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ological Survey.

EXPLANATION

TO ACCOMPANY

SHEETS 167, 168, 178, AND 179 OF THE MAPS, AND SHEET 13
OF THE LONGITUDINAL SECTIONS

OF THE

GEOLOGICAL SURVEY OF IRELAND,

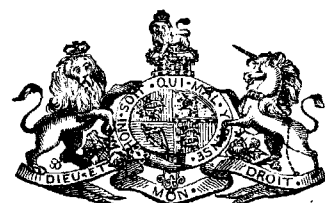
ILLUSTRATING PARTS OF THE

COUNTIES OF WATERFORD, WEXFORD, KILKENNY,
AND TIPPERARY.

By G. V. DU NOYER, M.R.I.A., F.R.G.S.I.

WITH PALEONTOLOGICAL NOTES BY W. H. BAILY, F.G.S., L.S.

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

SIR RODERICK IMPEY MURCHISON, K.C.B., G.C.ST.S.,

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

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

IRISH BRANCH.

Museum of Irish Industry, 31, Stephen's-green, Dublin.

LOCAL DIRECTOR :

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

SENIOR GEOLOGISTS :

G. V. DU NOYER, M.R.I.A.; W. H. BAILY, F.G.S., L.S.; G. H. KINAHAN, F.R.G.S.I.;

F. J. FOOT, M.A.; J. O'KELLY, M.A.

ASSISTANT GEOLOGISTS :

R. G. SYMES, F.R.G.S.I.;

COLLECTORS OF FOSSILS, &C. :

MR. C. GALVAN; MR. A. M'HENRY.

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

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

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

Condensed memoirs on particular districts will also eventually appear.

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

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THIS district was surveyed in the years 1848 to 1851, the Lower Silurian and Trappean portion principally by Mr. W. L. Willson, who subsequently joined the Indian Survey under Dr. Oldham; the Kilkenny part chiefly by Mr. A. Wyley, who was afterwards appointed Geological Surveyor of the Cape Colony; and the Suir Valley region, and that extending from Arthurstown to the Hook, by Mr. G. V. Du Noyer.

The first edition of the maps was published in the year 1856, when the trappean rocks were separated into sub-divisions by Mr. Willson and myself, as well as we could from the data which were then entered on the six inch maps.

No one had, up to that time, mastered the varieties of these igneous rocks with anything approaching to accuracy, and our determinations of them were anything but satisfactory even to ourselves.

The pressure for the examination and publication of new area, however, prevented our attempting to revise the work until lately, when Mr. Du Noyer has succeeded in carrying out a revision of the whole trappean districts of Wicklow, Wexford, and Waterford, and a new edition of those sheets of our map has been accordingly issued.

Although this revision has of course been carried out under my inspection, I am by no means inclined to claim for it anything more than an approach to absolute correctness. The whole subject of the varieties of the trappean rocks is one that requires investigation in conjunction with a chemist who could work with us in the field as well as in the laboratory.

In addition also to the difficulties in determining these varieties by mere inspection in the field, we have had to contend with those arising from the nature of the ground. This ground has been so worn down and eroded, and the rocks so covered by drift and other superficial accumulations that their exposures are few, small, and isolated, and the connexions between them left to be decided by mere guess-work. The maps of the trappean districts of the Lower Silurian ground therefore are to be taken only as what appeared to us to be the most probable interpretation and connexion of the observed facts. With respect, however, to the Old Red Sandstone and Carboniferous formations we may advance higher claims to accuracy for our work, inasmuch as the facts are both simpler and better shown.

J. BEETE JUKES.

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EXPLANATION

TO

ACCOMPANY SHEETS NOS. 167, 168, 178, AND 179

OF THE MAPS OF THE

GEOLOGICAL SURVEY OF IRELAND.

GENERAL DESCRIPTION.

THESE four Sheets of the Map comprise a narrow strip of the extreme south-eastern part of the county Tipperary in Sheet 167; a portion of the southern end of the county Kilkenny in that and Sheet 168; and a portion of the county Wexford, ending in Hook promontory, in Sheets 168 and 179, the remainder of the area belonging to the county Waterford.

The principal place in Sheet 168 is the city of Waterford, with the villages of Passage and Cheekpoint in the county Waterford; Mullinavat, Kilmacow, Ballinorea, and Glenmore villages in the county Kilkenny; and the villages of Arthurstown, Ballyhack, and Duncannon, in the county Wexford. In Sheet 167 the principal place is the town of Carrick-on-Suir, with the villages of Kilsheelan (in the county Tipperary), Pilltown and Fiddown (in the county Kilkenny), and Portlaw, Rathgormuck and Mothel (in the county Waterford). In Sheet 178 is the town of Dungarvan, with the villages of Ringville, Stradbally, Kilmacthomas, Ballynaneen, Kill, Bunmahon, Knockmahon, and Annstown, all in county Waterford; and in Sheet 179 the watering places of Tramore and Dunmore, in the county Waterford; with the village of Slade (at Hook point), in the county Wexford.

From the peculiar geological structure of the district comprised in these four Sheets of the Map it has been deemed advisable to describe it as one area.

1. Form of the Ground.

The Comeragh mountains rise in the western part of the district in the form of a broad ridge, running nearly north and south between the valley of the Suir and that of Dungarvan. Towards the west the ground sinks into the pass of Ballynamult, which separates the Comeraghs from the Knockmealdown mountains. The summit of this pass does not exceed a height of 600 or 700 feet above the sea. The highest point of the Comeraghs is 2,597 feet above the sea; and several eminences exceeding 2,000 feet occur for four miles to the N.W. and three miles to the S.W. of that point.

This high land has a gentle slope in every direction except towards the east, where it terminates in bold escarpments, with many almost perpendicular precipices overlooking a rough undulating plateau of ground, which varies from 300 to 500 feet in height.

The Dungarvan valley is the eastern termination of the valley of the Blackwater, which runs nearly due east from the borders of Kerry, past Mallow, Fermoy, and Lismore, to Cappoquin, where the valley is suddenly deserted by the river, which there turns S. through a series of ravines to Youghal bay.

The valley of the Suir, in like manner, runs from west to east between the Comeraghs and Slievenamon, but is terminated towards the east by a continuous ridge, which sweeps round it from Portlaw, past Waterford, to Ballinacree and the Mullinavat hills; continuous, that is to say, in general outline, but cut through near Waterford by the gorge through which the river escapes to Waterford harbour.

The ground in the eastern part of the district, around Waterford and towards New Ross, is abruptly undulating, the summits of the hills rising to heights of 300 or 400 feet above the sea. Slievecolthia, however, three or four miles south of New Ross, is 888 feet above the sea.

The river Barrow, coming from the north, cuts through this undulating country, as does the Suir coming from the west, and both united then run south into Waterford harbour.

The Barrow, and its other tributary, the Nore, are affected by the tide for many miles beyond this district, and the Suir as far as a point a mile and a-half above Carrick-on-Suir.

J. B. J.

The hills which immediately bound the valley of Dungarvan on the north vary from 683 to 402 feet in elevation, while those on the southern side vary from 445 to 661.

The western slopes of the Reeks of Glenpatrick and the N.W. flanks of the Comeraghs are drained by the river Nier, which has its rise in the Comeragh and Coumstillogh loughs, and which flows to the west out of the district, receiving some minor streams from the north and south. (See Explanation to Sheet 166.)

Milk hill, 1,449 feet, and the elevation to the west of it, as well as the western slopes of the Comeraghs, are drained by the Colligan river, which runs from north to south, and falls into the sea at Dungarvan.

The Reeks of Glenpatrick and the Comeragh mountains are not only steeply escarped along their eastern sides, but also deeply hollowed into narrow glens, and wide "cul de sacs."* Of the latter, the largest encloses the lake of Coumshingaun, which lies at a level of 1,254 feet above the sea, having almost perpendicular precipices around it on the N., W., and S., which attain at one place a height of 1,288 feet in a horizontal distance of about 400 yards, thus presenting a mean slope of $46\frac{1}{2}^\circ$.

Crotty's lough, which is also on the eastern face of the mountains,

* These would be called "cloughs" and "corries" in the north of England and Scotland. —J. B. J.

lies in another hollow, a mile to the north of Coumshingaun, and at an elevation of 1,896 feet above the sea; on its western side a precipice overhangs it to the height of 1,337 feet, in a horizontal distance of 400 yards, the mean slope being 48° .

Coumgorra lough, on the northern face of the Comeraghs, lies at the head of a wide and precipitous glen, opening to the north, and at a level of 1,818 feet, the mountain over it being 2,428 feet above the sea.

Coumdulla lough and Loughmore both lie on the eastern face of the Reeks of Glenpatrick, the former at a height of 1,533, and the latter 1,518 feet above the sea.

The Comeragh mountains are likewise deeply hollowed on their western sides, the most remarkable of the glens being that lying to the W. of Coumgorra lake, which will be more fully described in the part treating on glacial action.

To the south of this are two deep and wide amphitheatres, bounded by precipitous cliffs of over 710 feet in height; that to the north encloses the Comeragh loughs, which lie at elevations of 1,650 and 1,537 feet above the sea; and that to the south have the Coumstillogh loughs within them, at an elevation of 1,700 feet above the sea.

To the south of Coumshingaun lake, the Comeragh mountains send out a remarkable spur to the eastward for about four miles, forming Croughan hill, an elevation of 1,285 feet above the sea.

The plateau lying to the east of the Comeragh mountains attains in places to a height of about 500 feet, though to the south of the village of Mothil, near the valley of the Clodia river, it falls to 260 feet. Along its northern and eastern margin it rises into a well defined ridge sloping steeply to the river Suir.

Many small streams pass from off this plateau to the north and east, cutting deeply through the ridge to fall into the river Suir between Clonmel and Carrick. Of these the most important is the Glasha river, which runs through the deep valley of Glenpatrick and falls into the Suir just below the village of Kilsheelan. The main drainage of the plateau, however, is from W. to E., past Rathgormuck and Clonea, giving rise to the Clodia river which runs in a deep valley through Curraghmore demesne, and falls into the Suir at Portlaw.

Croghaun hill, 1,285 feet in elevation, and the ground extending from it to the eastward, forms a minor watershed, whereby the drainage of its southern portion is thrown partly southwards into the sea by the river Mahon and its tributary, the Aughnafally river, which joins it at Kilmachthomas, and partly to the eastward by the Pouldrew river, which rises near Newtown cross-roads, and falls into the Suir below the little village of Kilmeddan. The S.W. portion of the plateau is drained by the rivers Tay and Dalligan, which have their rise on the S.E. flanks of the Comeraghs, and which fall into the sea at Stradbally and Ballyvoyle respectively. This tract in its extension to the east beyond the meridian of the village of Kill, is considerably narrowed by a bend in the river Suir as it approaches Waterford; its main elevation is lessened, and it becomes dotted over with rocky bosses and low hills, the highest of which is Ballyscanlon hill, 419 feet, and Carrickaroik hill, 457 feet above the

sea. The main direction of the watershed is now somewhat E. and W. about midway between the coast and the valley of the Suir, the northern side being drained by the Whitfield river, which falls into the Suir at Mount Congreve; the southern side by the Woodstown and Kilfarrasy streams, which fall into the sea, the one at Annestown, and the other opposite Burke's Island. To the east of this the ground retains its bossy aspect, but it soon slopes into the low and open valley of the John's river and that of the Pickardstown stream, extending N. and S. from Waterford to Tramore.

The railway between Waterford and Tramore runs through this valley, the highest level of which is seventy-five feet above the sea at a point three miles N. of Tramore. To the east of the valley of the John's river the ground is undulating, attaining a maximum elevation of 230 feet at Carrigeenaveagh hill. At Cheekpoint, to the eastward of this, the elevation is 434 feet, and to the southwards, at Passage, it is 252 feet, when it falls rapidly to the sea.

As we approach the neighbourhood of Dunmore the ground again rises to 417 feet at Knockavelish hill.

The entire coast westwards from Credan head (202 feet), past Brownstone head (158 feet), is quite precipitous, and it presents the same aspect for the distance of fifteen miles westerly, from Newtown head (110 feet) to Ballyvoyle head, where it is 243 feet in elevation.

Helvick head, at the S. side of Dungarvan bay, is 255 feet above the sea, and its shores are also abrupt.

The river Suir, where it enters the N.W. corner of the district at Clonmel, has an elevation of fifty-nine feet above the sea; but at the bridge of Carrick its elevation is only twelve feet; thus giving a fall of forty-seven feet in a distance of twelve miles. Ordinary tides increase the depth of the river at the distance of a mile and a quarter above Carrick, and spring tides to a further distance of a quarter of a mile. Vessels of 150 tons have no difficulty in reaching Fiddown, four miles below the town of Carrick, and large smacks and lighters can come alongside the quay wall of Carrick.

The ground north of that portion of the valley of the Suir which extends into Sheet 168, has an elevation of 861 feet at Knockbackgeldon to the west of Mullinavat; Tory hill to the south of that village, attains an elevation of 960 feet, having various hills to the eastward varying in height from 487 to 661 feet, and one of 603 feet just over the village of Ballinorea. From this point the ridge is continuous in a southerly direction past the city of Waterford where it is cut through by the ravine of the river Suir, the banks of which are 276 feet high, at a point over the Kilkenny railway station, and 210 feet east of the city over Suir hill.

The eastern side of this hilly ground slopes rapidly into the valley of the river Barrow, which traverses the eastern portion of the district from N. to S. as far as Snow hill and Cheekpoint.

That portion of the county Wexford which extends along the eastern portion of the district is for the most part undulating, but rises at its northern margin to an elevation of 888 feet to form the hill of Sleivecoiltha, which makes a striking feature in the landscape. Broken ground running easterly from near Dunbrody, attains a height of 257 feet; further to the south, the county, though rather level,

attains here and there to elevations of 250 feet, and on the east coast of the Waterford estuary to the south of Duncannon, the cliffs reach a height of 128 feet, and at Broomhill bay 208 feet above the sea. On the east coast of Hook promontory, at Houseland, the cliffs are, some of them, over 140 feet in height, but to the south of this the promontory becomes lower, with an average height of about forty feet, reaching to sixty feet at the cliffs between the village of Slade and the extremity of Hook head.

G. V. D.

2. Formations and Groups of Rock entering into the Structure of the District.

AQUEOUS ROCKS.

Name.	Colour on Map.
Alluvium, Bog, or other superficial covering,	Burnt Sienna (pale).
Drift,	Engraved dots.

Carboniferous.

Upper Palaeozoic.	d ⁴ . Upper Limestone,	Prussian blue (dark).
	d ³ . "Calp" or Middle Limestone,	Prussian blue and Indigo.
	d ² . Lower Limestone,	Prussian blue (pale).
	d ¹ . Lower Limestone Shale,	Prussian blue and Indian ink.
	m d. When any of the above Limestones were Magnesian on original deposition,	Burnt Sienna over Prussian blue.
	μ d. When magnesianized from subsequent dolomitization,	Same with blue dots.
Old Red Sandstone.		
	c ³ . Upper Old Red or "Yellow Sandstone,"	Indian red (dark).
	c ² . Old Red Sandstone,	Indian red (pale).

Lower Silurian.

Lower Palaeozoic.	b ² . Bala Beds,	Pale purple.
	Red Conglomerate in Bala beds,	Pale purple with yellow dots.
	l b ² . Limestone in Lower Silurian,	Cobalt.

IGNEOUS ROCKS.

Lower Silurian.

F. Feldstone,	Scarlet (dark).
Fs. Feldspathic Ash,	Scarlet (pale, dotted).
Fs. 2. Feldspathic Ash Calcareous,	Ditto with blue dots.
D. Greenstone (Diorite),	Crimson (dark).
Ds. Greenstone? Ash,	Ditto (pale dotted).
E. Elvan, Crystallized Feldstone,	Carmine (dark).

LOWER PALEOZOIC ROCKS.

The Lower Silurian Rocks are of the ordinary character of the main mass of the deposit which forms so large a portion of the S.E. of Ireland; they are dark or light gray, pale greenish gray, and occasionally pale purplish in colour; they sometimes present a ribbed appearance on weathered surfaces when not affected by cleavage. Thin grits and gritty laminae are common throughout them. When free from grit and cleaved they yield a small rough dark gray roofing slate of little value, as is proved by the abandonment of all the quarries where such works have been attempted. At two or three localities black carbonaceous bands occur, in which graptolites are found. The Lower Silurian rocks of the Wexford portion of the district are comparatively free from cleavage, and have a ribbed aspect; and some of the grits have a singular mammillated concretionary structure; thick beds of black shale are of frequent occurrence along the coast between Arthurstown and Dollar bay.

The Limestone of the Lower Silurian Rocks.—This rock occurs only in narrow bands in the slates; its colour is pale gray, and it has a tendency to weather into small irregular hollows. In no instance has it been found to form a lime by burning, the large percentage of earthy or sandy ingredients rendering it liable to form a slag in the kiln. Its thickness cannot be over 200 feet, with numerous interstratified slate layers.

The fossils found in these Lower Silurian rocks are discussed by Mr. W. H. Baily farther on at pp. 18 to 30.

Liver-coloured Conglomerates and Shales in the Bala beds.—These beds, which are clearly interstratified with the Lower Silurian beds, closely resemble some of the ordinary conglomerates and shales of the Old Red Sandstone, for which they were formerly mistaken. The conglomerates are formed of rounded pebbles of quartz and reddish grits. There are two groups of these singular beds, the lower being about 500 feet thick, with a feldstone above and below it; and the upper about 200 feet thick, formed of reddish shale, and separated from the lower by about 600 feet of pale gray calcareous and fossiliferous grits and flaggy layers of impure limestone, with a band of feldstone in their midst.

The lower and thicker of these beds has been found by some mining operations to the N.W. of Bunmahon, to extend to about a mile and a-half from the coast of Ballydowane bay, where they are exposed in section. A synclinal fold causes the same bed to appear at the crushing floors of Knockmahon mine, but its further extension to the N.E. is not as yet determined. The form of the deposit is that of a long lenticular mass, though it is of course impossible to say how far it really extends to the S.W., as that portion of it is beneath the sea.*

* Mr. Jukes was the first to suggest that this singular deposit, so unlike the ordinary character of Lower Silurian rocks, was not a portion of the Old Red Sandstone let into the Lower Silurian traps and slates in great cubical masses by means of faults crossing each other at nearly right angles, but a red conglomerate of Lower Silurian age, and instanced the fact that similar conglomerates appear in the Lower Silurian slates at Taggart in the county Wexford.

In my subsequent examination of the coast at Ballydowane bay, I fully proved the accuracy of this supposition.—G. V. D.

IGNEOUS ROCKS, associated with the Lower Silurian Rocks.

Elvan (Elvanite).*—This rock occurs but sparingly in the district. It is composed of a granular aggregate of feldspar and quartz, to which is sometimes added a green mineral supposed to be chlorite or some variety of hornblende, when the rock assumes a greenish tinge. In no instance over the entire area of the Lower Silurian Trappean rocks in the S.E. of Ireland, have I ever found it to contain common mica, and it frequently passes imperceptibly into the ordinary compact feldstone. So far as my observations have led me, this elvanite has no connexion with the true or mainchain granite of the counties of Wicklow and Wexford, on the contrary, I find it to occur in long lenticular-shaped beds or masses like an ordinary feldstone, and it appears to be interstratified with the Silurian slates or their associated feldstones and ashes; following the line of their bedding and never producing any appreciable metamorphism in the rocks in contact with it, such as micacizing or hardening. I therefore regard it as a mere variety of feldstone which has been ejected under water, and which is contemporaneous with the Lower Silurian rocks.

Feldstone.—This rock is of common occurrence, and for the most part is compact and flinty looking. In colour it is either pale yellow or clear gray; it often contains minute shining crystals of feldspar, which on the weathered surfaces become white, and give the rock a porphyritic look. The rock weathers to a cream white colour to the depth often of $\frac{1}{4}$ of an inch from the surface. Occasionally it exhibits a delicately streaked structure, the result, as it is supposed, of a slowly flowing movement in the particles, while in a pasty or semi-fluid condition. This structure is only observable on weathered surfaces, the feldstone being apparently perfectly homogeneous when broken into. Sometimes these *striae of fusion*, as they have been called, are observed to envelope a little lump of compact feldspar or quartz.

The feldstone is sometimes nodular or concretionary, the nodules varying in size from a pea to a lump of several inches in diameter. These are usually hollow, but sometimes contain a nucleus of quartz, or the cavity is coated with silicious crystals, the enveloping mass being compact feldspar, or feldspar containing numerous minute shining crystals of the same mineral, which weather to a milk white colour. Sometimes the feldstone is a rough dark greenish gray rock, having an appearance of rude bedding. This variety weathers into large rugged bosses and peaks, and may be mistaken for a compact ash breccia, which it externally very much resembles. The feldstones run in apparently continuous bands sometimes for several miles—the

* This term of "Elvanite" was proposed by me for convenience sake, and Professor Phillips, in the last edition of his "Guide to Geology," adopts the term. I meant it to apply to the granite devoid of mica, of which elvans usually consist. Some elvans however do contain mica. The masses to which this name has been applied by us in Wexford and Waterford, are so called rather because we do not know exactly what else to call them than for any better reason. Their relations to the surrounding rock are nowhere well shown, but I should differ from Mr. Du Noyer, inasmuch as I believe the rock to be always intrusive, and never interstratified with the aqueous rocks, which it frequently alters so far as to make them hard, brittle, and easily breaking into angular fragments with rusty surfaces.—J. B. J.

masses being apparently lenticular-shaped, or thinning out at either extremity.

Fs. Feldspathic Ash.—This variety of the trappean rocks is one which is frequently most difficult to identify, as subsequent baking or metamorphism has often so hardened it and modified its structure, that it resembles a cleaved and decomposing feldstone. The best marked varieties are flaky in structure, and contain numerous flaky chips of black slate.

Sometimes the flaky variety is soapy to the touch, with a decided slaty structure, either the result of a most delicate lamination, like an uncleaved slate, or else that of cleavage. In this variety of ash there are no extraneous fragments, the rock being made up of pure feldspar powder. The ordinary enclosed fragments in the ash are subangular crystals of feldspar; rounded lumps and pebbles of feldstone; flaky bits of black slate, some of them several inches in length and half an inch in thickness; and flakes of a green mineral resembling chlorite. Sometimes the ash is a breccia or conglomerate; and in one instance I observed that the feldstone pebbles had been thoroughly decomposed and rendered white over the entire surface by long continued atmospheric action, before they had been enveloped in the ash matrix. In the same deposit I observed rounded pebbles of a pre-existing ash, formed of the same ingredient as the rock in which they were imbedded.

Many of the flaky varieties of the ash resemble a gray glossy slate, and owing to the presence of numerous thin strings and small lumps of carbonate of lime, they weather to a rusty sand.

At one locality the extraneous fragments in the ash are splintery bits and large lumps of feldstone and black slate, as sharp in their angles as if they had but recently been blasted from the solid rock. They are enclosed in a very compact pale gray feldspathic paste, in which are delicate layers of fine sand and granular fragments of feldspathic grit, and clay slate with quartz. In the same ash are occasional thin layers of a pale greenish gray vitreous-looking feldstone.

As a general rule the bedding of the ash is well developed, its flaky structure, and the layers of embedded particles, following the lines of deposition; its mode of occurrence in lenticular masses is precisely similar to that of the feldstone.

Greenstone? Ash.—The dark greenish gray variety of ash is not of common occurrence in the district. It sometimes presents the outward appearance of a greenstone, but its true character is determined by the presence of minute fragments of black slate, and a mineral resembling chlorite. Sometimes it is a breccia, more or less fine, the embedded fragments being gray feldstone, and gray grits, in a greenish chloritic-looking paste, and sometimes it is mottled black, as if from flaky fragments of hornblende.

Occasionally this green variety of ash is quite slaty and fine-grained, when it forms a kind of hornblendic or chloritic schist. It is also frequently calcareous.

As all the ashes are as strictly sedimentary deposits as any sandstone, the enclosed flaky fragments, when being deposited through water, would naturally follow the laws of all such depositions which

require the longest axis of each flake to lie parallel with the surface of deposition. I have often tested the truth of this in attempting to determine the dip of the rock by observing the direction in which its flaky particles lay, when other evidences of bedding were wanting, and I seldom failed to prove the accuracy of the observation by finding a bed of slate or a flow of feldstone near at hand.

All the ashes, and oftentimes the feldstones, are affected by the cleavage which pervades the associated Lower Silurian slates; but the flaky structure of these rocks is most usually due to original deposition.

In one instance this green variety of ash contains minute fragments of *stenopora* trilobites, *orthis*, and other well-marked Lower Silurian fossils, &c., arranged in thin layers.

Greenstone, "Diorite."—This rock is of two varieties, viz., contemporaneous, or interstratified with the Lower Silurian rocks, and intrusive. The former variety is flaky or finely crystalline in structure, sometimes calcareous, and with veins of asbestos; it often passes into a green ash, and has not produced any hardening or metamorphism of the rocks in contact with it. The latter is unconformable to the rocks about it; it is highly crystalline, dense, often full of iron pyrites and crystals of hornblende, as well as straw-coloured crystals of feldspar, when the rock becomes a porphyry. In colour this variety of the greenstone is of a darker green than the former, and it is sometimes purplish.

The slates and grits in contact with the intrusive greenstone are often hardened or silicified, and converted into a kind of hornstone or porcelain rock.

Epidote is a constant ingredient of this rock, occurring in stringy lumps, or coating what appear to have been joints or thin fissures. This is very apparent in the greenstone porphyries occurring to the westward of Enniscorthy. On exposed surfaces this greenstone often weathers into small rough pimples, the result of some structure not apparent under other conditions.*

THE UPPER PALÆOZOIC ROCKS.

Old Red Sandstone.—In the lowest portion of this deposit the beds are very massive, and formed entirely of various-sized angular fragments, derived from the subjacent Lower Silurian rocks, with pebbles of vein-quartz, forming a breccia of 100 to 250 feet in thickness, cemented by a greenish gray or dull brown sandy paste. This is very clearly seen in the glen of the Glasha river (Glenpatrick), at the N.W. corner of the district, where the denudation has cut through the Old Red Sandstone, and exposed the Lower Silurian beds beneath, and also in the district around Dunmore, where we find the breccia to contain a large per-centage of fragments of feldstone ash and greenstone.

It is remarkable that the Old Red basal beds in the neighbourhood of Waterford—at Passage and Ballyhack, and at Drumdowney hill—are totally different in character from those of the Dunmore district,

* This would probably be the Variolite of continental authors.—J. B. J.

though the distance between them is only a few miles. Near Waterford the lower beds are conglomerates of well-rounded pebbles of grits, slates, and vein-quartz, whereas near Dunmore they are breccias with many trappean fragments. We may perhaps suppose that the trappean breccias were formed as shingle on or near to a beach either in isolated patches, or in larger beds separated by subsequent erosion into patches, and that the quartzose conglomerates spread over the whole on farther depression taking place.

The thickness of the Dunmore breccia may be about 200 feet, and it is overlaid by conglomerates formed of well-rounded pebbles, of various-coloured grits and vein-quartz, with beds of liver-coloured shale and sandstones similar to the Waterford beds. In the Dunmore district the stratification is nearly horizontal.

The Old Red Sandstones forming the mass of the Comeragh and the neighbouring mountains, as well as that band of those rocks which skirts the southern side of the valley of the river Suir, between Kilsheelan and Waterford, and is prolonged to the N. of Waterford by Ballinorea to Mullinavat, and again to the west of that village, are of precisely the same general character as those in the immediate neighbourhood of Waterford and Passage.

It is remarkable that the basal breccia so well developed in the Dunmore district is absent over the area just mentioned, with the exception of a strip of about six miles in length and 200 feet in thickness, extending from the northern base of the Reeks of Glenpatrick to the glen of the Coolnamuck stream.

On the eastern face of the Reeks, and the Knockanafrin range, the thin basal breccias are overlaid by a brownish red conglomerate, of the ordinary character, of about 1,000 feet in thickness; and these are succeeded by reddish brown shales, and sandstones and grits, with strong conglomerates, about 2,200 feet thick, the whole forming a mass of about 3,200 feet thick, the beds of which lie at remarkably low angles, with a general dip to the westward.

Upper Old Red or "Yellow Sandstone."—This portion of the Old Red Sandstone is well developed in the district, but the line of boundary between it and the main mass of the deposit is quite arbitrary, and determined merely by a change of colour in some of the slaty beds. It is indicated on the map by a narrow strip of dark red colour. The characteristic beds are pale yellow and greenish shales, and brownish sandstones, which are often very hard and quartzose, with a few light red shales and brownish red conglomerates; the thickness varies from about 550 feet at the N.W. of the district over the village of Kilsheelan to about 200 feet to the south of Mullinavat. Some of the pale yellowish and greenish shales of the yellow sandstones yield plant impressions.

The total thickness of the Old Red sandstone in this district is remarkably variable in comparatively short distances. Thus, in the ridge south of Carrick-on-Suir it is about 1,700 feet only, while to the S.W., in a distance of only eight or nine miles, at Cumneshingaun, we have the basal beds of the Old Red escarped to the depth of 2,097 feet, and where these beds are followed westerly into the glen of the river Nier, they are overlaid by others, till their aggregate thickness must be about 3,200 feet.

The Carboniferous Limestone.—This portion of the Upper Palaeozoic rocks is capable of being sub-divided into four distinct groups.

The Lower Limestone Shale.—The uppermost beds of the Yellow sandstone sometimes pass up by a gradual change of colour and lithological character into the base of the Carboniferous Limestone, as is very well seen in the Hook promontory, where thin dark gray sandy calcareous shales and thin grits alternate with occasional seams of black chert and impure gray limestones, all more or less fossiliferous. Immediately above these beds the limestone begins to predominate, and the shaly and earthy portions die out in the thickness of about 200 feet. Fenestella and encrinite fragments are often most abundant in the shales, with spirifer and modiola, and other marine remains. Their presence determines the base of the Carboniferous rocks in contradistinction to the fossils of the Yellow Sandstone, which there consist of a few plant fragments only.

The Lower Limestone.—These beds are generally thick, evenly deposited, and regularly jointed; they are dark or clear gray in colour, finely crystalline, and their blocks often yield a metallic ring when struck with the hammer.

At Granny Castle and Dunkitt, to the N.W. of Waterford, where this limestone is extensively quarried, the upper portion of the workings show the limestone to be somewhat flaggy. Here also they become magnesianized, either from original deposition or from subsequent metamorphic action. In this case the character of the rock is completely changed. It becomes of a pale brown colour, with a saccharoid texture, and a pearly lustre, and weathers freely to a coarse sand. All trace of original bedding is frequently lost, and all fossil remains disappear in the metamorphic variety.

This unbedded dolomite occurs in irregular patches here and there in the mass of the limestone, but chiefly in the valley of the Suir from the north of Carrick-on-Suir, to the village of Pilltown.

It is difficult to estimate the thickness of the Lower Limestone of this district, but it cannot be much less than 700 feet.

The Middle Limestone or "Calp."—This sub-division is characterized by dark gray and black, thick and thin, compact, and evenly-bedded limestone, with occasional layers and nodules of black chert and beds of earthy shale; some of these limestones are fetid, and others finely crystalline; in thickness they are about 500 feet, where they appear in the N.W. corner of the district near Clonmel.

The Upper Limestone.—The beds are for the most part light gray, crystalline, with shale partings, and thin beds with nodular layers of black and sometimes white chert. The thickness may be 400 feet, as is apparent to the north of Clonmel.

From the foregoing observations we may infer that the total thickness of the whole mass of the Carboniferous Limestone in this district may be about 1,800 feet.

Drift.—Over the limestone district in Sheets 167 and 168 we find a gravelly drift, the pebbles of which have principally been derived from the destruction of the limestone itself, though there is a large admixture of Old Red sandstone and Silurian fragments through it. In the glen of the Nier river, on the western slopes of the Comeragh

mountains, pebbles of limestone, mixed with the debris of the local sandstones, may be observed to the height of 650 feet.*

Over the Rathgormuck plateau the drift is chiefly derived from the surrounding Lower Silurian rocks and the adjoining Old Red sandstones, though there are small patches of the limestone gravel to the north of Rathgormuck and Mothel left here and there, at elevations of 250 to 350 feet. These are perhaps the remains of an extensive deposit of such materials which once spread over the whole plateau. Similar outlying patches of this gravel were observed resting in hollows on the Old Red sandstone to the north of Mullinavat.

There are many large erratic boulders of Old Red conglomerates scattered over the country between Kilmacthomas and the sea. The largest of them is called Cloughlowrish, and so far as we know it is the largest transported boulder in Ireland.

Fig. 1.



Cloughlowrish Stone.

Erratic Boulder of Old Red Conglomerate at Cloughlowrish Bridge.
Sheet 24, County Waterford.

It rests at a height of 148 feet above the sea, on the banks of the river Tay, $2\frac{1}{2}$ miles to the north-west of Stradbally, and about $2\frac{1}{2}$ miles in a direct line from the nearest Old Red sandstone "in situ." The block, which is now split in two, measures about $50 \times 35 \times 18$ feet, the subsoil rock being porphyritic Feldstone. There is another very large boulder of Old Red close at hand, but considerably smaller than the Cloughlowrish.

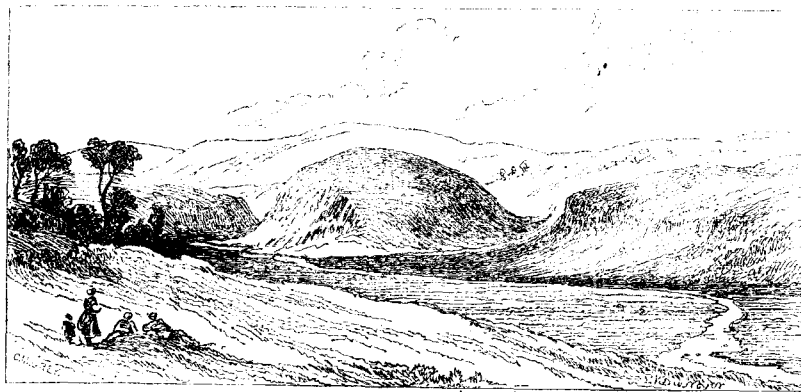
In the valley between Tramore and Waterford, and along the coast to near Stradbally, the drift is derived from the Lower Silurian and Old Red sandstone rocks, the pebbles being embedded in hard brown clay. At the distance of a few miles inland this drift is comparatively thin, but the coast sections at Tramore, and between that place and Bonmahon, expose a thickness of 50 or 60 feet of this deposit in several places.

* In the district to the west of Sheet 167 the limestone drift reaches a height of 800 feet. (See Explanation of Sheet 166.)

Alluvial Flats.—The most extensive of the alluvial flats are those which stretch southwards from Waterford up the valley of the John's river, and those to the north of Tramore, the latter including the tidal flats called the Back Strand, the greater portion of which has been just reclaimed.

The subjoined view on the river Mahon (fig. 2), two miles to the north of Bonmahon, is instructive, as showing how a sluggish river can change its bed without any apparent cause.

Fig. 2.



View on the River Mahon, looking northwards, showing the old and present course of the river.

Sheet 24, County Waterford.

To the east of the district, in the county Wexford, a broad alluvial valley extends southwards from Dollar Point, on the river Barrow, to Dunbrody, a distance of $2\frac{1}{2}$ miles, with an average width of half a mile. Extensive embankments have from time to time been constructed along the margin of this flat, reclaiming most valuable pasture and arable land.

There are also extensive alluvial flats on the banks of the Suir, between the town of Carrick and the bend of the river, to the west of the village of Ballygorey.

Bogs.—There are no bogs of any great extent in the district, the largest lying on the Silurian plateau, to the east of the Comeragh mountains and the Eragh mountains, close to the escarpment of the Old Red sandstone.

Mines.—The mines in the district are those of Knockmahon and Bonmahon yielding copper, a detailed account of which will be found farther on.

G. V. D.

3.—*Palaeontological Notes.*

The following is a List of the LOCALITIES at which FOSSILS were collected, on Sheets 168, 178, and 179 of the One-inch Maps.

LOWER SILURIAN LOCALITIES.

No. of Locality.	Quarter Sheet of 6-inch Map.	Townland.	Situation, and Sheet of 1-inch Map.
County of WATERFORD.			
SHEET 168.			
1	9/4	Gibbet Hill, . . .	New road cutting on S. side of River Suir, a little N.W. of Waterford; black argillaceous slates.
2	17/4	Killure, . . .	Old quarry at the back of Farm House, three miles S. of Waterford, on the road to Clohernagh Bridge; brown calcareous impure limestone.
3	18/4	Raheen, . . .	Rocks on shore, a little N. of Newtown Head, Waterford Harbour; dark gray concretionary shales.
SHEET 178.			
4	23/4	Carrigeennageragh, Big, . . .	On Dalligan River, about one mile N.W. of Dalligan Bridge, and five miles N.E. of Dungarvan; black argillaceous slates.
5	24/4	Williamstown, . . .	New road cutting, a little N. of Williamstown cross roads, about two miles N.E. of Stradbally; gray slates, much cleaved.
6	24/4	Brenan, . . .	Quarry on the W. side of by-road a little N. of Brenan cross roads, about half a mile N.E. of preceding locality; greenish grit, altered Silurian.
7	24/4	Ballynasissala, . . .	East side of River Mahon, about one mile N.W. of Knockmahon.
8	24/4	Ballydowane, West, . . .	Ballydowane Bay, two miles W. of Bunmahon; gray slates, much cleaved.
9	25/3	Knockmahon, . . .	Rocks on shore, under Engine House shaft, about half a mile from Knockmahon; bluish gray hard "trappean" beds.
10	25/3	Dunabrattin, . . .	On shore, at Dunabrattin Head; dark gray calcareous slates, much cleaved.
SHEET 179.			
11	25/4	Woodstown, . . .	Road cutting, about half a mile N. of Annes-town; dark gray calcareous slates, much cleaved.
12	26/1	Kilcarton, . . .	About two furlongs N. of Ballyscanlan Lough; green trappean slates.
13	17/4	Towergare, . . .	In Farm-yard, about one mile and a half N. of Cullen Castle, and three miles N. of Tramore; dark gray slates.
14	17/4	Munmahoge and Lisduggan, . . .	In stream a little W. of preceding locality; gray argillaceous slates.
15	17/4	Munmahoge, . . .	Near cross roads a little S. of preceding locality; hard greenish slates; "ashy beds."
16	17/4	Towergare, . . .	In a field a little S.E. of locality No. 13; "ashy beds."
17	17/4	Castletown, . . .	A little S. of "Castle;" brown calcareous rock.
18	26/2	Quillia, . . .	About a mile S. of preceding locality; brown calcareous rock.

LIST of LOCALITIES at which FOSSILS were collected—*continued.*

No. of Locality.	Quarter Sheet of 6-inch Map.	Townland.	Situation, and Sheet of 1-inch Map.
County of WATERFORD— <i>con.</i>			
SHEET 179.			
19	26/2	Pickardstown, . . .	A little W. of the road to Tramore; gray calcareous rock, "impure limestone."
20	26/4	Tramore, . . .	On shore at Tramore Bay, a little S. of Tramore; gray calcareous slates.
21	26/3	Newtown, . . .	Various fossil localities on shore at Tramore Bay, commencing about a quarter of a mile S. of Tramore, at Lady Elizabeth's Cove, and continuing to Newtown Cove, a distance of about three-quarters of a mile; black slates, with graptolites and gray calcareous slates.
22	26/3	West-town, . . .	Fossil localities between Newtown Cove and Great Newtown Head, Tramore Bay; gray calcareous slates.
23	26/3	Caher, . . .	Rocks on shore at Garrarus Strand; black slates.
OLD RED SANDSTONE LOCALITIES.			
County of WEXFORD.			
SHEET 179.			
24	49/4	Porter's Gate, . . .	Rocks on shore at Lumsdin's Bay, W. side of Hook Head; gray micaceous sandstone.
25	49/3 & 4	„ . . .	Rocks on shore at Houseland Bay, E. side of Hook Head; gray micaceous sandstone.
CARBONIFEROUS LOCALITIES.			
County of KILKENNY.			
SHEET 168.			
26	43/3	Granny, . . .	Half a mile E. of Granny, N. shore of River Suir; Lower Limestone shale.
County of WEXFORD.			
27	49/3 & 4	Porter's Gate, . . .	W. shore of Hook Head at Lumsdin's Bay; Lower Limestone shale.
28	54/2 & 4	Porter's Gate, Loftus Hall, Churchtown, and Slade, . . .	Various localities round Hook Head, from Lumsdin's Bay to the Lighthouse and Woorwoy Bay; Lower Limestone.

LIST of the SPECIES of FOSSILS collected from the LOCALITIES in the preceding Table.

The numbers opposite each name refer to corresponding ones in the list of localities, and indicate the places at which the fossils were collected.
The mark x before a number is intended to show the comparative abundance of the species at that locality.

LOWER SILURIAN FOSSILS.

Plant impressions? Localities.
21.

AMORPHOZOA.

Cliona antiqua, perforating shell of *Orthis crispa*, . 21.

CŒLEENTERATA.

ACTINOZOA.

Stenopora fibrosa, branching variety, 2, x x 6, 9, 12, 13, 14, x x 15,
16, 17, 18, 19, x x 20, x x 21,
x x 22.
,, ,, var. *lycoperdon*, x 5, 6, x x 9, 10, x 12, 15,
16, 17, 19, x x 20, x x 21,
x x 22.
Favosites cristata, 20.

MOLLUSCA.

POLYZOA.

Callograpsus elegans, Hall (? *Dictyonema*), . . 21.
Dendrograpsus flexuosus ? Hall, 21.
Diplograpsus pristis, x x x x 1, 21.
Didymograpsus sextans, x x 4, 21.
Graptolithus tenuis, x x x 1.
,, *priodon*, 3, 21.
? *Polypora* (*Fenestella*) *assimilis*, 3, 4, 5, 12, x x 15, 16, 20.
Ptilodictya dichotoma, 20.

BRACHIOPODA.

Athyris (*Atrypa*) *filosa*, x 10, 20.
Crania divaricata ? 3.
Discina subrotunda, 22.
,, species undetermined, 3.
Leptaena sericea, 6, 13, 17, 18, 20, 21, 22, x 23.
,, *calcarata*, 9, 10, 20.
,, *quinquecostata*, 3.
Lingula brævis, 20, 21, 22, ? 23.
,, species undetermined, 3.
Orthis bifurcata, 2, ? 10, 11, 14, 20.
,, *calligramma*, 2, 3, 5, 6, 11, x 12, 13, ? 14, 15,
16, x x 17, 18, 19, 20.
,, *crispa*, x 2, 6, x x 9, x 10, x x 15, 16,
x x 20, x 21, x 22.
,, *elegantula*, x x x 3, 17, 20.
,, *simplex*, 8, 9, 20.
,, *productoides*, 9, 20.
Strophomena alternata, 6.
,, *concentrica*, 17, x x x 18, x x x 19.
,, *corrugata*, 2, 3.
,, *deltoides*, 12, 19, x 20, x 21, x 22.
,, *expansa*, x x 12, 19, 20, 21, 22.
,, *funiculata*, 20.
,, *plicatilis* (? *depressa*), 20.

CONCHIFERA.

Ctenodonta, species undetermined, 3.

GASTEROPODA.

Holopea, species undetermined, ? 20.
Murchisonia, small species undetermined, . . 3.
Raphistoma elliptica, 9.

HETEROPODA.

Bellerophon perturbatus, 3.
,, species undetermined, 3, 13.

PTEROPODA.

Conularia elongata, 2, 3, ? 20, 22.
Ecculiomphalus Bucklandi, ? 3.
Theca triangularis, ? 3.

CEPHALOPODA.

Cyrtoceras inaequiseptum, 20.
Orthoceras Brongniarti, ? 18.
,, *tenuicinctum*, 21.
,, (species undetermined), 22.

ANNULOSA.

ECHINODERMATA.

Crinoid joints, 3, 11, 13, 14, 18, 19.
Echinospirites aurantium, x x 2, x x 3, x x x 10, 13, 15.
Glyptocrinus, ? 11, 19, 20.
Palæaster obtusus, 19.

ARTICULATA.

CRUSTACEA.

Acidaspis Jamesii, 3.
Agnostus trinodus, 11.
Amphion pseudo-articulatus, x 18, 19.
Ampyx mammillatus, x x x 3, 20, 21, 22.
,, *rostratus*, 21, 22.
Asaphus gigas, 5, ? 7, 9, x x x x 10, x 11, 14,
18, 19, x x 20, x x 21, x x 22,
23.
Beyrichia affinis, 20, 21, 22.
Bronteus Hibernicus, 21.
Calymene Blumenbachii, x x x 2.
,, *brevicapitata*, 3, 5, 10, 18, x x 20, x x 21,
x x 22, 23.
Cheirurus bimucronatus, 17, 21, 22.
,, *gelasinus*, 19, 20, 21, 22.
Cybele verrucosa, 2, 3, 5, 17, 19, x 20, x 21, x 22.
Encrinurus sexcostatus, 7, 12, x x 20, x x 21, x x 22.
Harpes Flanaganii, 3.
Ilænus Bowmanni, 3, 7, x x x x 10, 14, 17,
x x x 20, x x x 21, x x 22.
Lichas Hibernicus, 2.
,, *laxatus*, 3, 21.
Ogygia Portlockii, x x 3.
,, (species like *O. Buchii*), x x 10, 11, 21.
Phacops Brongniarti, ? 3, 5, ? 7, 9, 11, 12, 14, x x x 18,
x x x 19, x x 20, x x 21,
,, *truncato-caudatus*, 5, x x 7, 8, 10, 12, 20, 21, 22.
Remopleurides Colbii, 7, 11, x x 20, x x 21, x x 22,
23.
,, *longicostatus*, 21, 22.
Sphærexochus mirus, 3.
Trinucleus seticornis, x x x 3, 7, 8, x x x 20,
x x x 21, x x x 22.
Trilobite fragments, undeterminable, 13, 16.

OLD RED SANDSTONE FOSSILS.

Plant remains, like ferns of the genera *Adiantites*
and *Sphenopteris*, and others not perfectly de-
terminable, 24, 25.

CARBONIFEROUS FOSSILS.

CŒLEENTERATA.

ACTINOZOA.

Amplexus coralloides,	28.
Aulopora campanulata,*	28.
Chetetes tumidus,†	X X 28.
Cladochonus crassus,	28.
Cyathophyllum ceratites?	28.
" (small undetermined sp.)	26.
Michelinia favosa,‡	26, 28.
" megastoma,‡	28.
Syringopora ramulosa,	28.
Zaphrentis cylindrica,	26, 28.
" patula,	28.

MOLLUSCA.

POLYZOA.

Cerriopora rhombifera (serialis, Portlock),	28.
" gracilis,	26, 28.
" interporosa,	28.
Fenestella antiqua,	26.
" flabellata,	28.
" irregularis,	28.

BRACHIOPODA.

Athyris lamellosa, X	28.
" Roysi, X X	28.
Chonetes Hardrensis, X X	26, 28.
Discina nitida,	28.
Orthis Michelini, X X X	26, 28.
Producta gigantea,	28.
" longispina,	28.
" pustulosa,	28.
" semireticulata, var. Martini,	26.
" Youngianus (aculeatus?)	28.
Rhynchonella pleurodon, X X X	26, 28.
Spirifera cuspidata, X	28.
" lamiosa, X X	26, 28.
" striata, X X	26, 28.
Spiriferina cristata, var. octoplicata,	26, 28.
Streptorhynchus crenistria,	26, 28.
Strophomena analoga, X X X	26, 28.
Terebratula hastata,	28.

CONCHIFERA.

Axinus? (sp. undetermined),	26.
Pleurorhynchus fusiformis,	28.
" (species undetermined),	28.
Pullastra bistriata,	26.

GASTEROPODA.

Acroculia vetusta,	28.
Euomphalus tabulatus,	26, 28.
Loxonema (species undetermined),	28.

PTEROPODA.

Conularia quadrisulcata,	28.
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* This is probably the young of Syringopora ramulosa.

† Verticilopora abnormis, M'Coy, appears to be a branching variety of this species.

‡ These two species are perhaps identical.

ANNULOSA.

ECHINODERMATA.

Actinocrinus triacontadactylus,*	28.
" joints,	26.
Archæocidaris glabrispina,	28.
" (plates and spines of a smaller species),	28.
Cyathocrinus planus,	28.
Palæchinus elegans, X X	28.
Pentremites oblongus?	28.
Platycrinus lævis,†	28.
" (or new species),	28.
" laciniatus,	28.
" striatus,	28.
Poteriocrinus abbreviatus,	28.
" crassus,	28.
" dactyloides,	28.
" gracilis,	28.
" (sp. undetermined),	28.
Woodocrinus macrodactylus,	28.

PISCES.

Cochliodus (Psammodus) contortus, palatalteeth, X X	28.
Chomatodus (Psammodus) linearis,	28.
Helodus (Psammodus) levissimus, X	28.
" (?) cinctus,	28.
Orodus ramosus,	28.
" cinctus?	28.
Psammodus porosus, X	28.
Palæoniscus Egertoni? scales,	28.

Remarks on the Fossils.

Silurian Fossils.—Considering the Silurian fossil localities of this district in the order of their distribution on the sheets of the one-inch maps, and taking Sheet 178 as that farthest south, we find on the Dalligan river about five miles N.E. of Dungarvan (locality 4 of the preceding list), black argillaceous slates from which Mr. Galvan (who made nearly all the recent collections from this district) procured specimens of small double serrated graptolites of an open V shape, which I believe to be *Didymograpsus sextans* Hall,‡ a form not easily mistaken, and new to Ireland. Mr. Salter has identified and figured this species from the black slate west of Wigtownshire;§ the formation to which it is assigned in "Siluria" (3rd edition) is that of the Llandeilo flags.

At a cutting for the new road, about two miles N.E. of Stradbally, (locality No. 5) in highly cleaved gray slates, several fossils were met with; but in consequence of their great distortion, it required a considerable amount of discrimination to determine the species. The most abundant fossil at this place is *Stenopora fibrosa*, variety *lycoperdon*, a small hemispherical coral, rounded above, and with a flattened base, from the centre of which the small tubes radiate; as this form of coral occurs at most of the Silurian localities in this district, it becomes an important and characteristic fossil. In Sir R. I. Murchison's *Siluria* (3rd edition, p. 204) it is stated to be a variety of *Stenopora fibrosa*, a branching species. It is, however, so very unlike that well-known and also abundant coral, and frequently occurs with it without exhibiting any alteration of form, such

* Probable synonyms of this species, *A. polydactylus*, Miller; *A. icosidactylus*, Pork; *A. tessellatus*, Phillips; and *A. costus*, M'Coy.† Probable synonyms, *P. trigintadactylus*, Austin; and *triacontadactylus*, M'Coy.

‡ "Palæontology of New York," vol. i, p. 273, pl. 74, fig. 3.

§ *Quarterly Journal of the Geological Society*, vol. v, p. 17, pl. 1, fig. 10, b, c.

as would indicate a gradation or passage between the two, that it is difficult to believe them to be identical. The other fossils from this locality are a Fenestella-like Polyzoan, which appears to be identical with *F. assimilis*, but which, perhaps, would be more correctly placed in the genus *Polypora*; a small *Orthis* *O. calligramma*; and five species of Trilobites, the most numerous being *Asaphus gigas*; some of them are most curiously drawn out, and others, on the contrary, squeezed up into a very small compass by cleavage. These species are *Phacops Brongniarti*, *Phacops truncato-caudatus*, *Cybele verrucosa*, *Calymene brevicapitata*, *Asaphus gigas*.

On the roadside, about half a mile N.E. of the last, a fossil locality (No. 6), occurs in a greenish grit, the branching form of *Stenopora fibrosa* is particularly abundant, the casts of its branches quite characterizing the rock. It is accompanied, but not so plentifully, by the *Lycoperdon* in small hemispheres about an inch in diameter, standing out from the rock when broken, or as at Knockmahon weathered out by the action of the sea, and resembling in shape some of the Fungi. The only other species collected were Brachiopods; *Leptaena sericea*, *Strophomena alternata*, and *Orthis calligramma*.

Two miles W. of Bonmahon, at Ballydouane Bay (locality No. 8), are slates, from which Trilobites and Brachiopods were obtained of the following species—*Orthis crispa*, and *O. simplex*, *Trinucleus seticornis*, and *Phacops truncato-caudatus*. These were the only species determined by me. A previous collection had been made which I had not the opportunity of examining.

About one mile N.W. of Knockmahon, near the River Mahon (locality No. 7), are gray slates, in which the principal fossils are Trilobites. The species collected were *Phacops truncato-caudatus* (most abundant), *P. Brongniarti*, *Trinucleus seticornis*, *Remopleurides Colbii*, "*Ilænus Bowmanni*," *Encrinurus seccostatus*, and *Asaphus gigas*.

A remarkable fossiliferous locality occurs at Knockmahon, on the shore close under the engine-house of the Knockmahon copper mines (locality No. 9), which Mr. Du Noyer describes as an "ash bed:" it is a hard bluish gray rock, characterized by bands of the variety of *Stenopora fibrosa*, called *Lycoperdon*, which stand out from the rock where exposed to the sea action like nodular concretions, until on a closer examination they are found to be corals of the species before mentioned; they are accompanied by comparatively few specimens of the branching variety. The fine Brachiopod *Orthis crispa*, so frequently occurring throughout this district, is also plentiful here; an uncommon gasteropod shell *Raphistoma elliptica*; and the Trilobites *Phacops Brongniarti* and *Asaphus gigas* have also been collected at this place.

The cliffs at Dunabratton Head (locality 10) afford a rich locality for fossils, especially Trilobites; they occur in dark gray flaggy beds much cleaved, the cleavage, cutting obliquely across the bedding, distorts the fossils considerably, and makes it difficult to procure them entire. In some of the beds, which are decomposed, the fossils are better shown, and some of the Trilobites, such as *Ilænus Bowmanni*, are found entire.

A fine Brachiopod, described by Professor McCoy as *Atrypa filosa*,* (but which is, I believe, an *Athyris*), and of which he gives a very imperfect figure, is found rather plentifully at this locality. I consider this to be a good species, although I do not see it included in Professor Morris' Catalogue of British Fossils, or the Table of Fossils in "Siluria." The surface of this shell is covered with very fine longitudinal striae. *Orthis crispa* and *bifurcata* also occur at this locality with *Leptaena calcarata*.

* See R. Griffith's Synopsis of Silurian Fossils, p. 39, pl. 3, fig. 28.

Ilænus Bowmanni is a remarkably abundant Trilobite in these rocks, some of the beds being literally one mass of their remains. *Asaphus gigas* is also very abundant, as is also an *Ogygia*, which I believed to be *O. Buchii*; Mr. Salter, however, who is more experienced in this class of animals, informs me that it is not that species, but identical with a common Bala one he has not yet named. *Trinucleus seticornis*, *Phacops truncato-caudatus*, and *Calymene brevicapitata* are the only other Trilobites occurring at this locality.

On Sheet 168 there is a good locality for Graptolites (locality No. 1) at the new road cutting near the base of the cliffs on the banks of the River Suir, a little N.W. of Waterford. The cliffs are here 150 feet high, and in them occur a few bands of black carbonaceous slates, which readily split into laminae, the surfaces being covered by Graptolites, amongst which I could detect only two species, *Diplograpsus pristis* and *Graptolithus tenuis*. The former, according to the "Table of Fossils in 'Siluria'" (3rd edition), is characteristic of Llandeilo flags, and also doubtfully referred to strata of Caradoc or Bala age. The latter is included in the same table as occurring in Caradoc or Bala strata only. The Graptolites are very distinct, particularly the double form, *Diplograpsus pristis*, which is also the most abundant. Sometimes they are stained pink, probably in consequence of the presence of iron, otherwise they are white, and exhibit a strong contrast to the dark slates in which they are embedded. Both forms are sometimes present on the same surface, but generally they are found separate, and usually on opposite sides of the same slab.

On the same sheet of the map, near its southern margin, three miles south of Waterford, on the road to Clohernagh bridge (locality No. 2), fossils were obtained in a brown calcareous impure limestone, at an old quarry at the back of a farm-house near the road (locality No. 2). Part of this collection was made many years ago, the remainder was collected by Mr. C. Galvan. The former collection I have not had an opportunity of examining. Of those lately obtained the following are the most important species:—*Stenopora fibrosa* branching, *Orthis crispa*, *Strophomena corrugata*, a pteropod *Conularia elongata*, and a cystidean *Echinospheerites aurantium*, a few species of Trilobites, amongst which are fine examples of *Calymene Blumenbachii*, *Cybele verrucosa* and *Lichas Hibernicus*.

The only other locality on this sheet from which we have any fossils is a very important one, from the number of species and good state of preservation of the fossils; it is situated a little north of Newtown Head, on the shore of Waterford Harbour, about seven miles S.E. of the city of Waterford* (locality No. 3). The principal of these highly fossiliferous beds are only exposed at low water. They consist of dark gray concretionary shales, in close contact with igneous rocks. The remains of Trilobites are the most abundant fossils at this place, several of them being found entire. A few small Brachiopods and other Mollusca, and still fewer Echinodermata, are the only classes of organic remains represented in the collection from this rich fossiliferous locality, which contained 300 specimens. No corals were observed. Single specimens of *Polypora* (*Fenestella*) *assimilis*, and *Graptolithus priodon* were collected; of the Brachiopoda *Orthis elegantula* was particularly abundant; of Conchifera, only a small bivalve, probably a species of *Ctenodonta*, and one Gasteropod, probably *Murchisonia*, were obtained, whilst of Heteropoda *Bellerophon*

* This locality has sometimes been confounded with that of Great Newtown Head, Tramore Harbour. It has been so mistaken in the late General Portlock's Report on Londonderry, &c., p. 262, in mentioning the locality for the specimens of *Amplexus mamillatus*, contributed by Major Austin, which, instead of being given as Tramore should have been Newtown Head, Waterford Harbour.

perturbatus, and an undetermined species, were a little more plentiful. Several examples of Pteropods, of the species *Conularia elongata*, *Theca triangularis*, and *Ecculiomphalus Bucklandi*, were collected, and the remarkable Echinoderm, *Echinosphærites aurantium*, so abundant at Carrickadagan, county of Wexford, and also, but less frequently, at locality No. 2, and other localities in Tramore Bay, is not uncommon in these beds. Amongst the Trilobites from this locality the most prevalent is *Ampyx mammillatus*, of which species as many as 111 specimens were collected. Out of this large number, however, very few of them were entire. The specimens consisted of 6 of the entire animal: 32 heads detached, 51 tails do., 3 heads with parts of body attached, 9 tails with parts of body attached, and 2 of the body alone. The next most abundant species was *Trinucleus seticornis*, of which 72 specimens were collected, 4 of them being the entire animal, 49 detached heads and fragments of do., 15 tails detached, 4 tails with parts of body attached. This analysis of the condition under which these characteristic species of Trilobites occur serves as a kind of index to that of the others, and may be useful for the purpose of showing the parts which are most usually preserved in these extinct crustacea—the body, which is composed of a number of rings or segments, being less frequently met with than the head or tail, which would become easily detached from it.

The next most frequent species from this locality is *Ogygia Portlockii*; of this Trilobite 32 specimens were collected. *Ilænus Bowmanni*, so extremely plentiful in the cliffs of Tramore Bay, is represented in this collection by three specimens only—*Cybele verrucosa*, *Harpes Flanaganii*, *Acidaspis Jamesii*, and *Calymene brevicapitata* also occur, but sparingly.

On Sheet 179, at a road cutting about half a mile N. of Annewstown (locality No. 11), are dark flaggy beds like those at Dunabrattin, with somewhat similar fossils, although not in such profusion. The species identified in the collection from this locality are *Orthis calligramma* and *bifurcata*, *Glyptocrinus* plates, and crinoid joints, *Asaphus gigas*, *Phacops Brongniarti*, *Ogygia* sp. like *O. Buchii*, *Remopleurides Colbii*, and *Agnostus trinodus*.

The next locality on this sheet (No. 12) from which fossils were collected is a little north of Ballyscanlan Lough, from a hard green rock or "ashy slate" similar to that at locality 6, north of Brenan cross-roads. It contains the prevalent coral *Stenopora fibrosa* branching, and hemispherical variety *lycoperdon*, the latter being the most abundant; *Polypora* (*Fenestella*) *assimilis*, *Orthis calligramma*, *Strophomena deltoidea*, and another brachiopod shell of large size, which appears to be identical with *Strophomena expansa*, the Trilobites *Phacops Brongniarti* and *truncato-caudatus*, and *Encrinurus sexcostatus*.

On the same sheet, in a farm-yard, about a mile and a half N. of Cullen Castle, and three miles N. of Tramore (locality 13), from dark gray slates not very fossiliferous, were obtained the following species:—*Stenopora fibrosa* branching, *Orthis calligramma* and *bifurcata*, *Leptaena sericea*; *Bellerophon*, probably *perturbatus*; a heteropod shell only found at one other locality (No. 3); Crinoid joints, and the Cystidean *Echinosphærites aurantium*, with Trilobite fragments, which were indeterminate.

In a stream a little W. of locality 13 are gray argillaceous slates with comparatively few fossils. The species collected from this locality (No. 14) are *Stenopora fibrosa* branching, *Orthis calligramma* and *bifurcata*, the most characteristic Trilobite being *Trinucleus seticornis*; with this occurs *Phacops Brongniarti*, *Ilænus Bowmanni*, and *Asaphus gigas*.

Near the cross-roads, a little S. of the locality previously mentioned (locality 15), are hard greenish slates, or ashy beds, in which the prevailing fossil is the branching coral *Stenopora fibrosa*, which is very abundant, accompanied more sparingly by the variety *lycoperdon*; *Polypora*

pora (*Fenestella*) *assimilis* is also plentiful, occurring in layers throughout the rock with the *Stenopora*; good impressions of *Orthis crispa*, showing the beautiful imbricated ribs of this brachiopod shell, *Orthis calligramma*, and *Echinosphærites aurantium*, were the only species from these peculiar beds.

Locality 16 is situated in a field a little to the south-east of locality 13. From these trappean ashy beds a few fossils in bad preservation were obtained, the only species that could be made out being *Stenopora fibrosa* branching, and hemispherical variety, *Polypora assimilis*, *Orthis crispa* and *calligramma*, with fragments of Trilobites of an indeterminate character.

The last four localities, 13, 14, 15, and 16, are all situated near each other on quarter-sheet V' of the six-inch map.

We arrive now at the consideration of a somewhat different set of fossils in the three next localities, 17, 18, and 19, which occur in the bands of impure limestone running S.S.W. of Waterford in the direction of Tramore. The fossils in this limestone are very abundant at certain localities, and well shown where the rock is decomposed, often appearing with a ferruginous coating, which distinguishes them from the matrix in which they are embedded. Trilobites are remarkably abundant, especially the species called *Phacops Brongniarti*, which is often so perfect as to exhibit the eyes with their numerous lenses. The Trilobites are, however, seldom found entire, the heads and tails being almost invariably detached and the body-segments rarely met with.

Commencing with the locality nearest Waterford (No. 17), at Castletown, a little S. of the castle, we find a brown calcareous rock similar to that of Quillia (locality 18), full of fossils, although the species are not numerous; they consist of *Stenopora fibrosa* branching and variety *lycoperdon*, *Orthis elegantula* few, and *O. calligramma* abundant; a large depressed brachiopod, which appears to be *Strophomena concentrica*, common at all four localities, and *Leptaena sericea*; the Trilobites are *Phacops Brongniarti*, the prevailing fossil at these localities, accompanied by the less frequent species, *Cybele verrucosa*, *Cheirurus bimucronatus*, and *Ilænus Bowmanni*.

About a mile south of the locality just described is that of Quillia (locality 18), where a similar brown calcareous rock occurs highly charged with fossils; *Stenopora fibrosa*, the branching coral, is, however, comparatively rare, as well as *Orthis calligramma*, the large brachiopod before referred to; *Strophomena concentrica* is abundant, and *Leptaena sericea* is also plentiful in some beds; Cephalopod shells, which appear to be rare in nearly all the Silurian fossil localities of this district, occur at this locality, and in the cliffs of Tramore Bay, a single specimen of an *Orthoceras*, resembling *Brongniarti* of Portlock, having been collected at this place. Crinoids are also rare throughout this Silurian district, a portion of a Crinoid stem and some of the joints being the only evidences of their presence here. Of the Trilobites *Phacops Brongniarti* is, if anything, still more abundant than at the last-mentioned locality. *Phacops truncato-caudatus* also occurs here, but is comparatively rare. Another very distinct Trilobite, *Amphion pseudo-articulatus*, which we have not before had occasion to mention, is found also at this place in a very perfect condition, as far as the disconnected heads and tails will testify, their bodies, like those of the other Trilobites, being generally absent; the hypostome or labrum of *Asaphus gigas* is all we have to indicate the prevalence of this species, so prevalent at other localities in these deposits. *Calymene brevicapitata* and *Ilænus Bowmanni* complete the list from this place.

At Pickardstown and Drumeannon, a little W. of the road to Tramore (locality 19), in gray calcareous rock, we get a very similar assemblage of fossils, consisting of *Stenopora fibrosa* branching, and the variety *lycoperdon*,

Orthis calligramma, *Strophomena deltoidea*, *Strophomena expansa* or *concentrica*, abundant, with *tenuistriata*, a plate of *Glyptocrinus* and a few crinoid joints, and for the first time a rare form of starfish *Palæaster obtusus*. *Phacops Brongniarti* is about as numerous as at the last locality. *Amphion pseudo-articulatus*, only observed at the locality last mentioned, also occurs here, as well as *Cheirurus gelasinus*, found also at localities in Tramore Bay; *Asaphus gigas*, and *Cybele verrucosa*.

In the cliffs of Tramore Bay, from near Tramore to Great Newtown Head, are many fossiliferous localities from which numerous specimens were collected by the officers of the Geological Survey, some of them many years ago. Recent collections have also been made there. As most of the places at which these fossils were collected are very similar as regards the description of the rocks and the fossils contained in them, it will be only necessary to allude to those occurring at localities included under the numbers 20, 21, and 22, as one assemblage.

There are, however, some black slates appearing at the boat station, Lady Elizabeth's Cove, which deserve special mention, as indicating by their fossils, beds usually referred to the age of the Llandeilo flags. They consist of dull black argillaceous slates, nearly vertical. The fossils contained in them are mostly Graptolites or allied forms, with what appear to be plant stems, perhaps fucoids. Small branching polyzoa which appear to be identical with *Dendrograpsus flexuosus* Hall,* and another, Fenestella-like form, resembling the *Dictyonema* (*Graptopora*) *sociale*, figured in Siluria (3rd edition, p. 47, woodcut of fossils 7, fig. 3), but still more closely that of *Callograpsus elegans* Hall,† are associated with the following graptolites in these slates:—*Diplograpsus pristis*, which is the most frequent species, next to it in point of numbers being *Didymograpsus sextans*, and the fewest in individual specimens that of *Graptolithus priodon*.

We have, therefore, throughout this district, as far as has been observed, three localities only where black slates occur containing Graptolites; at two of them, localities 4 and 21 (that now under consideration), are species which are said to be found no higher in the series than the Llandeilo rocks.‡ The third locality, that near Waterford (No. 1 of the preceding table), has furnished but two species; one of them, *Graptolithus tenuis*, on the authority of the authors of the list of species appended to Sir R. I. Murchison's Siluria, 3rd edition, is said to be confined to strata of Caradoc age; the other *Diplograpsus pristis* being doubtfully continued from the Llandeilo rocks into that of the Caradoc or Bala series.

The other fossils from the several localities on the shore of Tramore Bay, are found in compact bluish limestones decomposing into a brown rock, and in brown shaly beds; and are all, according to the authorities before referred to, considered to be from strata of Caradoc or Bala age, as will be seen on reference to the list of species from localities 20, 21, and 22. The Brachiopoda and Crustacea are well represented, and the number of individual specimens collected of these groups was considerable. The prevalent coral, *Stenopora fibrosa*, branching, and variety *lycoperdon*, the latter being the most frequent, occurs at most of the localities examined, accompanied at one locality only by a coral with branches of greater diameter and larger pores, which agrees with the species named *Favosites cristata*, and the Polyzoan *Ptilodictya dichotoma*, *Polypora* (?) (*Fenestella*) *assimilis* is also included in the collection recently

* Geological Survey of Canada, Decade 2, pl. 4, fig. 1.

† Ibid. " " pl. 19, fig. 2.

‡ These black slates containing the so-called Llandeilo forms, are intimately associated with the beds which are rich in Bala fossils, and cannot in this district be separated from the rest of the series.—J. B. J.

made from the locality in Newtown Cove. The Brachiopoda from these localities include *Athyris* (*Atrypa*) *filosa*, *Orthis crispa*, *bifurcata*, *simplex*, *calligramma*, and *elegantula*. *Strophomena deltoidea*, *expansa*, *funiculata*, *plicatilis* (probably identical with *S. depressa*), *Leptaena sericea*, and *calcarata*, *Lingula brevis* and *Discina subrotunda*.

The Conchifera are entirely absent, and of the Gasteropoda only one specimen occurs in the collection, that of a spiral shell, doubtfully referred to *Holopea*. Two specimens of a singular fossil were included in the recent collection made by Mr. Galvan, which appears to me either to be a new species of *Conularia* or that described as *C. elongata* (Portlock). The same fossil also occurs at Newtown Head (locality 3).

The Cephalopoda, which are extremely rare, only occurring at one other locality in the Silurian rocks of this district (locality 18) are here represented by two species of *Orthoceras*, one undetermined, the other referred to *O. tenuicinctum*, from Newtown Cove. A fine example of the curved shell of *Cyrtoceras inaequisseptum* is contained in the recent collection made from these localities.

The only examples of the class Echinodermata are crinoid arms and plates similar to those from other localities in this district referred to *Glyptocrinus*.

The crustacea are here represented by about twenty species of Trilobites, several of which occur in great abundance. Amongst them are the peculiar little species *Agnostus trinodus*, of which twenty-three specimens were collected, two of them with the head and tail attached, and another which I believe to be a new form, of which six specimens were obtained. A still smaller kind is that of the *Beyrichia affinis*, in form somewhat resembling the human ear; it occurs in this collection in dark gray shaly beds, occasionally associated with the previous species. Of *Calymene brevicapitata* sixteen specimens were collected, two of them entire. *Cheirurus gelasinus* a large species, of which three specimens were obtained from the limestone, all being heads; and fragments only, consisting of one of the pleuræ or body segments, and part of the head of *Cheirurus bimucronatus*, a species common in the Silurian limestone of the Chair of Kildare. Of *Cybele verrucosa* the proportion of heads to tails were very remarkable, there being, in the collection made of this species, but one head to fourteen tails. Of *Encrinurus sexcostatus* (a species not hitherto recorded as found in Ireland) out of twenty-seven specimens collected four are entire animals, the proportion of heads and tails being nearly equal. Of *Lichas laxatus* and *Bronteus Hibernicus* one specimen only of each was obtained. *Trinucleus seticornis* and *Illæus Bowmanni* were about equally abundant, the rock in some places being full of the remains of both these species. Some of the latter are found entire, and show ten body segments, as in *Illæus Davisii*, and are generally very similar to that species from the Bala limestone of Rhiwlas, figured and described by Mr. Salter in Decade 2 of the Geological Survey, pl. 2, who alludes to the specimens from Tramore Bay, figured by the late General Portlock, as being referable to *Illæus Bowmanni*; the specimens from which those figures were taken were not, however, so perfect as some recently collected by the Geological Survey, and could not have shown the number of body segments so distinctly. It appears to me, from these circumstances, that the two species might be united. *Phacops Brongniarti* is also an abundant species at these localities in Tramore Bay; 53 specimens were collected one of them only being entire. Mr. Salter suggests that the variety *Dalmanni* is the female of this species. According to that view I have made out 19 males and 34 females as the proportion in this collection, giving a large preponderance to the latter, if such a distinction of sex

can be satisfactorily established. Only two specimens of *Phacops truncato-caudatus* occur in the collection from these localities, and those are fragments of a doubtful character. *Ampyx rostratus* and *mammillatus* are also included amongst the species from these rocks, the latter being rather plentiful. One specimen only of *Ogygia*, of the species similar to *O. Buchii*, together with some portions of the head of a different species, are doubtfully referred to this genus. *Remopleurides longicostatus* and *R. Colbii* complete the list of fossils from these localities; the latter species being abundant; with it I should feel disposed to unite *R. dorso-spinifer* and *latero-spinifer*, as suggested by Mr. Salter in Decade 7, p. 6, 7, &c.

The only other locality remaining to be noticed is that on the shore, at Garrarus strand, about a mile south of Tramore Bay (locality 23), where from black shaly beds a few fossils were collected, such as *Lingula brevis*, *Leptæna sericea*, *Trinucleus seticornis*, *Asaphus gigas*, *Calymene brevicapitata*, and *Remopleurides Colbii*.

On the Wexford side of Waterford Harbour, from black slates, on the shore near Duncannon Fort, *Orthoceras calligramma* and a fine Trilobite, entire, *Acidaspis Jamesii*, are said to have been obtained. These specimens are included in the collection formerly made by the Ordnance Survey from this part of Ireland. When visiting this part of the country some time since, I looked in vain for any indication of fossils at the locality specified. Since then I have seen a description of these beds, and those on the opposite shore at Newtown Head, by Major Austin, a gentleman who was Commandant at Duncannon Fort for some years, and had good opportunities of examining the neighbourhood, he describes the fossiliferous beds in the black slates as being only visible at low water, and as I was not aware of that fact at the time of my visit, it would be sufficient to account for my want of success.

Carboniferous Fossils from Hook Head.—It will be seen by the above list of species that the limestone beds of Hook Head furnish a great variety of organic remains. Nothing can exceed the beauty of these fossils where the beds are exposed and weathered, as they are nearly all round the shores of this point. The rocks of dark, nearly black limestone are almost horizontal, and rise by a succession of steps from the sea, with great fissures or joints interrupting the continuity of the beds. The surfaces of these beds are crowded with *Corals*, *Polyzoa*, *Brachiopoda*, and *Crinoids*, and sometimes fish remains. The delicate network of the *Reteporidae*, and elegant structure of other kinds of *Polyzoa*, with the internal arrangement of the *Brachiopod* shells, and the graceful *Crinoids*, with stems, arms, and heads attached, are all displayed in perfection at this favourite locality; and I know of no other place where such a fine field is open for investigating the structure of these particular groups of fossils *in situ* as this place affords.

WILLIAM HELLIER BAILY.

June 11, 1865.

NOTE.—The occurrence of small assemblages of Llandeilo species here and elsewhere in Ireland, in peculiar beds, which are, as far as can be determined, interstratified with the beds containing Bala or Caradoc species, reminds us of M. Barrande's colonies. I have long suspected that the two assemblages of species were contemporaneous in reality, and had each their peculiar *habitat*, their occurrence as fossils depending on the nature of the rock quite as much as its period of formation. The Irish facts augment this suspicion, nor would the facts in N. Wales, so far as they are known to me, suffice to destroy it.—J. BEETE JUKES.

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

There are few districts in Ireland where the geological structure of the ground has more clearly influenced its main physical features than that under review.

The lowest ground is almost entirely occupied by the Carboniferous Limestone. The next in elevation has been formed on the Lower Palæozoic rocks, especially when they have been associated with trappean beds. The third level is on the same formation, where it is purely schistose; and the highest ground is covered by the overlying Old Red sandstone. To these general rules there are, however, a few minor exceptions.

It is remarkable that over the area occupied by the Lower Palæozoic rocks, the forces of denudation have excavated valleys and formed hills directly across the general stratification, and totally uninfluenced by the comparative hardness or softness of the beds.

Over the greater portions of the limestone areas, however, this rule is reversed, and the valleys follow the strike of the beds, and cut into the very lowest shaly and soft portions of the deposit. The Old Red sandstone beds which rise directly from beneath the limestone, have also yielded on the lines of their deposition and least resistance.

At the eastern end of the limestone basin, which occupies a part of the northern portion of the district, the denudation has cut across not only the limestone, but the Old Red sandstone and the Lower Palæozoic rocks beneath. The Carboniferous Limestone, in the form of a long wide trough, occupies the valley of the River Suir, which stretches across the northern portion of the district from W. to E., and the valley of Dungarvan, at the extreme S.W. corner of the district, is similarly formed. The low ground at the extremity of Hook promontory is also on this limestone.

The northern and eastern escarpment of the central plateau (which we may call the Rathgormuck plateau) overlooking the valley of the River Suir, is formed of highly inclined Old Red sandstone beds; and these rocks curve round past the city of Waterford, and strike northwards past the village of Mullinavat. At Waterford these beds are cut through by the River Suir, to the depth of 227 feet.

The entire area of the Comeragh mountains, and the Eragh mountains south of them, is formed by the Old Red sandstone, which, like a flattened arch, dips to the N. and S., into the valleys of the Suir and Dungarvan respectively. To the east of these mountains the crown of the sandstone arch has been completely denuded, and the Lower Silurian rocks exposed in the plateau of Rathgormuck.

That this great flattened Old Red sandstone arch extended very much further to the eastward, is evident from detached portions of it still remaining at Dunmore, Passage, and Ballyhack; and in the county of Kilkenny at Drumdowny Hill, and to the north of it, while to the westward of the Comeragh range, the sandstone stretches far beyond the limits of this district.

From the mode of occurrence of the Carboniferous Limestone, it is equally clear that it extended over all the Old Red sandstone rocks not only in this district, but over that now occupied by the whole S. of Ireland, whenever these beds appear; and I believe I do not

hazard too wild a conjecture, when I say that the Coal-Measures themselves overspread the Carboniferous Limestone in the great area thus indicated.

Prior to the denudation of the rocks certain forces of disturbance acting in an E. and W. direction, both on the Lower Palæozoic rocks, and the superimposed Old Red and Carboniferous beds, raised the centre of the district, and threw the rocks into long E. and W. troughs along the northern and southern side of it.

One large fragment of Old Red sandstone forms Croghaun hill, 1,273 feet high, which extends for three miles and a half in an easterly direction from the Comeragh escarpment into the Rathgormuck plateau. In the county Kilkenny, to the N.E. of the city of Waterford, we have Drumdowney hill, 405 feet high, capped by nearly horizontal beds of Old Red sandstone, extending for the distance of two miles and three-quarters from N. to S., with a maximum width of over three-quarters of a mile. To the north of this are two small patches of the same deposit, the larger measuring 650 yards from E. to W., by 250 from N. to S.; the smaller 350 by 180 yards. In the county Wexford, at Ballyhack, and in the county Waterford, at Passage, along the banks of the Waterford estuary, we find other outliers of Old Red sandstone, the extent of which will be sufficiently apparent by reference to the map (Sheet 168).

To the south of this (Sheet 179) we find an extensive outlier of Old Red sandstone in the Dunmore district, measuring about six and a half miles from N.E. to S.W., with a maximum width of two and a half miles; and on the opposite shore of the Waterford estuary, we have another outlier of the same rock, forming the base of the Hook promontory, between the bays of Templetown and Houseland.

To the south of Mullinavat, on the western side of the little river Blackwater, the Old Red sandstone has been worn through in two places, so as to expose two irregularly-shaped patches of Lower Silurian rocks; the eastern being faulted along its eastern side. The extent of these erosions is one mile and three-quarters, by 600 yards for the eastern, and about the same extent for the western.

The Old Red sandstone beds of the Comeragh range lie at very low angles of dip, the general inclination being to the westward; and when they are followed in that direction into the district of Ballymacarbery, they pass beneath the Carboniferous limestone, which occupies the lower ground of the valley of the Russelstown river.

To the north the Comeragh beds dip northwards beneath the limestones of the valley of the Suir, and to the south they pass in that direction beneath the limestones of the Dungarvan valley, but rise again on the southern side of that depression to form the anticlinal ridge terminating in Helvick Head.

All the great valleys and amphitheatre-like hollows, which indent the Comeragh range on the east and west, have been produced solely by denudation. Thus the precipice over Lough Coumshingaun, which attains a height of 1,288 feet, exposes the edges of horizontal beds of sandstone and conglomerate in great ledges, while the escarpment at the Reeks of Glenpatrick, exposes horizontal beds of conglomerate to the thickness of about 1,300 feet.

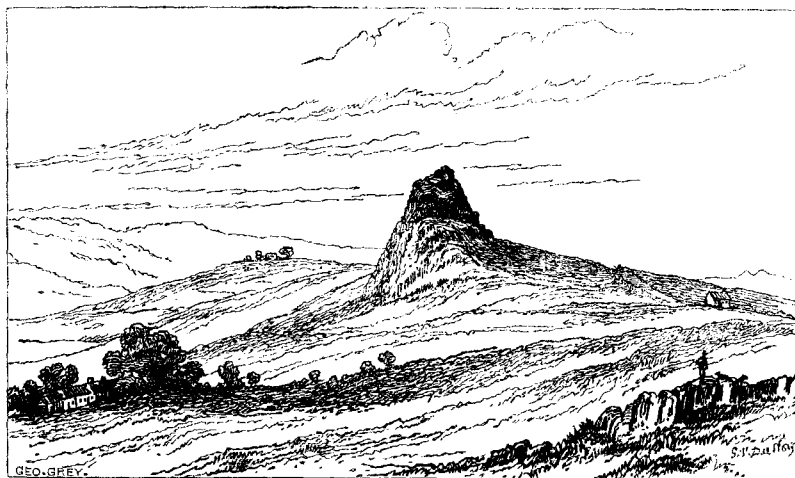
The comparatively low ground which extends in a N.E. direction from the head of Tramore Bay to the strand on the W. side of the

Waterford estuary, between Passage and Newtownhead, is formed on the Lower Silurian slates; its highest level being 253 feet.

In the county Wexford, at the N.E. corner of the district (Sheet 168), the peaky hill of Slievecoiltia, which attains a height of 888 feet, is formed of the Lower Silurian slates, and forms a prominent feature, as the ground to the south and east of it is comparatively low and undulating; the highest point being 276 feet at the distance of about one mile to the S. of Thistletown, and falling to 150 feet to the east of Duncannon.

The southern extremity of that remarkable band of Lower Palæozoic trappean rocks which traverses the S.E. of Ireland, from near Rathdrum, in the county Wicklow, to Ballyvoyle Head, in the county Waterford, crosses the district from N.E. to S.W., attaining a maximum width of eight miles and a half to the N.W. of Tramore, but lessening on the east side of the district to four miles, and on the S.W. to about five miles. The surface of this trappean band is irregular, rising here and there into rugged ridges, usually formed by the feldstone, varying in height from 231 to 541 feet. Of these the most prominent is the range of hills to the E. of Dunbrody, the summit of which is 231 feet (Sheet 168), and that to the N.E. of the village of Kill (Sheet 178), which reaches to a height of 541 feet, with the intermediate ranges of Carricaroirk, 457 feet, lying to the west of Sporthouse cross-roads in Sheet 179; and that of Carriegenaveagh,* which attains a height of 230 feet at the distance of three and a half miles to the southward of the city of Waterford.

Fig. 3.



View of Sugarloaf Rock, looking westwards.

This peak is distinctly visible from many parts of the Counties of Wexford and Kilkenny.

* This word means "the little rock of the Deer." See appendix for a list of Irish names still existing in this district with their significations.

To the N.E. of Tramore the trappean country becomes dotted over with sharply escarped feldstone bosses, which strike the eye while looking on the district from any eminence to the south of Waterford. Of these the most remarkable is in that called Sugarloaf Rock (Sheet 168), the summit of which is about 280 feet above the sea.

In the district around Sporthouse cross-roads many of these well-marked feldstone bosses still retain their original Irish names; indeed the Irish names of places are so numerous, not only over the interior of the district, but along the coast, that I have been induced to give a list of them, with their signification in English. (See appendix.)

To the S. and S.E. of Ballyscanlon Lough (Sheet 179), there are many prominent hills, varying from 320 to 436 feet in height, formed of feldstone and consolidated feldspathic ash; and to the westward of the same lake the ground again becomes hilly, attaining a height of 340 feet, and exposing beds of greenstone and chloritic or greenish ash with nodular feldstone.

Between the villages of Kilmacthomas and Kill the feldspathic rocks form lofty and undulating ground reaching to elevations varying from 399 to 540 feet.

At Carrickcastle hill, to the south of the village of Ballynaneen (Sheet 178), a thick band of feldstone, which passes into a green and crystalline variety of the same rock, and which I have ventured to class with the diorites, forms a knoll rising to a height of 260 feet above the level of the valley of the Mahon river, which cuts through the ridge from N. to S. at an elevation of twenty-seven feet above the sea. To the N. and W. of the village of Stradbally the ground, which is undulating, does not present any marked feature till we approach the escarpment of the Old Red sandstone; here, at Carrigmorna, a peaky hill is formed of Lower Silurian slates, with a hard band of feldspathic ash on its northern flank. The summit of the hill is 577 feet, having alluvial and boggy flats to the N. and E., at a level of 200 to 300 feet above the sea.

The trappean beds, with their interstratified masses of gray Lower Silurian slates, are but imperfectly exposed along their western limit on the valley of the Dalligan river (Sheet 178), along the western side where they are soon concealed by beds of Old Red sandstone.

The Lower Silurian district, to the south of Kilmacthomas, which may be called the Rathgormuck plateau (Sheet 167), exposes dark and light gray and greenish gray slates, with here and there a band of purplish slates and grits; but the whole mass is so crumpled and otherwise contorted, that it is quite impossible to say which are the higher or which the lower beds, or to determine on what horizon the purplish bands appear. Long after the removal of the Old Red sandstone which once covered the whole of this plateau, the surface of the slate rocks has been subjected to the ordinary forces of denudation, the sea or the atmosphere, and has been moulded into deep glens and rounded hills. Near the villages of Clonee and Mothil, and at the cross-roads near the old church of Fenoagh, the slate rocks are traversed by dykes of greenstone, and a band of feldspathic ash occurs in them at the village of Mothel; and at the southern side of Curraghmore Demesne, on the flank of the hill over Ballin's bridge, we find a vesicular and calcareous greenstone, with several bands of feldspathic ash near it.

To the west of Rathgormuck the Lower Silurian ground rises gradually towards the escarpment of the Old Red sandstone; and in the townland of Clondonnell, to the south of Glenpatrick, forms a well-marked hill of 1,031 feet in height. To the west and south of Curraghmore Demesne the height of the plateau is 500 feet, but to the eastward it falls gradually to 238 feet, as we approach the village of Kilmedan, and the valley of the Suir.

The general outline of the Lower Silurian ground lying to the north of Waterford city or the county Kilkenny (Sheet 168), is very similar to that just described; here and there it rises into rounded hills which vary in height from 294 to 603 feet at its southern limit, and 158 to 661 feet at its northern. Rochestown hill, a small though well-marked knoll, 161 feet in elevation, on the west side of the river Barrow, opposite to Dollar Point, is formed by a broad lenticular mass of porphyritic feldstone in the Lower Silurian slates. On the opposite side of the river Barrow, in the county Wexford, the Lower Silurian slates form the peaked hill of Slievecoiltia, 888 feet high, near the summit of which a dyke of hornblendic greenstone traverses the slates in a N.E. and S.W. direction; and on the western slopes of the hill, as we approach the village of Oldcourt and the chapel of Carrickbein, we find four or five thick dykes of the same greenstone, traversing the slates in a similar direction. The longest of these dykes can be traced almost continuously for nearly two miles. In the farm road near to and east of the Roman Catholic chapel in the townland of Ballykelly, some of the hard greenish grey grits and slates appear to have been slightly micacized by the coarsely crystalline greenstone observed in the neighbourhood, and the slates exhibit a similar metamorphism when they appear to the north of the chapel and in the adjoining road, as well as in the S.W. corner of the townland of Ballykelly, where they appear in the by-road; while elsewhere the same rocks exhibit a general hardening when they are in connexion with this greenstone. In the wood in the S.W. corner of the townland of Dunganstown, on the east bank of the Barrow, a large wedge-shaped mass of coarsely crystalline hornblendic greenstone appears in the midst of the gray slates which are observed to be hardened when in immediate contact with this rock.*

There are many other masses of greenstone in the Lower Silurian slates, the positions of which will be apparent by reference to the map, and of these an account will be given in the detailed description of the rocks.

G. V. D.

* The slates in contact with this greenstone were not merely hardened but burnt, falling into small angular fragments of a rusty brown colour, as is so often the case with rocks altered by contact with greenstone or other trap-rocks. I have observed the same effect produced by elvan dykes, but never by larger masses of granite, which, if they produce any effect at all, produce that of *micacization* on the adjacent rocks.—J. B. J.

DETAILED DESCRIPTIONS.

5. *Position and Lie of the Rocks.*

In describing the area included in these four sheets of the map, it will be convenient to divide it into the following sub-districts:—I., neighbourhood of Arthurstown; II., the Newtown Head section, p. 41; III., the Waterford district, county Kilkenny, p. 42; IV., the Waterford district, county Waterford, p. 44; V., the Tramore district, p. 51; VI., the Annstown district, p. 56; VII., the Knockmahon district, p. 58; VIII., the Stradbally district, p. 63; IX., the district near the village of Kill, p. 63; X., the Kilmacthomas district, p. 64; XI., the Rathgormack district, p. 65; XII., the Clonmel district, p. 67; XIII., the Carrick-on-Suir district, p. 69; XIV., the Pilltown district, p. 72; XV., the Portlaw district, p. 73; XVI., the Kilmacow district, p. 73; XVII., the Dungarvan district, p. 75; XVIII., the Dunmore district, p. 76; XIX., the promontory of Hook, p. 77.

1. *Neighbourhood of Arthurstown.*—At the distance of two miles to the north of Arthurstown we enter on a range of low hills extending from the shore N. of Hook Bay, in a N.E. direction, for about three miles and a half, and here we find almost all the varieties of the Trappean rocks which occur over the district. The central portion of the range is formed of vesicular and, probably, intrusive Greenstone or Diorite, traceable in a N.E. and S.W. direction, for over a mile, in the form of a long irregular oval, having a maximum width of 560 yards at its N.E. end, where it is overlaid by a few beds of greenish ash breccia, dipping N.N.W. at 30°; both these rocks are well seen along the eastern margin of Ballyvalley townland.

On the southern side of the greenstone, in the townland of Ballyvellig, and on the summit of Carrickshawn hill, we find a band of grey feldstone porphyry, with minute crystals of quartz, which induces me to class this rock with the Elvans. The same rock appears to the N.E. on the opposite side of the Glen, in the townland of Tinnock, and I believe that it is continuous in the same direction for a further distance of one mile and a half into the townland of Killesk, beyond the old castle of that name, to the S.W. of Carrickshawn hill. At the distance of not quite half a mile a similar rock appears to the eastern corner of the townland of Grange.

Beneath this Elvanite, and along its southern margin, in the townland just named, we find thin beds of hard feldspathic ash dipping to the N.W. at 10°, and having an aggregate thickness of about 100 yards, and to the southwards, still lower in the section, we find a band of feldstone, which, in its extension to the S.W. in the eastern corner of the townland of Grange, becomes streaky in structure. This same feldstone can be traced for the distance of one mile and a half into the townland of Killesk, beyond the old castle, where it and the associated Elvanite are cut off by a N. and S. fault, as shown on the map. Along the southern margin of this feldstone (which can be traced from Killesk on the N.E. to the hill over Nook Bay on the S.W., a distance of about three miles and three-quarters) we find the ordinary dark gray Silurian slates. As we proceed

along the road from Carrickshawn southwards and Boderan cross-roads, we pass over alternations of feldstone, feldspathic ash, and a hard dark gray feldspathic ash breccia, with bands of dark gray slate, the trappean beds being merely large lenticular accumulations, running N.E. and S.W., the last named being almost one mile in length, with a width of about 150 yards.

To the N.E. of Boderan cross, between Boderan bridge and Cool cross-roads, we find lenticular beds of greenstone and hard dark gray ash breccia, and to the east of the last-named locality, in the eastern part of the townland of Cool, there is a thick lenticular deposit of light gray calcareous ash grit, which weathers to a rusty brown colour, the beds of which dip to the N.N.W. at 55°, but soon curve to the N.E. at 30°. The superficial width of these beds is about 200 yards, and they have dark gray and black slate both above and below them.

On the northern side of the greenstone of Ballyvellig and its associated ash, we find a lenticular band of gray mottled feldspathic ash, with a boss of pink granular feldstone porphyry just beyond it, and which is well seen to the S.W. of the farm houses close to the western boundary of the townland. Beyond this to the north, as we approach the village of Campile, we find nothing but feldstone for half a mile, and this same rock extends to the N.E. for about one mile and a half. Here, on its northern boundary, in the townland of Carrowanree, it becomes streaky in structure, and is overlaid by gray slaty ash, dipping to the N.W. at 20°, and having a superficial width of about 200 yards.

To the S.W. of Campile, in the townlands of Dunbrody and Saltmills, the feldstone becomes interstratified with thick deposits of feldspathic ash. These are well seen in the eastern portion of the townland of Dunbrody at three localities, but especially on the summit of Dunbrody hill, 139 feet in elevation, and along its northern base, where the beds have a general dip to the N.W. at 20°, 30°, and lastly at 50°.

The total superficial width of what we may call the Ballyvellig igneous rocks is about a mile and a quarter, and the extent from N.E. to S.W. three miles and three quarters. At the southern side of the north-eastern end of this Trappean ridge we find a large lenticular mass of intrusive vesicular greenstone a mile in length, with a maximum width of 250 yards. It is well exposed along the by-road leading north from Killesk cross-roads and the old castle of Killesk, where it is crystalline and mottled black and white. The Ballyvellig traps are terminated eastwards by a fault, and to the east of this fault the dark gray slates are seen along the new road leading from Campile, while the mass of the trappean beds are here represented by a thick band of hard gray feldspathic ash breccia, apparently dipping to the N.W. at 20° to 40°, being overlaid by a thick bed of feldstone, a section through which is exposed along the road leading north through the townland of Knockea, the superficial width of both rocks being about 450 yards. To the north of this, in the adjoining townland of Garryduff, we find, first, a vesicular greenstone, then a feldspathic ash, and lastly a feldstone, which latter rock is well seen in the by-road leading E. from the farm houses, the three beds of Trappean rocks measuring superficially about 400 feet from N. to S.

The eastern extension of these beds is also cut off by a N. and S. fault, as is proved by the presence of the ordinary dark gray slate along the road to the east.

Between the northern limit of the Ballyvellig traps and the village of Whitechurch we have, at least, nineteen massive lenticular beds of feldspathic ash and feldstone, and one of greenstone, as also three bands of

gray calcareous feldspathic slaty ash. The position and lie of all these beds will be apparent by reference to the map, and their best exposures are in the townlands of Ballykeerogbeg, where a boss of hornblende and crystalline greenstone appears to the north of the feldstone and ash;—at the old church of Ballykeerogmore, in the S.W. corner of Ballybrassil townland, where the calcareous ash appears to the north of a boss of feldstone;—in the townland of Ballynamona, where, at the "Burnt school-house" cross-roads, the calcareous ash just mentioned is seen dipping N.N.W. under a flinty-looking feldstone, which is apparently overlaid by another calcareous ash bed, a portion of which is seen in the N.E. corner of the townland of Priestshaggard; and lastly along the main road, to the W. of Fruit Hill House, the S.W. extension of the calcareous ash, noticed at the "Burnt school-house," is exposed by the road cutting, and the beds are clearly seen to dip to the N.W. at 65° to 70° ; the ash here is gray, glossy, and slaty, and is interstratified by thin layers of gray earthy slate. There is little doubt but that this same bed extends across the alluvial flats to the east of the Great Island, and appears on the eastern side of the island, between the village of Newtown and Kilmokea church. The extension, therefore, from N.E. to S.W. of this bed is at least three miles and a half, and its apparent width 150 yards.

A slaty feldspathic ash is well seen along the northern shore of the Campile River, opposite to Dunbrody Abbey, where it dips to the N.W. at 50° to 60° ; and is overlaid by a feldstone and a feldspathic ash. On the shore to the E. of Kilmannock House, we find a pale greenish, finely crystalline greenstone, having a feldspathic ash below, and a streaky feldstone above it. The latter rock is supposed to cross alluvial flats, and to form the southern end of the Great Island. The N.W. corner of the Great Island presents the following section of trappean beds in descending order, commencing from the point at Ballinlaw ferry. Fine feldspathic ash breccia, dipping N.N.W. at 60° to 70° , extends along the entire northern coast of the island. The lowermost of these beds become very hard, possibly from the influence of a mass of crystalline greenstone which appears beneath them. Below this latter rock we again find a feldspathic ash, containing flaky pebbles of pink feldstone, and becoming very hard and of a greenish colour when near to or in contact with the greenstone. Next we have a large boss of very hard finely crystalline hornblende intrusive greenstone, 150 yards in width, and about 600 yards from N.E. to S.W. Beneath this rock we find a feldspathic ash dipping to the N.W. at 40° , very much hardened perhaps by the superincumbent greenstone throughout a thickness of possibly 100 feet, when it regains its normal character of a soft flaky or slaty rock, smooth to the touch. This ash is seen along the shore for 220 yards, where it passes into a hard greenish variety of the same class of rock, the dip being N.W. at 60° . I believe it possible that this hardening of the ash and change of colour may be due to the presence of the intrusive greenstone at no very great depth from the present surface. The section terminates with a thin band of gray slate resting on a hard gray feldspathic ash, dipping N.N.W. at 60° .

The coast section opposite Cheekpoint,* from Dunbrody Abbey to Nook Bay, cuts across the Ballyvellig Trappean beds. Dunbrody Abbey stands on a band of dark gray slate, but the coast line to the W. of the

* Cheekpoint, Sighepoint, or Fairypoint, from a rock uncovered at low water, about twenty yards from the shore, the hill over the point being celebrated in fairy lore.

abbey is probably formed of feldspathic ash. As we pass into the townland of Saltmills we find alternations of feldstone and feldspathic ash, the latter often containing rather large flaky fragments of gray slate. The general dip of all these rocks is to the northwards or to the N.N.W. at various angles up to 60° . A little N. of Nook Bay there is a thick boss of crystalline hornblende greenstone in places containing carbonate of lime in vesicles. To the south of the greenstone we find the ordinary dark gray Silurian slates dipping S.W. at 30° ; they soon, however, become horizontal, and roll along the shore of Nook Bay at angles varying from 20° to 40° . The cleavage in some of these beds strikes N.W. and S.E., inclined at 40° to the N.E.

At Duncannon Point we find a very interesting and isolated group of Trappean rocks associated with the ordinary dark gray Silurian slates. If we examine this little promontory by following up the exposed section from the south to the north, we find along the shore of Duncannon strand dark gray and black slates, with thin grit layers dipping N.W. at 40° to 50° , the uppermost exposed beds being wrinkled and otherwise crushed. Beyond this is a hard crystalline greenstone, with some slates above it. These rocks are here cut off by a N. and S. fault, on the W. side of which the slates and thin grits dip to the N.W. at 60° , but flatten to 45° in the distance of a few yards. Over them is a bed of crystalline intrusive greenstone about sixty feet thick, having some thin grits and slates resting on it. These are traversed in every direction by thin veins of greenstone, and have been rendered quite porcelanic by it, while the beds below are unaltered. Resting on the porcelanic slates we find a few beds of hard greenish ash full of broken crystals of feldspar and small lenticular pebbles or fragments of gray grit arranged in layers. This ash dips to the N.W. at 30° at the base of the cliff, but on its sea face they dip to the N. at the same angle. Directly over the ash we find a massive boss of hard finely crystalline vesicular greenstone, the vesicles being filled with carbonate of lime; the same mineral often coating joints and cracks in the rock, and thus suggesting the idea that its presence is due to infiltration long after the rock had been consolidated. The thickness of this greenstone is about fifty yards, and as we pass round the extreme point of the promontory we find it is overlaid by layers of dark gray slate and grit, dipping N.W. at 40° , the latter having been hardened or silicified. The same beds are traceable round the northern face of the fort, till at the eastern corner of the old pier we find a boss of crystalline greenstone with hard black slates abutting against it on its eastern side, probably having been brought into that position by the N. and S. fault described as apparent on the southern shore of the promontory. These black slates contain graptolites. To the north of this the general dip of the slates and thin grits is N.E. at 50° . At the distance of about 170 yards to the north of the quay we find a thin band of feldstone in the slates, the same rock appearing on the main road, due W. by the Martello Tower.

In the townland of Clonsharragh, due E. by the Martello Tower, we find a dyke of dark green crystalline and ferruginous greenstone, and a similar rock appears still further to the east in the adjoining townland of Ramsgrange. Before leaving the Arthurstown district I have to direct attention to the Trappean beds which appear to the east of the fault which traverses the eastern portion of the townlands of Drillistown and Tullerstown, and which appears on the map to the west of Burkestown cross-roads. If we proceed along the road from Killesk cross-roads to Burkestown cross-roads, we have no evidence of any other rock but gray

slate, especially in the townlands of Tullerstown and Burkestown. As we approach to within 350 yards of Burkestown old bridge, however, we come at once upon a feldstone, and probably a greenstone, to the W. of it. If now we take to the fields and traverse the western side of the glen from S. to N., we soon enter on a mass of trappean rocks, consisting of feldspathic ash breccia, striking N.E. and S.W., and having a superficial width of 450 yards. To the north of this a feldstone appears for a distance of 175 yards, then a crystalline greenstone fifty yards across, and then a mass of gray feldstone 250 yards thick, both these rocks being well seen along the road-cutting in the eastern corner of Drillistown townland. If these beds are continuous to the S.W. beyond the brow of the glen, they should all appear along the main road to the W. of Burkestown old bridge; but we have seen that no rock, except slates and grits, are there present, and hence I have introduced this fault as shown on the map. These trappean beds, in their extension across Burkestown glen to the N.E., and into the townland of Rathumney, are tolerably well exposed on either side of the road leading N.E. from Drillistown; here the feldstone on the N.W. of the road becomes at one place elvanitic or crystalline, containing some free quartz.

To the north of Burkestown cross-roads a rocky boss exposes blackish purple close-grained ash, a thin band of feldstone, then some layers of hardened or silicified slate, with dark purple ash breccia, and thin dyke-like beds of greenstone over all; the general dip being eastward at 80°. At the distance of half a mile N.E. of Burkestown cross-road, a by-road striking to the N.N.W. exposes a superficial section of the trappean beds seen to the south of that locality, the adjoining gray slate dipping to the N. To the north of this is a band of gray feldstone overlaid by coarse-grained gray grits, dipping N.W. at 70°; and at the northern angle of the road the section terminates in a boss of crystalline greenstone.

If we now proceed to Rathnacusheran cross-roads, and from thence into the townland of Ballygarvan, we find thick lenticular masses of green chloritic ash, with gray slates between, in which, to the south of the central ash band, there are layers of gray calcareous slate containing fossils, and weathering into rough flags. This locality is indicated by a star on the map.

If we follow the road from Rathnacusheran cross-roads northwards to Nash bridge, we pass over a large lenticular boss of crystalline feldstone (elvanite?), containing a green mineral supposed to be chlorite and some free quartz. To the north of this, and close to Shannon's mill, below Nash bridge, we find gray grits, with a feldspathic ash to the east of them, the dip of the former being W.N.W. at 70°. To the east of the fair-green of Nash, a lenticular mass of feldstone, close to which, on the north, gray grits and slates appear dipping N.N.W. at 60°.

If we now proceed northwards to the farm-houses of Carrickshedoge, we find that the rocky boss close to and W. of the farm-houses is formed of streaky feldstone, ending abruptly along a line which strikes N.N.W.; and, as at the E. side of it, we find gray slates and thin grits close at hand, all striking N.W. and S.E., or at the feldstone, a fault is presumed to separate the two rocks, as shown on the map. At Cassagh cross-roads, to the north of the last-named village, we find some beds of slaty feldspathic ash, dipping N.W. at 45°, containing flaky fragments of feldspar; this deposit is presumed to extend to the S.W., and again to appear at the surface at Aughboy bridge, where a feldstone shows to the north of it in the boggy flat. To the west of this, thick bands of feldspathic ash appear at two localities, the latter near Bawnacroaka.

The Hill of Slievecoilthia, lying between the villages of Oldcourt and Aughlare, is formed of gray and greenish gray slates and thin grits, apparently dipping as a mass to the N.W. at various angles up to 70°. On the western slope of the hill four thick dykes of crystalline porphyritic greenstone have been intruded into the slates, for the most part along their apparent bedding. This porphyry can be well seen along the road just north of, and close to, the Roman Catholic chapel, in the townland of Ballykelly, as well as near the northern margin of the same townland, and at the southern end of Ballintreskin townland. The slates near to, and in contact with, the greenstone have been hardened and silicified; and occasionally under peculiarly favourable circumstance have been slightly micacized. This latter remarkable metamorphism is well seen in the slate appearing in the lane west of Ballykelly chapel, as well as in the lane at the extreme S.W. corner of Ballykelly townland; and again, close to the margin of the porphyry, where it appears near the road to the west of Ballintreskin farmstead, and lastly in the extreme S.E. corner of the same townland on the western slope of the hill summit.*

Due east of the summit of Slievecoilthia, on the side of the river Barrow, in the townland of Dunganstown, north of Killowen Demesne, we find a large boss of coarsely crystalline hornblende greenstone exposed for 150 yards from N. to S., and quite similar in general character to that last noticed. This greenstone appears to have been squeezed into an anticlinal curve in the slates, as these rocks dip away from the greenstone on its northern and southern side. The slates in immediate contact with this intrusive mass are hardened, broken up into countless concealed joints, and weather to a rusty brown colour. To the north of this, at the distance of 200 yards, four small dykes of greenstone have been injected into the slates along the line of their bedding.

2. *The Newtown Head Section.*—Newtown Head, which lies on the W. side of the Waterford estuary, exposes some trappean beds which are possibly on the same geological horizon as those observed at Duncannon on the opposite coast. The following is the coast section, commencing at the north, and noting the beds in descending order:—Greenish slate, decomposing and dipping N.W. at 65°; beneath this is a band of hard feldspathic ash, 60 yards thick, the lower part of which is filled with broken concentrically formed nodules of feldstone, held together and cemented by a feldspathic paste; next comes a thin dyke of greenstone, beneath which is a green chloritic ash which in many parts is soft and decomposing; then we have a band of rotten gray slate containing some fossils, with a thin gray grit exhibiting fucoid impressions, beneath which is a thin layer of hard ash conglomerate, dipping as before, but at 40°, and containing pebbles and blocks of feldstone in a sandy feldspathic paste; we then have a second thin run of greenstone, below which we have thin ash layers passing down into a massive-bedded close-grained greenish gritty ash about 60 yards thick. This rests on a feldstone with

* I know it has been doubted that a greenstone has ever produced such an effect upon them as I have described. My observations, however, in this and the Arklow district, lead me to believe that, under favourable conditions, it does do so. On the shore to the north of Arklow, near Pack's Bridge (Sheet 139), I found a massive dyke of intrusive greenstone squeezed into the slates, which it had hardened and micacized to the distance of 15 to 20 feet, the small particles of mica being most abundant and the rock most ponderous nearest to the greenstone, and these effects gradually disappearing in the distance named.—G. V. D.

some feldspathic ash beds, dipping N.W. at 60°, the aggregate thickness of which is about 200 yards, with two intrusive dykes of greenstone. Below this feldstone there is a narrow band of feldspathic sandy ash, and then we find a dyke of finely crystalline greenstone contorted into an S shaped fold with a feldspathic ash above it. We next meet a feldstone which may have a thickness of 150 yards, a short distance inwards; and lastly, the extreme point of the headland is formed of a massive dyke of finely crystalline intrusive greenstone, very shattered looking and breaking up into small angular fragments, the rock being exposed along the coast for the distance of 200 yards.

The extension of all the Newtown Head Trappean beds inland is entirely a matter of conjecture, as the surface of the ground is thickly covered by local drift.

3. *The Waterford District, County Kilkenny*—At Rochestown Hill, which lies at the distance of six miles N.E. from Waterford city, we find a remarkable lenticular boss of crystalline feldstone (Elvanite) occupying a space of over half a mile from E. to W. and about 350 yards from N. to S.

The central portion of this mass is highly feldspathic and crystalline, and the quartz granules quite resemble those seen in an ordinary granite. At the eastern extremity the rock is finely crystalline, and the dark green mineral, supposed to be either chlorite or hornblende, is more abundant. The crystalline granules of quartz are, however, still present. Around this portion of the boss the gray slates are very well exposed, and they have not undergone any hardening, micaziation or other metamorphism. At the western extremity of the boss the slates are equally well exposed, and the changes in their strike show that they have been displaced by the intrusion of the granitic feldstone. This fact is very apparent along the by-road leading southwards up the hill from Rochestown village to the wood over Rochestown House.

On the shore to the east of Rochestown, as well as that to the south of the hill opposite Dollar Point, the greenish slates and thin grits are traversed by dykes of crystalline greenstone, which have invariably hardened the slates which are in contact with them. At the latter locality a bed of feldspathic trap becomes a breccia of fine feldspathic fragments along its northern side. At the former place we find two thick dykes of crystalline hornblende greenstone, striking E. 40° N., inclined to the S.E. at 45°. The slaty beds in contact with them being rendered porcelanic, have at the same time a tendency to weather white.

At Ballinlaw ferry, two miles to the S. of Rochestown, the river Barrow has cut through the trappean beds on the N.W. side of the "Great Island;" on the county Kilkenny side of the river they present a steeply escarped section for the distance of about three-quarters of a mile, their aggregate thickness being about 1,100 yards, or close on three-quarters of a mile.

Proceeding southwards from the ferry, and following the rocks in descending order, we find a thick deposit of slaty and sandy feldspathic ash, the beds dipping to the N.N.W. at 60°; below there is a thin band of feldstone, becoming pisolitic at its basal portion; below this is a feldspathic breccia, with a thin layer of hard green ash; and a thin layer of feldstone, and next a thick deposit of feldspathic ash, passing downwards into a green chloritic greenstone, which is occasionally somewhat flaky or ashy. Beneath these beds we have a thick mass of intrusive greenstone, below which is a green chloritic ash dipping N.N.W. at 60°.

and traceable along the shore for the distance of 220 yards, the dip being clearly to the N.N.W. at 60°. The section terminates in the boss of feldstone, 100 yards thick, called Carrickgarraunbaun or "The White Horse Rock," which forms a lofty cliff over the river. Underlying this feldstone, on the south, there is a gray feldspathic ash, dipping N.N.W. at 60°, which rests on the ordinary Lower Silurian gray slate and grits.

From the ash beds under Garraunbaun Rock, southwards to Snow Hill, a distance of nearly a mile, the shore is formed of dark gray slates and thin grits; these become horizontal a quarter of a mile south of Garraunbaun; but at Snow Hill they regain their normal dip to the N.N.W. at 50°. Throughout all these beds there is no apparent cleavage. To the south of Snow Hill point, the dip of the slate and grit beds is still to the N.N.W. at 30°; but as we pass round the point under Snow Hill House the dip is to the N.E. at 75°. Along the shore, between the old Drumdowney flour-mills and Glass House, we find some beds of consolidated pale greenish-gray chloritic ash; these dip to the N.W. at 75°, and doubtless underlie the gray slates of Snow Hill. These beds are on the same geological horizon as those at the southern end of the Ballinlaw section, but thrown out of their line of strike by the contortion in the slates between White Horse Rock and Snow Hill point. The Ballinlaw Trappean beds, in their extension to the S.W., appear here and there in the Drumdowney glen, especially along its western side, and to the south of the corn-mill. Here the feldspathic ash beds dip to the N.W. at 70°, and at the mill we find a thick band of very coarsely crystalline porphyritic greenstone, the feldspar crystals being well developed. To the north of this, at the flour-mill on the main road to Waterford, we find two bands of hard feldspathic ash, and runs of feldstone, the latter rock attaining a thickness of fully 500 yards at the summit of the rise of ground, where the old church of Rathpatrick stands. To the north of this, and just over the Glenmore road, there is a dyke-like bed of sub-crystalline chloritic greenstone, which is probably contemporaneous with the slates.

The upturned edges of all these rocks, including those described to the south of Ballinlaw ferry, and the associated slates of Snow Hill, are overlaid by the outlying flake of Old Red sandstone which caps Drumdowney hill, and the extent of which is two miles and a half from N. to S., with a maximum width of something less than one mile.

Over ground between Drumdowney glen and the suburbs of Waterford city at Ferrybank, all the trappean beds are concealed by local drift, with the exception of a superficial exposure of feldspathic ash at Prospect House;—a boss of feldstone, at the N. side of the by-road to the N. of where the old church of Kilmurry once stood, and the high ground on the northern bank of the river Suir, in the townlands of Rathculliheen, Newtown, Christendom, and Abbeylands, where we find thick alternating deposits of hard feldspathic ash and streaky feldstone; the former, when they appear at the waters edge at Annemount House, dipping to the N.W. at 75° to 80°. At Rocklands House is a boss of sub-crystalline, dark green, chloritic greenstone, about 150 yards wide, forming the knoll overlooking the river, called "Cromwell's Rock." At the northern base of this eminence we find thin layers of dark gray and black slate dipping to the E.S.E. at 70°, with a gray feldspathic ash above them. To the north of this the shore exposes a similar greenstone, which is well seen at the church of Abbeylands at Waterford ferry. It is about 250 yards long, its northern boundary being not exactly known. From the general aspect of this greenstone, which often contains minute flaky crystals of a

green mineral, supposed to be chlorite, and the fact that the slate in contact with it is not hardened, I think it may be classed with the contemporaneous greenstone. The superficial width of the boss of greenstone at Cromwell's Rock is about 150 yards, and that of the Abbeylands' greenstone about 250 yards, though its northern boundary is problematical.

The suburb of Waterford city, called Ferrybank, is formed on the Lower Silurian slates and grits which extend in a N.E. direction till they reach the district to the east of Davistown, where they spread out to form the open country around Glenmore, and that to the east of Mullinavat. To the north of Ferrybank these slates are soon overlaid by the Old Red sandstone which forms the high ground skirting the carboniferous limestone valley of Kilmacow.

4. *The Waterford District, County Waterford.*—To the east of Waterford, in the parish of Killoteran, and on the southern side of the rise of ground which is capped by the Old Red sandstone, we find thick alternating deposits of feldstone and feldspathic ash. Similar trappean beds appear on the north side of the river Suir, in the county Kilkenny, to the south of the village of Licketstown. From the observed dips it is probable that in this exposure we have but one bed of feldstone with a feldspathic ash above it, repeated by a synclinal and anticlinal fold. This will be apparent by examining those beds at the following four localities, where they are well exposed:—

1st. On the southern boundary of the synclinal, in the townland of Knockhouse Lower, where the feldstone, though black and flinty looking, weathers freely to a milk white colour.

2nd. At the distance of a mile W. of this spot, in the townland of Woodstown, close to the road, where similar black silicious-looking feldstone is overlaid by compact feldspathic ash, dipping N. 10° W. at 75°.

3rd. In the large quarry N. of, and close to Carrickphierish House, where the ash, on the northern side of the synclinal, dips S. 15° E. at 70°, having the feldstone beneath it. In this latter rock, at this locality, we have the evidence of the anticlinal, as above it on the north we see the gray feldspathic ash, dipping N. 10° W. at 70°, close to the summit of Carrickphierish hill, where the Old Red sandstone lies nearly horizontally over the Lower Silurian rocks.

4th. To the westward of this knoll, where the ash may be seen at various localities, as far as the townland of Woodstown, in the northern portion of which it is well exposed, dipping to the northwards, being then overlaid again by the Old Red sandstone.

In the district just described, two faults having a N.N.W. and S.S.E. direction, and about three-quarters of a mile apart, traverse and displace both the Lower Palæozoic rocks and the superimposed Old Red sandstone. Their downthrows are to the eastward, and though of not very great magnitude (about 600 feet), yet in their prolongation to the southwards they appear to unite and produce an important change in the geological structure of the district, two miles to the S.W. of Waterford city, in the parish of Kilbarry. The eastern of these faults is prolonged northwards from the parish of Killoteran, across the limestone flats of Kilmacow, and along the W. side of the small river Blackwater, past the village of Mullinavat.*

* Mr. Wyley was the first to determine the fault to the S. of Mullinavat, and I to record those to the W. of Waterford city. Our conclusions were based on perfectly independent evidence.—G. V. D.

That the Killoteran faults unite somewhere to the N. of the main road, and E. of Evergreen cottage, and form there one fault prolonged to the S.E., is also evident from the facts presented to us along the western margin of the parish of Kilbarry, and in the cutting on the Tramore railway, in the townland of Ballyhoo.

In the extension to the eastward of the trappean beds of Killoteran, they emerge from beneath the Old Red sandstone, along the shore of the river Suir, at the distance of half a mile above the bridge of Waterford. Here also some of the Lower Silurian slates are seen, in two black bands in which graptolites are found in great abundance, some of the impressions being tinged of a light red colour. The lowest of the trappean beds here is a feldspathic ash, resting on one of the graptolite beds. Above this is a band of gray slate, with a green chloritic ash over it, having a width of about 70 yards. This is succeeded by gray slates which terminate in a bed of black graptolite slate, and above all is a hard feldspathic ash. Up to this point all the beds dip to the N.W. at 70°. Above all the beds just described we find a massive wedge-like mass of sub-crystalline feldstone, 70 yards thick, having some free quartz and a green chloritic-looking mineral disseminated through it. Hence the rock resembles some of the Camaros Elvanite of the county Wexford, and has been so coloured on the map. This Elvanite is bounded on its northern side by a hard feldspathic ash, and the section terminates in a pink feldstone exposed for the distance of 150 yards. In the distance of 100 yards from the river bank, all the trappean rocks are overspread by the Old Red sandstone conglomerate, which dips to the N.W. at various angles up to 25°.

To the S.E. of the city of Waterford the trappean rocks consist almost entirely of feldstone, both amorphous and streaky, with some hard feldspathic ash beds, both rocks being well seen in section along the river bank from Suirville to near the point opposite to the Little Island. They occupy a superficial width of over a mile and a half, the apparent dip in the ash layers being in the N.W. at 80°.

The Little Island is made up principally of the hard feldspathic ash beds and some feldstone. In the southern corner of the island, however, some Lower Silurian slates dip beneath the trappean beds to the N.W. at 80°. On the western side of the island the ash beds dip to the S. and E. at 80°, whence it is probable that they are bent anticlinally. The uppermost beds of the ash at this locality consist of exceedingly finely laminated soapy feldspathic slate; a structure which may be due either to delicate lamination or to cleavage. The section here terminates in a thin bed of dark green ash, which in some places resembles a decomposing contemporaneous greenstone. The trappean beds of the Little Island again appear on the northern portion of Faithleg Demesne, where they flatten suddenly, and curve round to the westward, as appears from the subjacent Silurian slates exposed at Faithleg school-house being nearly horizontal.

At Cheekpoint we find a thick pale greenish-gray consolidated ash, which passes into a rock closely resembling a calcareous greenstone, veined with carbonate of lime. Near the point a thin layer of black slate is interstratified with this rock, and at the extreme point we find a greenish ash conglomerate and breccia, containing lumps of greenstone in a hard greenish paste. It is very probable that the Cheekpoint rocks are on the same geological horizon as those observed on the opposite shore, north of Nook Bay in the county of Wexford.

To the south of Faithleg the Lower Silurian slates form a band of

nearly three-quarters of a mile in width. Along its southern or basal boundary, according to the observed dips which are to the N.W., we find a few bands of greenish gray calcareous ash, the joints of the rock being often coated with carbonate of lime. This peculiar ash is well seen in the townland of Knockboy, on the road leading to the Roman Catholic chapel, where it and the slates have an apparent dip to the N.N.W. of 80° . It appears again a mile to the eastward, on the right bank of Ballycanvan stream, at the mills below Springhill House; and lastly, at the distance of three-quarters of a mile to the east, on the banks of the stream, on the northern corner of the townland of Carriglea, where the calcareous ash overlies a pale greenish-gray slaty ash, the dip at Kilcullen Bridge being to the N.N.W. at 50° . Beneath the gray slates in the lower portion of which these calcareous ash beds appear, we find a massive greenish gray slaty chloritic ash having a width of 500 to 600 yards, with the same dip as that last stated. This ash is exposed along the roads leading to the Roman Catholic chapel of Knockboy or Ballygrennan, and again, on the north side of the road in the latter townland; and lastly, on the right bank of the Ballycanvan stream, south of Springhill House. Beneath this band we find a thick accumulation of dark greenish gray ash breccia, which is very well exposed in the neighbourhood of Rockview and Mount Druid, where they present a superficial width of 600 yards, having a general dip to the N.W. at 60° . These beds all thin out in their extension to the eastward beyond the Half-way House Bridge on the Passage road, and are all eventually concealed by the covering of Old Red sandstone which forms the high ground extending along the western bank of the Waterford estuary between Passage and Cheekpoint Hill.

To the south-east of, and parallel to, the ash breccia a large lenticular mass of Elvanite is well exposed at the cross-roads E. of Strongbow's Bridge, in the townland of Carriglea. Here, at the southern end of the large quarry, the Elvanite passes into an ordinary feldstone, and the same fact is observable in the line of strike of this rock, at the distance of one mile and a quarter to the S.W., on the high and rocky ground N. of the ruined chapel of St. Mary's, in the townland of Ballygunnertemple, where the feldstone is streaky in structure and weathers to a milk-white colour. At this locality the width of the feldstone is about 500 yards; and if we accept the dips observable in the greenish gray breccia to the N.W. as that of the mass of this rock, it rests on a band of dark gray slate, the best evidence of which is to be seen in the glen between the townland of Ballygunnertemple and Ballyvoreen, half a mile N. of Callaghan Bridge, on the Dunmore road.

To the S.E. of this slate band we have another run of feldstone, thinning out to the N.E. and S.W., and attaining a maximum width of about 700 yards, in the vicinity of Callaghan Bridge, where the rock is well exposed, the rock to the west of the bridge being mottled greenish gray, with angular segregated patches. At the distance of 200 yards to the west of this, in the bed of the small stream and beneath the bridge, some pale greenish-gray slaty feldspathic ash was exposed when deepening the water-course. Its position is indicated by a line of dots on the map.

At the distance of one mile to the W.S.W. of Callaghan's Bridge, in the townland of Ballygunnertemple, we find a boss of dark green sub-crystalline greenstone about 60 yards thick, a feldstone adjoining its southern side, with dark gray slates to the south of the feldstone. To the W. of this, in the adjoining townland of Kilearagh, we have a thick deposit of dark gray and greenish gray ash, in some places slaty, and in others a fine

breccia. These beds appear to dip to the north at 50° , and are underlaid by a dark gray feldstone which in its central portion becomes pisolitic where it forms the ridge of ground stretching N. and S. through the extreme S.W. corner of the townland just named.

If we attempt to follow these beds in their extension to the westward into the adjoining alluvial flats between the parishes of Killure and Kilearagh, we find that the low ground is entirely occupied by the gray slate, and as the superficial width of the feldstone is nearly half a mile from N. to S., along the brow of the glen, and as the general strike of all the trappean beds is from N.E. to S.W., we are forced to believe that the feldstone is here cut off by a fault, as shown on the map.

On the western side of the alluvial flats just noticed, and in the southern extremity of the townland of Killure (opposite the fault), is a rounded hill 194 feet in elevation, and here we find the following section, in ascending order commencing at the south:—Fragments of gray slates at the base of the hill; then a feldstone, forming a lenticular mass of about 250 yards across; over this a band of gray sandy cavernous limestone, 125 yards in width, and the beds dipping to the N.W. at 65° . This rock is iron stained, decomposes freely to a sand, and contains a few fossils. In this limestone, and close to its upper or northern boundary, there is a thin layer of gray feldspathic ash breccia; above this is a band of feldspathic ash, 150 yards wide, with a run of feldstone about 50 yards thick in the middle of it; beyond this gray slates are exposed for a distance of 150 yards.

As we proceed northwards along the brow of this rise of ground we pass from off the gray slates, and just over Killure Bridge we find a gray slaty calcareous ash, which weathers into small rusty hollows, and on the farm road which crosses the townland from W. to E., a similar rock appears, the joints of which are coated with carbonate of lime; above this calcareous ash there are some beds of hard feldspathic massive bedded ash, which appear to dip to the northward at 70° ; and with this rock the section terminates.

If we now cross the alluvial flats to the W., and examine the rocks so well exposed in Ballynamona Demesne, and over Carrigeenaveagh Hill, we fail to find a trace of the sandy limestone or the calcareous ash. If, however, we suppose that these beds, and the associated gray slates between them, rapidly thin out in their extension to the S.W., we may escape the necessity for introducing a N. and S. fault along the eastern side of Ballynamona Demesne.

All the rocks forming Carrigeenaveagh Hill are formed of dark gray feldstone, which in some places has the appearance of a consolidated ash.

In the northern part of Ballynamona Demesne, and in the adjoining southern end of the townland of Ballycoarda, a very hard and massive greenish gray ash breccia and conglomerate contain rounded pebbles as well as large lumps of pink feldstone. These beds pass up into a dark purplish gray and greenish breccia, containing pebbles and fragments of black slate, grits of various colours, and feldstone. On the hill to the W. of the farm-houses, in Ballycoarda, the ash assumes a slaty structure, and the section terminates in dark greenish gray breccia, containing pebbles and fragments of grits and feldstone. To the W. of Ballycoarda, in the townland of Ballindud, are large bosses of feldstone, the rock in some places being quite pisolitic; and proceeding northward towards the alluvial flats of the John's River, which are traversed by the Tramore railway, we find that the feldstone along its northern side is split up by a

thick band of hard and massive bedded feldspathic ash. This rock is well seen in the railway cutting at the bridge W. of the corn-mill, in the S.E. corner of the townland of Ballyhoo, where the ashes are overlaid by the dark gray Silurian slates, the dip of both being to the S.S.E. at 80° . These slates, in their extension from the railway cutting to the N.E., would abut against the feldstone just described; and here I have introduced a fault between them supposed to be the south-eastern extension of the united faults so well seen to the W. of Waterford city and the parish of Killoteran.

If we now proceed N.W., past the five cross-roads, into the townlands of Ballybeg and Ballynaneashagh, we find the wooded knoll in the latter to be formed of gray and pink feldstone, which in some places becomes pisolitic, and is exposed over a surface of 600 yards. To the north of this, in the former townland, we find a soft slaty rough ash, dipping S. at 70° , variable in texture and yielding large flags, and below this a dark gray feldstone. All these beds form a well-defined ridge, striking N. and S. through the townlands named; but if we attempt to follow the ashes and the overlying feldstone in the line of their strike to the eastwards, we at once pass into a comparatively low and level tract extending eastwards into the valley of the John's River, and its alluvial flats, apparently formed on the Lower Silurian slates. I am satisfied, therefore, that here we have evidence of the presence of a fault, striking N.N.W. to S.S.E., which would agree accurately with that seen in the Tramore railway cutting, and the more western of the two faults in the parish of Killoteran.

Though the continuity of the trappean beds is doubtless interrupted by this fault over a line extending for the distance of two miles, the absolute amount of vertical displacement may not be as much as one would suppose. We have only one well defined dip in the flaggy ash, that to the S.S.E. at 70° , at either extremity of the section, and if we suppose that the intermediate beds are at all contorted, a downthrow at either side of the fault of 2,000 feet would possibly produce all the observed facts.*

Butlerstown Hill, on which stands the old castle of that name, three miles S.W. of Waterford, is formed for the most part of feldstone, with some bands of feldspathic as well as greenish-gray slaty ash on its southern flank; the latter rocks being tolerably well seen along the main road, in the townland of Ballycashin, while the former are better exposed on the northern slope of the hill just below the castle. A very beautiful pink feldstone appears on the knoll in the central part of Ballycashin townland, to the S. of the main road; this rock becomes flaky on the northern side of the knoll, a structure which may possibly be due to cleavage, though at first sight the rock would be regarded as a consolidated slaty ash. To the W. of Butlerstown Castle, in the townland of Orchardstown, the feldstone is of the ordinary type, and is widely used for road metal.

On the direct road from Butlerstown Castle to Mount Congreve there is a boss of sub-crystalline greenstone in the southern portion of the townland of Baunfine. This rock, which lies on the northern limit of the great trappean zone, is very possibly in the same geological horizon

* It is obvious that the evidence, as stated by Mr. Du Noyer, is quite insufficient to sustain such a dislocation, or to prove any fault at all. The hypothesis of a fault is one way of explaining the structure of very obscure ground, which appears to Mr. Du Noyer the most probable.—J. B. J.

as the greenstone seen to the east of the Killoteran and Tramore railway fault, near to the N.E. boundary of the parish of Kilbarry, half a mile south of Bleach Bridge, and again at Cromwell's rock and Abbeylands opposite to the city of Waterford, on the Kilkenny side of the river. The presence of this rock near Butlerstown Castle helps to prove the propriety of prolonging the Killoteran fault to the S.E.

The trappean beds exposed in sections along the banks of the River Suir, at and opposite to Mount Congreve, are very interesting. They are a continuation to the S.W. of those beds described as occurring in the parish of Killoteran, and consist of bands of feldspathic ash and feldstone, with gray, gritty, and dark gray slates, the section terminating on the west in a thick mass of dark gray feldstone, and a massive finely crystalline greenstone, about 100 yards in width. As all these beds are followed to the S.W., we find that at Whelan's Bridge the dark gray flinty looking feldstone is brought abruptly against a pale greenish gray chloritic greenstone, which at the quarries at the turn of the road, just south of the bridge, has a very ashy structure. As these rocks are never seen to pass one into the other I have introduced a fault between them.

To the south of this greenstone we find a thin band of feldstone, with some feldspathic ashes above it, dipping to the S.S.E. at 70° in the lane leading through the wood from Whelan's Bridge to Woodvilla. These ash beds terminate in 150 yards, being overlaid by dark gray slate. The prolongation of the trappean beds between Whelan's Bridge and the village of Ballyduff, a distance of nearly a mile and a half, is a matter of inference. At Ballyduff, however, we have a very good superficial section across a thick band of trappean rocks, which, without doubt, are on the same geological horizon as that described on Whelan's Bridge, and to the N.E. of it. On the northern boundary of these beds, and at the village, we find the dark gray slates striking nearly E. and W.; to the south of this a thick band of feldstone is exposed in bosses along the west side of the road, the rock being often of a streaky structure, and in some places very flaky or ashy looking. It is doubtful, with our present knowledge of these rocks, whether we should class a highly consolidated feldspathic, though flaky rock, with the ashes, when no fragments of extraneous rocks can be detected in it. I have therefore coloured all this band, which is 450 yards across, as feldstone.

In the townland of Carrickanure, a mile and a quarter to the W. of Ballyduff, the ashy looking feldstone widens to three-quarters of a mile from N. to S.; and in its further extension to the westward, it forms prominent detached and often steeply escarped bosses, which give a peculiar aspect to the outline of the country.

In the northern part of the townland of Greenane, on the rugged knoll to the S. of Carroll's cross-roads, is composed of massive bedded dark gray earthy ash, which in places is a fine breccia of slate fragments, along with broken crystals of feldspar. The feldspathic paste on decomposing sets free the slate fragments, and the surface debris thus formed has all the appearance of having been derived from the slate rock. At the distance of about a mile to the east of this, in the eastern side of the townland of Ardeenloun, East, and the northern corner of Ballygarran, as well as on the southern side of the adjoining townland of Carriganure, the streaky feldstone forms prominent and steeply escarped bosses.

To the south of this, for the distance of over two miles, the feldstone, both flaky and finely porphyritic, as well as compact, is the only rock which appears at the surface. If, however, we proceed by the shortest route towards Ballyphillip, we find a marked change in the character of

the rocks in the townland of Ballyleenane, Ballycraddock, and Shanaclone. As we enter the northern extremity of the first-named townland, we pass from a finely porphyritic feldstone at the cross-roads, on to a boss of chloritic flaky greenstone, about 60 yards across; to the south of this we have a few green ash beds, which become slaty at their southern limit, their width being about 200 yards. To the south of them we have another run of finely crystalline greenstone, about 150 yards across from N. to S., having a green slaty ash on its southern side. Proceeding still further to the south along the Ballyphillip road, we see a green ash breccia at the distance of 200 yards from the last-named rock, doubtless a portion of the same mass.

To the W. of the cross-roads between Ballycraddock and Shanaclone, there is a thick boss of dark purple porphyritic greenstone, nearly 400 yards across, which on the northern side is veined with asbestos, the western side of the boss exhibiting a hummock of streaky feldstone, and the section terminates on the south by some hard, streaky, and finely porphyritic feldstone. Proceeding northwards from the last-named cross-roads through the central portion of the townland of Ballycraddock, we find that none of the rocks just described are prolonged to the N.E., their places being supplied by nodular and pisolitic feldstone, many of the nodules of feldstone having a radiated structure, and containing a nucleus of clear quartz and fine thin bands of green slaty ash striking to the N.E., in which direction they thin out. As the two groups of rock, so different in lithological character, are observed in close proximity, I cannot account for their relative positions otherwise than by supposing that they are brought together by a fault, the direction of which is nearly N. and S., the downthrow being to the east, but its amount not determinable, from the absence of any reliable dips.

If we now proceed eastwards towards Ballyscanlon Lough, we find that the high and rugged ground to the southward and S.E. of Pembrokestown House is formed of dark gray finely porphyritic feldstone, which in many places so closely resembles a consolidated ash that I was at first disposed to class it with those rocks. There is an apparent bedding throughout it, the dip of which is to the N.W., at 40° to 60° , as is clearly seen over Carrickaroirk Hill. In many places here the feldstone contains angular segregations, which on the weathered surface gives the rock the appearance of a coarse breccia. It has, however, been deemed right to class this rock with the feldstones.

The singularly peaked and very prominent boss called "Sugarloaf Rock," in the S.W. corner of Knockeen townland, is formed of this hard, dark greenish-gray semi-porphyrific feldstone.

In the low ground which skirts the southern base of Carrickaroirk Hill and the rugged ridge to the eastward, over Sporthouse cross-roads, we find a narrow band of dark gray slate. In this, at the distance of half a mile due S. of Carrigaroirk summit, and in the townland of Clonfadda, there is a boss of dark green crystalline hornblendic greenstone. To the S.W. of this, in the townland of Reisk, and about a quarter of a mile S. of the old church, we find some pale greenish-gray hard calcareous grits, with slaty layers, containing fossils, and weathering rusty. These dip to the N.N.W., at from 10° to 20° , and rest on the dark greenish-gray, and somewhat porphyritic feldstone, very similar to that described at Carrickaroirk Hill. If we attempt to follow these fossiliferous beds in their extension to the eastward, we find that just at the boundary of Clonfadda

* Vide N.W. corner of Sheet 179.

townland they all abut against the underlying greenish-gray feldstone for a distance of 250 yards, by means of a fault striking N.N.W. and S.S.E., the downthrow being about 250 feet, to the westward. To the east of the fault the same fossiliferous bands are observed in the townland of Clonfadda dipping in a curve to the N.N.E., N., and N.W., at 10° to 20° .

Ballyscanlon Lough, which lies at an elevation of about 210 feet, at the distance of 600 yards south of the southern boundary of these fossiliferous beds, in the townland of Reisk, is supplied by springs which probably rise in the fault just described, in its prolongation to the S.S.E.*

Ballyscanlon Hill, which lies to the south of the lake, is formed of a mass of feldstone, through which we can detect finely porphyritic bands striking N.N.E. and S.S.W. At the summit of the hill (418 feet), the feldstone is streaky, and at its northern base, just over the lake, the feldstone has at one spot all the appearance of a gray flint. To the N.W. of the hill, in the townland of Matthewstown, near the stone fort or caher, the feldstone is dark greenish-gray and finely porphyritic, and to the north of this spot, near the giant's grave, called "Leaba Thomas MacCaba," or the bed of Thomas, son of Caba, this passes up into massive dark green and gray ash breccia, sub-crystalline in places, and weathering into small hollows from the decomposition of sub-angular fragments of feldspar crystals.

The district to the eastward of Ballyscanlon Hill, in the townland of Carrickavrantry and Knockanduff, presents many varieties of feldstone and dark greenish-gray ash, fine breccia, and ash conglomerate, the last named rock being well seen at the farmstead on the northern side of the latter townland, where it consists of pebbles of feldstone and lumps of purple slate, forming a rock not unlike some of the basal beds of the Old Red sandstone. To the S.E. of the same farm-houses, the feldspathic ash breccia contains fragments of black slaty ash, which is full of broken crystals of feldspar.

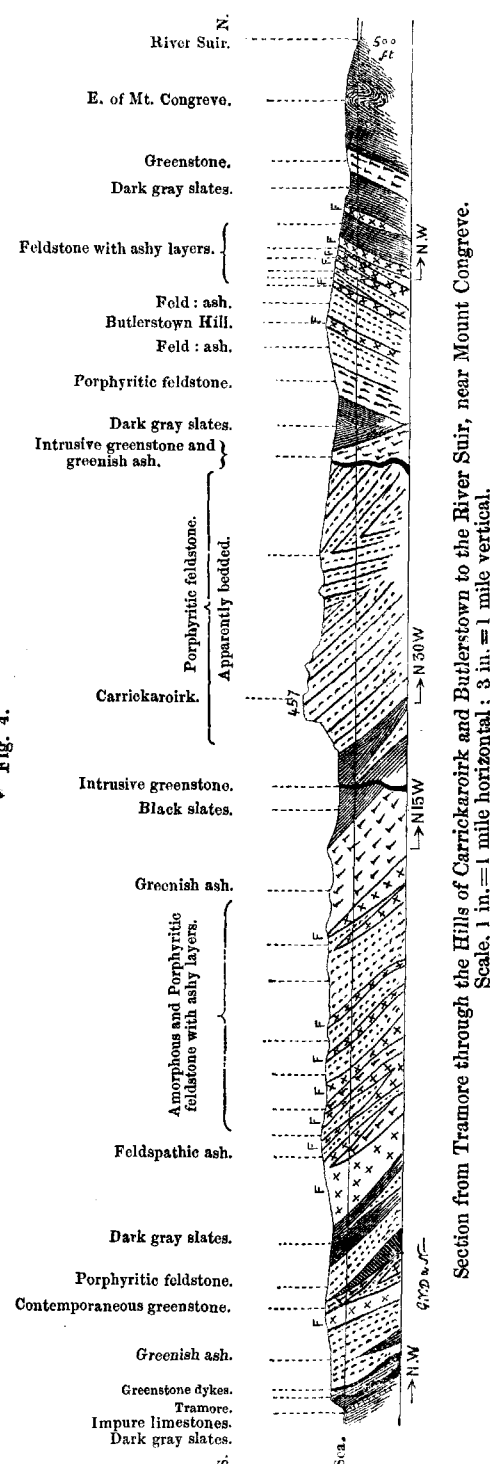
5. *Tramore District.*—To the south of Carrigeenaveagh Hill, in the townlands of Castletown, Ballykinsela, and Quillia, a low narrow ridge extends in a N.E. and S.W. direction, the central portion of which is crossed by the road leading south from Carrigeenaveagh to the head of the back strand of Tramore. On the north this ridge is formed of dark gray feldstone, with a thick band of feldspathic ash to the north of it, and another band of greenish-gray ash to the south. The southern end of the ridge exposes a massive lenticular boss of highly crystalline hornblendic greenstone, which weathers into rough pimpled surfaces. To the west this greenstone is overlaid by a feldspathic ash, dipping to the westward at 80° , which is exposed in many quarries on the western slope of the hill, and close to the well called Tober na-fannia. The ash dipping W. at 45° is itself overlaid by a band of feldstone. In the low ground along the eastern side of this ridge we find clear evidence of the presence of gray slate, in which there is a narrow band of impure fossiliferous limestone.

Three miles north of Tramore, at the eastern side of the townland of

* As a source of water supply to the city of Waterford, I came to the conclusion, when I examined the district in the summer of 1863, that Ballyscanlon Lough is peculiarly well adapted for such a purpose. Though the surface drainage which the lake at present commands is but small, it might be vastly increased by a series of open cuts to catch the rainfall over all the surrounding high ground, as well as various springs which occur over it; and by embanking the embouchure of the lake, its present area of 26 acres would be increased to one of 95 acres, with a maximum central depth of about 150 feet.—G. V. D.

Ballyknock, a rough ridge of ground extending N. and S., is formed of bands of amorphous feldstone, and a fine grained feldspathic porphyry, the western continuation of the beds appearing on the southern side of Carrigeaveagh hill. At the northern end of this section, south of the farmstead, a thin band of gray slate was observed; and as similar slate is exposed in the road-cutting three-quarters of a mile W.S.W. of this spot, on the boundary of the townlands of Towergare and Carriglonig, this rock is supposed to be continuous between the two localities.

At the southern end of the townland of Ballyknock, the feldstones are bounded by the ordinary dark gray Lower Silurian slates, which are well exposed here and in the adjoining cutting on the Tramore railway, on the western side of the townland of Ballykinsella, the observed dip being all to the N.N.W. at 50° , the cleavage striking N.N.E. and S.S.W. vertical. A mile to the S.S.W. of this, in the townland of Pickardstown, the following group of rocks forms the high ground on the west side of the glen to the north of Hammondville. The uppermost beds, or those to the N., are dark gray slates, with pale gray sandy limestone bands exposed at either side of the by-road, and containing fossils. Below this is a thin layer of gray ash grit, then a thin band of dark gray slate, below which is a vein of feldstone about



70 yards across, next a black slate band about 50 yards thick, and then another feldstone 150 yards thick, having a small lenticular bed of dark green ash in the middle.

This feldstone along its southern or lower side is quite thin bedded, the layers dipping to the W.N.W. at 55° , as is apparent along the by-road along the brow of the hill, and in the small farmyard to the N. of Hammondville. Beneath this feldstone there appears a thick lenticular bed of dark green flaky greenstone, containing numerous cubical crystals of iron pyrites, traceable for 600 yards from N.N.E. to S.S.W., having a maximum width of 65 yards. Below this is a thin bed of sandy limestone, containing fossils, and this rests on a thin layer of conglomerate, containing rounded lumps of feldstone and red quartzite. The section terminates in dark gray and black slates (the lowest rock), dipping W.N.W. at 50° , which appear along the glen traversed by the Tramore railway.

In their extension to the S.W., almost all the rocks just described are traversed across their strike by the small valley to the south of Rosemount and Hammondville. Commencing at the uppermost rock, close to Rosemount, we have gray slates dipping to the N.W. at 25° to 40° , which correspond in geological position to those seen in the railway cutting in the western corner of the townland of Ballykinsella, and noticed first in the section just detailed. Below these we find a hard dark purplish gray crystalline greenstone, the thin bands of pale gray impure limestone and the gray ash grit described in the former section, not being exposed. Below this we find a massive bedded feldspathic ash grit, dipping N.W. at 60° , and having a probable width of 150 yards. A thin band of black slate is now supposed to be present, and below this is the second feldstone of the former section, having a presumed width of 160 yards. This is succeeded by a yellow feldspathic ash grit, the lamination and the bedding of which agree, and this passes down into a hard blue and greenish ash breccia and conglomerate, containing pebbles of feldstone and red quartzite, having the same dip as that last noticed. This rock occupies the geological horizon of the Hammondville greenstone and limestone, which appear not to extend to so far to the S.W., though the distance is only 300 yards. The section terminates in dark gray slates dipping to the N.W. about 45° , the same rocks as those in the glen to the N.E.

As we approach Tramore, we find that the beds just described are prolonged to the S.W., and that other trappean rocks occur in the dark gray slates on a lower geological horizon; and the whole group, with the exception of the slate bands, widen out and are prolonged still further to the S.W., past Tramore, to the coast opposite to Ship Island.

The coast section from Tramore to Great Newtown Head, a distance of nearly two miles, is exceedingly interesting. The cliffs, which here vary from 70 to 100 feet in height, show the dark gray Lower Silurian slates, which extend along the eastern boundary of the trappean rocks just described. The beds for the most part dip to W. 10° to 20° N. at 75° , but they flatten near the headland to 30° ; the line of coast following the strike of the beds. At the northern end of the section, between Tramore and Lady's Cove, we find two intrusive dykes of finely crystalline hornblende greenstone; the more eastern, or that seen along the edge of the cliffs, cutting across the bedding of the slates, which are here interstratified with thin nodular layers of hard gray sandy limestone containing fossils.

As we pass round the point to the north of the Lady's Cove we find that the dykes and associated slates, which dip to the W.N.W. at 70° , are faulted from N.W. to S.E.; the downthrow being about 170 feet to the north.

thus cutting off the more eastern dyke. The western dyke is now seen along the cliffs as far as Newtown Cove, a distance of one mile, and on the northern side of the Lady's Cove it has been fractured and fissured, the rent, which is eighteen feet wide, having been subsequently filled with a coarse breccia, derived from the rock itself, and cemented by a greenish feldspathic paste. This fissure, filled with breccia, extends into the slates on the eastern side of the dyke for the distance of thirteen yards. The accompanying sketch will more fully explain the singular appearance which this dyke and fissure presents when viewed from the coast.

Fig. 5.



Greenstone dyke fissured, N. side of the Lady's Cove, Tramore shore, sheet 24, county Waterford.

Drift gravel and clay overlies the dyke and fills up a trench in the trappean breccia.

At the distance of 300 yards to the south of the Lady's Cove, a thin lenticular band of feldstone is observed in the slates close to the greenstone on its western side; and as we approach Newtown Cove we find that the greenstone forms the termination of the cliff inland, while a thin band of feldstone traverses the slates along their bedding, parallel to the sea face of the cliff, the dip of both being N.W. at 45° .

At Newtown Cove the dark gray earthy slates and nodular layers of impure limestone dip to the westward at 40° , and have a thin bed of feldstone interstratified with them.

To the south of this, as far as Chair Cove, a distance of 560 yards, the cliffs exhibit the same beds as those last described; the general dip being to the W.N.W. at 30° . On the northern side of Chair Cove the slates are much crumpled, and they end abruptly against a fault striking N.W. and S.E., whereby they are made to abut against the hard massive-bedded greenish gray ash forming the southern side of the Cove and Great Newtown Head, as well as the cliffs to the westward, across Ronan's Bay.

Close to and west of the Metal Man Tower we find that the ash beds are traversed by a massive dyke of finely crystalline greenstone. To the W. of this, for the distance of about one mile, the coast section is formed of hard pale greenish gray massive bedded ash, dipping for the most part to the westwards at 35° to 65° , and between the Twelve Birds' Rocks and the Great Island, these rocks are traversed apparently along their bedding by

five dykes of a greenstone similar to that just noticed. At Lady's Cove, in the townland of Garrarus, we find a thick run of feldstone overlaid by hard pale greenish gray ash conglomerate, in which is a bed of greenstone; and I have little doubt but that this rock is on the same geological horizon as the greenstone seen at Rock Lodge, in the townland of Coolnagoppoge, at the distance of one mile and a half from the coast, and half a mile W. of Newtown Hill Cottage. To the west of this greenstone, and along Garrarus strand, we have a feldstone exposed for half a mile, the western portion of which is split up by four bands of dark gray slate, which are exposed in the S.E. corner of the townland of Caher, and in the adjoining portion of the townland of Island-i-Kane East. The boat strand opposite to Sheep Island has at its eastern extremity some coarse trappean conglomerates containing large blocks and smaller rounded and angular lumps of various kinds of feldstone, some of which is vesicular and amygdaloidal, the matrix being pale gray, hard and feldspathic. The remaining portion of the cliff is formed of feldstone, at the western extremity of which we find a few layers of feldspathic ash and black slate.

Sheep Island is formed of hard, pale greenish-gray massive ash.

From Sheep Island westward to the point opposite to Burk's Island (in the townland of Island-i-Kane South) the coast is formed of a pale yellowish gray consolidated ash-breccia, and conglomerate, the dip or strike of which is not apparent. Some of the conglomerates here contain rolled lumps of a pre-existing ash, as well as angular fragments of weathered feldstone; an interesting fact, as showing that many of these trappean rocks had been formed and consolidated before the production of others now not very distant from them. Along the western boundary of this ash-conglomerate we find a thick band of dark gray slate, and between these two rocks, at the distance of more than half a mile from the coast, and N.E. of the old church of Island-i-Kane, there is a large boss of dark greenish gray porphyritic greenstone, the feldspar of which appears in small though well-developed crystals.

At the S.W. corner of the townland of Island-i-Kane South, we find black slates exposed along the coast for about 300 yards; and in the adjoining corner of the townland of Kilfarrasy we have a band of feldspathic finely crystalline porphyry, about 200 yards thick. Between the western side of this porphyry and Kilfarrasy Island, a distance of about 500 yards, we have four bands of black slate enclosing thin layers of feldspathic ash, the apparent dip of which is to the S.E. at 60° .

At the base of Kilfarrasy Island, along its western side, we have gray columnar feldstone, which is apparently overlaid by two thin layers of black slate dipping to the N.W. at 50° ; the columnar feldstone appearing therefore to occupy the axis of an anticlinal curve. These slate layers are succeeded by a band of feldspathic porphyry, enclosing a dyke of gray finely crystalline greenstone, through which are thin veins of carbonate of lime. In the adjoining S.E. corner of Whitefield townland we find a gray compact feldstone. At the distance of 150 yards W. of this point we come on a massive dyke (fifty yards thick) of dark greenish gray finely crystalline feldspathic greenstone, plentifully veined with carbonate of lime; being, in fact, the same rock as that previously noticed on the S.W. of corner of Kilfarrasy. Here, however, the rock is shifted suddenly to the northwards by a small fault.

The Whitefield greenstone can be distinctly seen to strike along the coast for the distance of half a mile, appearing in the cliffs, which are here 200 feet in height, and along the shore at their base, after which it curves out to sea, and is lost.

As we pass along the shore into the townland of Woodstown we find the

greenstone to be underlain by a hard gray feldspathic ash, containing numerous small angular fragments of feldstone and flaky chips of black slate. As these beds are followed to the westward, they contain occasional subangular lumps of feldstone; and as we approach the Green Island, which forms the eastern side of Annstown Creek, we find that they enclose a thin band of black slate, which is well seen along the eastern side of the island; the island itself, with the adjoining small promontory, being formed of gray feldstone, which becomes finely porphyritic as it is traced to the northwards along the shore of the creek.

6. *Annstown District.*—At the mouth of Annstown Glen, on its east side, the feldspathic porphyry, just noticed, appears to be underlain by a band of dark gray slate, and this by a band of gray feldspathic ash. Both these rocks have been searched for copper at this locality, but with limited success, as the workings have long since been abandoned.

The shore on the opposite side of the creek and to the south of the village exposes hard gray feldspathic ash, which frequently becomes a fine breccia of feldspathic fragments. These beds dip to the S.E. at 65° , and rest on a mass of feldstone measuring 100 yards across. On the N.W. side of this rock there are a few beds of feldspathic ash and dark gray slate dipping to the N.W. at 70° ; and here it would appear that the feldstone occupies the axis of an anticlinal curve.

If we now proceed northwards from Annstown, along the road at the western side of the glen, we soon pass off the feldspathic rocks seen at the village and enter on a mass of dark gray slate exposed for the distance of about one mile. These slates, in their central portion, are interstratified with a thin layer of gray earthy vesicular ash, to the north of which we have two runs of feldstone, with a boss of crystalline granitic feldstone, containing free quartz, between them, but apparently separated from them by thin beds of gray slate. The northern boundary of the gray slates brings us close under Dunhill Castle; the prominent boss of rock on which the castle stands is formed of a gray feldstone, often streaky in structure. To the north of and close to Dunhill Bridge, a very remarkable gray ash breccia dips S. 20° E. at 20° . This singular deposit, which is quite unlike any rock of its class which I have seen elsewhere, consists of evenly deposited layers of feldspathic gravel, and a fine breccia of various kinds of feldstone, with black slate and hard gray grit—the fragments so sharp and so unworn that they seem to have been produced by some sudden explosive force, shattering the rocks and driving their fragments into the sea where they were at once enveloped in gray feldspathic mud and fine cleanly washed sand and gravel, and were rapidly consolidated. Throughout these layers of breccia and sandy gravel we find thin flows of semi-transparent feldstone.*

From the feldspathic traps observed at Annstown, westerly, as far as Dunabrattin Bay, a distance of one mile, the coast is formed of dark gray and black slates, which, from the observed dips, appear to be bent synclinally, their strike being N.E. and S.W. Throughout these beds are a few thin dykes of feldstone, some of which have been contorted along with the slates, and put on an intrusive appearance.

Dunabrattin Head, which lies south of the small cove of that name, is formed of black and dark gray slates, plentifully interstratified with pale gray, sandy, and fossiliferous limestones, dipping S.E. at 10° to 40° . In general character these calcareous beds bear a close resemblance to those described to the south of Tramore, at Newtown Cove.

* See specimens of this rock in the Geological Survey collection in the Museum of Irish Industry.

To the west of Dunabrattin Head, for the distance of half a mile, as far as Kilmurrin Cove, the only rock seen is a gray feldstone, with the exception of a hard gray feldspathic ash directly underlying the black slates at the face of the headland. At the head of Kilmurrin Cove we find the gray slates again exposed, for the distance of half a mile to the northward, and these are presumed to be on the same geological horizon as those noticed to the south of Dunhill Castle. At the northern limit of the slate band, and close to the farm-houses on the W. side of the Glen, there is a thin run of crystalline feldstone, containing free quartz and a green chloritic mineral; this is coloured on the map as elvan. The same rock appears at the distance of one mile to the eastward, in the N.E. corner of the townland of Knockane.

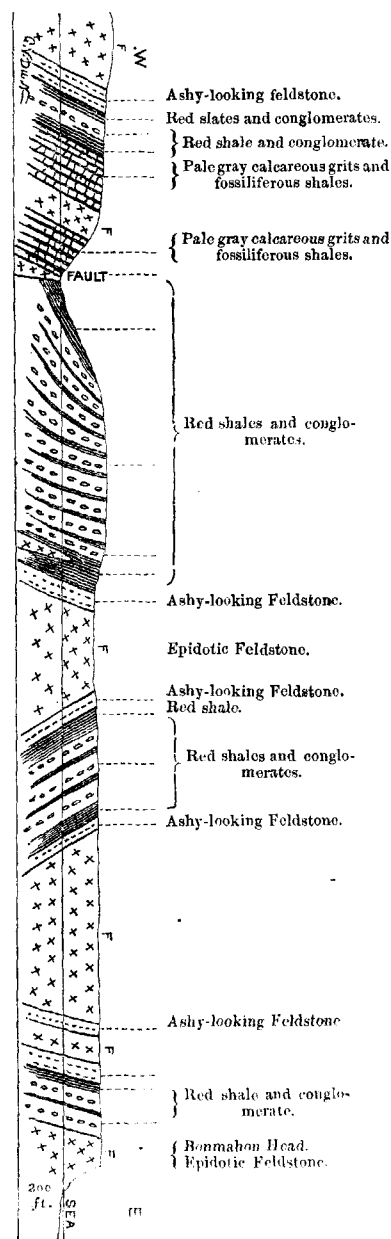
To the W. of Kilmurrin Cove, for nearly a mile, the coast exposes gray feldstones partly compact and partly finely porphyritic, the section terminating in a hard greenish-gray ash in the extreme S.W. corner of the townland of Tankardstown. At this spot the feldspathic beds are cut off by a N. and S. fault, and we enter on a mass of gray slates interstratified with some beds of greenish-gray feldspathic ash, which are traversed from N.W. to S.E., or across their general strike, by five of the most productive of the Knockmahon copper lodes, viz., Tankardstown lode, with its branch on the west called Rowe's lode, Boneyaught lode, Kilduane lode, and Seven Dials' lode, besides three minor lodes occurring between Rowe's lode and Boneyaught lode. This brings us into the townland of Knockmahon, the western portion of which is formed of alternate bands of pale greenish-gray feldstone, hard gray ash (sometimes containing thin layers formed of broken up fragments of trilobites, ennerinites, and small cup corals), and earthy gray slate, forming a portion of the same series of rocks just noticed and traversed like them from N.W. to S.E. across their strike by the old stage lode and its numerous branches, and at the western extremity of the townland, by four minor lodes. In the extreme north-western corner of this townland we find a thin dyke of greenstone overlaid by a feldspathic ash and a layer of purplish brown grit dipping to the S.E. at 20° .

All the various beds just described, which appear along the shore of Knockmahon townland, are much contorted, their general strike, however, being N.E. and S.W.

When we enter the adjoining townland of Ballynagigla, we find some beds of reddish conglomerate and reddish purple shale interstratified with a gray feldstone, the superficial extent of which is about 100 yards, and they are stated to thin out and disappear at the depth of 100 feet from the surface. On the shore due east of Knockmahon Bridge there is a small boss of finely crystalline greenstone, with thin bands of greenish gray feldspathic ash and feldstone to the north of it. From this point to the northwards, for the distance of three-quarters of a mile up the Glen of the Mahon river, the only rock exposed is a pale gray feldstone, with ashy-looking bands through it. Many of these, however, may be but the finely porphyritic variety of that rock decomposing, this result being produced by the weathering away of the minute embedded crystals of feldspar, which, by making the rock somewhat porous, admits of its rapid disintegration by the weather. Beyond this feldstone we find a thick band of black and dark gray slate, which occupies the northern portion of the townland of Ballynasissla. Throughout these feldspathic traps and black slates the North mine lode has been traced in a somewhat N.W. and S.E. direction, the copper occurring in the black slate not as a true lode, but appearing to fill up small fissures, the cupiferous deposition being, however, very uncertain, though of the purest quality.

7. *The Knockmahon District.*—All the beds just described, from the red conglomerate and shale discerned at the crushing floors of Knockmahon mine northwards to the black slates, extend across the valley of the Mahon river, and are traceable, in a S.W. direction, to the coast W. of Bonmahon. If we now resume our examination of the coast section we find that the cliffs to the south of the village of Bonmahon, as far as Bonmahon Head, are formed of greenish gray feldstone, which is occasionally porphyritic, and often veined and coloured by an epidotic-looking mineral. At Bonmahon Head these rocks are underlain by beds of red conglomerate and shale, dipping N.W. at 70° , forming a band of about 200 feet in thickness, and resting on epidotic feldstone, which forms the extreme point of the Head. These red beds are evidently the same as those previously described at the crushing floors of Knockmahon mine. On the west side of the small bay, directly to the W. of Bonmahon Head, we have clear evidence of a fault, by which these red beds are thrown out of their true line of strike. To the west of this, for the distance of one mile, as far as the eastern point of Ballydouane Bay, the coast is formed entirely of the pale gray feldstone, which, like that to the north of Knockmahon, is occasionally finely porphyritic.

Through these feldspathic traps the following copper lodes have been traced at Bonmahon,



Diagrammatic section of the coast, looking northwards, showing the interstratification of red shales and conglomerates in the Lower Silurian feldstones.

Ballydouane Bay, W. of Bonmahon, county Waterford; sheets 24, 32.
Scale 6 inches = 1 mile for length and elevation.

their direction being nearly N.W. and S.E.:—the River lode, the Red end lode, Templeyvrick lode, Trawnamoe lode, and Trawnastrella lode, with two minor lodes observed on the coast close to and east of the Red end lode. A small and unproductive lead lode was observed in these same rocks at the deepest part of the coast indentation, to the west of the point called Slippery Island in the townland of Ballynarrid.

At the eastern side of Ballydouane Bay the extreme point of the headland is formed of pale gray feldstone, which overlies a thick band of red shales and conglomerates, formed chiefly of pebbles of vein-quartz, precisely similar in character to the red beds of Bonmahon Head, but all dipping to the S.E. at 60° , and presenting a superficial width of about 150 yards. These beds rest on a gray feldstone exposed for a further distance of 150 yards, on the north side of which the red conglomerates and shales again appear, and extend round the northern side of the bay, but they now dip to the N.W. at 80° , flattening to 25° at the western corner of the bay. It is evident, therefore, that in the four exposures of these red conglomerates and shales we have but one set of beds, bent synclinally on the south, with an anticlinal fold on the north. (See fig. 6.)

On the western side of Ballydouane Bay we find some thin hard gray sandy fossiliferous limestones or calcareous grits with slaty layers having a band of gray feldstone in the middle of them, and a band of red shale above, the dip of all being to the N.W. at 30° to 65° ; and though these beds clearly overlie the red conglomerates to the east, they are brought abruptly against them by a fault, the direction of which is about N.W. and S.E.

The Ballydouane beds, in their extension to the eastward, are almost totally concealed by the local drift and clay. It is, however, exceedingly interesting to find that, at the distance of one mile to the N.E. of the bay, these same beds have been reached in the ten fathom sinking at the northern extremity of the Trawnamoe lode, the lode having disappeared when the red beds were reached. The idea, therefore, that these red conglomerates are part and portion of the Lower Silurian series, as suggested by Mr. Jukes when compiling the former edition of the map, is certainly correct, as my subsequent examination of the district has proved. The former supposition that these red conglomerates and shale were large dicelike masses of the Old Red sandstone let into the feldspathic traps by cross faults, is certainly not correct.

For the distance of something over half a mile to the west of the calcareous beds or impure limestones of Ballydouane, the coast is formed of gray feldstone of precisely the same character as that to the west of Bonmahon Head. Here however the feldstones thin out and become interstratified with dark gray slates, which are doubtless on the same geological horizon as those noticed to the north of the Knockmahon feldstones, in the southern portion of the townland of Ballynasissla, and it is rather remarkable that just here, in the townland of Killelton and Ballyvooney, these slates are likewise traversed across their strike by cupiferous deposits filling up small fissures. Here are some of the oldest mine workings, traditionally attributed to the Danes and consisting of numerous small addits driven inland from the cliffs.

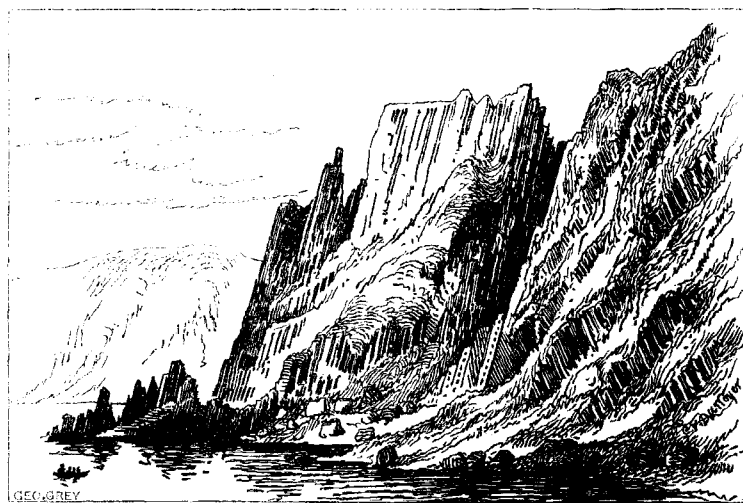
From this point, westerly for the distance of about two miles and a quarter, past the entrance to Stradbally Creek, the coast is formed of alternations of dark gray slates with thin grits, and massive bands of gray and greenish gray compact ash. Hitherto the strike of all the beds along the coast is nearly E.N.E.; but at the distance of half a mile to the west of this creek the strike changes to N.W. and S.E., the dip of the beds being 70° to the S.W. Near the lime-kiln at the head of the creek we find a bed of contemporaneous greenstone, flaky in structure, pale green,

in colour, and containing a mineral like chlorite and thin veins of asbestos at its upper surface. This rock changes to a hard ash, and thin beds of a similar ash, sometimes containing thin veins of asbestos, are interstratified with the dark gray slates which form the shores of the creek.

As we approach the high cliffs, in the townland of Stradbally-beg, which are formed of finely porphyritic feldstone, plentifully veined with epidote, (which indeed appears to be the colouring matter of this rock of all the porphyry seen along the cliffs west of Bonmahon), we find the gray slates are bent synclinally in the townland of Templeyvrick, dipping to the N.E. at 60° ; and that they rest on this porphyry. The porphyritic feldstone just alluded to extends along the coast for the distance of more than half a mile, and at its southern side, in the townland of Island, we again find the dark gray slates and thin gritty layers resting against it, but dipping to the S.W. at 45° . This shows that the feldstone occupies the axis of a synclinal—indeed it is quite possible that this rock itself is contorted, or it would not occupy so great an extent of coast. From this point, for the distance of half a mile to the S.W., and into the townland of Islandhubcock the coast is formed of black and dark gray slates throughout which are many thin beds of gray grit and feldspathic ash grit, and from the manner in which the slates are contorted, these grit beds have all the appearance of thin intrusive dykes. At the southern extremity of the section there are several thin bands of feldstone interstratified, and contorted, with the slates. The cleavage here dips 75° to the N.N.W.

This is the extreme south-western limit of the trappean beds of the Lower Silurian rocks of the S.E. of Island, as they are now overlaid and concealed by the Old Red sandstone. The subjoined sketch of these rocks, as seen from the seaward and looking westwards, will show the nature of their junction. The slates and associated thin feldstone bands dip to the N. at 60° —their denuded edges being overlaid by the Old Red sandstone which dips to the S.S.W. at 70° to 80° . Here, as elsewhere, I have remarked that the black slates are tinged red to the distance (or depth) of fifteen to twenty feet for the Old Red sandstone, the result,

Fig. 7.



Diagrammatic view, looking westward, of the junction of the Old Red sandstone and Lower Silurian rocks, east of Ballyvoyle Head, county Waterford. Sheet 32.

probably, of the infiltration of the oxyde of iron to which the red colour of the latter rocks are due.

It is a remarkable fact that in three conglomerate beds occupying a thickness of about twenty feet at the very base of the Old Red, the pebbles which form them have all been so arranged by the pressure which induced the cleavage in the slates that their longest axis is not in the line of the bedding, as it must have been originally, but in that of the cleavage planes; and the sandy matrix in which these pebbles are enclosed is cleaved in conformity with the cleavage observed in the subjacent slates. That the process of cleavage has this power to re-arrange the particles in a rock, I have already shown, when describing certain carboniferous limestones and shaly beds, containing nodules of chert, in the counties of Cork and Tipperary.*

If we proceed up the glen of the Mahon river we pass from off the finely porphyritic feldstone at the distance of three-quarters of a mile from the coast, and enter on a band of dark gray slate, half a mile in width, in the southern side of which, where the rock is black, excellent yellow copper ore is found, not occurring in true lodes, but filling up small cracks and fissures; hence the amount of the copper ore is very uncertain, though it exists in sufficient quantities to repay its being worked. On the opposite or eastern side of the glen, in the townland of Ballynasissla, these workings are at the extremity and somewhat in the strike of the North Main lode, and the copper was discovered in these black slates, on that lode being lost when these slates were reached.

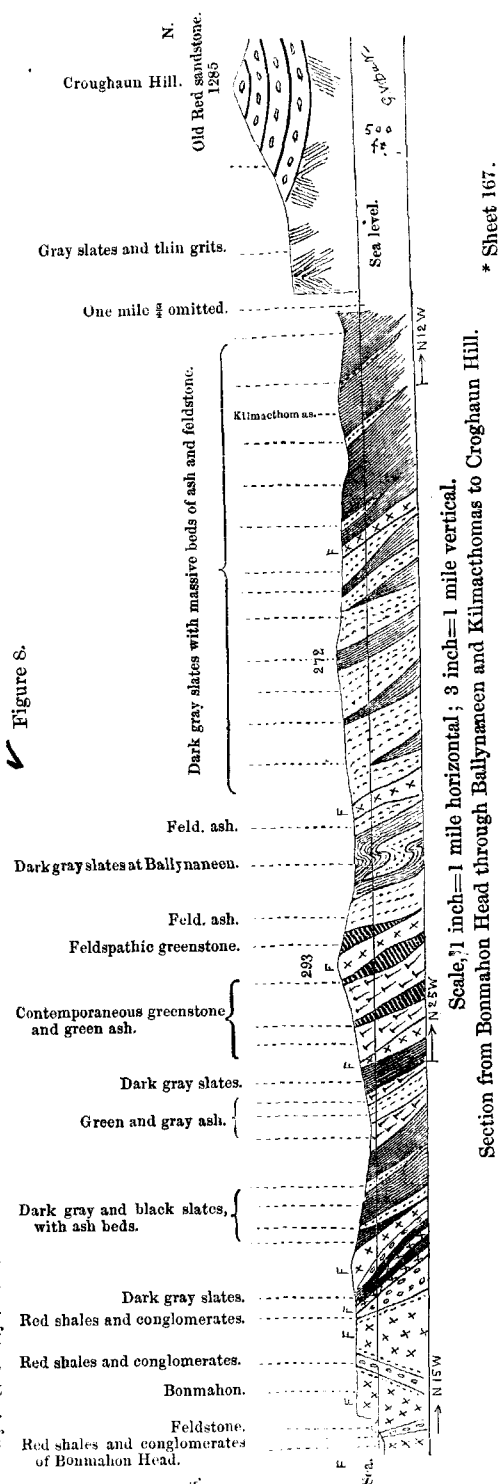
To the north of these slates, and apparently overlying them with a dip to the N.W., we find a band of hard gray and greenish gray ash 550 yards in width, and near the central portion of this deposit, in the cutting on the new road, just south of Seafield House, we find a band of singularly hard feldspathic ash full of rounded lumps of pink feldstone, minute angular fragments, and broken crystals of a mineral resembling chlorite and rounded granules of quartz.

From the occurrence of some gray gritty slates on the northern boundary of this ash deposit, at the farmstead, near the northern corner of the townland of Ballygarran, and from superficial evidence it is presumed that a narrow band of slate is continuous along the northern side of this ash for several miles.

We now enter the townland of Carrickcastle, and find a hard greenish-gray finely porphyritic feldstone passing into a greenstone, and this is overlaid by some pale green chloritic ash beds, dipping N.W. at about 50° or 60° , which are tolerably well exposed in the farm roads through the lands of Carrickcastle. This rock appears to pass up into a finely crystalline feldspathic greenstone which appears as a boss on the southern flank of Carrickcastle hill, 293 feet in elevation, and this appears to pass into a gray streaky feldstone containing minute rounded granules of transparent quartz, which forms the summit of the hill, and can be traced from N. to S., over it, for the distance of 300 yards. On the northern flank of this eminence, we find a repetition of the same finely crystalline feldspathic greenstone as that observed on the southern side to the west of Carrickcastle. On the northern side this greenstone is overlaid by a thick deposit of feldspathic ash, containing numerous flaky fragments and lumps of black slate, which is well seen about a mile to the S.W. at either side of the low ground, between the townlands of Ballylaneen and Brenan, the dip of the ash being N.W. at 70° to 75° .

* See explanation of Sheet 165, p. 21.
Do., do. 166, p. 18.

In the northern portion of the townland of Brenan, and extending into the adjoining townland of Ballylaneen, we find a thick lenticular deposit of an ash, quite similar in character to that just described, the embedded flaky fragments of black slate being often four to five inches in length, and their angles so sharp as to prove that they never were subjected to attrition, but were at once enclosed in the fine feldspathic mud, after having been blown out from some volcanic vent in the district. This lenticular ash deposit is clearly traceable for the distance of one mile from N.E. to S.W., with a maximum width of 300 yards, and is completely enclosed in black slate. As the dip of the adjoining ash beds is to the N.W. at 75° , and as that of the black slates seen at the village of Ballylaneen, and which lie to the northward of the lenticular mass, is to the S.E. at 45° , it is highly probable that this lenticular deposit occupies the trough of a synclinal, and hence its absolute thickness should be estimated at 150 yards. Moreover, as the black slates which underlie this ash are bent over to the northwards, at the northern end of their exposed section (on the road north of the village), the same ash is bent anticlinally, so as to dip to the N.W. at 75° , as is apparent on the road-cutting in the northern portion of the townland of Brenan. (See Section, No. 8.) From this point northwards to Kilmac-thomas, the exposures of



* Sheet 167.

Section from Bonmahon Head through Ballynaneen and Kilmacthomas to Croghaun Hill.

* Sheet 178.

rock become very scarce—even the section afforded in the glen of the Mahon river is disjointed, though sufficiently clear to enable one to determine the presence of massive deposits of porphyritic feldstone and feldspathic ash, separated by bands of gray slate, the stratigraphical relations of which, however, are impossible to determine with accuracy, as a clear “dip” in any of the rock masses is rarely to be seen. It is probable, however, from such scattered evidences as can be found, that we pass into higher beds as we proceed northwards from Ballylanean, and that the gray slates, and thin, far apart bands of feldspathic ash seen in the vicinity of Kilmaethomas, lie above all the mass of feldspathic trappean rocks to the southward.

The section in fig. 8 shows at its northern end the mode of occurrence of the Old Red sandstone, called Croghan hill, which forms a spur on the eastern side of the Comeragh mountains, the beds of conglomerate and sandstone occupying a shallow trough in the upturned and denuded layers of Lower Silurian slate.

8. *The Stradbally District.*—The general strike of the green chloritic ashes and gray Lower Silurian slates seen at Stradbally creek and along the coast to the east and west of it for the distance of over half a mile, is to the N.W., as far as the central portion of Woodhouse demesne, where it changes to S.W., and this direction is persistent for over two miles, till the Lower Silurian rocks are overlaid by the Old Red sandstone forming the range of hills to the N. of the valley of Dungarvan. Over the country lying to the N.W. of Stradbally, the rocks are only seen in bosses at wide intervals, though the section exposed in the valley of the river Tay, as far as Foxe's Castle, is tolerably continuous.

One of the most interesting of the isolated rock bosses is that occurring on the eastern flank of the hill in the N.W. angle of the townland of Barnankile, sheet V. This consists of hard finely porphyritic feldstone, weathering flaky, and in places ashy-looking. This boss, which is 560 yards in extent from N. to S., is overlaid by the Old Red sandstone of the Eragh mountains.

To the north of Carriekbarrahane, the gray ash and finely porphyritic feldstone forms very many prominent bosses, especially in the townland of Carriekarea, as in those which adjoin it on the east. In many instances a rude dip is discernible in this rock, which may indicate the successive flows of feldspathic lava as it was poured out beneath the sea. Some of the feldstones which appear about a mile N.E. of Stradbally, in the townlands of Williamstown, Monakirka, and Killelton, are of a gray colour, occasionally subcrystalline, and mottled with epidote, while the same rocks in their presumed extension to the eastward, in the townland of Ballynahilla, near Seafield House, have quite a flinty look.

To the south of this, on the by-road leading from Ballydowan, northwards, and in the townland of Ballygarran, near the farmstead, we find a singularly hard feldspathic ash, full of rounded lumps of pink feldstone, with minute angular fragments of crystals of a green mineral, resembling chlorite, and minute rounded granules of clear quartz. The same rock appears at the distance of one mile to the N.E., as previously noticed; and this fact, taken in connexion with the general strike of the other ash beds, has induced me to regard it as one bed.

9. *The District near the Village of Kill.*—Close to and south of the village of Kill, at the branch roads, there is a boss of very finely cleaved feldstone, the central portion of the mass, however, not appearing to be affected by the cleavage. At first sight this rock may be readily mistaken for a finely laminated and re-consolidated ash. At the village of Kill a similar rock appears at the surface.

To the west of Garden Morris, from Aughnagaul Bridge, northwards, through the townlands of Farranalahesery, Georgestown, Ballyvohalane, and into the southern portion of Greenan, a distance of three miles, we find bosses of various kinds of feldstone, amorphous, cleaved, streaky, pisolitic, and finely porphyritic; and in the northern portion of this tract, for the distance of over one mile, these rocks form a well marked ridge, striking nearly due N. and S. along the eastern side of the townland of Ballyvohalane, the highest point of the ridge being 541 feet above the sea. The extreme northern end of this section, close to the by-road through the townland of Greenan, is formed by a thick band of black cleaved feldstone, weathering white from the complete decomposition of the feldspar. So nearly does this rock resemble a "baked slate," that it had been mistaken for it. To the north of this there is exposed a gray cleaved earthy ash, with thin layers of feldstone throughout it, the strike of both being N. 20° E., and S. 20° W., vertical. I think it highly probable than in this ridge, across which various kinds of feldstone strike W.S.W. and E.N.E., we have the layers bent anticlinally, the axis of the curves being inclined to the S.W.; and if we continue this anticlinal to the west of the village of Ballylaneen, in the direction of Carrickbarrahane cross-roads, it may in some measure account for the blunt ending of the gray slates in the low grounds to the east of the latter locality, their western line of boundary indicating the upper margin, where they plunge beneath the great mass of the feldstone to the north of Stradbally. Moreover, this anticlinal curve would lessen by half the apparent thickness of the feldstones at this as well as at the former locality.

If we now proceed to the extreme northern end of this townland, we find a great boss of massive dark gray earthy ash, containing flaky fragments of dark gray slate—the rock being in places a fine breccia of such fragments, along with those of gray grit and broken up crystals of feldspar. When this rock is thoroughly decomposed by weathering, its debris is so full of slaty fragments as to lead to the idea that a slate rock may be here *in situ*. This ash appears to dip N. 10° or 15° W., at 50° to 60°, and is the last of the trappean beds observed on the northern boundary of the great mass of those rocks occurring to the southwards.

At the distance of one mile to the east of this, in the townlands of Ardeenoun east, Carrickanure, and Ballygarra, there are several large and prominent bosses of streaky and cleaved feldstone, which are overlaid by a bed of ash conglomerate, the pebbles being rounded lumps of feldstone. To the north of this the section terminates in a finely porphyritic feldstone, having an apparently bedded structure, with an ash deposit over it. These rocks are well seen in the townland of Carrickanure, along the brow of the hilly ground overlooking the great Lower Silurian plateau to the north.

These cleaved and streaky feldstones in their extension to the eastward pass to the south of the village of Ballyduff, as a band 350 yards in thickness, with dark gray Lower Silurian slates to the north and south of it, these rocks appearing on the road at the village just named.

10. *The Kilmaethomas District.*—The village of Kilmaethomas lies on the extreme northern verge of the great trappean band, and more than half a mile distant from the nearest run of feldstone. To the south of the village there is a thin band of feldspathic ash, and to the north there are two such bands, the intervening rock being gray slates, with thin gritty layers, the average dip of which is to the N.N.W. at 30° to 50°, and the rock well exposed along the road-cutting through the glen north of the village.

At the distance of a mile to the S.E. of the village, in the townland of Carrignanonsagh, at a quarry on the roadside, we find hard, gray, streaky, and cleaved feldstone, having a few layers of fine ash breccia beneath it; this, however, soon passes into a finely porphyritic feldstone, which is well exposed on the high ground in this and the adjoining townland of Kilmoylein. As these beds are followed to the N.E. into the townland of Whitestown, they thin out and become interstratified with gray slates and pale gray ash layers, their rocks being superficially exposed along the by-road which crosses the last-named townland. Some bosses of gray feldspathic ash and gray streaky feldstone, with greenish gray ash flags, appear over the high ground in the eastern portion of the townland of Kilmoylein, and in the adjoining townland of Whitestown, where the ground reaches an elevation of 430 feet.

To the north, and west, of Stafford Lodge (a mile and a half S.W. of Kilmaethomas), the strike of the slates and trappean beds changes to W.N.W. and E.S.E. over an extent of a mile, the apparent dip being to the S.W. at 65° at the northern end, and to N.E. at 65° at the southern end of the section. This, however, is a mere local contortion, for the rocks regain their normal strike of E.N.E. and W.S.W., with a dip of 55° to the northwards, between Stafford Lodge and Sarah Ville, and this they appear to retain for four miles and a half to the westward of the latter place, and with this "gisement" they pass beneath the superficial covering of Old Red sandstone forming the range of the Eragh mountains to the south of the Comeraghs, and their steep escarpment over the undulating district between Kilmaethomas and Stradbally.

To the east of Kilmaethomas, at the distance of four and a half miles, in the townland of Ross, beyond Carroll's cross roads, the dark gray Lower Silurian slates have been quarried for roofing purposes. The beds here are thin, with a wavy dip of 25° to the N.E., but dipping at the southern end of the quarry to N. at 80°. The cleavage strikes E. 15° N., inclined at 85° to the northwards. This quarry was worked in the summer of 1863, but it is now abandoned.

11. *Rathgormuck District.*—*Lower Silurian slates and basal beds of the Old Red sandstone.* (Sheet 167).—The most interesting and instructive exposures of the Lower Silurian slates and basal beds of the Old Red sandstone occurs in the glen near the head of the Glasha river, in Glenpatrick, and in the lower part of the valley of the Aughaverellia stream, above Glenpatrick-bridge. In colour the slates are sometimes gray, but most generally greenish, and there are many beds of hard greenish-gray grit, sometimes finely conglomerate, and greenish conglomerates through them. The average dip is to the southwards, from 30° to 80°, but many contortions are apparent, the cleavage when clearly developed striking E. 20° N. or E. and W. vertical. These slates have been quarried for roofing purposes at two localities in the glen—that to the north, in the townland of Toor, where the rock is of a bright bluish gray colour, very fine grained—the beds dipping to S. 20° E. at 76°, cleaved in the direction of N. 20° E. vertical, and jointed in the direction of N. 50° W., the joint surfaces inclined 70° to the southward. The thickness of this slate vein appears to be about 250 yards.

The second slate quarry is at the distance of 300 yards south of Glenpatrick-bridge. Here the slates are gray in colour, the dip being S. 30° W. at 40°, and the cleavage E. 20° N. vertical. Extensive operations have been carried on at this place formerly; but this as well as the former quarry has been abandoned for some years previous to 1851, and has not since been worked.

At the base of the Reeks of Glenpatrick, in the western end of the town-

land of Clondonnell, and just below the basal beds of the Old Red sandstone, a small quarry for roofing slates has been opened. The slates are gray and earthy, the dip not apparent, but the cleavage well developed, and striking E. 20° N., vertical. The hill of Clondonnell, to the east of this locality, which rises to the height of 943 feet, from a glen of 450 to 550 feet in elevation, forming a well marked feature, consists entirely of gray slates and thin gritty layers.

In the glen of the Ballycloghy stream, just south of the Castle, the greenish-gray gritty slates are well exposed with rolling dips to the N.E. and S.W. at 30° to 65°.

In all these glens the basal beds of the Old Red sandstone are well seen, especially in that last named, the layer of the Old Red, which rests on the upturned and denuded edges of the slates, consisting of a hard fine greenish conglomerate, composed entirely of small angular fragments of the subjacent slates and grits. This layer may be here about 100 feet thick; it is overlaid by fine conglomeritic greenish grits, passing up into a conglomerate, the pebbles of which are chiefly vein quartz, with various coloured grits, enclosed in a reddish sandy paste, which is rudely cleaved, in the direction of E. and W., the cleavage planes dipping at 55° to the south. These conglomerates may be about 250 feet in thickness, and they are overlaid by hard red shaly sandstones.

In the section of the Old Red sandstone and Silurian rocks in the glen of the Aughavilla stream, the junction beds of the former consist of green and purple conglomerate and breccia, forming a mass of about 300 feet in thickness, which rests on light greenish and brown earthy and gritty slates. About half a mile to the N.E. of this spot, the basal beds of the sandstone are represented by hard red shales, as the junction rock overlaid by some fine conglomerates, and those by hard dark red shaly sandstones, the whole being about 150 feet in thickness. It is evident, therefore, that the lithological character of the very lowest beds of the Old Red sandstone is extremely variable in short distances, and no rule, based on such characters alone, could determine the lowest beds of such a deposit. All we can safely assert is that the basal portion of the Old Red sandstone of the county Waterford is more of a breccia of the subjacent Lower Silurian rocks than in any other part of the deposit. The total thickness of the Old Red sandstone, lower and upper, as exposed in the glen of the Glasha river, is about 4,250 feet.

Along the southern boundary of that great band of Old Red sandstone which bounds the northern limit of the Rathgormuck plateau, the green and gray Lower Silurian slates are everywhere clearly seen, but especially in Coolnamuck glen, below the mill, the beds being contorted to the N. and S. at angles from 40° to 75°, the Old Red sandstone being observed to rest on their upturned and denuded edges, with a dip to the N. as high as 70°.

To the south of Carrick-on-Suir, on the road side, near the northern boundary of the townland of Garravoon, a N. and S. fault is apparent, having a downthrow of about 200 feet to the W.

In the greenish gray slates on the road side in the S.W. corner of the townland of Curraghnagarraha, a lenticular bed of greenish feldspathic slaty, or cleaved ash, is exposed, the dip of both rocks being S. at 65°.

Near this, at the old church of Fenoagh, and on the road to the west of it, we have fragmentary evidence of the presence of two other similar ash beds.

As we pass round southwards towards Curraghmore, we find that the basal beds of the Old Red sandstone have been faulted at five different localities in the distance of one mile, the direction of the faults being for the most part north and south. The greatest amount of displacement

caused by the most important of these faults—(that to the east of the summit marked 672,) is about 750 feet. The basal beds of the Old Red sandstone at this locality are formed entirely of fragments derived from the subjacent Lower Silurian slate rocks.

In the northern part of the townland of Curraghballintlea the red, green, and gray slates, which appear close to the boundary of the Old Red sandstone, are interstratified with many beds of feldspathic ash for the distance of 250 yards, the strike being nearly E. and W., with a dip to the northwards of 30° to 50°. Both the slates and ash beds are cleaved in the direction of E. 10° N., the cleavage planes being inclined to the southwards at 60°.

As we pass round the escarpment of the Old Red sandstone southwards, towards Curraghmore demesne, we find that at Le Poer's tower (in the demesne) some hard red shales in the sandstone are plentifully veined with quartz which contains strings of specular iron ore.

From this point, for the distance of two and a half miles to the southwards, the junction of the Old Red and Silurian slates is clearly seen. The latter for the most part striking nearly E. and W., and the latter nearly N. and S., with dips to the eastward varying from 25° to 60°.

In the roads to the south side of Curraghmore demesne, in the townlands of Knocknacrohy and that of Guilcagh adjoining it to the east, we find some massive lenticular beds of pale yellow feldspathic ash with a similar shaped mass of hard green vesicular and flaky contemporaneous greenstone, lying to the north-east of them. This mass appears to pass into a dark green coarsely crystalline variety of greenstone, as may be seen on the main road to the S.W. of Guilcagh house.

At the village of Mothel the gray slates are bent synclinally to the N. and S. at 45° to 80°, and here we find alternating beds of rotten light brown feldspathic gritty ash finely conglomeritic, resting on greenish brown, rotten, and gritty slates. Above them there are some dark gray slates, filling up the trough of the synclinal.

The valleys of the Clodiagh river, and its various tributaries, have been excavated out of the original covering of brown clay, containing limestone pebbles, which once spread over this entire plateau, and the Lower Silurian slate rocks are consequently exposed in many places. There is nothing to be seen worthy of especial note in these short and broken sections, if we except the fact that we frequently find these rocks to be interstratified with fine greenish gray conglomeritic grit, and that at Glenaphuca cross-roads we have a thick bed of liver-coloured conglomerate in them, the enclosed pebbles being quartz and grits. This is interesting, as bearing on the fact that red conglomerates and shales are interstratified with the trappean rocks at Ballydouane Bay, on the coast W. of Bonmahon, which, as before stated, were at one time supposed to be a portion of the Old Red sandstone.

12. *The Clonmel District.*—This area includes but a narrow strip along the western side of sheet 167.*

The sections in the Old Red sandstone exposed in the various stream courses which indent the northern slopes of the Reeks of Glenpatrick, and the hills to the south of Clonmel, are all more or less instructive. A detailed description of some of them having been given in the Explanation to Sheet 166, it will be sufficient in this instance to particularize one only, that seen in the glen of the Tickincor river. This stream rises on the northern slopes of the summit called Laghtnafranke (1,710

* For a full account of the Clonmel and the adjoining districts see the Explanation of Sheets 155, 156, and 166.

feet), at an elevation of about 1,300 feet, and its first cutting is through a deposit of local sandstone drift at about 1,200 feet, where the first exposure of the Old Red sandstone occurs. This consists of thin bedded hard dark red shaly sandstones, dipping to the westward at 20° to 30°. At the turn of the new road, on the flank of the mountain, a good section through hard evenly-bedded dark red sandstone shows the beds dipping westward at 25°, and well cleaved in the direction of E. and W., the planes of the cleavage dipping 70° to south. From this point northwards down the glen, for a mile and a quarter, the rocks are for the most part hard red sandstone and shales, dipping to the N. at 30° to 45° increasing up to 60° at the northern end of the section. As the strike of the beds appears to coincide with that of the cleavage the latter is not perceptible in them.

At the distance just stated we have reached near the centre of Tickincor wood, and here a change occurs in the lithological character of the beds, but not in their dip or strike. Soft pale yellow sandstone and yellowish shales now appear; some of these beds being tinged with the black oxide of manganese. The yellow and sometimes salmon-coloured, sometimes purple, shales and pale brown sandstones now predominate, and this upper portion of the Old Red has been distinguished from the rest as the Yellow* sandstone. Its thickness here cannot be less than 700 or 800 feet.

To the east of this locality in the stream-cutting between the townlands of Tickincor Upper and Tickincor Lower, Lisheen and Derrinlaur Upper, and that bounding the demesne of Gurteen on the west, we have excellent sections through the upper Old Red sandstone; but, singularly enough, to the east of this, on the southern side of the valley of the Suir, these rocks are not again exposed in any continuous section though there is no difficulty in separating them from the lower Old Red sandstone.

In the stream course, 650 yards above Aughaverellia bridge, at the height of 1,050 feet, the Old Red shaly sandstone traversed from E. to W., or in their line of strike, by two dykes of greenstone 250 feet apart: that to the north is 230 feet thick, very hard, of a dark purplish green colour, hornblende and highly crystalline. The sandstones to the north of it, which dip to the northwards at 40°, lose all appearance of bedding within 100 feet of the wall of the dyke. The dyke on its southern side is overlaid by hard red shaly sandstone, which gradually loses its red colour and changes to a pale green for the distance of 100 feet when the second greenstone dyke is reached. This is but 130 feet thick, of a very light green colour, soft and ochreous. In the central portion of the dyke the trap is vesicular. To the south the sandstone is much shattered, and changes to a soft red marl when in contact with the greenstone. Here the dip of the sandstone is S. 26°, E. at 60°; but in a few yards it suddenly changes to N. 30° W. at 40° to 30°, and from that to 20°. If we attempt to draw a section through these dykes it would appear that the northern one is bent anticlinally, and that the southern one comes up along an E. and W. fault. It is possible, however, that there really may be but one dyke, and if so the greenstone is bent into an *∞* shaped fold, *i.e.*, an anticlinal in the north, and a synclinal on the south.

* Sir Richard Griffith has introduced in his Geological Map of Ireland a band of "Yellow Sandstone" both in the north and the south of the country. The beds thus distinguished in the south of Ireland are certainly the top of the Old Red sandstone, but I now believe that the beds thus coloured in the north of Ireland, although lithologically similar, are not the same as those in the south. The northern beds appear to be in the carboniferous limestone, often interstratified with fossiliferous limestones, which never occurs in the south. The existence of true Old Red sandstone in the north of Ireland has, I think, yet to be proved.—J. B. J.

On the western side of the road, which crosses from N. to S., through the valley of Glen Asup and between the summit marked 1,426, and the hill of Moanyarha, at a height of 1,400 feet, we find numerous large angular fragments and blocks of light green greenstone, often vesicular and amygdaloidal, the vesicles being filled with carbonate of lime. Some of these fragments are soft and ferruginous, and they are mixed up with angular debris of the local red sandstones and fine conglomerates which thickly cover the mountains. Without doubt this greenstone is here *in situ*, and might occur as a dyke, the form of which is indicated in the map.

In the various glens and stream courses which strike the head of the river Nier, we find many continuous and interesting sections in the Old Red sandstone—one of the best being in the bed of that river itself. The basal portion of the Old Red sandstone for the thickness of about 1,300 feet is chiefly made-up of conglomerates, while the remaining portion is comparatively free from such deposits. A few basal beds of the yellow sandstone which occupies the valley of the Russelstown river, extend into the extreme western limit of this sheet at the distance of three-quarters of a mile N.N.W. of the village of Knockalisheen. From this point, therefore, in a line due east, to the base of the Reeks of Glenpatrick, we have the whole of the Old Red sandstone which forms the Comeragh mountains to the S.E., this great extension being due to the flatness of the beds.

On the county Waterford side of the river Suir, south of Suir Island, at Clonmel, in the townland of Glebe, and at the southern abutment of the Gasshouse-bridge, compact gray fossiliferous limestone dipping to the north at 45° has been quarried. These beds are supposed to represent a part of the Lower Limestone Shale which occurs here in a very narrow band. From this point easterly along the margin of the yellow sandstone, within the limits of sheet 167, this rock has been introduced in the map on theoretical grounds. There cannot be a question but that it is present, but we don't see it till we enter the limits of Sheet 168. In the Explanations to Sheets 155, 156, and 166, which bound the Sheet No. 167, a lengthened account has been given of the character and mode of occurrence of the Carboniferous Limestones, with especial reference to the Middle and Upper limestones, and the Coal Measures which lie to the north of Clonmel. And as the present explanation is necessarily voluminous we shall ask the reader to refer to the publications alluded to for detailed information regarding these beds, merely premising that the original supposition as to the extent to the eastward of the Upper Limestone and Calp of the Clonmel basin requires modification. It is now believed that these beds stretch much further to the eastward than was at first supposed, especially the Calp beds, which occupy a trough in the lower limestone of five miles and a half in extent, with an average width of over half a mile, as shown on the new edition of the map.

13. *The Carrick-on-Suir District.*—To the south of Carrick-on-Suir, in the glen of the Ballynagrana brook, some of the lower limestone shales are well exposed in the east bank of the glen 550 yards above the railway bridge. They consist of cleaved dark gray shales with chert layers and a few beds of dark gray limestone. The dip of the beds being N. 20°.

* At the southern margin of Sheet 2 of the 6-inch maps, and in the townland of Knockalisheen, there is a boss of conglomerate, apparently a boulder, called Cloghaniller, it measures twenty-two feet from E. to W., by fifteen feet from N. to S., and exhibits lines of bedding, dipping to the east at 40°. The people of the neighbourhood assert that between the hours of 1 and 2, P.M., about the 2nd of March, 1843, a thunderbolt was seen to strike the N.W. angle of the rock, ploughing up the ground for many yards in advance of it. Several large splinters were riven from the mass, some of them so heavy that two men could not turn them over. On the west face of the boss a hole was made in the ground by the electric fluid.—G. V. D.

W. at 15° , and that of the cleavage S. at 30° . Higher up the glen, just south of Wilmer mill, some highly fossiliferous dark gray shales appear dipping N. from 5° to 20° , the cleavage which pervades them striking E. 20° N., vertical.

From Wilmer mill northwards, for the distance of 400 yards, we find a pale gray amorphous dolomite which weathers to a sand. As this rock is traced to the northwards it exhibits lines of bedding and has many layers of white and gray chert and a few encrinite fragments. The upper, bedded portion of the dolomite dips N. 20° E. at 45° , and is overlaid by some beds of dark gray shaly limestone with thin crystalline layers, all highly fossiliferous, and dipping N. 20° to 30° E. at 50° to 60° . These beds are cut off by a fault striking E. 15° S., and W. 15° N., on the northern side of which we find light gray-bedded magnesian limestone, dipping S.W. at 20° , directly abutting against the dark gray shaly beds just described. From the fault northwards, for the distance of 400 yards, we find the light gray-bedded dolomite exposed in the glen. To the N.E. of this, at the cross roads, near the northern corner of the townland of Ballyrichard, some thin-bedded light gray and slightly magnesianized limestone, with abundant gray and pinkish chert layers through them have been quarried, the dip of the beds being N. to E. at 35° . The most northern of the dolomite beds of this section appear on the by-road at the south side of the quarry in light gray cherty limestone, in the southern corner of the townland of Mainstown, the dip of the latter beds being N.W. at 20° .

On the side of the main road to the E. of this, in the townland of Cregg, we find many quarries on the light gray, compact, hard, and irregularly-bedded Lower Limestone: but the best exposure of these rocks is at the large quarry in the N.E. corner of the townland of Mainstown. Here the lowest exposed beds are thin and full of black chert. Of these some are slightly magnesianized and decompose to a sand, others contain large masses of white calc-spar and a few fossils. The upper beds of the quarry are thick, light gray, and compact; the whole dipping to the south at 30° , flattening to 15° .

Over that Lower Limestone tract, along the northern limit of Sheet 167, extending below Carrick-on-Suir and Clonmel for a distance of nearly twelve miles, there are many large quarries. Of these one of the most important is that in the northern bank of the River Suir, two miles and a half W. of Carrick, in the townland of Ballinderrig. Here the beds of gray crystalline limestone which are nearest the river dip to the northwards at from 65° to 45° . They soon flatten, and on the northern side of the main road they dip to the southwards at 40° , but a short distance to the north of the main quarry they flatten and roll over to the north at 10° , eventually dipping to the same point at 45° .

To the west of this, around the cross-roads of Ballydine, and especially to the north of that locality, the light gray crystalline and compact Lower Limestones are well exposed, along the by-road leading to the old castle and church of Kilcash, the beds rolling to the N. and S. at 50° to 75° .

At a quarry 300 yards N. of this cross-road, the thin irregularly-bedded gray limestone has between each bed a thin seam of bright red oxidized shale enveloping thin lenticular seams of carbonate of lime.

In some of the shaly beds of this locality which dip to the north there is a distinct cleavage, dipping to the south at 75° .

At the extreme northern limit of Sheet 167, and to the N. of Kilsheelin, in the southern portion of the townland of Ballyglasheen Little, we find a quarry, the lowest beds in which are gray and crystalline: directly over them there are some thick beds of fine-grained oolitic limestone, which

weathers to a sand, the whole dipping south at 75° . To the west of this, at the distance of nearly half a mile, in the line of strike, and with the same dip, a similar oolitic limestone is exposed; and to the east of the Ballyglasheen quarry, at the distance of one mile and 350 yards, in the eastern portion of the townland of Seskin, we again find a few beds of coarsely oolitic limestone in the same strike as the former, but bent over so as to dip to the N. at 75° . These oolitic beds are thus continuous for a distance of fully two miles.

At this last-named quarry there is a dyke-like mass of dolomite striking E. and W. across the quarry on the line of bedding.

Around the village of Kilsheelan there are many quarries opened in the gray Lower Limestone and in the dark gray and black "Calp," the dip of the beds being either to the N. or S., at very high angles, some of the lower beds having many nodular layers of black chert through them. East of the Roman Catholic chapel of Kilsheelan a quarry exposes evenly-bedded compact dark gray "Calp" limestone, some beds of which are almost a black marble.

In the N.E. corner of the townland of Clogharrigeen West a quarry exposes beds dipping N. 10° E. at 80° , and more or less coarsely oolitic. I have no doubt but that these beds are the same as those noticed to the northwards of Ballyglasheen, three-quarters of a mile to the southwards, being brought in here by repeated rolls of the beds. Along the western side of Clogharrigeen West, and in the townland of Priorstown, to the W., the thick and thin bedded gray crystalline limestones are well exposed, dipping to the south at 70° to 85° ; and on the roadside, just over the River Suir, these beds appear to be overlaid by finely crystalline magnesianized limestone, with calc-spar very abundant and filling up fissures and cracks in the beds.

Half a mile to the east of Carrick-on-Suir, on the north bank of the Suir, the lower beds of the Lower Limestone, or the upper beds of the Lower Limestone shale, have been opened up for the distance of a quarter of a mile, exposing dark gray crystalline beds dipping N. at 20° to 35° , with hard earthy shale partings, chert layers, and nodules. At the east end of the quarry the lowest exposed beds are slightly magnesian.

On the banks of the Lingaun river, which divides the counties of Tipperary and Kilkenny, there are some detached exposures of limestone. Close to Tinvane-house the beds are gray and very fetid, and dip to the W. at 15° to 20° (a local contortion). To the north of this, at the flour-mill of Cregg Lower, the beds are dark gray, shaly, and cleaved in the direction of E. and W. On the county Kilkenny side of the river, between this locality and the three bridges on the Waterford road, we find a tolerably continuous section through the limestones; the general dip being to the northwards at from 10° to 20° .

Just north of Cregg Lower flour-mill the sandy amorphous dolomite sets in, and is exposed along the Kilkenny side of the river for the distance of 550 yards. From this point northwards, as far as Craigbridge, the rocks are concealed by the limestone drift; but just north of the bridge we find some thin irregularly bedded light gray limestone dipping to the eastward at 25° , layers of black chert being abundant in the lower beds, while the upper are almost entirely a mass of chert. Close to these beds, on the north, and overlying them, we again find the amorphous magnesian limestone; and this rock appears to extend in an unbroken sheet to the eastwards, through the demesne of Castletown, and southwards, into the townlands of Craigue and Baungarriff, this dolomite occasionally retains its bedding, as we see in the plantation to the south of the fishpond of Castletown, where the dip is to the south at 30° , and S.E. at

40°; and again at the southern end of the townland of Banngarriff, where the dip is to the S.W. at 30°.

These dolomitic limestones as they are followed to the S.E. form a narrow band, and extend in that direction to Pilltown, and to the southern corner of Bessborough demesne.

Several small patches of this dolomite occur in a N.W. and S.E. direction over the limestone district, between Bessborough-house and the western corner of Fanningstown demesne (N.W. of the village of the Sweep).

To the south of Fiddown, at the village of Turkstown, a large quarry has been opened in thin bedded, dark gray, fetid limestones, which dip E. 20° N. at 20°, and at the southern end of the quarry the gray limestone suddenly changes to a dark brown colour and dips to the S.E. at 30°, the line of demarcation between the two varieties of rock being so sudden as to suggest a fault.

The limestones about Sheepstown are light gray and compact. At the extreme eastern margin of the Sheet, at Pollerone House, on the shore of the river Suir, we find some of the Lower Limestone shales exposed. These dip to the northwards at 15° to 40°, and they are overlaid by light gray, compact, splintery limestone, which soon passes up into a pale-gray dolomite, which may be observed along the river bank for the distance of a quarter of a mile.

14. *The Pilltown District.*—The Old Red and yellow sandstone which occupies the extreme N.E. corner of Sheet 167 is tolerably well exposed on the S.W. slopes of the hills over the valley of the Suir. The former rock forms the summit marked 834 feet, just out of the limit of the map, in the townland of Dowling, where the hard Red sandstones and conglomeritic grits dip to the W. and N.W. at 15° to 25°. On the western slope of the same townland, and along the by-road leading down the hill, the Yellow Sandstone is superficially exposed, the lowest bed being a soft light yellowish sandy conglomerate, with scattered lumps of hard greenish yellow shale. Above this are bands of dark pink and red shale, succeeded by thin yellow sandstones with red shale above them, the general dip being to the S.W. at 15° to 30°. This section is sufficiently characteristic to give a general idea of this band of rock throughout the district.*

The Lower Limestone is well exposed in many quarries to the south of Pilltown, in the townland of Fiddown. These, however, are probably the upper beds of this subdivision, as they contain many layers of dark gray limestone with chert. The general character of the rock, however, is compact, and it is of a clear gray colour, the dip being to the N. at 30° to 35°.

Two outlying basins of "Calp" limestone occur near Pilltown, the position and form of which will be best understood by reference to the map. These beds are well seen in the glen and along the road just south of the hotel, as well as in the rabbit burrow in the southern corner of Bessborough demesne. Some "Calp" beds are exposed in the northern corner of the townland of Tubberaghny, 400 yards S.W. of the gate-lodge to Billine House, on the lower road. Here the beds dip to N. 40° W., and S. 60° W., from 12° to 20°, the limestone being black, compact, and fetid, with shale partings and chert layers. These beds if continued on their line of strike to the N.E. would come against the amorphous dolomite so well exposed along the adjoining road bounding Belline demesne.

In the northern basin of Calp the rocks are seen at two quarries, the

* In Oldeourt glen, a mile N.W. of Timakilly, a quarry in the Yellow Sandstone affords beds of yellow shale containing plants. (See Sheet 156).

larger being at the cross-roads called the Sweep. Here the beds are nearly flat, dipping anticlinally to the N.E., the W., and S.W., at from 5° to 10°. As these beds are followed on the line of their strike to the S.E. they are found to abut by means of a fault against the light gray Lower Limestone, which also is bent anticlinally to the N.E. and S.W. at 10° to 25°, and which soon becomes dolomitic along the brow of the little glen under Brenar House for the distance of half a mile. The other "Calp" quarry is to the east of and close to Ballyhenebery House.

To the north of "the Sweep," close under Fanningstown House, a large quarry is opened in the light gray cherty Lower Limestone. Some of the lowest exposed beds here are magnesian, and accordingly weather brown and soft.

15. *The Portlaw District.*—The Old Red and Yellow Sandstones which form the high ground to the west of Portlaw, in Curraghmore demesne, have already been sufficiently described. We have therefore merely to notice the limestones of this district. Some characteristic beds of the Lower Limestone shale are exposed in a small quarry to the west of the road 350 yards north of Coolfin House. These consist of hard, dark gray, gritty and micaceous, but slightly calcareous, shales, cleaved unto slate. The beds dip E. at 5°; while the cleavage dips S. 30° W. at 65°.

To the north of Portlaw, in the townland of Rocket Castle, very extensive quarries have been opened in the lowest beds of the Lower Limestone. These consist of thick irregularly bedded gray crystalline and very fetid limestones, with dark gray shale partings. The limestones are wholly crinoidal. The beds have a general wavy dip to the eastward, at from 20° to 35°.

16. *The Kilmacow District (Sheet 168).*—The relations between the Old Red sandstone and the Lower Silurian slates of this district will be best understood by reference to the map, where it will be seen that the Old Red has been denuded from off them at two localities between Kilmacow and Mullinavat. The slates are gray and greenish gray, and very hard, and are well exposed over the small areas alluded to. The basal boundary of the Old Red sandstone is remarkably well exposed. The igneous rock seen in the Silurian slates is hornblende greenstone, with a mottled green and purple ash to the west of it.

Over all the high ground to the southwards and westwards of Mullinavat the Old Red sandstone stands out in large bosses with escarped sides, and is therefore easy of observation. To the south of the village of Carrickinnane, on the road bounding the townlands of Rahard East and Rahard South, Mr. Wyley has noted some conglomerates and coarse sandstones, and makes the following remark on them:—"These beds are derived from granite, and contain the two ingredients, feldspar and mica, in nearly the original proportions, the former being quite crystalline and undecomposed."*

The carboniferous rocks in this district are so like those described in the valley of the Suir to the westward, that we need not particularise them here further than to describe the section passing through them from N. to S. (See fig. 9.)

At the northern end of this section the Lower Limestone shales are not seen, though they appear about a mile to the west. The lowest beds of the Lower Limestone appear in the townland of Melville, E. of Ballykillaboy, and they consist of thick-bedded coarse gray limestones dipping southwards at 10° to 12°. To the west of this, in the townlands of Ballykillaboy and Ballykeaghan large quarries have been opened in gray

* The nearest granite is that on the western side of the Arrigle valley south of Thomastown about six miles away. J. B. J.

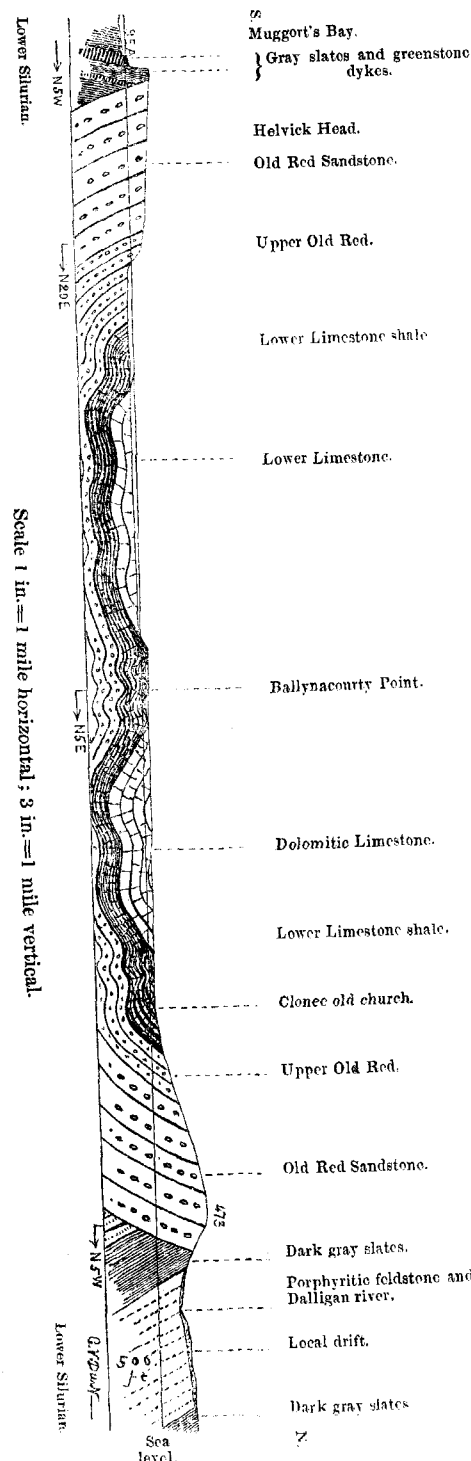
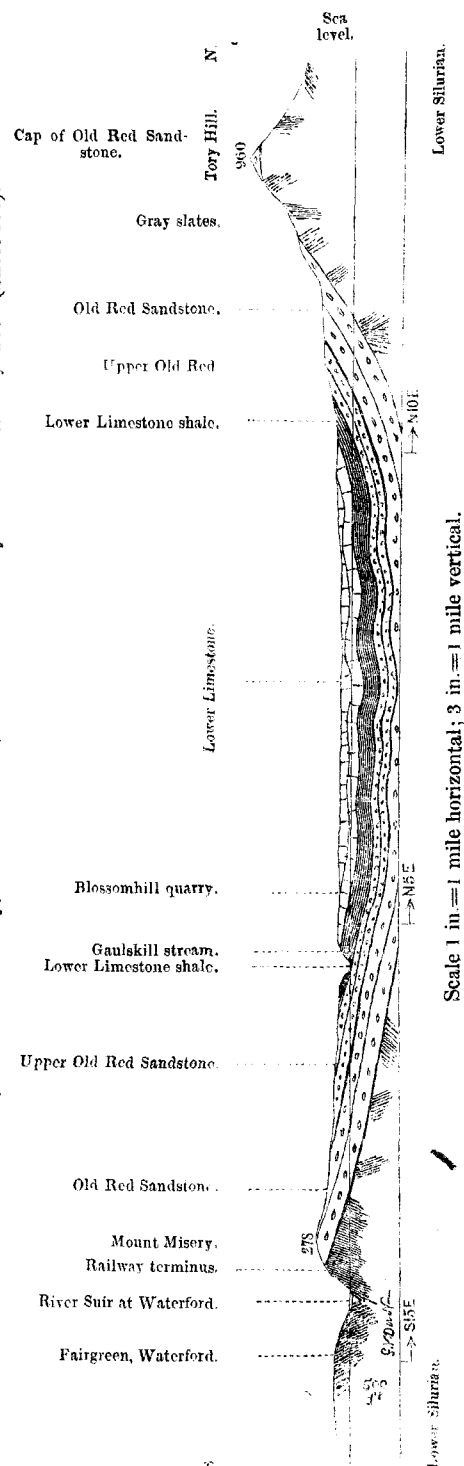
crystalline crinoidal limestones, which overlie those first noticed. To the E. of Bishopshall demesne extensive quarries expose similar limestones with chert layers and shale partings dipping to the west at 3° to 5° ; and still further to the south, on the N.E. side of Ballincurragh demesne, several quarries expose gray crinoidal crystalline, and often cherty limestones, dipping N.N.W. at 5° to 25° . To the south of this, in Blossomhill townland, the section crosses some compact blue limestones dipping N.N.W. at 20° ; and at Strang's mill, due E. of Dunkitt House and the great quarries there, the limestone is clear gray in colour, crystalline, and crinoidal, the beds dipping N. 10° , W. at 10° to 15° . These are the lowest beds of the Lower Limestone at the southern end of the section, and they are underlain by dark gray friable shales and thin limestones, which are well seen along the bank of the river to the east of Granny Castle, dipping to the northward at 20° to 25° , which are assigned to the Lower Limestone shale.

The Yellow sandstones beneath the Lower Limestone shales are not well exposed in the line of section, but the Old Red sandstones are clearly exposed on the northern slopes of Mount Misery, over the city of Waterford.

The Lower Limestone, with its associated dolomitic beds and the Lower

Section from Waterford, over Mount Misery, to near Dunkitt, and from that nearly due north to Tory hill. (Sheet 168).

Figure 9.



Section from Helvick Head, across the harbour and valley of Dungarvan to the Glen of the Dalligan River. (Sheet 178).

Figure 10.

Limestone shale, are well exposed in the vicinity of the villages of Mooncoin and Doornane, and the Old Red sandstones to the southward, between the villages of Ballygorey and Licketstown, are also clearly exposed over the area indicated on the map.

17. *The Dungarvan District.* — This district will require but a very short description, chiefly with reference to the section. This crosses the double synclinal in the limestone valley of Dungarvan, from the Lower Silurian and Old Red Sandstone rocks which appear to the N. and S. of it. On the northern end (see fig. 10) the section commences with the broad band of dark gray slates to the south of Carrigmorna; it then crosses the thick band of finely porphyritic feldstone which is cut by the Dalligan river in the neighbourhood of Dalligan-bridge, superficial exposures of which rock occur in the townlands of Ballykeeroge Little and Englishtown. To the south of this the section crosses the ridge of Old Red sandstone which terminates in Ballyvoyle Head. In the townland of Ballagharorrage, at the elevation marked 473 on section, the Old Red sandstone contains beds of coarse conglomerate with Red sandstones and micaceous shales. The Upper Old Red on the line of section is not exposed, but it is clearly seen on the coast to the eastward at the distance

of a mile and a quarter, where the yellow and red sandstones are interstratified with highly micaceous shales dipping S.W. at 60° . At Clonee old church the upper beds of the Lower Limestone shale are well exposed, dipping S. 10° , W. at 45° . These consist of highly fossiliferous gray limestones and shales, which on the coast contain nodular limestone bands, the cleavage in the shales, according to Mr. Willson's notes, striking E. 20° , S. and W. 20° , N. vertical.

Along the shore under Clonee Castle, E. of the old church, thin bedded gray limestones and shales, dipping to the S.W. and N.E. at 20° to 25° , are well exposed, the cleavage in the shales often obscuring the bedding. The greater portion of the section (fig. 10) from the old church of Clonee southwards to Ballynacourty point, runs parallel to the coast, and about 300 yards distant from it.

The lowest exposed beds of the Lower Limestone are amorphous, of a light yellow white and brown colour, highly crystalline and dolomitic. In many places the rock when partly broken is pale brown, and has a more brilliant pearly fracture than the generality of the Lower Limestone dolomitic beds. Near the point of Ballinacourty the lower shales appear in great force, and dipping as a mass to the northwards at 10° to 30° , though there are detached dips to the southwards; the shales here are highly fossiliferous and cleaved E. and W. vertically.

The Lower Limestone shale is so well seen here that for a long time it was spoken of amongst us as the Clonee beds.

The remaining portion of the section through the limestones, though drawn through Dungarvan harbour, is not the less accurate in its details. The Lower Limestone shales at its southern end are well seen in the townland of Mweelahorna, at the base of the long sandy promontory which stretches northwards from the ridge of Helvick Head to near the town of Dungarvan. These beds are precisely similar to those under Clonee Castle, and dip to the northwards at 60° , while the gray limestones which overlie them are exposed inland, to the S.W. of the town. The Yellow and Old Red Sandstones forming Helvick Head promontory are clearly exposed along the coast line, dipping northwards at 65° to 70° . They agree accurately with similar beds to the north of the section.

The extreme southern end of the section shows the Old Red sandstone resting on the upturned and denuded edges of the Lower Silurian slates, the former dipping N. 15° , W. at 50° , and the latter S. at 60° . The basal beds of the Old Red, for the thickness of 100 feet from their junction with the Silurian rocks, consist of red shales and fine conglomerate, with a bed, six feet thick, of coarse pebbly conglomerate, and the Silurian rocks are here traversed by the thick dykes of greenstone, with a thin bed of feldstone above them.

18. *The Dunmore District.*—The Old Red sandstone, and the Lower Silurian slates in junction with it, are the only rocks to be described in this district. As we approach Dunmore from the north the Old Red sandstone is first observed on the main road in the townland of Ballyloughmore, just east of Ballylough, the Lower Silurian gray silty slates appearing at the base of the rise of ground occupied by them. The basal beds of the Old Red sandstone consist entirely of a breccia or conglomerate formed of the sub-angular debris of the Lower Silurian grits, slates, and trappean beds enclosed in a sandy matrix; and these rocks are exposed almost continuously for the distance of one mile and 300 yards, or beyond the five cross roads N. of Killea village.

To the south of this, for the distance of one mile, the sandstone breccia is not exposed, but it again appears at the village of Killea, the beds being nearly horizontal. As we descend the southern side of Killea hill we lose

the breccias in the distance of 300 yards, and find that they rest upon dark red sandstones and shales. The rocks are not again exposed till we see them in the sea cliffs around the village of Dunmore. Here we find shales and red conglomerates, the latter containing a large percentage of well-rounded pebbles of grit and quartz, with some angular fragments of grits, slates, and traps, similar to those in the lowest beds. The dip here is to the South at 5° .

The height of the lowest bed of this breccia, on the northern side of the Old Red sandstone area, is about 200 feet; and as the ground rises to the height of 400 feet in the distance of three-quarters of a mile, we have a thickness of this deposit of 200 feet. If to this we add another 200 feet, to represent the beds to the southward and those around the village of Dunmore, we have a total of 400 feet for the thickness of the Old Red in this district. One of the best exposed junctions of the Old Red and Lower Silurian rocks in this district is just below Knockaveelish cottage, to the west of Knockaveelish Head, on the western side of the Waterford estuary, where the coarse conglomeritic breccia rests nearly horizontally on bluish gray and black slates, with thin grit bands dipping to the N.W. at 45° . Another junction is on the western side of the Old Red area close to the Roman Catholic chapel of Kilmacleague, where the gray and black slates and grit layers are contorted, though dipping as a mass to the N.E. at 60° , the red conglomerates lying on them with a dip to the eastward of 10° . The entire coast, from Rinnashark harbour, past Brownstown Head, to Swine's Head, and from that easterly, past Dunmore to Credan and Knockaveelish headlands, exposes many good sections in the Old Red beds, where their structure and general character can be well studied.*

19. *The Promontory of Hook.*—That portion of the Hook promontory which is included in Sheet 179 is the most interesting to the geologist, and I shall confine my descriptions to it.

If we proceed from Duncannon along the coast towards Brownhill point, we find cliffs of about 100 feet in height, composed of almost vertical beds of gray slates and thin grits and thick bands of black slate or shale, according to the presence or absence of the cleavage. These beds are much contorted, though the general dip is N.W. or N. On the northern side of Booley Bay, many of the hard gray grits have a remarkable wavy structure, which gives the surface of the bed a mammillated look. Wavelite is found here in some of the shales.

At Black point some of the gray gritty beds are concretionary, and weather into spheroids.

In the hollow of the coast, called Dollar Bay, just south of Black point, there are some blackish gray shaly beds, containing lumps of hard gray grit, which form a rude conglomerate; and on the S. side of the bay the Old Red sandstone appears abutting against the slates by a fault striking E. and W. from a point 200 yards north of the height marked 102.

The Old Red sandstone terminates on the south of an E. and W. fault appearing on the N. side of Stonewall Bay. South of this, for about three quarters of a mile of coast, the gray Silurian slates appear to dip persistently to the N.W. at from 30° to 70° , showing a thickness of about 2,600 feet.

From the hollow in the coast N. of Templetown Bay southwards the lower Old Red sandstone conglomerate is seen for a distance of 1,150

* See paper by the Rev. Samuel Houghton, F.R.C.D., on the Structure and Jointing of the Old Red sandstone of Dunmore.—*Journal of the Geological Society of Dublin.*

yards, and the upper Old Red or yellow sandstone for a further distance of 900 yards. The lower beds dip to the westwards and to W.S.W. at from 5° to 20°, and the latter gradually curve round from W.S.W. at 20° to South at 25°. Throughout the Yellow Sandstone are beds of conglomerate with red sandstones and red micaceous shale. Plants are frequently found in the yellowish shales, in which also are flakes of carbonate of copper; and carbonate of copper is abundant in a coarse pale yellow conglomerate at the base of this subdivision of the Old Red. The passage beds from the Yellow Sandstone into the Lower Limestone shale and Carboniferous Limestones are remarkably well and clearly developed on the eastern side of the promontory on the north side of Woarwoy Bay, under Houseland Castle. They consist of light yellow sandstone, passing up into red sandstone, thin-bedded and shaly, with soft red and green shales, the latter containing fucoid impressions. These pass up into thin gray shales and gritty layers containing fossils, having some bluish gray crinoidal shales above them; hard gray limestones with gray shales completing the section. At Lumsdin's Bay, on the west side of the promontory, these junction beds do not present the same variety of lithological character as on the east side, the passage from the pink and yellow quartzose sandstone and red and green shales into dark gray fucoid shale being sudden.

At Carnivan Head, which is just out of the extreme eastern limit of Sheet 179, and nearly due east of Graigue-house, the junction between the Old Red sandstone conglomerate and the Lower Silurian slates is exceedingly interesting, and deserves some note. The dark gray slates, which have some conglomeritic beds in them, dip N.W. and S.E. at 70° and 80°. This anticlinal is well seen to the north of the headland; and these rocks, at a short distance from what is now the coast line, have been escarped vertically by the sea of the Old Red sandstone period and the sandstones deposited against this anticlinal cliff, so as to dip to the S.E. at 15°.

In the small hollow of the coast to the west of the head the sandstone has been denuded so as to expose the underlying Silurian slates, but a small E. and W. fault running parallel to the line of coast has let down some of the upper red shaly beds of the Old Red, and have thus formed a breakwater protecting the slate rocks of the main cliff, which is about 120 feet in height.

The remaining portion of the Hook promontory for the distance of two miles and three-quarters is formed entirely of the lower subdivision of the Carboniferous Limestone; and but for the occurrence in it of a thick deposit of magnesian limestone, its description might be very brief.

On the southern side of Patrick's Bay, which is on the east of the promontory, in the townland of Galgystown, the thin gray limestones which have been traced in unbroken succession from the Lower Limestone shale for the distance of one mile are observed to dip to the S.E. at 10°, and to be suddenly overlaid by brownish gray magnesian limestone, having a beautiful pearly lustre where fractured. This rock decomposes to a dark chocolate colour; and the vertical joints become so numerous and well developed, that in the distance of 250 yards from the gray beds the bedding is nearly obliterated, and the dolomite assumes quite a basaltic

* For a similar well-marked example of the Old Red sandstone having been deposited against an ancient cliff of Silurian rocks, see the Explanation to the Dingle promontory, Sheets 160, 161, 171, 172, Derrymore glen and Coomastala glen.

form appearance. These beds can be traced along the coast for the distance of 450 yards, the dip being to the S.S.E. at 10° to 15°, when they are cut off by an E. and W. fault, by which means the ordinary light gray nodular limestone and crinoidal shales are brought abruptly against them, though the dip and strike of these two kinds of rock is the same. On the N. side of the fault the magnesian beds are broken up into a fine breccia forming a dyke-like mass cemented by carbonate of lime. The gray limestone beds are now traceable to the southward for the distance of 130 yards, where they are overlaid conformably by magnesian beds similar in general aspect to those first described. These are seen for the distance of about 100 yards, where they are again overlaid conformably by gray fossiliferous limestone of the ordinary type, the dips being as before to the S.S.E. at 15°.

From the foregoing facts it is evident that we have two bands of magnesian limestone, or dolomite, in the gray beds; the first or northern one being about 200 feet, and the southern 90 feet in thickness; the original bedding being preserved in both.

To the south of this point, past the village of Slade, to the extreme end of Hook Head, the coast exposes dark gray, thin bedded and highly fossiliferous limestone, the general dip of which is to the S.E. at angles from 10° to 15°; the beds being in many places cut up by faults and many open joints.

On the east side of the headland, at the northern point of Doornoge Bay, and at the distance of half a mile from the Lighthouse,* we again find the dark brown magnesian beds interstratified with the gray limestones, the dip being to the S.S.E. at 25°. Here also we have evidence of two bands of dolomite, and, strange to say, the northern one is separated from the ordinary limestones by a fault, as was the case on the opposite side of the promontory.

Along the shore to the west of Hook old church we see the gray limestone rising from beneath the dolomite beds, the dip of both being nearly east at 30°. And at the little hollow in the coast, called Rockwell, there are two faults which cut through the magnesian beds; that to the north separating them from the ordinary gray limestone, which forms the coast line from this place northwards for the distance of two miles. The dolomitic beds on either side of the promontory may be connected, though dislocated by the faults. The rocks, however, except on the coast, are concealed by a thick deposit of local drift, so that the boundaries marked on the map can only be taken as approximations to the truth.

* This beautiful tower, which forms not only a prominent landmark but a lighthouse, stands on the extreme end of the promontory, and was erected by the Anglo-Normans shortly after the landing of De Clare, Earl of Pembroke, surnamed Strongbow, in the reign of Henry II. The tower is about ninety feet in height, and though circular externally is square within; the spaces formed by the external and internal walls being converted into a passage for a winding stairs and small square rooms. There are three floors, each arched with stone.

The smaller terminal portion of the tower, forming the lighthouse, is a modern addition.

According to the best historical authorities Strongbow effected his principal landing on the shore at Crook, on the western side of the Waterford estuary, and not at Baginbun Head, which is an exposed, precipitous, and rock-bound promontory, quite unsuited for such a purpose. It is probable, however, that here the Anglo-Normans constructed a redoubt by spanning the narrowest part of the headland with a strong earth work, or on their occupation of the Hook promontory, they found a native Irish earthen fortification at this place. Within the inner enclosure, on the northern side of the headland, there is a small rectangular depression in the soil, which is traditionally pointed out as the site of Strongbow's tent; and I see no reason to doubt the accuracy of the statement.—G. V. D.

6. Drift and evidence of glacial action over the district.

During the summer of 1850, when I first examined the district along the western side of Sheet 167, I was much struck by the evidence of glacial action presented by the debris and rock markings in the glen between Coumgorra Lough and Comeragh Lough. This glen, which is little over 1,000 feet in width, and one mile in length, opens to the N.W. and the view obtained of its mouth, from the pass between the glen of the Nier River and the village of Rathgornmuck, looking to the S.E., is singularly interesting. Mound after mound of coarse angular local debris, arranged in flat lunets, span the mouth of the glen from side to side to the width of nearly half a mile, and through them the present little river which comes from the glen has cut a deep channel. The mountain bounding the glen rises to a height of 2,500 feet. The head of the glen reaches a height of about 2,000 feet, and it falls to 1,200 feet in the distance of a mile. Thus a fall of 800 feet in the mile is equal to a slope of 8°. At the upper end of the glen, and 2,000 feet above the sea, the Red sandstone and conglomerates which appear at the height of 20 feet above the present level of the stream, have their surfaces beautifully polished and striated, the striæ being parallel with the longest axis of the glen, or N.W., while the precipitous faces of the rocks, which rise high at either hand, are rounded and polished.

I think it highly probable that when this glen was blocked by ice formed on the higher levels, the sea washed what is now its embouchure, and cut off the descending glacier. Such a phenomenon as this is yet to be seen on the Spitzbergen* and other northern coasts, and it explains the occurrence of such lunet-shaped mounds at the mouths of short glens; such as we see at Derrymore glen, and Bartregaum glen, on the northern flank of the Tralee mountains, and at the southern end of the Gap of Dunloe,† and in this district. The great mounds of debris at the mouth of such a *cul de sac* as that in which Coumshingham Lake lies, may be similarly accounted for.

Glacial striæ are not uncommon on exposed rock surfaces over the district, those to the east of the Comeragh mountains having a general bearing of N.N.W. and S.S.E., while to the west of the range they follow the longest axis of the various glens which indent their sides. Thus the Comeragh mountains, like the Reeks of Macgillicuddy, Mangerton, and the mountains to the eastward, with the range of the Tralee and Dingle mountains, were centres of glacial dispersion. In the Comeragh district, the depression of the land during the glacial period below its present level was about 1,400 to 1,500 feet, that being the present height above the sea of the moraines at the mouths of the Comeragh glens. Over the Old Red sandstone escarpment extending along the eastern side of Curraghmore demesne, from Mount Bolton to the eastern limit of Sheet 167, glacial striæ were observed on exposed rock surfaces, their direction being about N. and S., or nearly parallel with that portion of the valley of the River Suir which lies to the east of the escarpment. No doubt the direction of the valley influenced the direction of the ice current, and thus we are assured that the present conformation of the ground was mainly the same at the period we allude to as at present.

On the Old Red sandstone which appears to the N.W. of the city of Waterford, glacial striæ are apparent at an elevation of 120 feet above the sea.

* See Kane's Arctic Expedition.

† Vide Explanations to Sheet 160, 161, 171, 172, and the Killarney Sheet, 173.

7. Knockmahon and Bonmahon Mines.

The following information relating to the Knockmahon mines, was kindly given to me by Mr. James Hore, the cashier of the mines:—

"September, 1863.

"The Danes are said to have been the first discoverers or workers. Ancient tools and excavations found some years since afford evidence of their being worked at a very remote date. Tradition also tells of ore being raised therefrom in the reign of Elizabeth and other periods down to 1730, when we find a Mr. Hume worked profitably the Stage lode for a length of time. In 1796, and some years subsequently, Colonel Hall and Mr. Galway spent a large sum on various parts of the ground unsuccessfully. It then passed into the hands of the Hibernian Mining Company, and in 1824 became the property of the Mining Company of Ireland, who have prosecuted the workings continuously to the present date with varying success; for the past year, 1862, the net profit exceeded £20,000.

"The sett is an extensive one, comprising five royalties, namely, Tankardstown or Knockmahon, Kilduane, Ballinasila, and Bonmahon; and dues varying from one-fifteenth to one-twentieth are paid to the respective owners.

"Seven steam-engines and six water-wheels assist in the general operations, such as pumping, drawing stuff from underground, crushing and dressing ores, &c. The water power is principally derived from the River Mahon, being brought to the dressing floors by an artificial cut three miles in length.

"About 6,500 to 7,000 tons of copper ore is raised annually, of an average produce of ten and a half per cent. This is shipped off to Liverpool and Swansea markets by vessels that (weather permitting) come close in shore, there being no harbour nearer than Dungarvan or Waterford.

"Large quantities of timber are used annually, greater portion of which is imported direct from Norway. There is a large saw-mill in constant work, and about 800 hands find constant employment in the various surface and underground operations.

"JAMES HORE."

These works stretch along the coast for a mile and three quarters, spreading in some places a mile inland. In the earlier workings the most productive lode was the *Stage Lode* till it was lost in the ground N. of Knockmahon Creek. Further explorations, however, to the N.E. of these workings either discovered another lode, or hit upon the continuation of the former one.

This received the name of the North Mine Lode, and proved very profitable, being worked with success for many years. During all this time the works at Bonmahon were progressing, and the lodes there were found to be more regular in their strike and more uniform in their produce than those to the east at Knockmahon, and they still retain that character.

Various other lodes to the east of Knockmahon were in process of being tried, and yielded various results, some of them very encouraging, until the Tankardstown lode, which was supposed to have been worked out, unexpectedly proved superior in value to any of the other workings. This arose from the unusual width of the lode (or lodes) which it acquired where it branched at a short distance from the coast, and at the depth of 100 fathoms. It here presented a productive width of 40 to 60 feet, and in some places more than this, all the stuff yielding yellow copper ore of remarkable purity.

In the townland of Kilmurrin, a mile and a half east of Knockmahon, four small lodes of copper ore, with strings of lead in connexion with them, have been discovered in the pale greenish gray porphyritic feldstone. After a fair trial these workings were found unprofitable, and abandoned.

The Tankardstown lode is the most eastern of all the lodes at Knockmahon. It appears on the coast in the townland of the same name, and strikes N.W. for half a mile from the coast, when it strikes to the N.N.W.,

and has been worked at detached localities for a further distance of half a mile. It inclines to the S.W. at angles varying from the horizon from 52° to 68°.

Seawards, this lode has been profitably worked for the distance of 250 yards from the shore.

Rowes lode appears in the cliff at the distance of 60 yards to the west of Tankardstown lode, which it joins inland at the distance of 125 yards. It occurs on the line of a fault, and strikes N. and S., with an inclination of 70° to the west. At the junction of these two lodes the solid copper-bearing lode was nearly 70 feet in width, decreasing, however, rapidly to four feet as it was followed on the strike of the greater lode.

Boneyaught lode is the next met with. It appears on the coast along a line of fault, and has been traced for the distance of half a mile in the direction of N. 10° to 15° W., with an inclination of 50° to the eastward. This lode has not been worked beneath the sea.

Sixty yards east of Boneyaught lode is the Kilduane lode, the general strike of which is N.N.W. from the coast, with an inclination of 50° to the eastward; it, or a lode resembling it, has been followed inland for about a mile. A hundred yards to the west of this lode is the Seven Dials lode, the strike and inclination of which is the same as the one last noticed. All the lodes last enumerated occur in gray slate as well as in the feldstone, crossing the bedding at right angles.

At the distance of 350 yards west of Seven Dials lode is the Old Stage lode, with its numerous branches and strings, discovered close to the coast line. The shaft N. of the Old Stage was sunk 212 fathoms, and in driving on this lode, seawards, several runs took place, from the works having been carried on too close to the sea floor, and at the distance of about 350 yards from the coast the sea broke into the mine some years since, and great difficulty was experienced in staunching the break. The works on this lode have been carried on beneath the sea to the distance of about 500 yards from the coast line. The strike of the Stage lode is about N.W. from the coast, the "hade" being variable, but generally vertical. When the "red ground" (the red conglomerate and shale beds in the Silurian rocks) was reached, under the crushing floors of the mine the lode was lost, but it is supposed that to the north of these beds, under the name of the North Mine lode, it was recovered, and it has been worked for the distance of over three-quarters of a mile through the porphyritic feldstone into the townland of Ballynasissla. Here this lode was again lost where the black slaty band on the north was reached, but by further explorations in the neighbourhood these black slates were found to contain copper in workable quantities, disseminated through them in strings, and filling up small cracks and fissures. Sinkings on this copper bearing slate have been made to the depth of 30 or 40 fathoms with good results.

The lodes at Bonmahon (to the west of Knockmahon) consist of the "River lode" once worked in the northern corner of the townland of Templeyvrack, but now abandoned; its strike is N.W. and S.E. On the E. side of Bonmahon Head is the "red level lode," which has been followed from the coast in the direction of N. 30° W. for the distance of 1,100 yards, its inclination is to the N.E., but variable in amount. On the W. side of the same headland are two minor lodes, having the same strike as the former; and at the distance of 250 yards to the west of the head is the Trawnamoe lode, striking N. 25° W. from the coast. This lode is soon lost in the red conglomerates and shales of Ballydouane Bay in their extension to the N.E. At the southern end this lode inclines to the S.W., and at the northern end to the N.E.

The last and most westerly lode is called the Trawnastrella lode, being that first worked at Bonmahon, and from which the mines there have been named. This lode has been followed for the distance of 800 yards from the coast, its "hade" being to the eastward; all the lodes to the west of Bonmahon occur in the pale greenish gray porphyritic feldstone.

The average per-centage of copper in the dressed ore is 11, and its price varies from £9 to £12 per ton. The number of hands (male and female) at present employed is about 800, and the average outlay per month for wages alone is £2,000.

The men are engaged both by tutt-work and tribute-work.

At every available opportunity the dressed ore is shipped on the spot, being brought to the vessels which lie off the coast in the open roadstead in leather bags, which are emptied into the hold and returned to the works.

The average shipment is from 500 to 600 tons per month.

G. V. DU NOYER.

APPENDIX.

IRISH NAMES of PLACES, retained in the WATERFORD DISTRICT, with their ENGLISH SIGNIFICATIONS, as kindly supplied to me by W. M. HENNESSY, Esq., M.R.I.A.

Aughavilla,	Pea-field.
Bleantour,	The summer flanks. <i>Óléanta rannra</i> . (There is a place in Wicklow called "Green Flanks;" in Irish " <i>Óléanta glár</i> ."
Carrickrower,	The thick rock.
Carricknaclog,	The rock of the bells.
Carricknagower,	The rock of the goats.
Carrickastump,	The rock of the tree stumps.
Carrickauvaun,	The rock of the waste ground.
Carricknagroagh,	The rock of the ricks.
Carrickavrantry,	The rock of the stagnant pools.
Carrickattunaun,	The rock of the furze. (This name is doubtful. It might also mean "the long rock of the river;" " <i>carraig [c]lata na haban</i> .")
Carrickaroirk,	The rock of the prospect.
Carrickagunna,	The rock of the gun, or gun-shot wound.
Carrickbarahane,	Berchan's or St. Berchan's rock.
Carrickadda,	The long rock, properly "Carrickfadda."
Carrickbein,	The point rock.
Carricknagaddy,	The robber's rock.
Carricknamoan,	The rock of the bog.
Carrickapane,	The cup rock.
Carrickeenaveagh,	The little rock of the deer.
Carrickinnane,	Finan's rock. There is a Rossinan within a couple of miles of the place. Finan is pronounced Inan in the genitive case, in consequence of the aspiration of the F; and therefore Carrick-Finan would become Carrick-Inan. Or, Carrickinnane may mean the Ivy rock, from <i>Érónan</i> , Ivy; pron. " <i>Inan</i> " in Munster.
Carrickmorna,	The rock of Morna. This Morna was, perhaps, the father of Goll Mac Morna, the rival of Fin Mac Cumhail, who was the recognised chief of the Fenian band called Clanna Baiskny, while Goll was looked up to as the leader of the Clanna Morna.
Carrickadurish,	The rock of the door. <i>Deogh-a-durish</i> , "the drink of the door," or "The stirrup cup."
Cloughaniller,	The Eagle's rock.

Cloughlowrish, . . .	The stone, or rock of Lawrence. There is a kill or church dedicated to St. Lawrence in the neighbourhood. Or it might mean "the stone that speaks," from <i>clough</i> , or <i>cloch</i> , a stone, and " <i>labras</i> ," the third person singular, present tense, of " <i>labrad</i> ," to speak. The former seems the more likely interpretation.
Coumshingaun, . . .	The valley of the ant. This may seem a very unlikely derivation; but there is a Cnock-na-Singaun, or "Hill of the ants," in the county of Louth. (See "Annals of the Four Masters," Index locorum, voce Cnoc or Knock). The word "Shingaun," gen. of "Sengan," an ant, enters into the formation of many names of places in Ireland.
Coumeragh Lough, . .	The laughing or "calling" valley. Probably so called from the <i>MacCúla</i> (MacAlla), or "son of the rock," i.e., echo, which is heard there. The echo in this glen is one of the most distinct of any heard in either of the great <i>cul de sac</i> valleys of the Comeraghs. The name would also signify the "short valley."
Coumgarra, . . .	
Couma Lough, . . .	The valley lake.
Coumfea, . . .	The valley of the hunt, or deer.
Coumstilloga, . . .	The valley of the rocky streaks or ridges. (This is quite descriptive.)
Coumdouala, . . .	The valley of the black cliff.
Culnacuppoge, . . .	The corner of the docks, or dock corner, from <i>cúl</i> -corner and <i>cuppoge</i> , or <i>coppoge</i> , a dock.
Knockavelish, . . .	Wild-mustard hill.
Knockbackgeldon, . .	MacIldown's hill, or it may be the hill of the brown-white cows.
Knockanafrin, . . .	The hill of the Mass. Probably so called from the celebration of Mass thereon in the Penal times.
Mweeling, . . .	The little base or pointless hill.
Moanyarha, . . .	The short bog.
Rinnamoe, . . .	The point or ridge of the cows.
Seefin, . . .	The Seat of Fin (Mac Cumhail).
Slieve Coiltia, . . .	Caoilte's mountain. Called probably from Caoilte Mac Ronain who occupies in the Fenian legends a position somewhat like that which Mercury fills in the Greek mythology.
Trawnastrella, . . .	The noisy strand.

NOTE.—It would be impossible for me, without some personal knowledge of the situation of the places mentioned in the foregoing list, to vouch for the accuracy of each interpretation; but I believe the explanations will be found generally correct.

W. M. HENNESSY.

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