelly house, and close to the limestones just noticed, the black shales of the Coal Measures appear. Many quarries of Upper Limestone occur here and there on the west of the St. Johnstown river, but they are not of sufficient importance to need detailed descriptions. They expose dark bluish gray irregularly-bedded limestones, usually crystalline, and frequently containing nodular layers of black chert. Their dip is variable, both as to amount and strike. Proceeding south to Cramp's castle we observe bluish gray, massive, and crystalline limestones, which, though somewhat different in appearance to those observed in the north at Knockkelly, yet undoubtedly belong to the upper division of that rock.

Between Cramp's castle on the west, and the village of Cloneen on the east, very many quarries of limestone have been opened, but all in the Upper Limestone. In the south-west corner of the townland of Milestown this limestone is observed to be brownish yellow, dolomitic, and weathering to sand. The dip of all these beds, especially when they approach to the Coal Measures on the north, is invariably to the N.N.W. at 5°, rising to 40°, and from that to 55°. At the village of Cloneen, the limestone is gray, thick-bedded, and granular, dipping north at 40° to 55°.

East from Cloneen, as far as the west side of the townland of Kilvemnon, a distance of four miles, no Carboniferous Limestone is to be seen in situ at the surface, though in this very district the two or three subdivisions of that group must of necessity exist, as the Upper Old Red sandstones of Slievenaman rises on the south, and the Coal Measures of Kilnagranagh and Ballywalter appear on the elevated ground to the north, distant from the former little more than one mile.

*Coal Measures.*—By following the upper boundary of the limestone before described to the west of Mullinahone, the space enclosed will include a small outlying basin of the lower beds of the Killinaule coal field, about six miles long from east to west, and three miles broad from north to south. In but few places, however, over this area are the coal shales seen, and then very imperfectly indeed. The best sections are to be had along the road between Mullinahone and Cloneen; again at the branch roads one mile east of St. Johnstown limestone quarries; and lastly in the ditches which intersect in all directions the hill of Tinakelly, east of Brook hill. The lowest beds, or those resting directly on the Upper Limestone, consist of black or dark gray, earthy, splintery shale, which rapidly pass up into thin, hard, dark and light olive gray grits, which are often slightly micaceous. At the second locality mentioned above, a short section through the lower Coal Measures is seen on the roadside. These consist of thin gray shales, with regular alternating thin bands of olive gray sandy and slightly micaceous grits, each layer of grit or shale being only one-half or one and a-half inches in thickness, a structure which gives to it a very symmetrical appearance, and indicates a remarkable regularity in the mode of deposition of the material of the rock.

In the townland of Tinakelly, in the parish of Peppardstown, an unsuccessful search was made some years back for culm. The workings were soon abandoned.

From the lowness of the dip of the Upper Limestone beds, which seldom exceeds 10° wherever they are observed in contact with the black or dark gray shales of what may be called the Tinakelly Coal Measures, and from the smallness in extent of this outlier, it is evident that these shales cannot be of any great thickness, certainly not more than about 1,000 feet.*

North of the limestones described at Drangan and St. Johnstown, a portion of the Killinaule coal field extends into this sheet. Its outline will

* The lowest workable bed of culm in the Kilkenny and Tipperary coal fields is, from the observations of Mr. G. H. Kinahan, and Mr. O'Kelly, upwards of 1,500 feet above the top of the Carboniferous Limestone; there, is, therefore but little chance of any workable coal, or culm, being found in any of these outlying basins, until at least that thickness of the lower Coal Measure shales and sandstones are found resting on the Limestone.

J. Beete Jukes.

be apparent by reference to the map; and the localities where the lower shales come into contact with the subjacent Upper Limestone have already been pointed out. These Coal Measures are but seldom well exposed at the surface, and where observed present the same aspect as those last described; the basal beds consisting of black and dark gray shales, which pass up into thin, hard, olive gray grits, and subsequently into grits and shales alternating with one another. These may be seen on the road passing through the west of Ballyluskey townland, but the best exposed sections occur along the Fethard road, between Lismorlagh house and Killinaule, on the road at Mortlestown castle school-house. The shales are rolling north and south at from 5° to 20°, being horizontal for a part of the way, where they exhibit rudely spheroidal concretions. As this is but a small portion of the Coal Measure country, and the rocks are but rarely seen in any thing like good or continuous sections, it would be impossible to state, from observations here, even the probable thickness of the Coal Measure series on the whole.

A small trough of Coal Measures, lying S. of the town of Fethard, appears to terminate on the east at a north and south fault, for close to its south-eastern corner the Upper Limestone may be seen dipping away from these Coal Measures at an angle of 50°, and the beds adjoining are crushed. This may be seen at the corner of the plantation on the opposite side of the road from the south-east corner of Grove wood.

The limestones at and adjoining to Fethard are quite similar to those described as occurring between Cramp's castle and Cloneen. They may be well seen in some large quarries, as well as on the rocky eminence, at Knockbrack, to the south of the town. Here they dip south at 35°, and in this manner pass under the Coal Measure hill of Grove wood. The same beds appear again on the south of this hill, dipping northwards at 50°; and on the Clonmel road, a mile to the west of the latter locality, they have a similar dip.

*Limestones of the S.W. and S. part of the map.*—If we proceed along the road east of Grove house towards Slievenaman, at the east corner of Grove demesne we find thin-bedded gray fetid limestones, with nodular layers of gray and black chert, dipping north 20° west at 35°. Beds having somewhat the same dip and strike, with smooth joints cutting through them in a north and south direction, appear about three-quarters of a mile still further to the east, in the townland of Claremore; but they change their aspect and character as they are traced southwards to the Roman Catholic chapel of Killusty, when they are light brown in colour, finely crystalline, amorphous, and dolomitic.

The limestones at and around Kiltinan castle are for the most part gray, thin-bedded and finely crystalline, dipping in various directions, and occasionally changing to a light brown dolomite. At the site of Kiltinan village these dolomites appear bedded, having a dip to the north-west of 30°. Similar limestone occurs on the east bank of the Clashawley river, opposite the turret and waterfall south of Kiltinan castle; but the bedding is obliterated, and the rock is an amorphous mass.

Thick and thin bedded dolomite, dipping south-east at 30° and north-east at 30° may be seen on the opposite bank of the river south of this last locality; and the fact of the bedding having been preserved in this rock, as we here see it, suggests the idea that the magnesian limestone in this instance was deposited as such, while in the former example it is probably a metamorphism from an ordinary limestone.

At Rocklow a large mass of this light brown and gray crystalline metamorphic dolomite appears, having gray finely laminated limestones on its southern boundary, dipping northwards at from 45° to 65°, and having a mass of light gray, compact, amorphous, and highly fossiliferous limestone to the north of it, appearing along the east bank of the Rocklow stream, on the road south-east of Kilmore mill.



Gray crystalline metamorphic dolomite again appears for the distance of nearly 1,000 feet, when the magnesia ceases to appear in the rock, which, as we proceed eastwards, becomes gray and compact, with a doubtful dip to the north-west of 15°. The fossil called Fenestella is common in these beds. By following the road which runs south to Brackford bridge, four or five quarries may be observed in what is presumed to be the Lower Limestone. The lowest observed beds are gray, thin-bedded, and compact, with nodules of black chert; these pass up into others, which are a coarse-grained oolite, all dipping south at from 65° to 70°. Close to the bridge similar limestones are seen, having the same dip to the south; and after passing Brackford bridge, a few beds of gray crystalline limestone, dipping at each other at 60° and 75°, so as to form a synclinal bend, may be observed south of the farm houses. In some quarries a quarter of a mile to the east of this, in the townland of Ballinvoher, gray thick-bedded limestones are overlaid by thin-bedded, black, earthy beds, with black chert, all dipping south at 75°; and at the farm houses, gray limestones, with black chert, dip north at 85°. These appear to be the basal beds of a set of limestones coloured as "Calp" on the map which extend as far as this locality from the westwards, where they are much better seen in large quarries in the townland of Ballyvaughan. There the limestones are very much broken by faults which run in the strike of the beds, which are themselves all highly inclined, and rolled to the north and south. The lowest beds of these quarries are black, and very compact, thick and thin-bedded, with black chert; they pass up into dark gray limestone also containing nodular layers of black chert. Here a synclinal curve appears to repeat the beds just noticed. Still further to the west, and at the extreme south-west corner of the map, a few limestones belonging to the upper subdivision can be seen; they are thick-bedded, and light gray in colour; and where they pass into thin beds, they contain nodular layers of black chert.

If we now proceed east, along the foot of the southern slopes of Slievenaman, and examine the limestones which lie in that direction over the space included in the map, the last locality where the dolomite appears is in the townland adjoining Templeetney on the east. Here it would be classed with the deposited dolomite as the dip of these beds, which is S. 20° W. at 70°, is well seen. The rock is very compact, and gray coloured, some of the beds weathering to a gray sand along the joints. A dyke-like mass of dolomite running north and south, occurs in the middle of the quarry. All these beds are jointed in the direction of N. 10° W. To the east of this place a few quarries appear, of thick and thin-bedded limestone, dipping S.S.W. at from 75° to 80°.

Similar limestones occur over the district to the east of Ballyglasheen castle, all dipping northwards and southwards at very high angles. Along the extreme southern edge of the map, extending east from a quarry a quarter of a mile north of Ballyglasheen castle, some beds of coarsely oolitic gray limestone can be traced for the distance of more than a mile and a-half; they overlie gray crystalline, thick and thin-bedded limestone, and all dip, at first, southerly, at 70°, and then to the north, at 75°. This oolite weathers rapidly to a gray sand. In a quarry in the townland of Seskin, adjoining the townland of Greenstand, where the oolite is last seen to the east, the beds dip north at 75°. Here appears a dyke-like mass of gray, sandy dolomite—from its mode of occurrence, clearly metamorphic.

The limestones which lie south of Kilcash castle, and eastward to Kilmurry old church, are all thick and thin bedded; gray, and sometimes dark gray, in colour; generally dipping south, at an average of 50°. In one place, however, on the north side of the townland of Ballynamona, the beds are very much contorted as they dip to the northward and eastward, at from 20° to 45°, an inclination contrary to what ought to be the natural lie of the beds. The jointing in most of the limestones is very regular, striking N. 10° W. vertical.

In the northern part of the townland of Figlash there is but one quarry which would appear in this sheet; it is to be seen a short distance south of

the road, and exposes thick-bedded, and very compact, light gray limestone, dipping E.N.E. at 60°, curving round to E.S.E. at 60°. By proceeding eastwards from this point, we pass into the county Kilkenny, and for the distance of two and a-half miles no limestone appears at the surface. We first find it in Castletown demesne, where it is dolomitic, though in several instances the bedding can be distinctly seen. In colour it is light gray, fine grained, with a pearly lustre when fresh broken. These quarries lie directly south of the line of the map, and out of its limit.

The band of Lower Limestone shale which is represented as separating the Lower Limestone from the Upper Old Red is drawn solely from inference, none of it appearing along the south, west, and central portions of this sheet although it is seen in the neighbourhood of Kilmaganny, and also in the country south and south-east of this map.

### 5. *Drift.*

The limestone Drift which occurs over the area represented by this map consists either of a brown, gravelly, calcareous clay, in which numerous pebbles and small well-rounded boulders of limestone occur, or else pure sand and gravel, the pebbles of which consist chiefly of well-rounded fragments of limestone.

When these two kinds of Drift occur together, the clayey portion is found below the other. The Drift, as mentioned in the general description, is found both spread over the lower ground which surrounds the Nine-mile-house table-land, and as a now isolated deposit on the lower parts of the summit of that table-land. The latter consists entirely of the brown gravelly, rather calcareous clay, containing boulders of limestone. At the head of the Lingaun river, north-east of Bawndun hill, boulders of limestone are so abundant in this drift, as to be collected and used for burning; indeed, all down this stream, as well as in that which exposes the drift to the east of Castle John, the boulders and pebbles such as are now described, are very common, and especially so just to the west of Boolyglass.

At Tullohea this drift reaches an elevation of 700 feet, but to the eastward, about Castle John and Cassan, its greatest elevation would be from 500 feet to 600 feet.

A curious feature may be observed in the limestone Drift which thickly covers the spur of Upper Old Red, which extends northwards from the village of Windgap. It is denuded, from along the crest of the ridge, for the distance of three miles, as well as from the summit of the small elevation south of Kyle, though the highest part of the ridge is only 317 feet above the sea.

Knolls and rocky ridges in the limestone, even over the low grounds surrounding the table-land, when their slopes are abrupt and they reach a height of 250 feet, are all usually denuded of the drift, as may be observed at Clone castle, and the eminence south of Rogerstown.

The maximum elevation, on the other hand, of the drift along the northern flanks of the table-land is about 600 feet near Windgap, and about 450 feet on the southern flanks, near Glenbower.

The outlying basins of Coal Measures noticed as occurring to the south as well as to the north-east of Fethard have been, for the most part, denuded of the drift, and other small elevations even in the limestone, as may be observed south of Brook hill, and to the north as well as west of Knockkelly house, and on the ridge to the east of St. Johnstown castle, are also free from drift.

The ridge of limestone which extends northwards from Ballyrichard house, near Drangan, is another example of this partial denudation of the Drift.

A large portion, however, of the Killinaule Coal Measures which extend into this map, at its north-west corner, are covered by the gravelly clay Drift.

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