

DATA AND DESCRIPTIONS

TO ACCOMPANY

QUARTER SHEET 45 S.E.

OF THE

M A P S

OF THE

GEOLOGICAL SURVEY OF IRELAND.



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DATA AND DESCRIPTIONS
TO ACCOMPANY QUARTER SHEET 45 S.E.
OF THE MAPS OF THE
GEOLOGICAL SURVEY OF IRELAND.

GENERAL DESCRIPTION.

1. *Form of the Ground.*

The principal features in the form of the ground included within the limits of this quarter sheet of the map, are the range of the Knockmealdown mountains with the western extremity of the Clonmel hills on the S. and E., the eastern end of the Galty mountains in its N.W. corner, and the broad valley between those elevations.

The Knockmealdown mountains form a many peaked range, running nearly due East and West, having several summits exceeding 2,000 feet in altitude, and one attaining to 2,609*. Their northern slopes are very abrupt, the ground descending, in the space of about two miles, or even a mile and a-half, from their summits into the valley of the little river Tar, which runs along their foot with a mean height of not more than 150 feet above the sea. Their southern slopes are much more gradual, undulating over a space of six miles into the valley of the Blackwater, in quarter sheet 51 N.E.

The height of the range gradually declines towards the West, sinking into much lower hills south of Mitchelstown, in quarter sheet 45 S.W. It declines also towards the East into the valley of Ballinamult, beyond which it again rises towards the East, up to the Commeragh mountains, in quarter sheet 46 S.W., and also towards the North in several parallel undulations, the most northern of which looks down upon Clonmel, and stretches east and west along the south side of the valley of the Suir. These Clonmel hills are formed of two or three east and west ridges, declining towards the West, and sinking into the valley of the Suir, within the limits of this sheet, in which their loftiest point is one of 1382 feet.

The Galty mountains form more of a cluster than a ridge. Their loftiest eminences are not within the limits of this sheet, but two or three which are included in it, exceed 2,000 feet in height, and one reaches 2,636. The southern and eastern slopes of this group of hills are less abrupt than their northern declivities, and than the northern slopes of the Knockmealdowns. The steepest inclination is from a height of 2,378 feet to 260 feet in the space of about three miles.

The valley between the two masses of high land is ten miles broad in the middle, narrowing to three or four miles towards the west, and opening out into a plain towards the north, with a mean elevation not exceeding 250 feet above the sea, except in two parts—one north of Clonmel, where the ground rises into low hills of about 500 feet in height; and the other north of Ballyporeen, rising to about 380 feet.

* All the elevations here and elsewhere are of course taken from the six-inch Maps of the Ordnance Survey.

On the northern slope of the latter elevation are the entrances to the caverns known as the Mitchelstown Caves. (See Paper by Dr. Apjohn, in *Journal Geological Society, Dublin*, vol. i. p. 103.)

The whole of the valley is drained by the river Suir and its tributaries. Entering the map at Cahir, in the centre of its northern side, and flowing round the eastern extremity of the Galtees, that river runs for several miles nearly due South, to the village of Newcastle, at the foot of the Knockmealdowns. Deflected by the rising ground of these and the Clonmel hills, it makes a sharp turn backwards, and runs almost due North again for four and a-half miles, up to Knocklofty, where it curves abruptly to the east round the foot of the Clonmel hills, and thence runs almost due East, past Clonmel and Carrick-upon-Suir, down to Waterford.

The level of the water of the river Suir at Cahir is 135 feet above the sea, and it falls to 60 feet at Clonmel.

2. Relations between the Form of the Ground and its Geological Structure.

The relations between the external form of the ground and its internal structure are simple and constant. The valley is almost entirely composed of limestone, the high ground of red sandstone and red slate rock. Nevertheless, the red rocks lie below the limestone, plunging underneath it on each side of the valley, and would be found beneath it all the way if the limestone were penetrated (see fig. 1.)

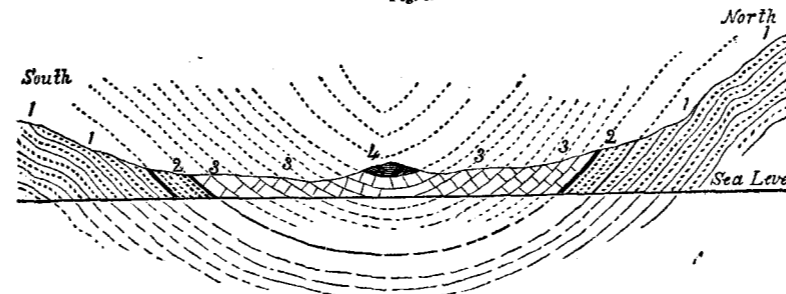
The elevations are due to the highly inclined position into which the beds have been tilted by the action of subterranean force, the rocks being most elevated over those spots, or along those lines where the elevating forces have acted most intensely, or for the longest period of time. On these spots, and along those lines, the lower rocks having been thrust upwards now rise from underneath those that formerly covered them, that former covering having been removed and washed away by another power acting from above, namely, the eroding and denuding action of moving water.

The limestone, which is now left in the valleys, was once equally spread over the rocks which are now the summits of the mountains. Moreover, since the upper beds of the limestone certainly extended originally over all the lower beds of the same formation, and since the uppermost beds, wherever they are now found in the valleys, are covered by the black shales of the coal measures resting upon them, we are compelled to conclude that all the limestone, both that which remains, and that which has been removed, was once entirely covered by these black shales. The patches of these upper rocks, which are now left here and there, are just those that have been spared by the denuding agency. In these patches, where the beds have been left comparatively undisturbed by the forces of elevation and denudation, the hills are formed by the highest, and not by the lowest beds, the rise of ground being in these places formed by the superposition of successive beds one upon the other, and not by the rearing up or tilting of some parts of the same set of beds to a loftier elevation than other parts.

The form of the ground, then, here as elsewhere, has been pro-

duced by the mutual action of the internal forces of elevation and depression, and the external forces of denudation. (Compare the little hill at 4, fig. 1, with the mountains to north and south).

Fig. 1.



4. Black Shales of the Coal Measure series.
3. Carboniferous Limestone.
2. Upper Old Red or Yellow Sandstone.
1. Old Red Sandstone.

Diagrammatic section across the valley near Ballyporeen, the vertical scale being four times the horizontal. The dotted lines above the present surface of the ground suggest the former extension of the beds, and the part removed by denudation.

The Knockmealdown and Galty mountains would never have attained their present altitudes if it had not been for the internal forces of elevation thrusting up the beds from below. They would have been far loftier if those forces had acted alone, and if vast portions of the elevated beds had not been stripped off by the wearing action of the forces of denudation.

The lesser coal measure hills that rise in the valleys where the rocks have been comparatively unaffected by the forces of elevation, owe their elevation above the ground about them, to the fact of that ground having been worn down by denudation.

J. BEETE JUKES.

3. Geological Formations.

The rocks comprising the district included in sheet 45 S.E. may be grouped in the following way:—

		Colour on Map.
AQUEOUS ROCKS.		
Alluvium and Superficial deposits.		<i>Pale sepia.</i>
Drift (Limestone Gravel).		<i>Engraved dots.</i>
Pipe-clay and Lignite.		<i>Purplish gray.</i>
Carboniferous.	d ⁵ Coal Measures.	<i>Indian ink.</i>
	d ⁴ Upper Limestone.	<i>Prussian blue (dark.)</i>
	d ³ Calp, or Middle Limestone.	<i>Indigo.</i>
	d ² Lower Limestone.	<i>Prussian blue (light.)</i>
	d ¹ Lower Limestone Shale.	<i>Prussian blue and Indian ink.</i>
Old Red Sandstone.	c ³ Upper Old Red, or Yellow Sandstone.	<i>Indian red (dark.)</i>
	c ² Old Red Sandstone.	<i>Indian red (light.)</i>
IGNEOUS ROCK.		
Greenstone.		<i>Dark purplish red.</i>

The Old Red Sandstone consists of a series of red rocks, arenaceous and argillaceous, interstratified with each other, the red colours alternating with green and yellow in the upper part of the series.

There would be little or no occasion to separate this series into two groups if we confined our attention to the district included in this quarter sheet, but as there is reason so to divide it elsewhere, it is necessary to do so here also.

c². The Old Red Sandstone proper is the lowest rock group seen in this quarter sheet. It consists, in the district of the Knockmealdown and Clonmel hills, of alternations of red, and liver-coloured, and brown sandstones, and indurated shales, the latter of which are commonly cleaved into rough slates. In this part of the district it is rarely conglomeritic, but the lowest beds of the group do not rise to the surface, in consequence of the arching over of the rocks across the line of the Knockmealdown and Commeragh anticlinal. The beds that are seen are calculated to have a thickness of at least 4,000 or 5,000 feet. These beds in the Galty hills are much more conglomeritic than in the other part of the district, pebbles of quartz, of red jasper, and occasionally of dark grit, coming in abundantly in some of the sandstone beds, especially in the lower parts of the group. Immediately out of this map, to the north-west, the local base of the Old Red sandstone may be seen reposing unconformably on the Lower Silurian rocks, but it by no means follows, that the beds which are there the base of the formation, are also its base in other parts of the country. The thickness on the S.E. of the Galtees is apparently about 3,500 feet.

c³. The Upper Old Red is usually characterized by the presence of yellowish or whitish sandstones and greenish shales (or slates), interstratified with red sandstones and shales (or slates). Sometimes, however, the red colour greatly prevails over the rest. The boundary between the Upper Old Red and the rocks below is a perfectly arbitrary one, since they graduate quite insensibly into each other.

The upper 1,000 feet of the red series has generally been taken as nearly as possible, to constitute the Upper group of *c³*, or what Sir R. Griffith has coloured as the Yellow Sandstone in this district.

The Carboniferous Rocks.—This series of rocks admits, first of all, of a two-fold subdivision into two principal groups, the Carboniferous Limestone below, and the Coal Measures above. The whole of the Carboniferous Limestone group is represented in the district included in this map, but only a small part of the Coal Measure series, not exceeding anywhere 300 or 400 feet in thickness.

The Carboniferous Limestone may, in adjacent districts, be naturally divided into four sub-groups, which are also traceable to a certain extent in the area included in this sheet of the map.

d¹. The Lower Limestone Shale is but a small band, not exceeding fifty or sixty feet in thickness. It consists of hard and very dark gray splintery shales, interstratified with thin calcareous grits and flaggy limestones. Fossils are very abundant in it, consisting of the same corals and shells which elsewhere characterize it.

d². The Lower Limestone consists principally of hard splintery limestone, of a pale or bluish gray colour. It contains layers and nodules of black chert in some places. It is invariably fine grained, and is

often traversed by such a number of different joint planes that its bedding is altogether obscured, and its marks of stratification sometimes obliterated.

It contains fossils occasionally, but not abundantly. It is difficult to form any exact estimate of its thickness in consequence of the obscurity of its stratification. It is probably about 1,000 feet.

d³. The Calp or Middle Limestone is only seen in a part of the district towards Clonmel. It consists of very regularly bedded limestone, containing much black chert, and being itself of a very dark gray, almost black, colour, and interstratified with layers of black shale.

It contains a few fossils occasionally.

Its probable thickness is about 800 feet.

d⁴. The Upper Limestone is a regularly bedded limestone, of a pale gray colour in general, with thin shale partings between the beds occasionally. The uppermost beds are commonly more cherty than the rest.

Fossils are rather abundant in it, especially the larger *Productæ*.

The probable thickness of the group is about 900 feet.

d⁵. The Coal Measures.—The part of this group which is to be seen in the district consists of dark gray or black shales below in thick beds, and of olive grey grits interstratified with thin shales above, the grits being very hard, and very regularly bedded.

No culm or coal is known in these beds within the district comprised in this sheet of the map.

The greatest thickness of these beds in this district is 400 feet.

They contain some fossils, consisting of small shells (*orthis* (?) &c.,) and a few plants.

The *Drift* and *Superficial deposits*, the *Pipe-clay* and *Lignite*, and the *Greenstone*, need no general description, and will be spoken of further on.

J. BEETE JUKES.
G. V. DU NOYER.
A. B. WYNNE.

DETAILED DESCRIPTIONS.

4.—Position and Lie of the Rocks.

(The details of the Southern and Eastern parts of the Sheet are by GEORGE V. DU NOYER; those of the North-Western parts by A. B. WYNNE).

Old Red Sandstone.—In order to describe the structure of the Knockmealdown range, it is best to commence at the south-east corner of the map beginning at Ballinamult. Near the barracks hard red sandstones, red shales, and shaly sandstones are to be seen dipping to the west, at from 30° to 40°; and passing down the stream to where it joins the boundary of the county Tipperary, similar beds are observed dipping to the west at angles varying from 15° to 20°. Near the dam and sluice of Finisk flour-mill the cleavage is very distinct, striking east and west, inclined 75° to the south. Passing west along the stream which forms the boundary of the county Tipperary, sandstones and shales, quite similar in every respect to those just mentioned, are met with, having an average dip of 25° to the west.

In Doon wood a thick lenticular-shaped trap dyke occurs, of a light-green coloured Greenstone, highly vesicular, and in some places amygdaloidal; the vesicles being filled with carbonate of lime. The dyke runs north and south for a distance of 600 yards, having a width of 200 feet in its widest part. At either side of this dyke, where it crosses the road west of Doon lodge, deep red shaly sandstones may be seen quite unaltered, but dipping from the dyke to the east at 40°, and to the west at 30°. This is the only instance of a trap rock in all the district, unless some angular fragments of a similar trap which occur on the mountain road, close to Waterford county boundary, nearly south of the summit of Knocknascullog, indicate a similar dyke.

The red shales and sandstones which appear along the road passing west from Doon wood, have all a westerly dip; and along the margin of the bog which this road crosses, they are concealed by a thick covering of drift, in which limestone pebbles are very common. This is at a height of 640 feet above the level of the sea. Dark red sandstones, containing scattered pebbles of small size, chiefly of quartz and hard grits, are occasionally observed, but they never become a conglomerate. In the stream forming part of the boundary of the county Tipperary, north of the townland of Broemountain, a short continuous section of the Old Red rocks is observed, and they dip S.S.W. at from 30° to 60°, and consist of hard, red, shaly, and flaggy sandstones, with traces of carbonate of copper in the lower beds.

Returning to Ballinamult barracks, and proceeding along the Ballymacarberry road, the red sandstones and shales are observed at intervals dipping westerly at from 15° to 30°, up to the turn of the road north of Caherbrack bridge; here the dip changes, and is northerly from 10° to 15°—a direction which, with a few scattered exceptions, it retains for a distance of more than four miles, or to a point more than half a mile north of the village of Ballymacarberry.

In the river Nier, which runs in an east and west direction at the village of Ballymacarberry, very good sections of the Old Red Sandstone rocks are seen, but not of any great amount, as the strike of the rock is more or less in the direction of the stream. The dips are invariably northerly, averaging 45°, and the beds hard red sandstones and shales, cleaved east and west vertically, and often jointed—the principal master joints having a direction of 20° to the west of north.

Trials for copper were formerly made in the townland of Knockatrelane, more than half a mile South of Ballymacarberry, on the Ballinamult road, but these were, after a short time, abandoned, as no true lode existed, the copper occurring as a disseminated ingredient in the sandstones. Indeed, it is not unusual to find specks of carbonate of copper in many of the rocks appearing on the banks of the river Nier.

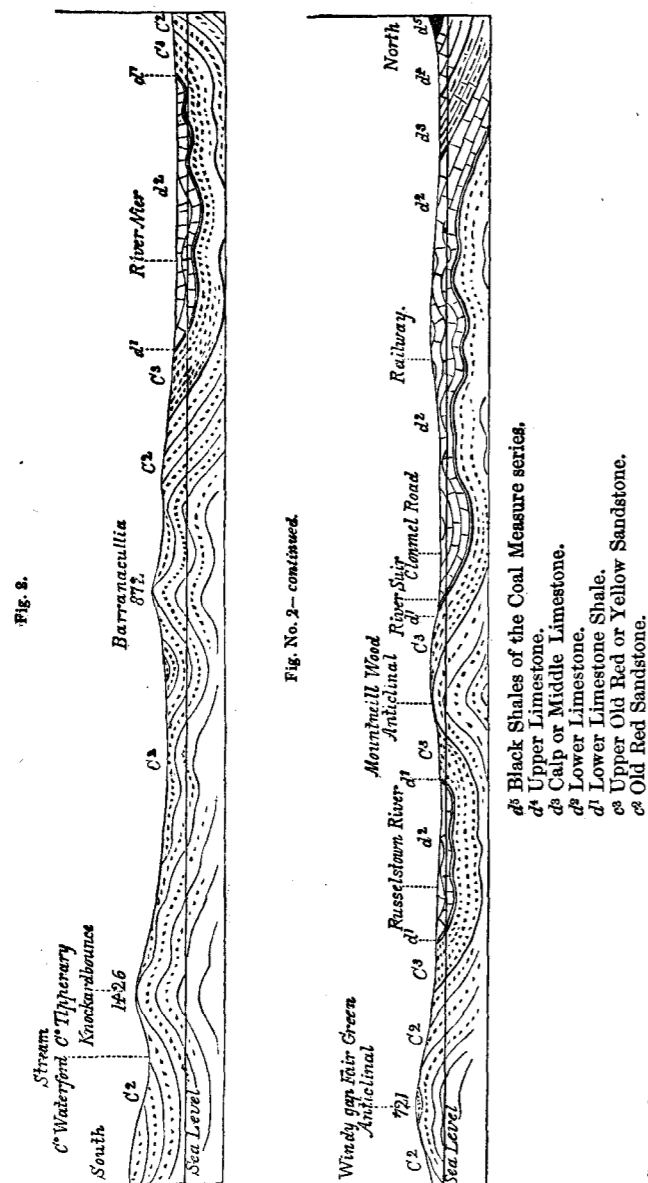


Figure No. 2 is a section which runs from the lower hills on the eastern side of the Knockmealdowns, across the termination of the Clonmel Hills, just W. of Clonmel to the Coal measure hills on the N. of it, and shows the anticlinal and synclinal curves into which the beds have been thrown along that line of country, the red beds, marked by dots in the woodcut, dipping under and rising from beneath the limestone in several undulations.

d⁴ Black Shales of the Coal Measure series.
 d³ Upper Limestone.
 d² Calp or Middle Limestone.
 d¹ Lower Limestone.
 c³ Lower Limestone Shale.
 c² Upper Old Red or Yellow Sandstone.
 c¹ Old Red Sandstone.

Section from N. to S. near the eastern side of the map, on the true scale, both vertical and horizontal distances being on the scale of one inch to the mile.

The Old Red Sandstone proper appears to terminate at the northern extremity of the wood east of Deerpark bridge, when it passes up into the beds known as Upper Old Red, or Yellow sandstone. These first appear on the banks of the Nier, close to the northern limit of the wood just alluded to, and consist of a few beds of hard, irregularly bedded, reddish yellow sandstone, with red shales above and below, the dip of them being northerly at 60°. A tolerably good exposure of these upper rocks of the Old Red is seen adjoining the National school-house close at hand; and also in the stream forming the boundary of the townlands of Clogheen and Clonana. The rocks are hard or quartzose sandstone, of a pale yellow colour, usually thin bedded and irregularly laminated with red shale beds between them. Their dip is here different to that first noticed, being south and south-west, at from 30° to 50°, thus forming part of the basin of the Carboniferous rocks which will be presently described.

If we now take a westerly course, and follow the range of the Knockmeal-downs, till they pass out of this map one mile to the west of Ballyporeen, we find the Old Red Sandstone and its associated Upper division presenting the same lithological characters as those observed between Ballinamult and Ballymacarberry. No good or continuous sections of either group is obtained, excepting in the streams running down the deep furrows which indent the northern slopes of the mountain range.

The best sections of the Yellow sandstone, and upper portion of the Old Red proper, in all this district, is obtained in the stream which flows east of the village of Bohernagaul into Newcastle. Commencing at its source, which is about half a mile N.E. of the summit of Knocknascullage, beds of hard and shaly sandstones and shales are observed in a continuous section of more than a quarter of a mile. The southern half of the rocks dip S. at 75°, and the northern to the N.N.W. at 20°. All those beds are cut up by cleavage, which has a persistent direction of east and west vertical. Proceeding down the stream, which now cuts through a thick accumulation of drift gravelly clay, in which pebbles and small blocks of limestone are of frequent occurrence, though at the elevation of more than 700 feet above the sea, the tops of red shaly beds are seen at intervals. In that portion of the stream which lies due east of the summit of Knocknageragh, the most continuous part of the section commences. The rocks, which first appear there are hard red sandstones, red earthy shales, and shaly sandstones, dipping north from 75° to 80°; and cleaved east and west—the cleavage planes being inclined to the south. Then a few beds dip to the south at 70°, showing a tendency to roll over, and thus lessen the apparent thickness of the section. Proceeding down the stream till it is deflected to the east, beds of the same character as those described are alone seen, and the cleavage is persistent in an east and west direction, inclined 70° to the south. The dip of all the rocks is N.N.W. at 75° on an average, with one exception, where for the distance of 400 feet they are rolled north and south at 75° and 80°. At the angle of the stream just alluded to, a few beds of thin greenish girt and shales occur. These may be the lower beds of the Yellow sandstone, though they are overlaid by a thick accumulation of hard red shales and sandstones. If, however, we regard them as really of the Old Red series, as it is most probable they are, the thickness of the continuous section passed over cannot be less than 3,000 feet, taking 75° as the average dip, and allowing for the repetition of the same beds indicated by the observed reversed dips.

At the distance of about 100 feet south of the stepping-stones at the cottages on the west bank of the stream, the first undoubted beds of the Yellow sandstone group are observed. These have a dip to the north of 80°, the same as the red beds of the underlying sandstone. They consist of thin, flaggy, and finely laminated yellow sandstones, with hard red shales alternating one with the other, but the sandstones predominating largely in amount throughout the entire section, which extends down the bed of the

river for the distance of 1,000 feet. At the northern termination of the section, the beds all dipping north flatten suddenly from 70° to 30°, when they undulate, and eventually disappear below the drift of the great limestone valley. Throughout the more argillaceous of these beds, the cleavage is the same as before described, viz.: east and west, but inclined at only 60° to the south in the northern portion of the section.

Further down the stream, at a spot due east of the trigonometrical point 190, on the Ordnance six-inch Map, the top of some flaggy Yellow sandstones appear; and somewhere close to this, it is probable that the shales of the Lower Limestone would properly come into the section.

If we allow 75° as the average dip of the Yellow sandstones just described from their junction with the hard red shales south of, and adjoining the stepping-stones, to where they flatten on the north to 30°, their total thickness would be about 650; and if this be added to the observed thickness of the old red rocks which occur higher up the stream, a total amount of 3,650 feet is obtained, and that of only a portion of the Old Red Sandstone of the district.

East of this portion of the stream, as far as Pastorville village, the harder beds of the Yellow sandstone crop out here and there; and as they give to the ground a low ridgy aspect, they suggest the boundary line of the Lower Limestone occurring on the north where the ridges cease.

In Bohernagaul stream, which has its rise to the west of the summit of Knockardbounce mountain, the lower portion of the section of the main mass of the Old Red which is wanting in the stream last described, is tolerably well supplied. The lowest beds are red shaly sandstones, rolling north and south, at from 25° to 50°; with one or two beds of a conglomeritic sandstone appearing here and there; and in that portion of the stream which is east of Kyledarragh bridge, the red sandstones and shales are rolled repeatedly from N. and S. so as to dip to the W. and to the N.N.E. and N.N.W., at angles from 30° to 75°; the cleavage in the beds contorted or otherwise, striking east and west, with an average inclination of 65° to the S. We may conclude, therefore, that the lowest beds, or those occupying the central portion of the great anticlinal, are contorted, and, therefore, add but little to the continuous sections obtained on the northern flanks of the mountain range.

The next best section is obtained in the stream which runs between the mountain peaks of Knocknagauv and Crohan West. At the head of this watercourse the rocks are contorted to the N. and S. in regular undulations, all of which have a tendency to dip westerly at angles varying from 20° to 60°; and the beds retain this undulating character for a considerable distance down the stream, till at a point about 1,000 feet north of the townland boundary of Curragh and Knockballiniry, they undulate to the north at angles varying from 20° to 80°. There are some thick conglomeritic sandstone, and hard red shaly beds; the cleavage of the latter being N. 80 E. vertical. At this part of the stream are some beautiful waterfalls, and north of them, at the angle of the river, is an east and west fault; beyond the fault are thin flaggy hard red sandstones dipping due south from 35° to 60°. The fault, therefore, occupies the axis of a synclinal. Further down the stream, where it is joined by a tributary on the west, hard red sandstones and shales, having an average dip to the north of 75°, appear at intervals for the distance of half a mile, when the rocks become concealed by the drift of the plain to the north.

All the rocks described as occurring on the lower portion of this section are dark red sandstones and shales, cleaved east and west or E. 10° N., dipping at 70° to S. Proceeding west along the flanks of the mountain towards Clogheen, sections through the upper portion of the Old Red proper, exposing beds identical in mineral character, aspect, and mode of occurrence to those described in the foregoing remarks, are to be seen: as for example, in the stream which runs down to Gortacullin village; in the upper portion of another rivulet which runs to the glen east of the peak called Graigue mountain; again, along the road side above the wood North of Bay lough,

on the Lismore and Clogheen road, and in the cliffs overhanging Bay lough; still further to the West, on the upper part of the stream which runs to Clogheen, and also in the stream which flows through Shanrahan wood.

Up to this point none of the Yellow sandstone beds are exposed in the stream courses; but in those which are to the east and west of Shanrahan wood, and adjoining to it, this want is supplied: in that to the east we have the lowest beds, thin yellow sandstone and shales succeeded by red flaggy beds which pass up into green and red shales, yellow sandstones and red marls. This section is continuous for the distance of 500 yards, and, with one exception, the beds dip steadily to the North at from 40° to 60°. The same rocks appear above the watercourse to the west of the wood, but with the addition of some micaceous brown flaggy grits in the middle of the section, and hard greenish yellow earthy shale, full of decomposed iron pyrites, at the top or where the rocks cease to be seen. The length of both cuttings is the same, and an equal stratigraphical thickness of rock exposed, viz., about 700 feet, allowing for contortion.

Passing still further to the West, towards Ballyporeen, each stream, which flows down the northern flanks of the Knockmealdowns affords a rock section more or less instructive. The stream to the west of Shanrahan wood, which forms the boundary of the townlands of Rearoe and Killeatin, affords a very good section commencing at the small mountain farm to the west of the summit of Knocklugga. A detailed description of this need not, however, be given, as the rocks are quite the same in every respect as those already observed. I might remark, that at a point a little to the South of due West from the southern extremity of Shanrahan wood, some of the thin hard red sandstone beds exhibit on their upper surfaces delicately formed ripple marks, their longest axis being parallel with the dip of the bed. Further down the stream some hard red earthy beds are cleaved East and West, but the inclination of the cleavage planes is only from 50° to 65° to the South. When this stream gets into the lower ground its course is rather tortuous; and at the distance of about 500 yards south of the cloth-mill it exposes the Yellow Sandstone beds, in which green shales are more common than usual, and the sandstone more felspathic. West of this stream is the Kilcaroon river in which rocks, quite the same as those last observed, are exposed, and at the mouth of Kilcaroon glen the Yellow Sandstones are seen.

The next stream to be noticed is that which has its rise close to and south of the summit of Knocknabrona, and which then flows northwards in the direction of Ballyporeen. Here, for a short distance, beds of thin, hard, red sandstone are exposed, at first horizontal, but lower down the stream dipping North at 20°. For nearly one mile no rocks are exposed in the stream course, which cuts through deep banks of sandstone drift, lying at an elevation of more than 800 feet above the sea; but at the height of 689 feet, pebbles of limestone were observed in this drift. Passing down the stream to a point East of the spot where the roads which skirt the East and West side of Carran hill cross one another, a set of beds occur, which, from their lithological character, resemble more nearly those belonging to the Yellow sandstone group than the Old Red proper, though their position which is so far south of the main strike of their upper beds would lead to the belief that they belonged to the lower. They consist of brownish red sandstones, hard red flaggy sandstones and shales, and light brown sandstones, often gritty and micaceous. These are observed in the stream for the distance of three quarters of a mile, rolling in every direction, at angles averaging but from 10° to 15°, though some dips at the northern end rise to 35°, having, however, as a whole, a basin-shaped arrangement. It is clear, therefore, that the stratigraphical thickness of these beds, to whatever part of the Old Red they may belong, is not great; and if they are upper rocks or Yellow sandstones, they are a small outlying patch rolled to the South, out of the main line of strike, by undulations in the lower rocks.

This completes the list of localities where sections of the Old Red sandstone can be seen along the north slopes of the Knockmealdowns, on this map; and at the point where we now are, it will be observed that the axis of the main anticlinal slopes towards the W., so as to allow of the upper beds, with the shales of the Lower Limestone, to come into the valley, which occurs on the extreme S.W. corner of the map. Here, along the boundary of the counties of Cork and Tipperary, a good typical section of the Yellow Sandstones and Lower Limestone Shale beds is observed. The former rocks consist of yellow and gray sandstones and slates, with red and brown slates and shales, all having an average dip to the south of from 35° in the lowest beds to 55° and 60° in the upper. Above them, and occupying the flats of the narrow valley of the Araglin river, are thin bedded crinoidal gray limestones, with gray shales, passing up into blue crystalline and crinoidal limestone, frequently containing chert nodules. The lower boundary of the Yellow Sandstone of the north side of Araglin extends in a continuous line from the extreme west edge of this sheet to a point on the stream forming the boundary of the counties of Tipperary and Waterford. Close to and south of "the Doons," and in the stream to the west of Glenadoon wood, a tolerably good section of these rocks is obtained. The best exposure of the upper part of the Old Red proper and the Yellow Sandstone in this neighbourhood is seen in the streams which run east and west of the eastern wood in the townland of Doon, and those adjoining it to the east. A detailed description of these sections is hardly needed, as the rocks are invariably of the same character as those described as occurring in the river courses in the northern flanks of the mountain. In the streams along the south margin of the map, and on the boundary of the counties of Tipperary and Waterford, dark red shales and sandstones of the Old Red are to be seen at intervals dipping in various directions.

On the stream forming the boundary of the counties of Tipperary and Waterford, which runs easterly from the east flank of Knocknascullog, and in the small section observed due south of the farmhouses in the county Tipperary, are thin bedded, and often flaggy red sandstones, and red shales; the former frequently exhibiting traces of carbonate of copper.

If we now return to the east side of the map, and suppose ourselves placed at the Deerpark bridge, on the Ballymacarberry and Clonmel road, we stand near the basal boundary of the Yellow Sandstone, close to its extreme eastern extension, in the line of the Knockmealdown mountains. The low grounds which extend northwards from this point close to, but south of, Farmhill house, are occupied by these beds, but the higher ground, which stretches westerly to Windgap Fair Green, and from thence north-westerly close to Barrack village, is formed by a large undulating anticlinal of Old Red, the axis of which slopes to the west (see fig. 2). Over this extent of ground but one continuous section is obtained, and that in the Glenkeel stream, a tributary of the Russelstown river. Throughout nearly the entire length of this stream, the only rocks observed are dark and light red sandstones, and shales, having an average dip of N.W. and W. at 30°. In that portion of the section due east of Barrack village, the beds are rolling to the N.W. and S.W. from 15° to 45°; but above the new road, near the embouchure of the stream, the dip is steady to the N.N.W. at 25° to 30°. Here the hard reddish sandstones and red shales pass at once into the yellow sandstones of the Upper division of the Old Red, and a short section of the upper rocks is now obtained, which, in every respect, resembles those so frequently described before. If we now strike east and take up the course of the Russelstown river, the same Yellow sandstone beds are traceable for the distance of about 200 yards beyond Glenabbey bridge, where they dip at N.N.W. at 25°, and are underlaid by the red beds of the Old Red sandstone.

By following up the stream we frequently observe beds of fine conglomerate in these lower red sandstones and shales; and where the farm road of Kilmaccommon touches the river, a group of fine hard conglomerate beds may

be observed. By following this stream to its source, very interesting exposures of the Old Red sandstone are obtained, though the rock is not penetrated to any great depth; the beds dipping in all directions, except to the east. Wherever the cleavage was observed it strikes from 10° to 20° N. of east and S. of west, either vertical, or dipping at a high angle to the south.

The high ground occupied by Mountneill wood on the north, is another but smaller anticlinal in the Old Red sandstone beds, of which the axis, in like manner, slopes to the west (see fig. 2). On its northern flanks over the town of Clonmel, sections from the Old Red through the Yellow Sandstone are obtained in all the stream courses which indent the side of the ridge. These are important, as showing how gradual is the transition from the lower to the upper division, and how very arbitrary is the boundary between them. The Yellow sandstones which skirt the outline of the two great anticlinals just noticed, cover a large extent of the low grounds east of the river Suir, between Ballymakee and Knocklofty, forming a broad belt, skirting the lower rocks, but allowing the Lower Limestone to occupy, in a bay-shaped form, the flat land extending from Suirmount on the north, round by the townland of Castlequarter on the east, to Four-mile-water bridge on the south, and again from Knocklofty house on the north round for the distance of a mile to the east of Kilmanaghan castle, and from thence south and westward by Kilmanaghan bridge to the glebe house of Tullaghmelan. Tolerably good sections of the yellow sandstones can be observed in the cutting along the Clonmel road, north of Suirmount, where, however, an unusual amount of dark purplish red shales and slates appear. The strike of the cleavage here is more deflected to the north than is usual, being E. 30° N. vertical.

Another section through these Yellow sandstone beds is observed still further to the north, along the carriage drive from the gate-lodge of Kilmanaghan castle to the main road leading to Clonmel. Here the mode of occurrence of these beds is very well seen, the rocks forming a perfect arch, inclining to the northwards at 25° , and to the southwards at 20° , and horizontal in the middle. On the opposite side of the river Suir, in the county of Tipperary, and in the strike of this anticlinal, the Yellow sandstone beds again appear as a large boss, which forms the mass of Knocklofty hill. A similar, but much larger extension of the Yellow sandstone, to the west of the river Suir, is to be seen in the prolongation of the Windygap Fair Green anticlinal.

Immediately on the banks of the river, the Yellow sandstone has a width, from north to south, of not more than three-quarters of a mile. It may frequently be seen at the surface between the glebe house of Tullaghmelan, and Suirmount house; and the Lower Limestone Shale also appears immediately to the north and south of it. Directly to the west of the glebe house, however, the surface exhibition of the Yellow sandstone is very much wider, extending to a mile and a-half from north to south.

About 700 yards N.N.W. of the glebe house, regularly bedded hard yellow sandstones may be seen in some high ground, striking steadily E.N.E. and W.S.W., dipping northerly at 70° and 80° . Between them and the glebe house, and south of this strike, thin and shaly beds of limestone are to be seen, likewise striking E.N.E. and W.S.W., dipping northerly at 20° . These facts prove the existence of a fault between these two places ranging about N.N.W. and S.S.E., having an upthrow to the west. Beds of yellow sandstone crop out south of the road leading from the glebe house to Flemingstown, dipping N.W. at from 20° to 30° ; and again in the road west of Flemingstown, and in the fields and plantations to the west of that, and in the turn on the road between Flemingstown and Knockeen, the upper beds of the Yellow sandstone, and the lower shales of the Limestone, may be seen very nearly in contact. About one mile W.S.W. of this point, in the townland of Knocknockillard, on and near the main road, the upper beds of the Yellow sandstone appear dipping N.W. and W. and S.W. at angles varying from 10° to 30° ; immediately beyond this is a flat in which, on the S.W. side,

quarries of limestone occur. A mile to the S.E. of this point, beds of yellow sandstone may be again seen in the townland of Ballynamona, dipping S. at 25° to 30° ; this is about one-fourth of a mile west of Burgesland house. These are, likewise, believed to be the upper beds of the Yellow sandstone, dipping beneath the flat in which the limestone occurs, striking easterly till they abut against the southern extension of the Tullaghmelan fault. Near the river Suir, on the northern extremity of the townland of Mulloughabbey, is a small quarry of limestone, having the same strike of E.N.E. and W.S.W., dipping S. at 30° .

Carboniferous Series.—The best locality for examining the base of this series is on the Clonmel road, a short distance south of Knocklofty bridge, where a continuous section from the Yellow sandstone up into the Lower Limestone may be observed. The top beds of the Yellow sandstone here consist of compact hard yellow sandstones, passing up into shaly micaceous sandstones of a similar colour, over which are dark gray earthy shales full of Fenestella, interstratified with thin shales, and thin crystalline concretionary limestones full of other fossils, and these are overlaid by compact, thin bedded, gray limestones, with a few black chert layers; and, above all, are regularly bedded gray and slightly fetid limestones smoothly jointed in lines striking north and south and east and west.

In the demesne of Knocklofty, and to the west of the house, similar shales to those last noticed are to be seen. Of the limestones the most continuous section occurs in Kilmanaghan demesne, from the sharp bend in the river Suir on the north, to the alluvial flats of the Russelstown river on the south. Above the dark gray earthy shales which form the base of the limestone, are thin bedded crystalline limestones with fossils; and in the beds under the castle are thick bedded highly fossiliferous crystalline limestones, with black chert nodules. In some shaly beds the cleavage is well seen, striking N. 60° E. and inclined only 30° to the southward; here the dip of the beds is S.S.E. at 10° to 40° . A few hundred yards south of the castle, the beds flatten to 10° , a dip which they retain till the small ravine and stream is reached, which flows close to the south gate-lodge of the demesne. On the south bank of the ravine the dip changes to N.N.W. at 25° , quite the opposite direction to that hitherto observed. We have, therefore, evidence of a synclinal in the limestone, and have reached the uppermost beds of this section; all the beds south of this, dip as just stated, viz.: to the N.N.W. at from 25° to 35° , being regularly jointed in lines striking North 20° to 30° West. The alluvial flats of the Russelstown river now conceal the rocks; and we do not again find a section through the limestone till we reach Suirmount house farther south. Close to the limekiln, south of Suirmount house, we again have the Yellow sandstone and Lower Limestone Shale nearly in junction, the former being hard quartzose, regularly bedded yellow sandstones, and light yellow shales, and the latter hard dark gray earthy shales with thin crystalline bands of limestone through them, all highly fossiliferous; the dip of both sets of rocks being S.S.E. at 40° to 50° . Further to the south, and along the farm road leading to the farm houses in Ardpadding townland, a tolerably good exposure of the limestones is seen in various quarries, the beds being variable in their thickness, irregular in their lamination, crystalline in texture, and of a light bluish gray colour. In the quarry west of the garden, beds of greenish rotten earthy shale alternate with the limestones, which are irregularly bedded and crystalline. Over the undulating ground, which extends easterly beyond the limits of the townland of Castlequarter, the limestones are exposed in many quarries; but they may be best studied along the northern banks of the river Nier, commencing at the townland of Castlequarter, where, on the eastern limits of the townland, the Yellow sandstone and Lower Limestone Shale are nearly in contact, and both rocks present the same lithological characters as they exhibit in the other localities previously mentioned; and as the boundary of the sandstone can be

traced with tolerable accuracy to the west along the limit of the flats south of the river, the limestone shales of course follow its outline, appearing at intervals in the banks of the stream. In the townland of Castlequarter the limestone is extensively quarried, south of the Roman Catholic chapel. The rock is bright bluish gray, and crystalline, and the lower beds contain abundant nodular layers of white chert. On the south bank of the river, south of Castle Coonagh, the hard, dark-gray, earthy, lower shales of the limestone appear, and are cleaved vertically in an east and west direction. Near the cross-roads, west of the townland, the limestone is gray and crystalline, dipping N. 30° W. at 30°; and on the river bank, S.E. extremity of Ballymakee townland, a few beds of limestone appear; and still further to the west, dark gray shales, with crystalline limestones, containing black chert, are to be seen on the south brink of the river. Between this point and the village of Newcastle, the limestone appears at the surface, and in quarries, in very many places, retaining much of the characters just described; but along the north banks of the river Tar, east of Newcastle, as well as immediately to the west of Newcastle itself, the bedding of the limestone becomes lost, and the rock assumes a massive homogeneous look, is light gray in colour, finely crystalline in texture, and broken up in every direction by numerous joints, giving to the rock a shattered and almost brecciated appearance.

Before taking up more fully the description of the limestones of this district, it is as well to remark, that wherever there is any exposure of rock at the top of the Yellow sandstone or the base of the Lower Limestone, it consists of dark gray earthy shales, and flaggy and thin concretionary limestones; and although these appear but at intervals, and widely apart, the regularity of their occurrence involves the necessity of representing them as a narrow band skirting the Yellow sandstone along its entire outline in this map.

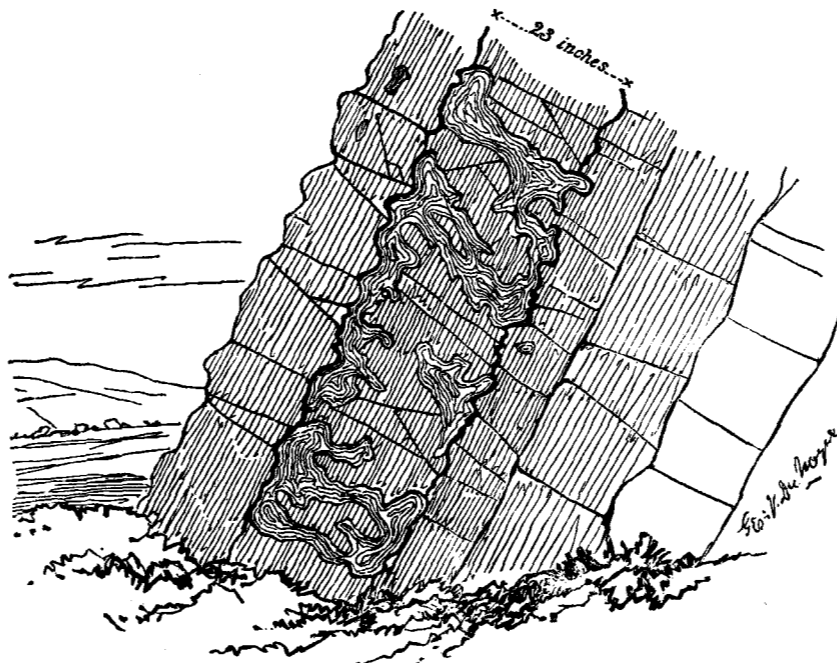
If we now commence the examination of the limestones north of Knocklofty and Clonmel, and pass over those lower dark gray and shaly beds, we find that in many places where the limestone is light gray, finely crystalline, and massive bedded, it becomes metamorphosed into a dolomite, as, for example, in the quarries east of Coole demesne, on the north bank of the river Suir in the townland of Loughtally, in the wood below the rath on the main Clonmel road between Birdhill and Abbey, in the quarries adjoining Haywood demesne, at Airmount; and lastly, still further to the east, on the Fethard road, north of Boreenduff.

It would be needless to enumerate all the localities where the Lower Limestone is exposed in the district particularly alluded to. I will, therefore, only mention the following. On the road in the townland of Nicholas-town, commencing nearly half a mile to the south of the old castle, the lowest beds observed are thin bedded gray crystalline limestones, containing some large *Producta*, and dipping nearly due north at 75°; and in similar beds at the limekiln south of the castle, bands of white chert occur. The castle stands on light gray, compact, and finely crystalline limestone, the dip of which is not apparent. Close to this spot, it is conjectured, that the middle subdivision of the carboniferous limestone called "calp" comes into the section, and the beds which here represent it, were well seen in the railway cutting, in the townland of Garryroe. They consisted of very dark gray and black limestones, both thick and thin bedded, dipping south at 60° on an average. One bed, which was very compact and black, contained numerous small bivalve shells, occurring in large irregularly grouped masses; the centre of each shell was filled either with Calc spar or else Arragonite, and the spaces occupied by the shells themselves were black; thus giving to the rock a singularly mottled appearance. The thickness of this bed varied from three feet six inches to four feet, and it was much shattered and broken by joints traversing it in every direction. Many of the crystalline segregations weather to a bright ferruginous brown colour.

Directly to the west of the Nicholastown beds, and chiefly in the townland of Ballindony West, a set of limestones appear which are quite different from them in lithological character. They are dark gray and black, compact in texture, rough bedded, with gray shale partings, and they dip invariably to the north, at from 50° to 75°. As the two kinds of beds, therefore, have the same dip, and if prolonged would be in the same strike, there must be a fault between them, and this is supposed to be a continuation of the Tullaghmelan fault, described in the account given of the Yellow sandstones of Suirmount house and Greenmount house. From the lithological character and position of the Ballindony beds, they clearly belong to the "Calp" division of the Limestone.

To the east of the Garryroe Calp beds, and in the townland of Carrickcooneer, the limestones resemble the Nicholastown beds, and are therefore quite different to those in Garryroe. They are light gray in colour, and contain layers of white as well as black chert. These beds dip S.S.W. at 60°, appearing to underlie the black beds in the railway cutting, and are therefore a portion of the Lower Limestone.

Fig. 3.



The tortuous lines represent the chert, the rest the Limestone.
S. of Caherlough House, 3 m. N. of Clonmel.

The next locality where the limestone is well seen is in the S.E. extremity of Barn demesne, and in the adjoining demesne of Oaklands to the east, in the townland of Patrick's Well, where the lowest beds consist of light gray, compact, thick and thin bedded limestone, with layers of chert, passing up into compact hard dove-coloured marble, with hard, pink, slaty shales, not calcareous. Above them are very hard crystalline light gray limestones, with layers of white chert. These same beds are repeated by means of a synclinal curve, and appear in the fields north of Oaklands demesne, and are traceable

easterly as far as Oaklands House. On the opposite side of the glen of Patrick's Well, not 200 yards distant to the east, are dark gray and almost black limestones, thick and thin bedded, compact, and very fetid. They dip west from 15° to 25° in gentle rolls, and as they occur directly in the strike of the Oakland beds, against the edges of which they appear to dip, it is probable that a fault occurs between them. If this be so, its direction is nearly north and south through Patrick's Well glen.

Three miles north of Clonmel, and immediately south of Caherlough House, there are several quarries, in one of which the gray semi-crystalline limestone beds dip S. 10° W. at 65° ; here the mode of occurrence and manner in which the black chert has segregated out of the limestone is well seen.

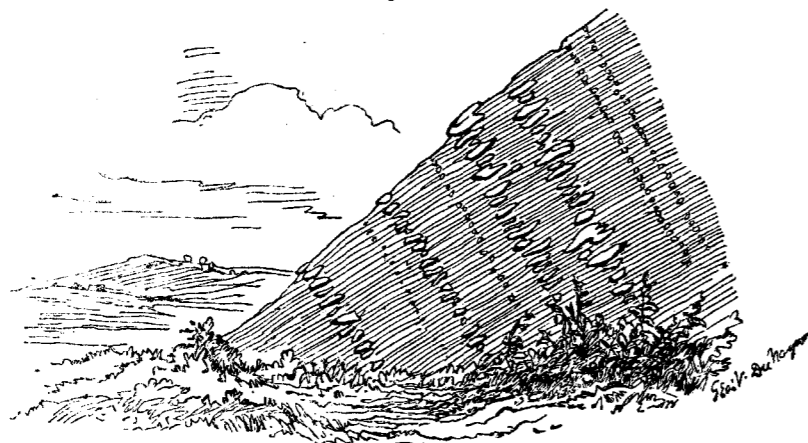
The upper and under surfaces of the beds are, generally speaking, very irregular, and that containing the chert particularly so. The chert occurs in irregularly shaped lumps, either solid, or enclosing a portion of pure limestone; the greatest amount of chert being along the edges of the beds.

The chert exhibits regularly concentric streaks of slightly different colour (see fig. 3).

The limestones to the northward of Clonmel are all light gray in colour, either compact or finely crystalline, unless in those localities where they become changed into a dolomite, and which have already been pointed out.

At the turn of the road west of the townland of Borheenduff, there are beds of gray earthy shales cleaved, and, therefore, converted into slate, which weather to a light brown colour. In these are irregular nodular layers of hard semi-crystalline limestone, containing fragments of encrinites. These nodules are remarkable in shape, being flattened ovals, the longest axis of which is at right angles to the line of dip, or parallel to the line of the cleavage, which is well developed. The dip of these remarkable shale beds is N. 25° W. at 60° ; and the cleavage strikes E. and W., dipping S. at 35° (see fig. 4).

Fig. 4.



The beds immediately over these shales are thin, with earthy light gray shale partings, and contain layers of white chert. A dislocation then is apparent, and as we proceed further to the north along the road, all trace of bedding is lost as the limestone becomes changed to a light brown dolomite.

At Summerhill house, and to the east of it, the dip of the beds is south from 35° to 50° ; but this changes to the northward along the stream forming the boundary of the townlands of Garryroe and Kiltegan. Here, at a point

between the houses in these townlands, it is conjectured that the Calp sets in, being represented by dark gray thick and thin bedded limestones, having black chert layers, in the top beds of the exposed section. The thickness of this group, allowing 65° as the average dip, is about 800 feet; but the thickness of the Lower Limestone is not exactly ascertainable. North of these Calp beds the limestone, which appears to rest upon them, changes to a light gray and compact rock, the beds being much jointed and broken. These are better seen to the east, in the townland of Rathronan, and the adjoining townlands, as well as in the townland of Rathkevin, to the west, than in the continuation of the section which we are now describing. These light gray limestones are clearly the Upper Limestone of the Carboniferous series, as close to where they appear in the townlands of Giantsgrave and Rathnasliggeen the black earthy shales of the Coal Measures appear. In no locality on this sheet can the thickness of the Upper Limestone be even approximately determined; but in that to the north, a continuous section through these beds gives 900 feet as the probable amount. If the fault first described as the Tullaghmelan fault is prolonged so as to form that which clearly exists between the limestones in Nicholastown and those in Ballindony West; and still further extended northwards, till it cuts through the western extremity of Woodroff demesne, the Upper Limestone will abut against it, and thus be brought into juxtaposition with the Calp, which, so far as the evidence supplied goes to prove, extends in a north and south direction to the west of the fault, from Markhamstown cross road, till it passes out of this sheet; its outline to the west being represented by a waving line curving from the extreme southern extremity of the townland of Lisnamuck on the south, past the old house of Kilmaloge, from thence along the east side of Loughloher hill, curving then to the N.E. at the east side of Knockfeagh hill, and then out of the map, on its north margin. The Coal Measure shales which rest on the Upper Limestone occur in this district as a small detached basin, of which scarcely one-half comes into the map. It extends in an east and west direction from the Tullaghmelan fault, which cuts off its western extremity, to the bend on the Clonmel and Fethard road, townland of Rathduff—a distance of about four miles and a-half, and varying from half a mile to a mile and a-quarter in width. The only well-exposed sections of these shales on this sheet are to be seen on the Clonmel and Chancellorstown House road, townland of Rathnasliggeen, and in the fields to the east and west of it. The lowest beds consist entirely of black shale, dipping north from 40° to 65° , in which many unsuccessful trials for coal have been made; higher up in the section thin greenish-gray hard grits occur, which are frequently micaceous, and contain plant impressions. These at first dip north at 30° , but at the northern limit of the coal strata basin dip S.S.W. at 8° . From this it follows that the total thickness of this deposit can be but trifling, from 300 to 400 feet, at the most. In the demesne of Woodroff house, where these shales appear to reach their greatest superficial extent, they are but imperfectly seen as fragments below the subsoil. There is but one quarry in this demesne, which is worth examining. It occurs at the north corner of the small plantation, at the parish boundary south of Bardona, and affords the following section:—thin bedded hard, olive-grey, nodular sandstones, soft, and cleaved vertically east and west, having thin olive-gray hardgrits above, which are overlaid by black shales.

Further details respecting the Coal Measures is not needed; and we shall now proceed to examine the main mass of the Lower Limestone which stretches to the west, in the direction of Ballyporeen.

In the neighbourhood of Ardfinnan the Lower Limestone is well seen, being exposed along the river Suir, forming cliffs, and elevated undulating ground. It is singular how, in many places here, the bedding of the limestone disappears, sometimes by a change taking place in the distinctness of the stratification within the space of a few yards, sometimes still more abruptly

on the opposite side of a joint or fissure. Thus, in the cliffs over the river flat, to the east of Ardfinnan, the limestone, which is of a light gray colour, is broken up by vertical joints, which are so regular in their occurrence as to give the rock a columnar look; while the dip is very obscure, appearing to be but 15° to the southward. The same appearance is observed in the rocks over the river south of the ridge; here to the east of the cliff the bedding is quite obliterated, and the limestone jointed in lines running N. 30° W., but as we proceed west the true dip appears, being N.W. at 40° in the lower beds, rising up to 70° in the upper. The limestone is light gray in colour and compact in texture, with some thin nodular beds. Directly south of the chapel, the beds last observed are cut off by a fault which strikes N.W. and S.E. and to the west of it the limestones lose all trace of bedding and become cut up by joints. Passing southwards from Ardfinnan to Ballybacon old church, the limestone appears in many places. It is invariably of a light gray colour, hard, and having a flaky structure, which conceals more or less the true lines of deposition. At the old church just mentioned, however, the dip is well seen to the north at 60° . In the fields S.S.E. of the Ardfinnan road where it branches from the Ballybacon road, there are two quarries; that to the north exposes hard, light gray, compact limestone, having a flaky structure, the beds dipping N. 50° W. at 40° , and in the adjoining field to the south a similar set of beds is exposed in another quarry, but dipping S. 30° W. at 45° . In both these quarries the cleavage is well seen, and has a direction of E. and W. inclined 75° to the south. Between Ardfinnan and Kilganny bridge, which is a mile and three-quarters north-east of Shanbally castle, and six miles west of Ardfinnan, the country is dotted over with quarries in the Lower Limestone, exposing beds so similar in every respect to those in the neighbourhood of Ardfinnan, that a detailed account of them is not needed.

In one of these quarries, however, in the townland of Ballyknockane, between Clogheen and Ardfinnan, the jointed structure of the limestone is so regular and so well shown as, perhaps, to make the following sketch worth introducing (see Fig. 5).

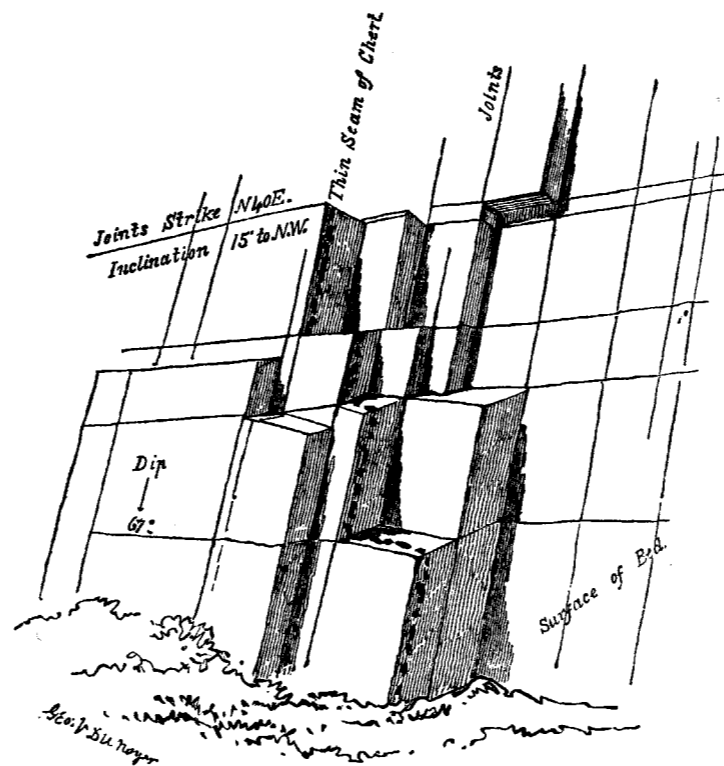
The limestone beds dip to S.E. at 67° , one set of joints strike N. 40° E., another set cutting these at right angles, or nearly so. The first set of joints are now inclined to N.W., at an angle of only 15° , but must once have been vertical, if they existed before the elevation of the beds.

The other set are either vertical or inclined from it slightly towards the west. These joints divide the beds into cuboidal or rhomboidal blocks. A layer of black chert nodules marks the stratification, and is almost the only test by which to distinguish it from the jointing.

The most remarkable fact, however, connected with these limestones is the apparent dying out of the Calp beds, or the middle subdivision of the limestone as we approach Clogheen and Ballyporeen.

South of Garrymore bridge, on the river Tar, in the first bend of the river, the Coal Measures are to be seen, consisting of black earthy shales and thin gray flagstones, dipping gently to the south, but contorted. From the occurrence of these shales, a small basin of the lower beds of the Coal Measures is inferred, which cannot be more than three-fourths of a mile in extent, from east to west, and one-fourth of a mile from north to south. The extreme northern limit of this basin appears to be about 200 yards south of Garrymore bridge, where the light gray Upper Limestone appears with a probable dip to the south; and from this point the limestones are observed northwards in a continuous section as far as Garrymore bridge. On the east of the Coal Measure basin in the western portion of the townland of Garrymore, the same limestones appear in two or three quarries. To the west of the basin, in Shanbally demesne, the same limestones appear again on the north of the eastern extremity of the small lake in the demesne; and lastly between this basin and Shanrahan church, on the south, the Upper Limestone alone appears in several quarries.

Fig. 5.



In the large quarry, about one-fourth of a mile west of Clogheen, light gray, very hard, and compact limestones are to be seen, occurring in thick and thin beds, containing regular layers of white chert. The dip is 75° to 80° south; and there are numerous well-defined joints, striking N. 10° W. Angles of dip so high as these cannot always be relied on as indicating the true lie of the beds. These, therefore, may belong to the Upper Limestone group.

South of this quarry, no rock is to be seen till we meet the Yellow sandstone beds of the Shanrahan wood sections; neither are any rocks visible in the valley to the east and west of Clogheen for the distance of from one mile to one mile and a-half. Although, therefore, no Calp is actually seen, its occurrence may be perfectly possible, at the same time that it may be lessening in thickness from where it was last observed north of Clonmel.

A short distance over a mile to the north of Ballyporeen, a second outlying basin of Coal Measure shale occurs directly in the strike of the one last described. It is not more than half a mile in width from north to south, but in its east and west extension it passes out of this sheet. The beds of these lower Coal Measures, which are very imperfectly exposed, are quite the same as those east of Shanbally castle. The limestones on which they rest are light gray, hard, and crystalline, as well as compact, differing somewhat, by the absence of white chert, from the upper limestone beds of Shanbally. They are exposed in the large quarries which are opened along the road which leads directly north from Ballyporeen.

In those beds which would come closest to these Coal Measures at the large

quarry north of Carrigavisteed, the dip is difficult to be determined, appearing only at the northern limit of the quarry, where it is north at 70°, flattening to 35°. Though these beds are hard, yet there runs through them a rude cleavage, having a strike of east and west, the planes inclined but 40° to the south. Near the limekiln on the west of this quarry, a few beds dip nearly south at 75°. Between this quarry and Ballyporeen, the dip of the limestone is nowhere apparent.

West of Ballyporeen, in the townland of Kilnamona, there are two large quarries in this hard, light gray limestone, in neither of which is the dip of the rock apparent. Very many joints, having a direction north and south, which are traversed by others east and west, break up the rock into cuboidal masses. As the probable boundary of the Yellow sandstone comes in within half a mile to the south of these quarries, somewhere on the flat south of Ballywilliam house, if we regard these limestones as belonging to the Upper group, we have certainly but little space for the Calp and Lower Limestone to come in between them. I am inclined, therefore, to believe, that the Calp subdivision is here entirely wanting.

Drift.—We have now but to notice the Drift which occurs in the district comprised in this map.

Over the extensive limestone plain which occupies the centre of the sheet, the drift is chiefly composed of rolled fragments of the local rocks, either arranged in detached mounds, or else mixed with brown gravelly clay, which forms the subsoil of the country. The drift limestone pebbles, mixed, it is true, with the *debris* of the local sandstones, extend up many, if not all, the valleys or indentations along the northern slopes of the Knockmealdown mountains, to the height of fully 750 feet above the sea, or about 500 feet above the average level of the limestone plain on the north. This fact is well seen in the stream which rises close to and south of the summit of Knocknabrona hill, and which flows from thence northwards towards Ballyporeen. At an elevation of 629 feet, well-rounded pebbles of limestone may be observed, mixed with the local sandstone drift. The boundary of this deposit, as it occurs along the North flanks of the Knockmealdown mountains, is capable of being defined with tolerable accuracy; thus it skirts along the centre of Shanrahan wood, after leaving the glen where it was last observed, and then at an elevation of about 620 feet is laid against the flanks of the mountain range, sweeping with gentle curves up into the mouths of the valleys as far to the east as the Glenboy river, south of Newcastle. Here, at about half a-mile South of Bohernagaul, and at an elevation of 408 feet above the sea, and 230 above the limestone plain on the North, a considerable accumulation of brown gravelly clay is exposed by the river, to the depth of forty feet, containing a large amount of rounded lumps and blocks of gray limestones. Higher up the stream, at a height of 660 feet, a similar thick deposit of clay, containing limestone boulders, is cut by the river to the depth of from forty to fifty feet.

Near the mouth of this glen, after heavy floods, the limestone boulders and large pebbles are collected out of the river bed, for the purpose of being burned for lime. At the height of 750 feet in this glen the limestone drift appears to cross the rounded ridge, separating this stream from that to the East, which flows to Newcastle, thus leaving the summit of Knocknageragh (910 feet) clear, and rising like an island out of the surrounding drift.

The drift extends up the stream east of Knocknageragh to the same height as in the Glenboy river.

The next ridge to the east of Knocknageragh is called Barranacullia (872 feet), lying between the two branches of the stream which runs to Newcastle. This ridge likewise stands clear out of the drift which stretches up the glen at either side to the height of about 750 feet. The same description will nearly apply to the eminence called Knockperry

(961 feet), which, however, assumes the appearance of a promontory rather than an island in the drift. At the head of the Barnahullia river the same gravelly clay drift extends to the elevation of 600 feet; and thence, sweeping round the east flank of Knockatallane, it joins on to the drift, in the Curragh-cloney glen.

If we now cross the Ballinamult stream, which runs north to Creggane bridge, and forms the boundary of the counties of Tipperary and Waterford, and follow its course to the north, we find its glen or valley entirely occupied by this limestone boulder drift; and along the east side of the stream in the county Waterford, this drift is laid against the western flanks of the high grounds, which there skirt the river at elevations reaching as high as 650 feet. On the west side of the townland of Curraghateskin, in the county Waterford, there is a small detached accumulation of sand and gravel, in which the limestone ingredients predominate; the small streams, flowing at either side of this escar-like deposit have scarped its northern termination, giving it here the aspect of a low hill or knoll.

The limestone drift now sweeps round the northern slope of the townland of Deerpark mountain, about three-fourths of a mile south of Creggane bridge, and is spread up the glen of the river Nier, and the various valleys which lead into it. The maximum elevation of this deposit being about 650 feet above the sea, though pebbles of limestone have been observed in the drift as high as 750 feet on the western and southern flanks of the mountain at Windygap fair-green and Curragheenavoher hill. All the low grounds between Pastorville and Suirmount and further to the North, along the East side of the river Suir, to the South flank of Mountainhill wood, and up the Russelstown river glen to Kilmaccommon, is covered with the limestone drift, but it is almost or entirely wanting over the rising ground of yellow sandstone to the north-west of Greenmount house, as well as on the boss of the same rock, west of Knocklofty. The drift then skirts along the northern slopes of the Clonmel range of hills, where it does not appear to reach an elevation higher than 500 feet.

It might be well to remark, that on the summit of the rising ground south of Knocklofty, on the county Waterford side of the river Suir, the limestone gravel rests directly on the subjacent limestone, and forms a coarse recent conglomerate, the pebbles being cemented together by carbonate of lime. Through the mass are occasional horizontal layers of fine sand and gravel, which give it a stratified look. The same recent conglomerate is observed in the plantation close to the road in the east corner of Park townland, near the Police barrack of Knocklofty, where it is decidedly stratified, the layers of coarse and fine materials resting at an angle of 15° inclined to the south-east.

The drift of which we have now given a description does not extend over the low ridge of Coal Measures which lie to the North of Clonmel.

GEORGE V. DU NOYER.

Details of the North-west corner of the Map.

Beginning at the north-west corner of the map, at the eastern end of the Galtees, the following are the places where the rocks are visible.

In the cliffs south of and about Lough Muskerry, the conglomerates and sandstones near the base of the Old Red Sandstone are seen.

On the southern slopes of the Galty mountains that rock is first seen in the stream that runs by Lord Lismore's lodge, in Glenagarra. Just above the lodge, red and purple gritstones, sandstones, and indurated sandy shales occur, with slightly micaceous and conglomeritic bands: they dip southward

from 10° to 20°, but are sometimes nearly horizontal. For about 300 yards south of the lodge, coarse, grayish, purple, and red ferruginous sandstones are seen, dipping south, at 20°. Lower down the stream, but above these in the series, massive purple conglomerates occur, dipping south at about 20°: and from thence until the river leaves the wood, purple, gritty, and salmon-coloured sandstones, dipping southward from 10° to 35°, are occasionally seen. The last beds visible before the river leaves the wood, are gray grits and yellow sandstones, over soft purple beds, dipping south at 55°.

Proceeding along the Caher road from Glenagarra bridge, about a mile and a-half eastward, where the road meets another from the south, and a stream has cut through a quantity of drift, are some beds of yellow and white coarse quartzose sandstone, with a quantity of dark-red shale, the whole dipping south from 35° to 50°. About a mile further on towards Caher, a considerable stream crosses the road, on ascending which the Old Red sandstone rocks may be seen. For the first three or four hundred yards, pale purple and red flaggy and sandy beds, with thin greenish and yellow sandstones and shales occur, dipping southward at 40°. For about a mile and a quarter further up this stream, soft purple and salmon-coloured conglomeritic sandstones and red grits are occasionally seen, dipping generally from 20° to 35° to the south-east. Underneath them is a thick red conglomerate, containing pebbles of gray grit in addition to the usual ones of purple grit and white quartz; it dips at an angle of 20°, but more to the eastward than the above beds. From underneath it, for about half a mile up the stream, soft red sandy grits, red indurated mudstones, and red conglomerates, crop out, dipping generally in a south-easterly direction at from 10° to 20°.

Eastward of this stream, about a mile and a-half, is Kilcoran wood, and in the stream which runs by it, about one-third of a mile above Kilcoran bridge, are pale purple, yellow, and salmon-coloured grits and sandstones, with soft red shales dipping south-east at 30°. They have been included in the Upper Old Red sandstone. North-east of Kilcoran bridge, in the river which runs by Brookfield old factory, may be found more of the Old Red sandstone rocks. Beginning at the top of this stream, and descending for about the first half-mile of the section, they will be found to consist of red, pale purple, and salmon-coloured grits, dipping to the south-east at about 30°; they are sometimes cleaved, the cleavage striking E. 25° N., and being nearly vertical. Above these are some very red indurated shaly sandstones, then more salmon-coloured grit, nearly horizontal, over which, at the junction of this and the Glenhenry stream, are purple grits, dipping to the south at 20°. From this point southward for half a mile, red and salmon-coloured grits and sandstones, sometimes conglomeritic, are seen at intervals, dipping southward at about 20°. Within the next half-mile, in the same direction, yellowish and greenish-gray hard grits, with soft greenish and pale purple shales occur: they are a good deal contorted, but have some dips to the southward from 20° to 50°: they are also sometimes cleaved, the cleavage dipping S. 10°, W. at 85°.

A little to the north-east of Scaragh wood undulating beds of yellow and fine purple quartzose grit, sometimes flaggy, together with liver-coloured shales, occur on the mountain side, generally dipping slightly to the south-east, but sometimes at 35°. Some of the beds are cleaved, the cleavage striking E. 15° S. and W. 15° N., dipping apparently to the southward.

The Lower Limestone Shale does not appear on the part of this map which I have examined.

South of the Galtees, in the part of the valley examined by me, the Lower Limestone may be seen at the following places:—Near Rehill wood, at the west side of the map and close to Glenfield house, is a quarry, in which dark gray, rough, thick bedded limestone, with shale partings, occurs, containing large corals, and dipping south at 30°. A mile to the east of this is Knockane hill, upon which, in several quarries, dark bluish, gray, blackish,

and earthy, sometimes finely crystalline limestone, containing corals, appears. It undulates, dipping sometimes to the north and sometimes to the south, the northerly dips being at about 50°, while those to the south are at about 35°. Half a mile south of Knockane hill, near Kilroe wood, hard, pale-gray, gritty looking limestone, full of north and south joints, is seen, and three-quarters of a mile east of this, to the south of Lacht cross-roads, occurs pale and dark-gray limestone, dipping east of south at 80°.

About half a mile nearly due west of the above mentioned cross roads is Burges hill, upon which are seen alternations of pale-gray, splintery and dark-gray, finely crystalline limestone, dipping to the east of south at from 40° to 50°. About 200 yards south of this hill, at a turn in the road, a dip to the north at 60° is seen in pale-gray cherty limestone.

Within half a mile east and north of Curraghmore bridge, the limestone is seen in several quarries, in the townland of Kilcoran. It is pale-gray, compact, sometimes variegated with yellow spots, and probably undulating. About a quarter of a mile from Ballylooby, on the way to Caher, and near some houses on the north side of the road, is a quarry, containing gray and dark gray limestone, dipping nearly south at 20°. About Roosca castle, within a circle of three-quarters of a mile, and between it, Ballygarrane house and Tubbrid bridge, on the north side of the Thonoge river, in the townlands of Roosca, Ballyea, Ballygarrane, Ballyhohan, and Crannavone, the limestone is abundantly seen in a great number of quarries, and projecting masses. It consists of pale and pale-bluish gray varieties of that rock, very compact and splintery, and having no apparent bedding. Some dark gray beds in quarries north of and near Tubbrid bridge, dip to the south, at angles from 15° to 50°. South-east of Ballydrinan, and below some islands in the Suir, a quantity of compact pale gray, hard, splintery, and somewhat earthy limestone has been cut through by the river, along the banks of which it forms small cliffs. It is nearly horizontal, but undulates a good deal.

In the townland of Cranna, gray and bluish gray, compact, and sub-crystalline limestone is seen, having, in a quarry, half a mile north-east of Farmley house on the east side of the road to Caher, dip of 45° to the south. About half a mile north-east of Garryroan house, in the townland of Garryclogher, and near a wood, is a remarkable swallow-hole, carrying off the water of a considerable mountain stream. About it is seen some dark gray lumpy looking limestone, dipping south-east at 30°. Southward of this, at a distance of about 300 yards, is another quarry in similar beds, dipping south at 10°. Nearly halfway between this point and Caher barracks, gray earthy and cherty limestone, with small scattered black crystals, is visible, dipping to the east of south at 35°. In the townland of Carrigeen, about half a mile north of the barracks, compact blue and dark blue regularly bedded rough limestone is seen, dipping south at 45°.

In Kilcommon demesne grayish blue cherty limestone, dipping to the south-east at 40°, occurs a short way south of the garden; and following the avenue till it comes to the river Suir, gray compact limestone is found cropping out of the wooded hill east of the river, where it undulates. Near the cottage, south of the metal bridge, gray compact limestone occurs, dipping to the east at 45°; and about 600 yards due south of this, gray cherty compact limestone, forms cliffs on the south side of a valley in which the Suir appears to have once flowed. It dips south at 35°. On the road from Garnavilla house to Caher, about half a mile from Garnavilla, gray cherty limestone is seen dipping to the north at 70°, and half a mile north of this, in a cutting on the Limerick and Waterford railway, gray splintery limestone occurs, rolling a good deal. About three-quarters of a mile further northwards on the same railway, more gray limestone is seen; the bedding is not, however, here apparent. Further north, close to Caher station, on the railway, more gray and bluish-gray limestone is seen: the bedding

here is doubtful. Immediately west of the railway bridge over the Suir, light gray limestone is seen, dipping north at 35°.

About a mile from Cahir, on the Clonmel road, and a little south of the road, gray compact limestone occurs. It is cherty, and in places variegated pink and gray, with numerous north and south joints. In one place a dip of 55° to the north is seen. It is cleaved vertically, the cleavage striking east and west. A quarter of a mile further on this road is another quarry, in bluish and dark gray limestone, with cleavage planes, nearly vertical, striking east and west. About the same distance from the last, and on the same side of the road, similar limestone is seen. Where this road bends round the northern part of Loughloher hill, in the townland of Knockmorris, and on both sides of the road, pale gray limestone occurs. On the hill south of this townland, pale gray limestone, very compact, and with east and west cleavage, is frequently seen at the surface: the bedding probably undulates. At the south side of the paddock field, west of Loughloher castle, may be seen some dark gray limestone, cleaved, the cleavage planes dipping S. 20° E. at 80°. On the road side south of this is a large swallow-hole. In the fields west of Loughloher-Keating old castle and church, gray, compact, cleaved, and splintery limestone appears. Half a mile south-east of this old castle are the ruins of Ballymacadam castle, about which bluish and gray compact limestone occurs in large quantity. Near Kilmaloge foxcover, north-east of Kilmaloge old house, is some gray and dark gray compact limestone; the dip, where seen, is to the north at 20°. South of the railway here some paler gray compact limestone appears, and about a mile to the west of this, (also south of the railway,) dark gray limestone occurs.

Four hundred yards south-west of Garnavilla cross-roads, nearly horizontal dark bluish gray sub-crystalline limestone, with shale partings, is seen, and half a mile south of the cross-roads, on the east side of the road, rough bedded dark blue compact limestone may be observed, dipping to the W. of S. at 20°. Further south, about 500 yards, pale gray limestone is seen on both sides of the road; and still further south, where the road makes two rectangular turns, dark gray limestone occurs, dipping north at 80°. Nearly in the strike of this to the east, dark cherty and calpy-looking limestone appears, dipping in the same direction at 70° and 80°; and eastward of Ardfinnan glebe house, paler gray compact limestone is seen.

At the road nearly south of Marlfield house, gray and buff variegated cleaved splintery limestone (probably magnesian,) occurs. It has the usual east and west cleavage of the limestone in this district. On the Clonmel road, about a mile east of Marlfield, in the townland of Glenaclohelea, pale gray, compact, and variegated cleaved and splintery limestone, also probably magnesian, is seen. The cleavage dips 10° W. of N. at a high angle. A little more than half a mile due north of this, pale and dark gray and brownish magnesian limestone occurs in two quarries; and half a mile to the west, at a rectangular turn in a by-road, gray and dark gray crystalline and compact limestone is to be seen, dipping N. 20° W. at 25°. North-west of that, and to the west of Lough Ryan, about where three roads meet, a good deal of limestone appears in several quarries. Near the meeting of the roads, dark gray compact and rough limestone is seen, that to the south of the roads, dipping west at 30°, being the axis of an anticlinal. North of this, on both sides of the road to Kilmaloge railway bridge, it dips W. of S. at 25° to 30°. North of this, again, at a short distance, pale sandy and dark gray compact limestone is seen, probably in places slightly magnesian. South of the railway, and west of Kilmaloge, a band of peculiar dark gray compact, and often black limestone, having a thin red coating on the faces of the beds, comes in. It can be seen in a number of quarries, and very much resembles the beds near Clonmel, which are referred by Mr. Du Noyer to the Calp. The dips are high, being in a northerly direction from 50° to 70°.

About a mile north of this band, at the junction of three roads near Comonsentire West, some dark gray and compact blue limestone appears, containing fossils, *Producta*, &c; this may probably be Upper Limestone.

Drift. In the part of this district which I have examined the Drift is generally composed of fragments of the local rocks. Limestone gravel may, possibly, extend a little way up the southern flanks of the Galtees, and yet not be seen, owing perhaps to its having been subsequently covered by the debris of the Old Red sandstone washed down from above. This debris spreads even for some distance over the limestone, and is often accumulated in great quantity on the lower slopes of the Old Red elevations.

The limestone gravel is however found at Cahir and Ardfinnan, as well as in many other places.

At two or three places in Loughloher, and Ballymacadam, south-east of Cahir, a superficial deposit of pipeclay has been found associated with lignite. (See paper by Sir Richard Griffith, in *Transactions of Royal Dublin Society*, and also a paper by myself in *Proceedings British Association*, 1857.) It is well seen at Ballymacadam, near the old castle, where two or three large swallow-holes carry off the water, said to rise in the pipeclay pits whenever they are sunk below a certain depth (about 15 feet), accompanied by a most offensive odour. The clay occupies a pocket in the gray limestone rock, which is not the lowest elevation in the immediate vicinity, as it might be supposed to do if it had been deposited by a lake existing subsequently to the formation of the present surface of the ground. Its being found in such a pocket, may perhaps suggest the idea of a larger deposit of the kind of which it is a remnant, and which has been perhaps swept away by the action of the Drift sea—it may be remarked that pipeclay occurs also, about three miles north of Cahir, and there too at a slight elevation above the surrounding country.

In the Ballymacadam pits lenticular masses of Lignite occur of a rich brown colour, in some of which the woody structure is very evident, and one small branch section clearly showed the medullary rays. Where the Lignite appears at the surface it seems to have a dip at a high angle southwards, and the people who worked in the pits say that it was not met with in some parts until about 15 feet of the clay had been passed through, and that there they could raise parts of trees as long as the diameter of the pits would allow them.

The clay itself is white or very pale gray, extremely tenacious, and has a smooth soapy feel: it contains small black specks, (probably vegetable remains) near the upper parts of the pits, which make it crack in burning, but that below the Lignite is said to be perfectly pure, and to have been formerly manufactured in England into cups and saucers, and all the finer kinds of ware.

A. B. WYNNE.

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