Memoirs of the Geological Survey.

EXPLANATIONS

TO ACCOMPANY

SHEETS 121 AND 130 OF THE MAPS

OF THE

GEOLOGICAL SURVEY OF IRELAND,

ILLUSTRATING A PORTION OF THE

COUNTIES OF WICKLOW AND DUBLIN.

BY

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WITH

PALÆONTOLOGICAL NOTES BY W. H. BAILY, F.G.S. & L.S.

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PREFACE.

THE tract of country described in the following pages was originally surveyed by Professor Oldham, formerly Director of the Geological Survey of Ireland, and his assistants, Messrs. Wyley and Wilson; but no descriptive memoir having been published along with the maps, the late Professor Jukes, in order to complete the series of "Explanations" now in course of publication, and which are intended to proceed *pari passu* with the issue of the maps themselves, made a partial re-examination of the district, in which he was assisted by the late Mr. Du Noyer; and at the conclusion of their investigations, drew up the following descriptive memoir, which, alas! neither of the authors lived to see published.

It thus falls to my lot to take charge of this memoir while passing through the press. I have done little more than correct the proof sheets, and am only too well aware how much the work has lost in value, by having been committed to other hands than those of the lamented authors themselves.

It will be observed that Mr. Du Noyer has largely quoted from the notes of his predecessor, Mr. Wyley.

EDWARD HULL,
Director of the Geological Survey of Ireland.

51, *St. Stephen's-green, Dublin,*
October, 1869.

EXPLANATION

OF

SHEETS 121 AND 130

OF THE

GEOLOGICAL SURVEY OF IRELAND.

GENERAL DESCRIPTION.

THE area described in this Explanation lies wholly in the county Wicklow, except a small part along its northern border, which belongs to county Dublin. The principal places in Sheet 121 are the towns of Bray, Newtownmountkennedy, with the villages of Enniskerry, Delgany, Kilcoole, and Newcastle. In Sheet 130 the principal places are the towns of Wicklow and Rathdrum, with the villages of Roundwood, Laragh, Drumgoff, Glenealy, Bullinaclash, and Redcross.

1. *Form of the Ground.*

In order to give an intelligible account of the form of the ground within the Sheets 121 and 130, it is necessary to include a portion of the districts in the adjacent sheets.

On the south side of Dublin Bay, the ground gradually rises into some low hills, the crest or water-shed of which runs about W. from Dalkey, by Glenageary and Foxrock, to the foot of the Threerock Mountain. The ground then rises more rapidly, and forms hills which may be called the Dublin and Wicklow Mountains. These terminate towards the north in the Threerock Mountain (1,479 feet), and Kilmashogue Mountain (1,339 feet), which overlook the eastern side of the plain that stretches across Ireland, from Dublin to Galway.

This high mountainous ground is continuous from these hills for about 25 miles towards the S.W., its crest forming a line of watershed between the streams that flow into the interior, and those that run directly off to the eastern coast. It is, however, remarkable that even the streams that flow into the interior are ultimately brought back to the eastern coast, being all tributaries either of the Liffey, which flows into Dublin Bay, or of the Slaney, which flows into Wexford Harbour. Some of the minor sources of these two rivers interlace (of course without intercommunication) in the lower country, about Donard and Dunlavin, to the west of the mountains.

The line of watershed turns south from the Threerock Mountain over Fairy Castle (1,763 feet), and then over the Tworock Mountain (1,699 feet), and Glendoo Mountain (1,919 feet). Between the two latter hills is the Glencullen Gap giving passage on the road from

Dublin into Glencullen, at a point which is 1,400 feet above the sea, being the lowest point of the watershed in that neighbourhood. The line of watershed bends from Glendoo Mountain to Killakee Mountain (1,761 feet), whence it runs due S. at the back of Lough Bray (upper and lower), over a nameless hill of 1,990 feet, and thence on to Sally Gap. The summit of the ridge hereabouts is broad and covered by mountain bogs and morasses, from which spring the head waters of the rivers Dodder and Glencree to the north of Lough Bray, and the rivers Liffey, Annamoe, and Dargle, a short distance to the south of it. The mean height of those bogs may be taken as about 1,700 and 1,800 feet. The surface of Upper Lough Bray is 1,455 feet above the sea, and that of the Lower Lough 1,225 feet. The highest point of the road across the hills between Kilakee House and Glencree Barracks is about 1,600 feet above the sea; while that from Blessington to Newtownmountkennedy crosses Sally Gap at a height of 1,630 or 1,640 feet, those being the lowest points of the watershed in their respective neighbourhoods.

From this part of the ridge two spurs start out bearing loftier eminences than those on the crest—one running to the N.W. through Kippure (2,473 feet), and terminating in Slievebane (2,128 feet), forming a watershed between some of the sources of the Dodder and the Liffey; the other to the S.E., terminating in Douce (2,384 feet), forming the watershed between some sources of the Dargle on the one side, and some of the Annamoe and Vartry rivers on the other.

From Sally Gap the main watershed is continued to the S.W. over Gravale (2,352) to Mullaghcleevaun (2,783 feet in Sheet 120), and then bends to the S.E. and S. to a nameless height of 2,684 feet, a little N. of the Seven Churches mining district. It then turns S.W. again, and is crossed by the Wicklow Gap, through which a road is brought at a height of 1,569 feet a little N. of Lough Nahanagan, the surface of the water of which is 1,389 feet. The watershed continues to run S.W. as far as the Table Mountain (Sheet 129), where it is crossed, at a height of 2,266 feet, by a road that leads from the S.W. part of the county of Wicklow to the county town. There is one eminence of 2,416 feet here in the townland of Conavalla to the E. of Table Mountain, while towards the west a lofty spur stretches out, that gives rise to the watershed between the Liffey and the Slaney. From Table Mountain the main watershed runs due S. to Lugnaquilla (3,039 feet), the loftiest eminence on the eastern side of Ireland, and is continued southwards between the basins of the Slaney and the Avonmore, over ground which, three miles S. of Lugnaquilla, sinks 1,000 feet, and though still hilly can no longer be called mountainous.

The general course of the line thus traced is about N.E. by N., and S.W. by S.; the ridge being a broad undulating mountain mass, with rounded hills like great woolpacks, and shallow open valleys, and all the ground barren, dreary, and monotonous, covered either with heather or bog. While this main ridge runs S.W. by S., however, from Dublin Bay, the general outline of the coast, runs S. by E., and thus takes in a gradually widening tract of ground between the main ridge and the sea. As we descend towards this district from the summit of the main chain, we find its sides indented by picturesque ravines, expanding into valleys, between which rise isolated hills, not so lofty as those we have left, but much more varied in outline, often exhibiting sharp peaks, or serrated crests.

Of these isolated hills we may enumerate the following; beginning at the N., Carrickgollogan (often called Shankill, 912 feet), Bray Head (795 feet), Little Sugar Loaf (1,120 feet), Great Sugar Loaf (1,659 feet), Downshill (1,232 feet), Dunran Hill (1,122 feet), Carrick Mountain (1,252 feet), Trooperstown Hill (1,408 feet), Kirikee Mountain (1,559 feet), Croaghanmoira (2,175 feet), Ballyshane Hill (1,259 feet), Westaston Hill (E. of Rathdrum, 894 feet), and Castletimon Hill (5 miles S. of Wicklow), 783 feet.

There are other eminences equal to these in altitude, but those mentioned above are selected as the most conspicuous in their several localities.

The head-waters of the rivers Dodder and Liffey spring from the high ground included in the N.W. corner of Sheet 121, and run from it towards the interior in the first instance; the remainder of the ground included in Sheet 121, and all that included in Sheet 130 is traversed by streams which run directly out on to the coast of Wicklow. These streams belong to three principal river-basins, that of the Dargle, the mouth of which is at Bray; that of the Vartry, which runs into the broad lough of Wicklow; and that of the Avonmore, which brings the drainage of the whole of the eastern flank of the main chain from Sally Gap to Lugnaquilla, into the sea at Arklow (in Sheet 139). What is called the source of the Dargle is in the mountain bog lying between War Hill (2,250 feet), Tonduff (2,107 feet), and Kippure; one so called source of the Liffey being on the other side of the same bog. At the edge of the high ground, the Dargle forms the well known Powerscourt Waterfall; and after receiving the Glencree River, which brings down the Lough Bray drainage, it cuts deeply into the rocks to form the picturesque Dargle Glen, below which it receives another tributary called the Glencullen or Cookstown River, and the little brook which issues from the pass called the Scalp, together with some other tributaries from the northern slopes of the two Sugar Loaf Hills.

The Vartry River does not draw any of its water from the crest of the main chain, its farthest sources coming from the slopes of Douce Mountain and the Great Sugar Loaf, and the Calary Marsh between them. It runs almost due south for about seven miles, in a shallow upland valley, the bottom of which is 600 or 700 feet above the sea, separated from the main chain by the deep trench of the Annamoe River, which so far runs parallel to it. The Vartry then turns suddenly to the east, and cuts through the hills in that direction, down a fine ravine called the Devil's Glen, in which it forms a well known waterfall. Escaping from this ravine it runs over some low land to the sea-coast, but is prevented from entering the sea directly by the long pebble beach which the sea has piled up along that coast. This pebble beach extends from near Greystones to Wicklow Harbour, a length of about ten miles. The Vartry runs into the tidal lagoon called the Broad Lough, inside the southern end of this beach, the formation of which will be more particularly described further on.

The Annamoe River is the head-water of the Avonmore, by which name it is known before reaching Laragh. That which would popularly be called its source is the Crockan Pond, in the mountain bog already spoken of as giving off a stream to the Liffey and the Dargle. From this it runs down in a rapidly deepening channel into the small lake called Lough Tay (807 feet), and then into the side of the larger Lough Dan (681 feet). At Laragh it receives two tributaries as large as itself, the Glenmacnass River from the flanks of Mullaghcleevaun, and the Glendalough River which is formed by the union, at the Seven Churches, of the Glendasan River from Lough Nahanagan (1,385 feet), and the Gleneala River which flows through the lakes of Glendalough, the upper of which is 440 feet above the sea. Ten miles below Laragh is the first Meeting of the Waters, where the Avonmore receives the Avonbeg, which brings through Glenmalure the drainage of the northern slopes of Lugnaquilla and all the adjacent mountains; whilst four miles lower down is the second Meeting of the Waters at the wooden bridge where the Ow River falls into it from the southern slopes of Lugnaquilla and the adjacent high grounds. Thus far the general course of the Avonmore has been nearly due south, deflected a little to the eastward occasionally, especially below Laragh, but it now turns to the S.E. falling into the general course of the Ow, and continues on that course for five miles till it enters the sea at Arklow. It is to be observed that the Avonmore through its course from Lough Tay to the sea receives all its principal tributaries from the west, forming as it were a great catch-water drain along the eastern margin of the main chain, while the brooks falling into it from the hills on its eastern side are short in course and insignificant in number and character.

These eastern hills, however, give off streams that run directly eastwards into the sea between the mouths of the three principal river-basins.

Of these we need only mention the following:—The brooks of Kilcoole and Newcastle, that have formed the marshes behind the pebble beach S. of Greystones, and escape through that pebble beach at a place called "The Breaches;" the brook called the "Three Mile Water," between Wicklow Head and Castletimon Hill; that called "Potter's River" between Castletimon and Ballinaclea Hill (353 feet); and the brook that carries the drainage of the Redcross Valley into the sea two miles S.W. of the point called the Mizen Head (in Sheet 139).

NOTE.—It has become so customary to speak of every river having *a source*, and to point to some particular spring or brook as *the source* of such and such a river, that we are in danger of treating that term as a reality which is but an arbitrary convention.

No river can have any one source nor even a small number of sources. Every large river must have an indefinitely great number of sources, running towards it from along the whole line of its watershed round its entire basin.

The *watershed* of a river basin is that line which runs from one side of the mouth of a river round to the other side of its mouth, without ever crosssing *running water*. The *basin* of a river is the area enclosed by its *line of watershed*.

Bogs, marshes, and lakes may occur in some places on a line of watershed, the waters of which run off by gradual drainage in opposite directions, but these where the line of watershed crosses them are not running water.

2. *Formations, or Rock-groups entering into the Structure of the District.*

AQUEOUS ROCKS.

Name.	Colour and Distinction on Map.
Bogs, Alluvial Flats, &c.,	*Pale sepia.*
Drift—Sands, Marls, Clays, and Gravel.	*Engraved dots.*
b^2. Lower Silurian beds, whether Llandeilo, or Bala and Caradoc,	*Pale purple.*
β^2. Altered Silurian beds, converted into Mica, and other schists, on the borders of the Granite,	*Pink.*
a. Cambrian Slates and Grits,	*Gray.*
q^r. Quartz-rock, which in this area occurs only in the Cambrian Rocks,	*Yellow.*

IGNEOUS ROCKS.

G. Granite,	*Pale carmine.*
E. Elvanite, a variety of Granite generally devoid of Mica,	*Dark carmine.*
F. Felstone,	*Carmine and chrome.*
F_s. Felspathic Ash,	*Carmine, dotted.*
D. Greenstone (Diorite),	*Carmine and lake.*
D_s. Greenstone Ash,	*Carmine and lake, dotted.*

AQUEOUS ROCKS.

a. The Cambrian formation consists chiefly of sandstones and slates, variously interstratified. Their prevailing colours are red and green, modified in different places into intermediate tints of purple, brown, and gray; rarely, if ever, showing any admixture of black or iron gray. The sandstones are usually fine-grained siliceous grits, but sometimes exhibit larger grains of partialy rounded crystalline quartz —the rock having such a crystalline aspect that it might easily be mistaken for an igneous rock if it did not consist so entirely of quartz.

Careful examination, too, will generally disclose some grains distinctly rounded.

The slates are more often of a bright purplish red than any other colour, but various shades of green passing into yellow also occur. They are less siliceous than the gritstones, but are rarely of a very "earthy" character. They are traversed by true "slaty cleavage," and seem very much of the same character as the Bangor slates of North Wales.

Either from a want of tenacity in the material, however, or want of thickness in the beds, or some other cause, no place has yet been discovered in which the slates are at all equal to those called "Bangor slates" for purposes of utility.

q^r. Quartzite or quartz-rock. Here and there throughout the Cambrian rocks there occur great beds and groups of beds of quartz-rock. This quartz-rock has generally some shade of brown or yellow, sometimes becoming reddish, sometimes almost white. When examined with a lens it is seen to be made up of minute granules of quartz, bound together by a siliceous cement into a smooth, almost compact stone, intensely hard, but rather brittle.

It is jointed in every direction both by large visible joints, and smaller imperceptible ones, which cause it to break up into small angular fragments. The original bedding of the rock can rarely be discerned in it, and its stratification can only be determined by following its upper and under surfaces, and tracing their junction with the slates and sandstones above and below.

Some of the gritstones are so siliceous, and some of the quartz-rocks becomes so granular, that it is not always easy to determine whether to call any individual mass of rock a siliceous grit, or a quartzite. The principal masses marked on the map, however, are very decided in character, and have always been called quartz-rock by every geologist who has examined them. They vary in thickness from twenty, to several hundred, feet.

Isolated sections in the Cambrian rocks sometimes show an aggregate thickness of three or four thousand feet; but as the lowermost beds of the group are nowhere exposed, nor any beds that can certainly be decided on as the uppermost, the total thickness of the whole formation cannot, of course, be ascertained.

Organic remains occur sparingly in the Cambrian rocks of this district, the principal fossil localities being Bray Head, and Carrick Mountain to the west of the town of Wicklow. They consist of *Oldhamia*, a form first observed by Dr. Oldham when Local Director of the Survey, and named after him by the late Professor Edward Forbes; and *Histioderma*, discovered and named by the late Dr. J. Kinahan. (*See Trans., R.I.A., vol.* XXIII., *p.* 556.

b². *Lower Silurian Rocks.*—These consist chiefly of black, or dark gray, slates, often interstratified with thin dark gray fine-grained grits. Some parts of them show very narrow parallel bands of dark and light gray colours, thirty or forty separate streaks in the thickness of an inch, and are then called by us "ribboned slates." Others make black smooth shining slates, two or three feet in thickness, without any alteration of colour or texture.

The dark gray grit-bands vary in thickness from one-tenth of an inch to three or four inches. Groups of beds of hard sandstone and gritstone also occur, each bed a foot or two in thickness.

These Lower Silurian rocks become in the southern part of the area variously interstratified with rocks of igneous origin, both traps and ashes. They are also traversed by intrusive masses of trap, chiefly greenstones.

The mass of the granite has also penetrated them, and sent off into them numerous veins, and altered them for a certain distance into mica schist.

β. Mica Schist (*altered Silurian*).—This rock in the immediate neighbourhood of the granite, is as perfectly a mica schist as any in the Highlands of Scotland or other highly metamorphosed district. It often contains imperfectly developed crystals of Andalusite or staurolite, and more rarely garnets and other minerals. It has also sometimes the wrinkled and puckered character so often observable in mica schist. In the middle of the glittering mica schist, however, the small gray grit bands may often be seen entirely unaltered except by induration.

As we recede from the granite the whole rock gradually loses its

metamorphic or semi-crystalline character, and becomes insensibly more dull and earthy till it regains the aspect of ordinary clay slate.

The first appearance of micaceous gloss, or other indication of metamorphic action, usually takes place about a mile from the appearance of the granite at the surface, but this is very irregular, depending on the irregular form of the granite below, and the undulations of the surface above.

The thickness of Lower Silurian rock in this district must be very considerable, and where interstratified with igneous rocks is doubtless greater than elsewhere. As, however, it rests unconformably on the Cambrian rocks, and its upper portion has been removed by denudation, there are no means of determining its total original thickness. Neither, in the absence of continuous sections, can any definite conclusions be arrived at as to the thickness of particular parts of it, with the exception of that afforded along the blunt promontory ending in Wicklow Head, where a continuous steady dip to the eastward at a mean angle of 45° along a coast section of two miles, but oblique to the bedding, certainly shows a thickness of several thousand feet of strata.

The Drift.—Patches of limestone-gravel rest here and there upon the granite at heights of more than 1,000 feet above the sea, and the same material thickly covers the lower slopes of the ground, frequently to a depth of 20 or 30 feet at least.

In many places beds of fine sand and gravel, with marl containing recent marine shells, repose on this limestone gravel, or directly on the rocks, without its intervention, to heights of 500 and 600 feet above the sea.

Igneous Rocks.

G. *Granite.*—The granite of the main chain is of pretty uniform character throughout, its varieties depending either on the size of its crystals, or the relative abundance of black and white mica.

According to the researches of the Rev. Dr. Haughton, F.R.S., it consists of—

Orthoclase, . . .	52·94
White Mica, . . .	14·18
Black Mica, . . .	5·27
Quartz, ...	27·66
	100·05

(*See Trans. R.I.A., vol.* XXIII., p. 606.)

In some districts the felspar forms large distinct crystals, and gives the rock a porphyritic character. In some places black mica is abundant, in others it is almost, or altogether, wanting. In some places veins of exceedingly fine texture and white colour traverse the coarser granite. This variety we have spoken of as Eurite, a name which is used by Dr. Boase, for a similar variety in Cornwall (*Trans. R. Geol. Soc. Corn., vol.* IV., *p.* 369, &c.)

The granite is much more durable in some places than in others, perhaps in consequence of its more siliceous composition. In general, however, it does not make a durable building stone, soon becoming stained with small ferruginous blotches, and gradually getting weathered and tender over the whole surface.

In some places, as on the flanks of Glencullen, it is decomposed *in situ* to a depth of many feet from the surface, so that the undisturbed crystals can be dug out with pickaxe and spade. Quartz veins may sometimes be traced undisturbed through this granite sand, showing that the decomposition of the rock is the result of mere weathering *in situ*. This decomposed granite is called in Cornwall *Growan*, and is said to have been dug into in some places to a depth of 140 feet. It is also said that veins of granite among the slate met with in mining below ground are sometimes converted into *Growan* (*Trans. Geol. Soc. Corn., vol.* II,, *p.* 377, *and vol.* IV., *p.* 478.)

F. *Elvanite.*—This is merely a peculiar variety of granite, commonly occurring in veins but sometimes in larger masses.

It is usually poor in mica, that mineral often being entirely absent; and it sometimes assumes the character of a felstone-porphyry, especially on the sides of the veins, while it is quite a granite in the centre. This is the character also of the principal Cornish Elvans. (*See Trans. Geol. Soc. Corn., vol.* IV., *p.* 292.)

F. *Felstone.*—This rock is in its ordinary typical character, a mixture of felspar, probably orthoclase, with an overplus of silica. It is a hard compact rock of various shades of gray, showing occasional crystalline facets of felspar (orthoclase) here and there, and sometimes a crystalline granule of quartz. These crystalline granules of quartz are sometimes quite globular, and can even be detached from the mass, leaving a smooth round cavity; they might then be mistaken for rolled grains or little pebbles of quartz, but are in reality *blebs* of that substance, formed during the consolidation of the mass by the segregation of some of the quartz which is elsewhere mixed up with the felspar in a state of paste.

Sometimes both minerals become crystalline throughout the mass of the rock, which is then a crystalline felstone, and passes into elvanite.

It does not often assume, in this district, the form of a regular porphyry.

Occasionally felstone assumes a streaky character, especially on the weathered surfaces, which show parallel striæ of different colours;—sometimes even, sometimes undulating. These are supposed to be due to the flowing of the rock while in a viscous state, and are sometimes spoken of as "striæ fluxion."

Fs. *Felspathic Ash.*—This is a laminated rock formed of the materials of felstone, frequently with a flaky structure, and decomposing into a softish mass easily ground down into powder. It sometimes includes angular chips and fragments of felstone, or even of slate or other rocks, and passes occasionally into a breccia.

When the rock is quite firm and compact, it is not always easy to distinguish it from some varieties of felstone, though in most cases its mechanically formed structure is discernible.

Its colour is gray, like that of felstone, but often with a greener tinge, and when decomposed it is often stained yellow or brown.

D. *Greenstone* (*diorite*).—There are many varieties of rock which can all be included under this designation, as being a variable mixture of a felspar with some hornblendic mineral, and entirely devoid of any granules of quartz. When coarsely crystalline the

minerals become distinct, but the crystals are sometimes so small as to be barely discernible with a lens, and the rock becomes almost compact.

One remarkable variety contains a dark bronze-coloured mica, both as distinct crystalline plates, and as a micaceous coating to the surfaces of the other minerals, or along minute irregular surfaces that show themselves when the rock is broken open.

It occasionally becomes porphyritic by the development of crystals of felspar larger than the rest.

Ds. Greenstone Ash.—One of the most marked varieties of this rock, is a dark apple green slate, of a smooth compact texture, with a soapy feel. It would not perhaps be recognised as anything but an ordinary clay slate, were it not for its peculiar colour and texture, and its only occurring among the trappean rocks.

Another variety is a dark olive brown rock, with minute black specks, but quite fine-grained, or even compact in texture. This only occurs in association with masses of greenstone which appear to be contemporaneous beds of that rock interstratified with slate. It occurs under precisely similar circumstances in the Berwyn Mountains in N. Wales.

There are several other more indefinite varieties of dark slaty rocks, some of which show veins of asbestos, and some include small lumps that are either extraneous fragments or nodular concretions. These have been included as greenstone ash, without any very exact determination of their character, but because they are associated with the trappean rocks, and are not felstone ash on the one hand, nor ordinary clay slate on the other.

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

The heavy round backed hills of the main chain described at page 6 are formed of granite, which here as elsewhere makes hills which look like great woolpacks.*

Where the granite is covered by a coating of mica-schist, the outline of the ground immediately assumes a more delicate and elegant form. This can be seen even from the neighbourhood of Dublin, by comparing the peaked outline of Douce Mountain, formed of mica-schist, with the more lumpish granite mountains to the west of it.

In the Cambrian formation the ground is irregular in form, its most striking features being due to the quartz-rocks, which stand out as abrupt crags, often forming rocky crests to the hills, as on Bray Head and Carrick Mountain. The Sugar Loaf Mountain presents a conical form when viewed from the N. or S., but when observed from the E. or W., it is seen to be merely the longitudinal crest of a N. and S. ridge.

The hills in the Silurian slate country are often peaked, but have generally smooth slopes, except where they are roughened by the occurrence of trap rocks. Many of these hills have rudely conical

* I believe true granite, as contra-distinguished from gneissose granite, or granitoid-gneiss, always makes ground of this character.

forms rising steeply out of lower gentle slopes, where the slate rocks are mantled over with Drift deposits.

The Cambrian rocks lie in such varied and confused positions that no general dip or strike can be assigned to them.

About the Great Sugar Loaf they are believed to strike N. and S., and dip towards the east. About Bray Head they strike apparently N.E. and S.W., and dip N.W.; and a N.E. and S.W. strike seems to prevail from Bray Head to Roundwood. Farther S. the strike is usually E. and W., and the dip towards the N.

As we ascend from the Cambrian area towards the granite hills, we everywhere find a band of black or dark gray Silurian slate interposed between the Cambrian and the ground where the granite appears at the surface; the slates being altered into mica-schist of a more and more decided character as we approach the granite.*

At Carrickgollogan a boss of Cambrian slate and quartzrock appears through the Silurian rocks, within half a mile of the surface edge of the granite. This is the closest surface approximation of the Cambrian to the granite, the width of the Silurian band being elsewhere never less than two miles, one half of which is metamorphosed into mica-schist. On reaching the latitude of Roundwood the Silurian belt is three miles wide, and a few miles S. of that it spreads completely across the Cambrian rocks, which from the S.W. end of Carrick Mountain, are no longer seen at the surface.

The relations of the Silurian to the Cambrian rocks are everywhere very obscure, and to the north of Roundwood are absolutely undeterminable. In the country S. of the Devil's Glen, however, I arrived at the definite conclusion, when I examined the district in the year 1853, that the Silurian rocks rested unconformably on the edges of the Cambrian rocks.

I was also induced to suppose that the main Cambrian area was cut off by a long fault running N.E. and S.W., the principal reason for that supposition being the sudden appearance of black slates at several intervals along that line.

Immediately to the S.E. of the line, however, rises the Cambrian ridge of Carrick Mountain, the beds of which strike steadily N.E. and S.W., apparently dipping at a very high angle to the S.E., at the S.W. end of the ridge, and being elsewhere vertical.

An unconformable envelope of black Silurian slate is supposed to fold all round the foot of this ridge; and to the southward of it nothing but Lower Silurian rocks are visible between the granite hills and the sea.

These Lower Silurian rocks appear to have a general strike of N.E. and S.W. This is shown by the few dips that can be determined in them, being usually either to N.W. or S.E. at high angles, and by the general run of the contemporaneous traps and ashes being from N.E. to S.W. From an entire absence of any good sections, however,

* See a paper "On the Structure of the North-Eastern part of the county of Wicklow," by J. Beete Jukes and Andrew Wiley, in the fourth volume of the "Journal of the Geological Society of Dublin," part first, in which the continuance of the Silurian slates between the granite and the Cambrian rocks, from Croaghanmoira Mountain, W.S.W. of Rathdrum, up to Killiney, was first insisted on, and was afterwards adopted, and acknowledged by Sir R. Griffith, in the subsequent editions of his map.

it is impossible to say with certainty what thickness the Silurian rocks may have, or even which are their upper, and which their lower beds. It is reasonable to suppose that the lowest beds are those next the Cambrian rocks, in which case the trappean beds lie at a considerable height in the Silurian rocks, and may possibly be in the uppermost part of them.

Intrusion of the Granite.—It is evident that some considerable disturbance and denudation of the Cambrian rocks had taken place before the deposition of the Lower Silurian. The deposition of the latter rocks together with all their felstones, and greenstones, and associated ashes, had also taken place before the intrusion of the granite. Perhaps we might venture to suppose that the ejection of those traps and ashes into the sea, in which the Lower Silurian silts were being accumulated was a symptom of the approach towards the surface of that igneous influence of which the granite was either a cause, or a consequence.

Whenever the intrusion of the granite occurred, it worked its way apparently through the lower or Cambrian formation into the upper or Silurian formation, without bringing up any of that Cambrian formation on its flanks. The granite does not appear to have acted as an elevating force, pushing up the rocks before it, but to have quietly eaten its way through them as it were. It does not form anything resembling a geological axis, with the aqueous rocks arranged in regular order on each side of it, according to the old idea of the behaviour of granite. On the contrary, the Cambrian or lowest rock of the country is nowhere in contact with the granite, and it does not appear that the Silurian beds which are in contact with it are the lowest beds of that formation, or that the same beds themselves everywhere rest upon the granite.

The appearance of detached bosses and knobs of granite at a distance from the main chain, as at Ballinacarrig and Ballinaclash, and the existence of the elvan courses running parallel to the main chain, but at some miles away from it, makes the existence of an irregularly undulating floor of granite, with veins sprouting from it at intervals, extremely probable. This idea is very well illustrated in the sections across Lugnaquilla and other parts of the granite chain, constructed and published by my predecessor, Dr. Oldham, when he was Local Director of the Irish Survey. Isolated patches of metamorphosed clay-slate, like that at no great distance from the granite, also render its existence at no great depth below the surface a probable occurrence even in places far removed from its out-crop.

J. B. J.

Remarks on the Fossils.

The asterisks prefixed to the names of species are intended to represent their comparative abundance.

Amongst the old collections made by the Geological Survey there were a few fossils from localities in the neighbourhood of Rathdrum, county of Wicklow, in Lower Silurian strata; some of these places have been more recently visited, and additional specimens procured.

The following are the species and localities referred to:—

Rathdrum Hill, Kilcommon, co. Wicklow, $\frac{3}{10}$† or $\frac{3}{20}$, in gray sandy beds.

* Leptæna Griffithiana, n. sp.*
Orthis calligramma.
Orthonota—species undetermined.
Calymene brevicapitata.
* Phacops Brongniarti.

Quarry near Rathdrum Bridge, on road to Glenealy and Wicklow, townland of Glasnarget north, co. Wicklow, 30† (?), in cleaved slate.

Stenopora fibrosa.
Orthis calligramma.
Crinoid joints and stems.
Trilobite fragments.

Some fossils in black slates included in this old collection were labelled "Wicklow $\frac{30}{3}$† one mile on road from Rathdrum to Redcross," and named as follows:—

Discina perrugata?
Lingula brævis?
Modiolopsis—species undetermined.

Mr. Davidson, to whom the Brachiopods were submitted for examination, considered them to be too obscure for exact determination.

When visiting this neighbourhood lately we looked carefully for the locality indicated, as from the character of the fossils it appeared to be important; we did not, however, succeed in finding any other specimens, although we met with a small exposure of black slates, very similar in lithological character, crossing the road in the townland of Glasnarget south, at about where it appeared probable the place might be situated.

We found fossils to be very abundant in gray slate of a different character (although difficult to extract entire in consequence of "cleavage" and the small quantity of rock exposed) at an old road cutting in the townland of Slieveroe, county Wicklow, $\frac{30}{4}$.†

The following species indicating strata of Caradoc or Bala age were identified from the former and more recent collections made at this place:—

Zoophyta.

** Stenopora fibrosa—branching and hemispherical varieties.

Mollusca—Brachiopoda.

** Leptæna sericea.
Strophomena depressa.
" tenuistriata.
Orthis elegantula.

Heteropoda.

Bellerophon perturbatus.

Echinodermata.

Crinoid joints.
Glyptocrinus; portion of column.
Palæaster? starfish allied to Teniaster (*Billings*).
Cystidean? plate.

Crustacea—*Trilobita*.

Beyrichia complicata.

* Named provisionally by Mr. Davidson, who believes it to be a new form, but defers its exact determination for the present.

† These numbers refer to the quarter sheets of the 6-inch map. We were, however, unsuccessful in determining the exact position of the above localities on our visit.

** Calymene brevicapitata; one specimen entire.
Homalonotus bisulcatus?
Lichas laxatus.
** Trinucleus concentricus.

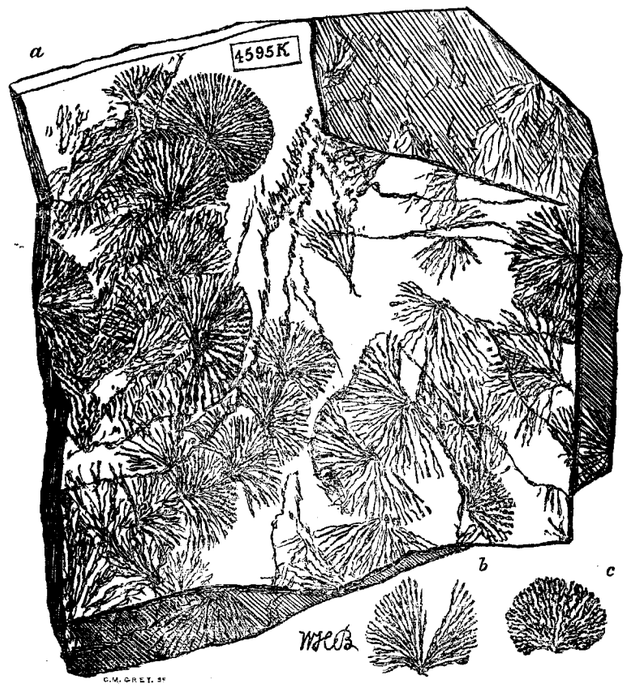
Annelida.

Tentaculites Anglicus.

The Cambrian rocks of the district included within these two sheets of the Geological Survey maps, contain a few fossiliferous localities only, being situated at its northern and southern extremities.

At Carrick Mountain, about five miles north-east of Rathdrum, the fossils named *Oldhamia antiqua* (Forbes), showing successive series of branchlets (woodcut, fig. 1), with tracks and burrows of marine animals, *Arenicolites didyma*, &c. (Salter), and ripple marks, are frequent in some of the brown and purple laminated shales.

Fig. 1.



At Dunran Demesne close to the small lough, about two miles S. of Newtownmountkennedy, markings resembling those of *Oldhamia radiata* (Forbes) and small tracks, occur in a green slaty rock; they are not, however, so definite in character as those observed in the rocks at Bray or Graystones.

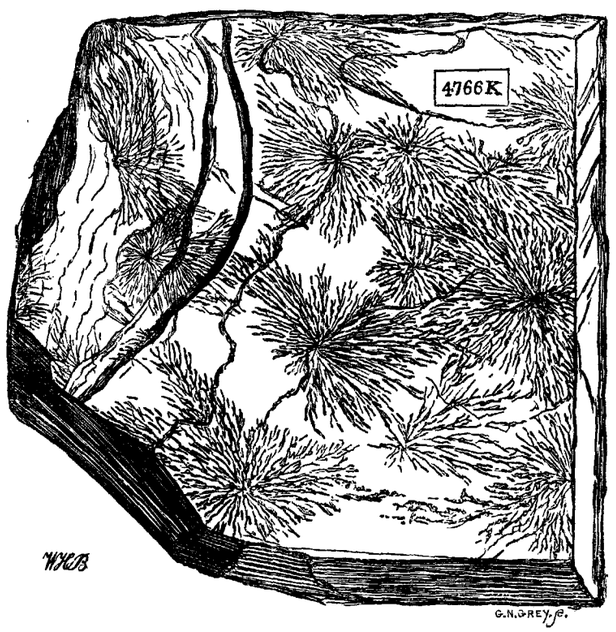
The rocks forming the low cliffs on the shore at Graystones, near Delgany, and at the railway cutting near the station, exhibit in certain beds, both of purple and green laminated grits, a profusion of *Oldhamia radiata* (Forbes),

(woodcut, fig. 2); and here, as well as in corresponding rocks more extensively developed on the shore at Bray Head, continuing for about two miles along the coast towards Bray, these remarkably characteristic fossils are to be obtained in the greatest perfection. *O. antiqua* is alluded to by the late Dr. J. R. Kinahan as also occurring at this place,* and a specimen presented by him, and said to be from this locality, is in the collection of the Geological Survey.†

The principal and most easily accessible places for obtaining these fossils are from the cliffs along the shore, especially at the group of rocks exposed at low water, called the Periwinkle Rocks, Bray Point, about one mile south of Bray.

The beds at this part consist of fine-grained green and purple grits and shales, highly laminated, dipping towards the N.W., in which the most frequent species, *O. radiata*, occurs in the greatest profusion, especially in the green grits, nearly every layer being more or less covered by the stelliform bunches of these well-defined organisms, and where the surface of the laminæ are tinged with a brownish hue, they are exhibited still more clearly. The sketch (fig. 2) taken from a fragment of this rock will serve to show the ordinary appearance of the species.

Fig. 2.



* On the genus Oldhamia; Trans. Roy. Irish Acad. (1858), vol. 23., p. 556.

† In the memoir above referred to by Dr. Kinahan there is evidently a mistake in the names attached to some of the figures of Oldhamia, said to be from Graystones; for instance, on pages 552 and 559, figs. 4, 9, and 10, called *O. antiqua*, should be *O. radiata*; in confirmation of which, at page 557, he mentions figs. 3, 4, 5, 8, 9, and 10 as examples of the latter species.

Both species are found indiscriminately in red, purple, and green beds generally in shales between harder strata, which are more readily acted upon by sea and atmospheric agency at various places in the cliffs along the shore to the Head, as well as in the cutting of the Dublin, Wicklow, and Wexford Railway, and in Kilruddery Demesne adjoining, the property of the Earl of Meath. The lithological character of the deposit in which they occur varies considerably, the red beds usually presenting the condition of a consolidated mud deposit, having a very fine and smooth surface upon which are occasionally scattered the disconnected fan-shaped branchlets of *O. antiqua* accompanied by horizontal and vertical tracks and burrows of Annelidan? worms of different sizes. The same species also occurs in the Kilruddery Demesne, at Bray Head, just inside the boundary wall, a locality first pointed out to us by Professor Harkness, of Queen's College, Cork, in beds of a purple colour and more sandy character, the branches of fan-like tufts presenting a plumose appearance, and sometimes impressed upon each other, cover the surfaces in considerable numbers, accompanied by tracks of various kinds and ripple marks; good examples of this species (*O. antiqua*) were also collected by Dr. Kinahan, and presented by him to the Geological Survey, from other beds (apparently from the cliffs on the coast) of a slaty character and green colour; scattered over the smooth surfaces of the thin laminæ of which these beds are composed, may be seen small but remarkably perfect branches of *O. antiqua* with tracks and markings of various kinds, including some resembling the sinuous furrows described and figured by Mr. Salter,* and the double markings or openings described and figured by him as *Arenicolites didymus* and *sparsus*.† A representation of a portion of one of these surfaces is shown at figure 3.

Fig. 3.

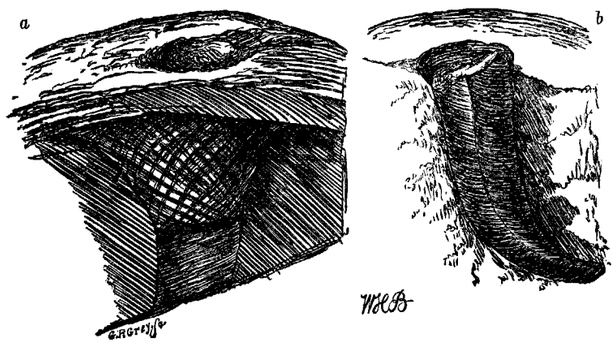
The large cylindrical casts of burrows described by Dr. Kinahan, and

* Journal of the Geological Society of London, vol. 12 (1856), p. 249, pl. 4, fig. 2.

† *Ibid*, p. 248, pl. 4, fig. 1, *a b*.; and vol. 13, p. 203, pl. 5, figs. 1 to 4.

named *Histioderma Hibernicum** (woodcuts, figs. 4, 5, and 6, the original fossils being represented on fig. 4, *a b*. We have lately

Fig. 4, *a b*.



had an opportunity of examining, through the kindness of Mr. Thomas D. Falkiner, who discovered a surface of rock covered with a number of the large mounds from which proceed the burrows of this supposed Annelidan worm. The bed in which these fossils occur is a compact greenish grit, situated on the shore close to high water mark, near the Periwinkle rocks, a little south of Bray Point. The mounds are about three inches in diameter; the opening to the tubular burrows, which usually proceed in a direction vertical to the bedding from a depression near the centre, the relative position they occupy to each other, is seen at fig. 6, which shows a portion of the surface with three of these mounds reduced to half natural size. One of the tubular casts (fig. 7) worked out with some difficulty from this extremely hard rock, by Mr. P. Mayne, who accompanied us on our visit, and presented it to the Geological Survey, is nearly four and a half inches long, with a diameter of three-quarters of an inch, the termination not having then been reached. These burrows are variable in length and amount of curvature, and may possibly have been caused by different animals. They usually occur in coarser and more solid beds than those which contain the Oldhamia. In the collection of fossils made by the Survey from Carrick Mountain is a large tubular cast of this character in micaceous grit, which may have been produced by a marine animal having similar habits, such as that of burrowing in the sand of the sea-shore, like the lob-worm of the present day.

The specimen to which Dr. Kinahan applied the name of *Haughtonia pœcila*, described as from red gritty beds, Periwinkle rocks, Bray Point, presented by him to the Geological Survey, and which he considered to be an aggregation of tubes of a gregarious Annelid allied to *Sabella*,† does not appear to us to be sufficiently clear to establish its organic character. It is, however, placed in the Palæontological collection, at present arranged in the museum of the Royal College of Science, 51, Stephen's-green, Dublin.

* Journal of the Geological Society of Dublin, vol. 8, p. 70, pl. 6.
† Journal of the Geological Society of Dublin, vol. 8 (1859), pp. 116–118, figs. 1 and 2.

Fig. 6.

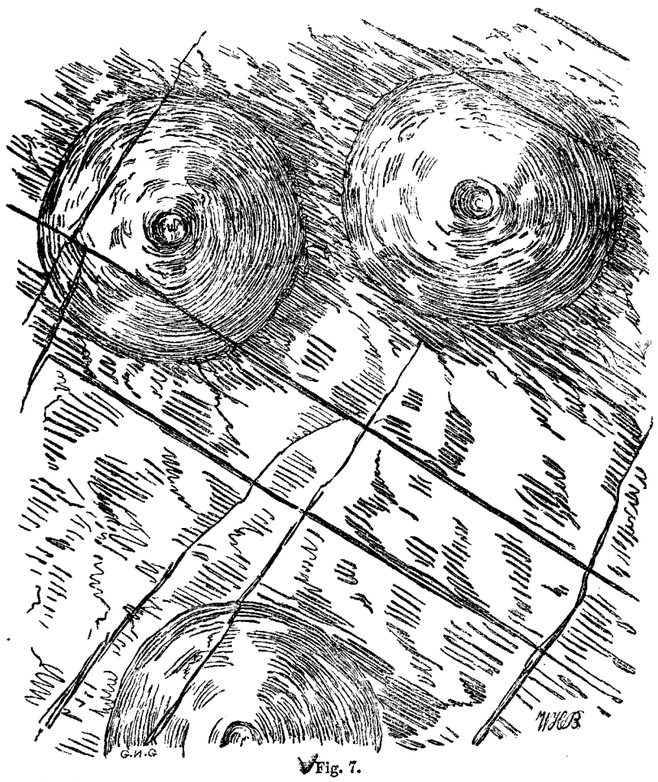
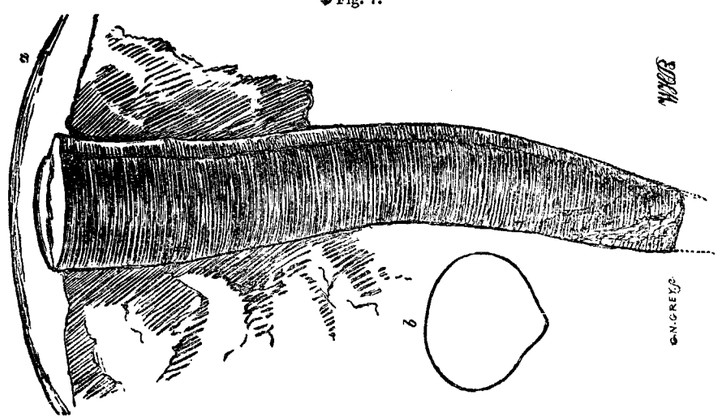


Fig. 7.



Rocks referred to the Cambrian formation also occur at Howth, county of Dublin, and are described in the explanation of the Geological Survey of that district ;* a few markings resembling *Oldhamia antiqua*, although not so distinct either as those from Carrick mountain, or the coast of Bray, were procured by Dr. Kinahan in brown laminated slates at Puck's Rocks, near the "Nose of Howth." Mr. C. Galvan, of the Geological Survey, afterwards collected an additional specimen at this place which was, however still less definite.†

In the absence of such distinctive characters as may be considered sufficient to determine the vegetable nature of the Oldhamia, to which division some palæontologists have referred them, it appears to us scarcely advisable to disturb the notions we have received from its discoverers as to its zoological affinities, or to decide at present with any certainty as to the positive alliance of these remarkable fossils either with plants or animals. Professor Thomas Oldham first hinted at their probable zoophytic character,‡ and a few years afterwards the late Professor Edward Forbes, when Palæontologist to the Geological Survey, described and named them after their discoverer, defining the two species, *Oldhamia antiqua* and *radiata* ;§ and with the clear judgment for which that eminent naturalist was distinguished, expressed his belief that they belonged either to *Hydrozoa*, as allied to *Sertularia* on the one hand, or to *Polyzoa*, through such forms as *Gemellaria*, and *Cellaria*.

The late Dr. J. R. Kinahan, Professor of Zoology at the Irish Industrial Museum, who next undertook the investigation of Oldhamia,‖ agreed with the first of the two suggestions as to their position in the animal kingdom offered by Professor Forbes, viz., that of their alliance with the Sertularian Polypes ; since then, in a recent article on the fossils of the Cambrian rocks,¶ after quoting the opinion of the eminent authorities who first described them as zoophytic animals, I ventured to offer the following remarks—"Some difference of opinion has been expressed as to whether these fossils belong to the animal or vegetable kingdom ; some continental writers having figured and described them as fossil plants,** others again have even questioned their organic character, considering them merely as markings caused by a peculiar condition of the rock." I believe, as I then stated, we have sufficient evidence of their organic nature, although their alliance either with animals or plants still remains doubtful ; their resemblance to some of the jointed marine plants, such as the lime-secreting *Nullipores*, being sufficiently near to justify their arrangement amongst fossil plants. On the contrary, their general form assimilates so much to that of certain Sertularian zoophytes, and, perhaps, to some of the Polyzoa, as to lead to the belief in their animal affinities ; an opinion which would be confirmed by the satisfactory discovery of polype cells,†† and accord with the views of the eminent authorities who first suggested their alliance with that class of animals.

WILLIAM HELLIER BAILY.

July 9th, 1857.

* Explanation to sheets 102 & 112, pp. 6 & 30.

† An allusion to the occurrence of Oldhamia in these rocks is given in the Explanation above cited at p. 6, and in a note by Mr. Jukes at the foot of p. 40.

‡ Journ. Geol. Soc. of Dublin, vol. 3 (1844), p. 60.

§ Ibid, vol. 4 (1848), p. 20.

‖ Trans. Roy. Irish Acad. vol. 23 (1858), p. 556, &c., *op. cit.*

¶ Geological Magazine, vol. 2 (1865), p. 385, &c.

** Ueber die Fossile Flora der Silurischen, &c., by Dr. H. R. Goeppert (1859), p. 436, &c.

(In the Memoirs of the Geological Survey, vol. 3 (1866), Mr. J. W. Salter follows Goeppert in considering these fossils to be plants; see appendix, page 281.)

†† Dr. Kinahan at one time believed that he had obtained specimens showing such cells ; they did not, however, appear to us to be sufficiently decided, and he probably mistook the jointed or bead-like character of the fasciculi of branchlets which is sometimes very conspicuous in both species, for these essential animal organs.

DETAILED DESCRIPTIONS.

In writing the detailed account of the rocks, as seen in their several localities, the country included in these two sheets will be divided into the following districts:—

a. The Carrickgollogan district.
b. The Bray Head district.
c. The Dargle district.
d. Lough Bray, Castlekelly, and Kippure districts.
e. The two Sugarloaf Hills.
f. Douce Mountain and Roundwood districts.
g. Togher or Roundwood.
h. The Devil's Glen and Carrick Mountain.
i. Glenmalure and Ballinacor districts.
j. The Wicklow district.
k. The Rathdrum district.
l. Connary, Kilmacoo, and Westaston districts.
m. The Castletimon district.

a. The Carrickgollogan District.—The quartz rock of Carrickgollogan Hill occurs in the form of a narrow ridge, striking N.E. and S.W., one mile and a half in length, with a maximum width of 250 yards at the S.W. extremity, where it also attains its greatest elevation of 912 feet. Light greenish and gray sandy slates, like Cambrian rocks show themselves in the ground on its northern side, and, taken together with the quartz rock, would point to the Cambrian as being the group to which these rocks most probably belong. Black and blue slates are seen on its southern side, the discerned dips in the latter being to the southward at 30°. A bed of greenish felspathic ash occurs in the black slates at the southern boundary of the quartz rock, which fact together with their colour and character, would group them with the Lower Silurian rather than the Cambrian rocks of the district.

At the distance of 250 yards N.W. of the summit of Carrickgollogan there occurs a thin band of gray quartz rock about a quarter of a mile long and 40 yards wide, having smooth greenish gray slates at either side of it. This and the former quartz bands appear to belong to a boss of Cambrian rock, which probably rises through the dark Silurian slates and schists.

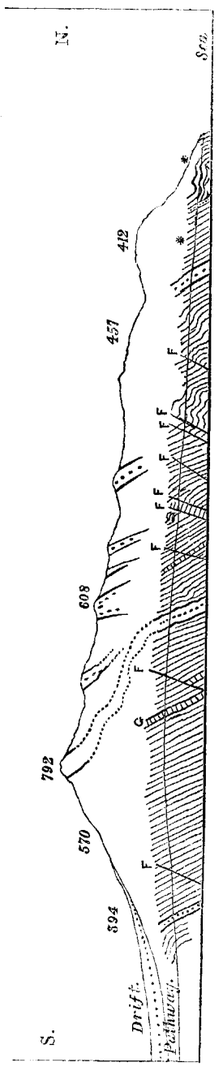
On the prominent bosses, which form the peak of Carrickgollogan, the Rev. Professor Haughton some years ago detected small highly glazed and vitreous-looking surfaces, resembling at a hasty glance fresh snail or slug tracts. On close examination, however, it is evident that many of them are distinctly lower than the adjoining unglazed quartz rock. These he attributed to the effects of lightning, and has called them "Lightning glaze." Many years ago I observed and noted the same appearance on the quartz rock of Howth, but was unable at the time to offer any explanation for it. To the north of this small boss of Cambrian rock, and on the northern slope of the hill towards the shot tower of the Ballycorus Smelting Works, some dark bluish gray Lower Silurian slates and gray grits are exposed for the distance of 30 yards, dipping to the S.E. at 30° to 40°. These beds, though traversed by two larger eurite dykes, and though the granite is distant from them but 320 yards to the northwards, are not in the least micacized ; as they are traced, however, in the direction named, they at once become highly micaceous over the space just indicated, and close to the granite the beds dip to the S.E. at 40°.

At the distance of a mile eastwards of Ballycorus, and close to Shankhill House, the gray micaceous slates touching on the granite, together with the adjoining unaltered slates, are exposed, and both varieties of rock dip to the S.E. at 30°, being in many places traversed by granite dykes.

The granite of Rathmichael, Ballycorus, and the Scalp is well exposed, especially at the latter locality, where it is deeply eroded, and its junction

with the mica slate clearly seen. To gain a better knowledge of the structure of the granite and its mode of occurrence, I must refer to the Explanation of the Dublin district, sheet 112, and the description of the granite of Killiney Hill and the adjoining shore.

Fig. 8.



b. The Bray Head District.—The rocks joining Bray Head are the most characteristic of those included in the Cambrian series of the county of Wicklow, and they are thoroughly well exposed along the coast for the distance of two miles. As a mass they are observed to dip to the N.N.W. or N. at 40° to 70°, and thus to represent a total thickness of about one mile and three quarters. Allowing, however, for occasional contortions and reversal of dips, as well as faults, which cause the beds to be repeated, we may safely estimate the thickness of the Bray Head section at one mile.

The various beds of quartz rock which strike N.E. and S.W. across the summit of the hill (793 feet) over a distance of three quarters of a mile, are cut off by a fault striking N.W. and S.E. along the sea face of the head, and are, therefore, not prolonged to the coast.

If we commence at the northern end of the section where the uppermost rocks are exposed, and follow them to the south, or in descending order, we observe the following beds:—Thick green quartzose grits, with occasional red grits dipping N.N.W. at 35°.

Similar beds, with some cleaved or slaty layers, are observed to the south of this at the Periwinkle rocks, and here the late Dr. J. Kinahan procured some fine specimens of *Oldhamia radiata*, as well as annelid tracks and fucoidal-looking impressions. The lower surfaces of some of these beds are mammillated, and they have all been twisted round to the westwards, and in one place slightly contorted. Near this are two bands of red cleaved rock or imperfect slate, in which *Oldhamia* has been found.

The first band of quartz rock, 50 yards thick, that appears on the shore, is now reached immediately north of the Brandy Hole, the green and purple grits and slates above and below it dipping to the N.W. at 40° to 50°.

This bed of quartz rock can be traced up the hill for the distance of 500 yards, where it is cut off by the fault previously alluded to. Here, however, strange to say, it is met by another band of quartz rock of nearly equal thickness, and which has the same strike, and can be traced for the distance of over three quarters of a mile into the plantation in Kilruddery Demesne, due E. of the house.

Higher in the series than the quartz rock just noticed, there is another mass of similar rock on the brow of the hill over the Periwinkle rock, which does not extend down to the shore; the true outline of this bed is not determinable, but from the fact that quartz rock

alone is exposed between this point and the village of Bray, a distance of nearly one mile and a half, it has been supposed that here we have the outcrop of a highly inclined and thick bed of quartz rock.

To the south of the Brandy Hole, for the distance of nearly three quarters of a mile, including the point of Bray Head, the coast section exposes hard greenish and reddish purple grits, the upper portion of which often becomes finely laminated and shaly looking, and occasional slaty beds, the dip of all being with but few exceptions, to the N.W. at 40° to 70°—the beds being, however, contorted here and there along the coast line. To the south of the point of Bray Head, at the distance named, the second most prominent quartz band appears on the coast; its width is nearly the same as that first described, and it can be traced inland to the S.W. for the distance of over one mile to the little village of Windgate. To the south of Windgate, the same quartz rock beds appear to be continuous for the distance of over three quarters of a mile, as far as the N.W. corner of the townland of Templecarrig Lower, opposite Belmont House.

Over the summit ridge of Bray Head Hill, between the two great bands of quartz rock just noticed, there are seven or eight smaller beds of the same, the general strike of which is in accordance with that of the larger masses, and the observed dips in the associated slates being almost invariably to the N.W. at 40° to 70°. The largest of these quartz rock beds is about three quarters of a mile.

Oldhamia was found just south of a gate-post on a cart track leading to the summit of the hill, and at the distance of half a mile due north of it, by Mr. W. H. S. Westropp, and similar fossils are found in a bed of red slate on the old road above the railway, at the distance of 600 yards N.E. of the summit of the hill.

The southern end of the coast section affords the usual greenish and reddish purple grits, and hard slaty layers, and at the distance of about half a mile N. of the Cable rock, these are traversed somewhat in their line of strike, *i.e.*, from N.E. to S.W. by a greenstone dyke, which on the shore branches into numerous veins. The N.E. end of this dyke is dislocated for the distance of about sixty yards, by a fault striking nearly E. and W., the downthrow being to the south. The dyke can be traced up the hill for the distance of about 260 yards.*

c. The Dargle District.—On entering the glen of the Dargle river, the first rocks seen are black and dark gray slates and thin grits, with some flaky cut beds occurring between Riversdale House and Dargle bridge. At first the beds appear to be horizontal, but they dip to the southward above the bridge at 30° to 55°.

To the southern side of the bridge at the confluence of the Cookstown river with the Dargle river, there are some black pyritic slates dipping N. at 40°, and close to them, higher up the river, there are hard greenish gray grits with hard slaty layers, which are evidently Cambrian; here, therefore, we have an exposed junction between the Lower Silurian and Cambrian rocks.

From this point, for the distance of nearly one mile up the glen, all the exposed rocks are Cambrian, those bosses which form the prominent features called "The Burnt Rock," "The Lover's Leap," and "The View Rock," being formed of quartz rock. In many places these beds are contorted, but their general dip is to the S. and the N.W. at 40° to 70°. From the bend in the river due south of Cookstown House, Lower, past Tinnahinch House, through Powerscourt Demense, and as far as Powerscourt Waterfall, a distance of four miles and a half, there are no rocks exposed in the glen, the river winding through alluvial flats for the distance named.

* This dyke was first discovered by Professor Harkness, and has been minutely described by Mr. W. H. S. Westropp in the journal of the R. Geological Society of Ireland for the year 1866.

In the glen of the Cookstown river, just south of Monastery House, some dark gray and bluish gray slates and grits are exposed, dipping to the southwards, from 30° to 65°, but beyond this, for the distance of one mile, the river cuts through drift till it then exposes the granite just north of Ballybrew House.

In like manner the Glencree river winds through an alluvial flat for the distance of over one mile from its junction with the Dargle river at the wooden bridge in the townland of Onagh, and though within this distance, it is presumed to cross the boundary of the granite with the mica slate, neither of these rocks appear in its bed, though they occur at no great distance to the N. and S. of it in the townlands of Lackandarragh Lower, and Ballyreagh, the mica slate dipping to the E. and S.E. from the granite at 40° to 50°.

On the N.E. slope of Maulin Hill (1869 feet), in the bed of the brook dividing the townlands of Crone and Bahana, the dark gray micaceous slates are frequently interrupted with thick grits, and in one place, at the N.W. corner of the large plantation these rocks are full of garnets.

At the summit of Maulin Hill dark gray mica slate with grit beds are exposed dipping eastwards at 15° to 20°, the granite bounding the hill on its western side; and here we have many excellent examples of wedge-like masses of mica schist, some of them 600 yards in length by thirty yards in width, stuck into the granite at an inclination of 50° and 60° to the S.E., these being the relics of the old bottom surface of the mica schist thus exposed by denudation. Here also the granite sends out tongues into the mica schist in the manner previously described in the Explanation to sheet 112.

The Dargle river, shortly after it enters the Deer-park of Powerscourt, falls in a magnificent cascade of more than 100 feet in height over a steep escarpment of dark gray Lower Silurian slate. At the Waterfall the beds dip to the S.E. at 30° to 40°, which is also the dip of all the Lower Silurian rocks which form the steep escarpment surrounding the head of Powerscourt glen to the N. and S. of the Waterfall.

Two thick granite veins traverse the gray hornblendic and micaceous slates and thin siliceous grits on the southern side of the river, half a mile W.S.W. of the Waterfall, on the northern base of Douce Mountain.

The ridge which extends for three miles from north to south along the eastern side of the Dargle Valley from Walker's Rock (776 feet), including the Long hill (1,073 ft.) to the Hill of Ballyremon (1,016 ft.) on the south, is formed of quartz rock interstratified with brownish and greenish gray and reddish slates and grits, the general dip of the mass being eastward. On the east, this ridge slopes to the glen of the Killough River, at the head of which purple, greenish, and red Cambrian slates are exposed, dipping as a mass to the E. and S.E. at 20° to 60°. On the eastern side of this glen the ground rises to form the great Sugarloaf Mountain.

d. Lough Bray, Castlekelly and Kippure Districts.—To the W. of Lough Bray, at the extreme limit of the map, a lenticular wedge of mica schist, measuring one mile and a half in length, and only 130 yards wide, occurs in the granite at the distance of three quarters of a mile to the N.W. of Kippure House. This isolated wedge of mica slate appears to be bent synclinally at its eastern end, and along its northern margin there are several much smaller and detached slate wedges. Mr. Wyley remarks that the felspar in the largest mass of mica slate is often in segregations, like as in granite.

At the N.W. corner of the map, which includes the summits of Slievebane and Glassavullaun Mountains, 2,128 feet and 2,035 feet respectively, the granite and mica schist are found in junction, and several granite dyke-like masses are seen to penetrate the altered slate.

At the extreme N.W. corner of the map, the mica slate is bounded on the N.W. by the ordinary dark gray Lower Silurian slates, forming Ballymore-

fin Hill (1,689 feet), and in the townland of Carrigeenoura these slates are traversed by two thick dykes of diorite; and Mr. Westropp found a thin dyke of decomposing felspathic porphyry cutting through similar beds on the southern bank of the River Dodder, at the distance of three quarters of a mile below the ancient chapel of St. Anne. The Lough Bray lakes lie in the very centre of the great granite ridge which traverses the western portion of the district included in sheet 121, and are about three miles distant from the junction of the granite and mica schists.

In the various depressions which give rise to the head waters of the rivers Dodder and Liffey the solid granite is rarely to be seen, owing to the whole surface being covered by a thick deposit of granite blocks and a superficial covering of peat. A tolerably good exposure of this rock is, however, to be seen on the northern branch of the Liffey head south of Lough Bray.

It is somewhat remarkable that throughout the entire course of the Glencree River the solid granite is not exposed, the whole surface of the valley being covered with a thick deposit of granite drift.

The boundary of this rock with the mica slate is, however, easily determinable, especially on the northern side of the glen in the townland of Lackandarragh Lower, and along the base of the western slopes of Maulin Hill (1,869 feet), and on the northern slope of Douce Mountain and War Hill, adjoining it on the N.W. in the glen which receives the head waters of the Dargle River. In Lackandarragh the mica slate dips away from the granite or to the eastward at 30° to 50°, while in Douce Glen the mica slate strikes obliquely at the granite with a dip to the S.E. at from 40° to 80°, many small lenticular wedges of these slates being stuck into the granite and retaining the normal dip of the main mass. Here, also, the granite has sent several dyke-like tongues into the slates, and three, by denudation, now appear as dykes detached from the main mass.

That portion of the River Dargle which skirts the eastern base of the elevation called "The Ride Rock" (1,013 feet), in Powerscourt Deer-park, and the southern base of Maulin Mountain, exposes good sections through the mica schist and unaltered Lower Silurian slates.

e. The two Sugarloaf Mountains.—The great Sugarloaf Mountain, which lies to the west of the lesser hill of the same name, is formed by the outcrop to the west of an enormous bed, or possibly a series of thick beds of quartz rock, the strike of which is nearly N. and S., with a dip to the east at an average of 60°.

This quartz rock ridge is exposed for the distance of about two miles and three quarters from the "View Rock" and "Lover's Leap" in the glen of the Dargle River, on the north, to the southern side of the townland of Glencap Commons, at the pass between the head of Kilmacanoge Glen and that of the Killough River. Over this area the quartz rock is frequently exposed, and on the western flank of the southern end of the ridge thin bands of brownish, purplish, red, and greenish slates are observed interstratified with the quartz rock. At the southern end of the ridge, and within half a mile of the summit (1,659 feet), we find at the head of the stream which passes through the townland of Kilmurry South some greenish gray and brownish grits, dipping to the northward at 30° to 50°, and then appearing to underlie the mass of the quartz rock to the north; and at the distance of about one-third of a mile to the S.S.W. of this spot, along the southern boundary of Glencap Commons, there are red and green slates dipping N.W., at 20° to 80°, thus affording additional proof that the quartz rock terminates to the south of the summit of the great Sugarloaf Mountain in the distance just stated.

At the head of the Killough River, at the western base of the summit of the great Sugarloaf Mountain, Cambrian slates and grits are well exposed, the average dip of the beds being to the eastward at 20° to 60°.

If we now descend from the main summit into Kilmacanoge glen, and in the direction of the little Sugarloaf Mountain, we pass from off the quartz rock, on to a thick deposit of limestone gravel lying against the eastern base of the summit at an elevation of about 550 feet, and about half a mile in width. On the eastern side of the glen the quartz rock rises from beneath this drift to form the peak of the little Sugarloaf (1,120 feet), which, like that of the greater, is an outcrop of quartz rock, the dip of which is to the W.S.W. at 40°, and hence it is possible that the same quartz rock bed forms the summits of the two Sugarloaf hills, the valley between occupying the synclinal.

On the eastern flank of the little Sugarloaf Mountain, and at the distance of 300 yards from its summit, there are bands of red, brown, and purplish slate 150 yards across, the beds dipping steadily westward at 30° to 40°. These slates on the eastern side are bounded by a band of quartz rock dipping eastward at 50° to 60°.* At the distance of 700 yards to the north of the summit of little Sugarloaf Mountain the quartz rock, Cambrian slates, and grit bands appear to be dislocated by a fault having an E.N.E. and W.S.W. direction, the downthrow being to the S., the amount of vertical displacement being about 750 feet.

The evidence for this fault is apparent at the northern end of Kilruddery Deer-park, and in that portion of the Commons of Barchuillia adjoining it.

To the east of the little Sugarloaf the ground falls to form the Glen of Kilruddery, but it again rises close to the village of Windgap, where the southern end of the thick bed of quartz rock which forms the summit of Bray Head Hill, makes an eminence of 532 feet in elevation, the slates which here appear over the quartz rock being observed to dip to the west at 30°.

Midway between little Sugarloaf Mountain and Delgany the quartz rock and hard greenish gray grits and brownish slates form the hill of Kindlestown (725 feet) and the district around it, the general strike of the beds being N.E., and S.W., and these same beds in their prolongation to the S.W. are cut through by the Glen of the Downs.

This remarkable Glen cuts directly across a mountain range, the maximum height of which is 1,232 feet at Downs Hill, to the depth of over 400 feet; it is about one mile and a quarter in length, with an average width of 450 yards from crest to crest, its level at the northern end being 316 feet, and at the southern 200 feet above the sea. The dark purple, green, and gray slates and grits are well exposed along the brow of the Glen, where bossy masses of quartz rock form rugged projections at either side. The general dip of the beds is to the northwards, but they are frequently for short distances rolled over to the southwards at the southern end of the Glen, where the quartz rock disappears. Indeed it is probable that a line passing N.E. and S.W. through the southern end of the Glen would define the southern limit of the great quartz rock deposits, which have aided in giving this portion of the county of Wicklow some of its most remarkable physical features.

The quartz rock beds at the northern end of the Glen of the Downs, in their extension to the N.E., appear over the high ground in the townlands of Coolagad and Kindlestown Upper, where, together with the slates, they form a hill of 725 feet elevation.

On the coast to the east of the Glen the low blunt promontory of Graystones exposes greenish gray, and dark purple slates and grits, dipping for the most part northward at high angles. At the northern end of this section there is an intrusive dyke of coarsely crystalline greenstone (diorite), and at the southern end there are two massive beds of quartz rock, overlying some hard green hornblendic grits, which Mr. Wyley describes as looking not unlike greenstone.

* In some of these beds, where they appear in the S.E. corner of Kilruddery Deer-park, Mr. Wyley found *Oldhamia*.

To the south of the village of Delgany the quartz rock appears in small isolated bosses in the townlands of Killickabawn, Drummin East, Priestsnewtown, and Knockroe.

To the southward of Downs Hill the Cambrian grits and slates with their associated quartz rock beds are well exposed along the northern and western boundary of Altidore Demesne, where the quartz rock forms long ridges and large bosses, and thin beds at their apparent extension to the westward; from the high ground in the townland of Carriggower and Drumbawn, the quartz rock forms a boss nearly three quarters of a mile in length along the western outskirts of the village of Newtownmountkennedy.

f. Douce Mountain and Roundwood Districts.—The district to the west of Douce Mountain, Lough Tay, and Lough Dan, as included in the map, is formed entirely of granite, rising here and there into lofty rounded bosses, overlooking extensive moory and boggy flats, and wide shallow glens. The eastern spur of Mullaghclevaun Mountain, which attains a height of 2,783 feet at the distance of one mile and a quarter to the S.S.W. of Duff Hill (2,364 feet), appears to be the most elevated in this tract, and in the glens which radiate from it to the S. and E., as well as in that lying to the west of Duff Hill, the granite is well exposed. This rock is here whitish gray in colour, coarse and firm in texture, and the mica is generally black. At the point marked "1877," in the townland of Carrigeenduff, the granite is coarsely porphyritic and veined with quartz. At the distance of one mile to the eastward of this point the granite contains black and white mica; it is coarse-grained, often porphyritic, with large crystals of felspar.

The summit of Douce Mountain is formed of brilliant mica schist, in which are numerous quartz veins, the dip or foliation of the beds being to the S.E. at 20°.

So far as we can determine the mica schist, as a general rule, dips away from the main mass of the granite, forming a band along the boundary of that rock of about one mile in superficial width. The mica schist, however, has a low average dip of 20° to 30°, and when we remember that the surface of the granite is exceedingly irregular, the absolute amount of metamorphism effected on the slates may not extend to the distance of a quarter of a mile into their mass, the great apparent stratigraphical thickness which they present being due to the oblique manner in which they have been cut down by the forces of denudation on a plan somewhat parallel to the concealed surface of the granite.

In the various stream courses which indent the eastern slopes of Douce Mountain, the mica schist and unaltered Lower Silurian rocks, as well as those of the Cambrian formation, are all well exposed. The most comprehensive of these sections is that in the glen bounding the lands of Grouse Lodge and White Hall on the south; and a detailed account of it will be sufficiently explanatory of the rest. At the distance of about three quarters of a mile from the summit of Douce, bluish black and gray slightly micaceous slates and gray grits appear in the glen, dipping to the S.E. at 30° to 60°, and are in places nearly vertical, and as we descend the stream we find a repetition of these bluish gray and black slates, the latter often glossy, and gray grits with quartz beds and veins, confused and contorted beyond measure, but, as a mass, dipping to the S.E. This exposure of Lower Silurian rocks extends for about three quarters of a mile, when we come on fine whitish sandstones, compact greenish grits, and greenish, purplish, red, and brown slaty beds, which from their colour and texture have been included in the Cambrian formation. This section is also three quarters of a mile in superficial extent.

Lough Tay lies directly on the junction of the granite and mica slate at an elevation of 807 feet above the sea, the granite forming a steep precipice

of upwards of 600 feet in height on its western side, where the ground rises to an elevation of 1,950 feet in the distance of half a mile from the lake; on the eastern side the ground attains a height of 750 feet in the distance of 500 yards from the lake, the cliffs being here formed of granite with fine, large, wedge-like bands and many minor beds of mica schist and gneissose slate left adhering to it, while the adjoining granite is often platy in structure with an excess of mica. At the presumed extreme limit of the mica schist, on the eastern side of Lough Tay, and at the distance of about three quarters of a mile of the lake, layers and thin beds of hornblendic slate have been observed.

On the eastern side of Annamoe Glen, between Lough Tay and Lough Dan, the mica schist is well exposed in cliff sections; and, as usual, dips to the E.S.E., or away from the granite at angles varying up to 40°.

Lough Dan, which lies at a height of 678 feet above the sea, occupies, like Lough Tay, a hollow mainly excavated out of the mica schist; the northern end of the lake, and the alluvial bed beyond it, penetrating into the granite, while the southern extremity of the lake just touches on the Lower Silurian dark gray and black glazed slates, in which are numerous thin gray grits and beds of quartz rock and quartz veins.

The peculiar character of the junction between the granite and mica schist is remarkably well seen to the north of Lough Dan as far as the Cloghoge river, and as far as the Glenmacnass river on the south.

At the former locality the granite is occasionally platy with much mica, and often exhibits a porphyritic structure, the crystals of felspar being large. Several thin wedge-like masses of slate adhere to the granite, with a dip of 50° to the S.E., and a wedge of granite penetrates the slates close to the junction of the two rocks. Just over the lake there are three such granite protrusions in the distance of 200 yards.

On the south side of the lake there are five such protrusions forming long parallel ridges of granite divided by a band of mica schist of only a few feet in thickness, while granite veins appear in the mica slate as far as 700 yards from the main granite mass. From this it is evident that the mica schist lies here on the granite in a thin sheet.*

At the distance of half a mile to the S.W. of this locality, and below the waterfall in Glenmacnass, parallel granite veins alternating with bands of mica schist can be observed along the Military-road on the west side of Glenmacnass, in the townland of Laragh West. The main mass of the granite is split up by a thick band of mica schist three quarters of a mile in superficial width, and striking in a westerly direction past Lough Ouler (1,826 feet) where its width is about one quarter of a mile. The southern extremity of this lake penetrates the mica schist, which here dips to the southward at 50°, its western side being bounded by a cliff of granite. A long narrow ridge of granite parallel with the boundary of the main mass is exposed at either side of the lake at its southern end. The lake drains underground to the N.E. in the "Lough Brook," which falls into the head of the Glenmacnass river.

On the south side of this large band of mica schist, the granite extends for several miles to the southwards, its boundary on the east being along the base of Mall Hill, and from thence in a S.W. direction past the head of the Vale of Glendassan, the western extremity of the upper lake of Glendalough, and the northern slopes of Lugduff Mountain.

Lough Nahanagan lies at the height of 1,382 feet above the sea, in the centre of this portion of the granite.

Between Lough Dan and the Valley of Glendalough the mica schist has

* See detailed description of the junction of the granite and mica schist on Killiney Hill. Explanation of Sheet 112.

an apparent maximum superficial width of one mile and three quarters; this, as I explained before, gives no idea of the true thickness of the altered or micacised slates, as the granite throughout this width may in many places be very near the present surface.

In the townland of Brockagh, on the S.W. side of Glenmacnass, and at the distance of three-quarters of a mile from the granite boundary (sheet $\frac{17}{4}$), where the arrow with a dip of 50° is engraved on the map, a quarry opened in the mica schist exposes a bed of what Mr. Wyley calls "tremolite rock," fifteen feet thick, exhibiting slight stains of cobalt crust. At the distance of one mile to the north of this quarry, on the east side of the glen, there are cliffs of dark mica schist, with thin grit bands, dipping to the E. and S.E. at 10° to 30°, then dipping away from the granite which appears in cliffs on the opposite side of the glen, at the eastern base of Mall Hill.

In the lower portion of the Valley of Glendassan, for the distance of three-quarters of a mile from the granite boundary, the mica schist is well exposed along the main road, as well as in cliffs on the opposite (or southern) side of the glen; in colour this rock is dark, and sometimes light gray, with lenticular beds of metamorphosed gray grits, with thin beds and veins of quartz, which are often full of iron pyrites; the discerned dips are all to the E.S.E. or east, at 20° to 35°, and away from the granite.

The picturesque lake of Nahanaghan, which lies at a height of 1,382 feet, in the central portion of that peninsula of granite lying to the west of the Seven Churches, supplies the river which runs through the Vale of Glendassan.

The precipices which enclose the upper lake of Glendalough on the north and south consist of mica schist—the beds of which dip to the E.S.E. at 20° to 40°, or away from the main mass of the granite which appears at the head of the lake, the geological position of which is thus precisely similar to that of Loughs Dan and Tay.

On the brow of the cliff over the northern side of the lake a boss of largely crystallized hornblende, or hypersthene, rock occurs in the midst of the mica schist.

To the south of Glendalough, in that portion of Glenmalure which comes into this map, the peculiar manner in which the granite comes into junction with the mica schist, viz., wedge-like masses and narrow beds of the slate stuck into the granite, while the latter has sent massive dykes, tongues, and veins into the altered slate, is nowhere better seen in the whole district. This is observable on both sides of the glen for the distance of fully three miles above Drumgoff Barracks.

From the fact that on the S.W. side of the glen just above Drumgoff Barracks, and on the N.E. base of Cloghernagh Hill (1,601 feet), the granite appears *en masse* for the distance of more than one mile; while, at the opposite side of the glen, at the distance of less than 300 yards, the rock is mica schist, with a few tongues of granite in it; and from the additional fact that the wedge-like masses and beds of mica schist at either side of the glen have no correspondence, though they are often not 100 yards apart, while they strike at each other at acute angles along the axis of the glen for the distance of two miles and a half, I am forced to the belief that a fault ranges along this glen, causing a downthrow to the N.W., possibly amounting to over 2,000 feet. This fault, however, is not marked on the map, as there is no further evidence for it than that which I have adduced. I think it right, however, to mention the possibility of its occurrence lest future examination should prove its existence.

But very little evidence exists for the presence of the mica schist over the space coloured to indicate that rock around the summit of Mullacor, 2,176 feet. Along the outskirts of this area, however, the unaltered Lower Silurian bluish black and gray slates, with thin grits and quartzose

beds are, however, tolerably well exposed to the south and east of Drumgoff Barracks, in Fananierin Mountain, 1,402 feet, and Carriglinneen Mountain, 1,496 feet, as well as around the summit of Kirikee Mountain, 1,559 feet, and in the southern end of the townland of the same name.

In the bed of the Glenmacnass River, close to the village of Laragh, there are some hard blue slates, with thick gray grits and quartz veins.

In the valley of the Avonmore river, between Laragh and Ballinacorbeg, a distance of about four miles, the Lower Silurian dark gray argillaceous and quartzose slates are only exposed at two localities—one where the Glenmacnass river joins the Avonmore to the south of Laragh; and the other to the north of the village of Annamoe, along the eastern side of the glen, in the townland of Ballinacorbeg, where black slates and bluish gray quartzose beds occur with an apparent dip to the S.E.; the amount not stated.

g. Togher or Roundwood.—To the south of this village, in the eastern corner of the townland of Ballynanima some Lower Silurian black slates and gray grits appear dipping to the N.W. at 30°. To the south of these beds, in the eastern corner of the townland of Raheen, and apparently underlying them, is a small group of purple altered-looking slates with coarse-grained greenish beds, seen to the west of the main road. In the centre of these beds is a thick short dyke of coarsely crystalline greenstone, passing into syenite, abounding with what Mr. Wyley supposed to be epidote. Mr. Jukes remarks that this may be diallage rock.

These purple and green beds are bounded on the south by black Lower Silurian slates, and Mr. Wyley supposes that they represent a boss of the Cambrian formation, the western limits of which is presumed to strike N. and S. at the distance of less than one mile to the east of this protrusion.

That portion of the valley of the Vartry which extends for the distance of one mile to the north of Roundwood, and one mile and a half to the south of it, has been selected as the site for the great reservoir intended to supply Dublin with water. The proposed lake is therefore fully two miles and a half in length gradually narrowing from a width of three-quarters of a mile at its S.E. end to a mere point at the other extremity.

The great dam is at the S.E. end of this lake, and is half a mile in length, and the water at its northern, or lake, side will be fully 70 feet in depth. The dam has been partly constructed along a ridge of pale greenish and gray quartzose, Cambrian grits, and thin slate beds, which dip to the S.E. at 60°.

In the valley of the Vartry, below the reservoir, the hard greenish gray and purplish grits appear at intervals with a general dip to the S.E. at 60° to 70°, the cleavage, which is best seen in the softer beds, dipping S.E. by E. at 70° to 80°. To the east of Annagolan bridge a deep gorge called the Devil's Glen has been excavated in these beds, which still retain their dip to the eastward at 35° to 60°, the cleavage dipping E. 50° S. at 60°.

In that portion of this gorge which lies along the southern boundary of the townlands of Ballymoneen and Birchwood, the rocks at either side of it dip northwards at 45° to 80°, and some of these beds which appear in the latter townland are quite micaceous, not apparently from any metamorphic action, but from original deposition.

h. The Devil's Glen District and Carrick Mountain.—To the south of the Devil's Glen, and extending for the distance of three miles, with a maximum width of half a mile, an apparently isolated mass of unaltered Lower Silurian black slates and gray grits is observed to occur on the Cambrian rocks. At the extreme northern end of this mass of black slate, where the townlands of Tiglin, Ballymaghroe, Ballardbeg, and Ballycullen, all touch on each other, these rocks are tolerably well exposed, though their dips are obscure. Those which are marked, however, in the northern end of the last-named townland show that the black slates dip away from, and thus overlie the adjoining green and purple Cambrian grits and slates.

Close along the boundary of these two groups, in the western side of Ballycullen townland, the Cambrian beds, as a general rule, strike at the black slates, though there are some places along the eastern side of the same townland where they appear merely to dip under them.

The Cambrian beds, which bound the Ballycullen black slates on the S.E., are seen in the S.W. corner of the townland Aghowle Upper, and from thence northwards into the eastern portion of Ballycullen, as before remarked. They thus occur as a narrow band of three miles in length, widening, however, at the northern end into the main mass of the same formation lying to the northwards.

To the eastward of this Cambrian band, and the mass of the same rocks to the north of it, the black slates appear at intervals in a direct line for the distance of about eight miles, the following being the localities where they have been observed:—Coming at the S.W. of the line they appear at the western corner of the townland of Aghowle; then at the distance of one mile N.E. of this locality in the glen of Ballylusk, then in the lands of Clonroe, and again to the N. of and close to the village of Ballynalea, where the mass of the beds appear to be but synclinally; again, at the distance of half a mile N. of the Roman Catholic chapel of Ballynalea, in the townland of Inchanappa, and on the east side of the main road; when the black slates dip E. at 45° the Cambrian green slates and grits appearing to the north of them at the distance of only 300 yards, and dipping E. at 60°, with a cleavage striking E. 20 N., vertical(?)

The black slates again make their appearance on the southern boundary by the wood of Inchanappa, North, and lastly, to the eastward of this spot, at the distance of half a mile on the by-road in the townland of Crony-Kerry, and to the north of the plantation in the southern end of the adjoining townland of Killoughter.

From Inchanappa wood, in a N.E. direction to the sea, a distance of about two miles and a quarter, the boundary between the black slates and green Cambrian beds, as indicated by the fault on the map, is inferential. It cannot extend, however, further northwards than somewhere close to Grange Hall, as just to the north of that place, in the townland of Barnacoyle the hard, green, and purple slates, and greenish gray Cambrian grits appear dipping N.N.W. at 80°.

The evidence for Cambrian rocks along this line of fault is quite as meagre as that for the lower silurian. In addition to the localities just named, where three beds are seen, we find them on the west of the main-road, outside the S.W. corner of the townland of Rathmore, where purple and green slates are seen dipping N.W. at 65°, and cleaved vertically in the direction of N.E. and S.W.

If we now retrace our steps along the northern boundary of the fault, and over the Cambrian rocks, we find these beds appearing in the bed of the Vartry river at the extreme lanthorn angle of the townland of Ballynahinch. To the S.W. of this, for the distance of one mile and a quarter, no rocks are seen till we find some purple slate on the road-side in the eastern corner of the townland of Ballycullen. From this point, for the distance of three miles in the direction just named, the Cambrian beds are well exposed along the western side of the road, close to the boundary of the isolated mass of lower Silurian rocks into the townlands of Aghowle Upper, Sleanaglogh, and the southern end of Pockroe, where, on the road-side, the two formations are seen in almost absolute contact, the purple and green slates and greenish grits of the Cambrian dipping N. 15° W. at 65°, the dip of the adjoining black slate in the south being unfortunately quite obscure.

The prominent ridge of Carrick mountains, like Bray Head, exhibits in

a most marked manner those large lenticular and irregular masses of quartzite so characteristic of the Cambrian area included in these two beds of the mass. The best sections which exhibit the structure of this ridge are as follow :—That to the S.W. of the glen of Ballylusk, where four distinct beds of quartz rock, separated by bands of hard, gritty slate, appear in a superficial width of 400 yards at this locality. The northern band is over 100 yards in thickness, and is capable of being traced in an almost uninterrupted line, from the village of Ballinalea, on the N.W., through the summit of Carrick mountain and the townlands of Garryduff and Ballinastraw to the glen of the Avonmore river, in the townland of Cronybyrne, on the S.W.—a distance of nearly six miles and a half, the apparent dip of the beds over Ballylusk glen being to the N.W.

The next section is that over the summit of Carrick mountain. Here we find seven or eight distinct veins of quartz rock, occupying a superficial width of about three-quarters of a mile ; that at the summit has a superficial width of over 200 yards ; but many of the others are mere massive beds. Each vein of quartz, which is separated from the other by greenish and brownish grits and sandy slates, which close to the summit on the N.W., dip to the S.E at 80° at the distance of one mile and a quarter to the S.W. of the summit of Carrick mountain to the townland of Ballymanus Upper. The quartz beds are but four in number, and occupy a width of only 400 yards ; and at the distance of one mile to the S.W. of this point, in the adjoining townlands of Garryduff and Barnbawn, the bands of quartz rock are seven in number, and they occupy a width of 800 yards ; their dip, as determined by that of the associated by the brownish and yellow olive-green slates, being to the S.E. at 75° to 85°, to the S.W. of the last-named townlands. The quartz veins extend into the adjoining townland of Ballinastraw, and there, with one exception, they appear to end ; the northern and most extended band alone appearing to strike still further to the S.W. into the townland of Cronybyrne, when it becomes split up into three or four narrow tongues or beds, dipping to the N.N.W. at 50° to 75°, as seen in the E. bank of the Avonmore river, in the western corner of the townland of "Stump of the Castle."

The quartz beds at the S.W. end of the Carrick mountain boss of Cambrian rock are but imperfectly shown on the one-inch map, owing to their thinness.

The elvan dykes striking at N.E. and S.W. cut through the Lower Silurian slates in the central and eastern portion of the townland of "Stump of the Castle," slightly altering or hardening the slates in immediate contact with them.

The most northern dyke extends most probably across the glen of the Avonmore river, and reappears close to the bridge over the stream dividing the townlands of Copse and Ballygannon.

(*i.*) *Glenmahon and Ballinacor Districts.*—That portion of Glenmahon extending above Drumgoff barracks has been already noticed in the description of the junction of the granite and mica schist.

To the southward of Drumgoff barracks the granite which forms the mass of Clohernagh mountain (1,601 feet), comes into junction with the mica schist in a gently-curving line throughout a distance of three miles, and somewhat parallel to the course of the Drumgoff Brook. At the summit of the Slieve Maan mountain (1,800 feet) a thin tongue of mica schist containing garnets is nearly enclosed by the granite, the dip or foliation of the slate being as usual away from the granite, or to the S.S.E. Along the military road, and in the various stream courses to the southwards of the summit just named, the mica schist and quartzose beds dip away from the granite to the E.S.E. at 35° to 50°. Between Drumgoff barracks and the extreme S.W. limit of map the mica schist is presumed to attain a superficial width of about one mile.

In describing the district around Ballinacor House we may first allude to Fananierin mountain (1,402 feet), on the northern flanks of which the rocks are best exposed. Here we find the mass of the hill to be composed of hard argillaceous slates and gray quartzose grits, the dip of which is E. or E.S.E. at 60°. On the northern side of the Avonbeg river these beds are traceable to the N.E. for a considerable distance, and they then form Kirikee mountain (1,559 feet). In the townland of Kirikee, at the S.W. base of the mountain, we find blackish and dark-gray slates and hard nodular grits, all more or less contorted, over an area of half a mile, the apparent dip being to the E.S.E. at 50°.

At the summit of this mountain, however, the bluish-black and dark-gray slates become less frequent, and the nodular quartzose grits approaching to quartz rock are so predominant, that Mr. Wyley is uncertain as to whether these lands should be regarded as Cambrian or Lower Silurian, the latter supposition being ultimately adopted.

To the east of Kirikee mountain, and on the southern slope of Castle Hill are blackish slates and numerous grit beds, dipping W.N.W., which can be traced in a S.W. direction for the distance of about two miles into the glen of the Avonbeg river, to the S.E. end of the townland of Ballinabarny, and into the demesne of Ballynacor, which includes the hill of Caran (772 feet), where highly-contorted hard gray argillaceous slates and quartz beds frequently appear at the surface.

On the S.E. slope of Castle hill, at the village of Ballinderry, the blue and black slates, with quartzose beds, are seen along the by-road up the glen, and close to the village is a thin granular elvan course, greenish when wet, but of a yellowish-grey colour when dry. To the south of this, and just below the corn-mill, is a coarse porphyritic elvan dyke having a brecciated appearance, with quartzose slate to the north of it, and smooth light-bluish slate south of it, dipping to the S.E. at 80°.

Along the main road north of this village are greenish gray and purplish-black slates, with quartzose beds, dipping N.W. at 60°, and these same beds are observed along the road to the N.E., in the valley of the Avonmore river.

Just north of the garden at Ballinacor House the Avonbeg river exposes dark argillaceous slate, with occasional quartzose beds, some of the former being impregnated with iron pyrites. Here also is observed a dyke of felspathic porphyry 20 feet thick, striking at N.E. and S.W., inclined to S.E. by S. at 50° to 60°.

Along the farm-road running through the central portion of the townland of Ballinacor, bluish slates and grits, often wrinkled and containing quartzose beds, are seen at intervals, the observed dips being to the S.E.

To the westward and southward of Ballinacor mountain (1,695 feet), and to the south of Croaghanmoira mountain (2,175 feet), and Carrickashane mountain (1,655 feet), as well as in the stream courses called Mucklagh Brook, Ballinagappoge Brook, Ballycreen Brook, Sheeanamore Brook, and on the N.E. slopes of Coolgarrow mountain (1,196 feet), various and comprehensive junctions in the mica schist and Lower Silurian rocks are to be seen.

Between the summit of Ballinacor mountain and the branch roads to the south of it, in the townland of Moneymeen, there are three massive lenticular intrusions and a thin dyke of fine-grained elvanite, the blackish and bluish and sometimes greenish slates which intervene, with an apparent dip to the E.S.E. at 35° to 50°, not having undergone any apparent metamorphism. To the southward of this, in the townland of Ballycreen Lower, there are a series of these lenticular dykes of elvanite, in light, green, and gray gritty slates, which dip S.S.E. at 85°. The position of these elvans will be best understood by reference to the map.

From the central portion of the townland of Ballycreen Upper, a thick lenticular mass of elvanite extends in a S.W. direction through the summit

of Coolgarrow mountain (1,196 feet), and thus passes out of the limits of the map. In the cutting afforded by the Sheeanamore Brook, which crosses this elvanite, the slates to the S.E. of this rock are described as soft and brown, and occasionally very quartzose, and not in the least micasized or otherwise metamorphosed. Hence we may regard these elvanites as being interstratified, and probably contemporaneous with the slates, and in this way analogous with the true felstones occurring to the end of the district.

At the distance of two miles and a half to the east of this elvanite, and at the extreme southern limit of the map, a somewhat spherical mass of granite, containing black mica, appears at the summit of Ballyshane hill (1,259 feet), the slates to the N. and S. of it being described as altered or hardened, while still further to the south, at Cushbawn hill (1,318 feet), just out of the limits of the map, where a similar granite appears over a much larger space, the slates close to it are described as "crystalline mica rock, passing into talcose clayslate," the stratification of which is almost obliterated.

The distance between the Ballyshane granite and the main mass of this rock is fully four miles.

(*j.*) *The Wicklow District.*—Between the town of Wicklow and the village of Rathnew the Lower Silurian brownish and blackish gray slates appear along the old road in short detached sections—the observed dips being to the eastward at 60°, and the beds much contorted. To the south of this, between Wicklow and the village of Glenealy, the road cuttings again afford the best exposure of rock—the beds being occasionally sandy and ribboned; and close to Glenealy, in the townland of Ballymanus Lower, we find blackish gray clayslate, sometimes ribboned, and with sandy beds, all the observed dips being to the east at 45° to 70°.

To the south of Wicklow, in the N.W. corner of the townland of Ballyguilemore, and along the coast as far as Wicklow Head, there are contorted beds of light blueish gray and dark gray talcose slate with numerous quartz veins; the slates, for the most part, presenting a silvery lustre or micaceous glaze. The general dip of these beds along the coast is E.N.E. at 30° to 60°.

Near a narrow chasm at Bride's Head there is a small vein or bed of felspathic trap.

To the south of Wicklow Head, and past Seapark Point, the rocks have a general dip to the east at 30° to 60°, and they are very similar to those just described. Here the grit beds are frequently nodular in structure.

At the spot called "the long rock" the dark gray talcose clayslates dip to the E. at 30° to 50°, and interstratified with them are three granular felspathic ash beds.

To the south of Seapark Point the slates are gray and talcose, with thin nodular gritty largess.

The stratigraphical thickness of the slates forming Wicklow Head, allowing 45° as the average dip, cannot be less than 5,000 feet, or close on one mile.

(*k.*) *The Rathdrum District.*—The village of Rathdrum lies at the extreme N.W. corner of that great mass of trappean rocks which occupies so large an area of the S.E. of Ireland.

The natural sections exposed in the glen of the Avonmore river across the strike of some of these beds, for the distance of nearly four miles to the south of Rathdrum, and the cuttings made through them in the same valley by the Dublin, Wicklow, and Wexford Railway, are the most clear and comprehensive of any in the S.E. of Ireland.

With the exception of those crystallised felstones, which partake so much of the nature of granite, and which are largely present to the southwards of Arklow, every other variety of these Palæozoic traps occurs in this district.

The lower beds, according to the observed dips, are those which appear to the N.E. of, and close to, Rathdrum, in the townland of Glasnarget North. And here the railway cuts through bands of hard gray calcareous ash, having an aggregate thickness of 170 yards, with gray slates above and below them dipping to the S.E. at 60°.

I may remark here that in almost every instance it is difficult to determine the absolute lateral extension of the ash beds. As, however, they fill up what was once local depressions in the sea floor, or else formed gently rising mounds upon it; their observed thickness is the only guide to determine this point. The greater the thickness the more extended the deposit must necessarily have been.

If we now follow the section in ascending order to the south, we find alternating bands of gray slaty felspathic ash, and dark gray and black slate, with a green ash bed and a greenstone ("diorite") vein, close to where the new hotel stands by the side of the railway.

To the south of this as far as the northern end of the tunnel the exposed rocks are purple greenish and gray clayslate, apparently vertical.

The tunnel has been excavated through a very compact purplish black amygdaloidal mass with a slaty fracture, the vesicles being filled with a semi-transparent mineral resembling quartz. Throughout this rock we sometimes find a fragment of hornstone, the aggregate thickness of the mass being 250 yards. On the opposite side of the glen, and directly in the apparent strike of this mass, we find a thick band of greenish-gray ash, having an extension to the N.E. of probably over a mile and a half. Close to and south of the tunnel are dark gray hornstone slate, in which some strings of lead were observed, and further to the south, throughout the extent of three-quarters of a mile, there are alternating bands of felspathic ash and clayslate; the former when it appears in the northern portion of Avondale demesne being gray, slaty, and calcareous, and fully 320 yards in superficial width. Opposite to Avondale, on the eastern side of the glen in the townland of Balleese Wood, the railway cuts across a dyke, as well as a large irregular-shaped mass, of diorite; the former occurring in the gray slates to the north of the Avondale ash, and the latter penetrating those ashes and splitting them into two narrow bands, which, however, again unite to the N.E.

This diorite, where it is cut by the railway, is of a clear greenish gray colour, rudely columnar, containing veins of asbestos and stringy veins of epidote, the joints of the rock being frequently coated with this mineral. In its central portion, to the east of the wooded ground, it contains a thin lenticular mass of altered slate or black hornstone.

On the N.E. flank of this diorite, and in the townland of Mountlusk, there is an irregular mass of hard, siliceous-looking felstone, having the S.E. branch of the Avondale ash bounding it on the S.E., and being itself here overlaid by dark gray slates, dipping to the S.E. at 75°. Close to this is a small boss of diorite.

The relation, outlines, and positions of the rocks just alluded to will be best understood by reference to the map.

To the south of Avondale House the gray slates occupy a superficial extent of about 700 yards, the dips being clearly to the S.E. at 55° to 75°. These slates in their central portion contain a band of felspathic ash which, on the N.E. side of the glen, attains a maximum thickness of 250 yards in the townland of Timullen. Near this are two short massive dykes of greenstone, that to the south penetrating these ashes and rendering them very hard.

A small boss of greenstone appears in the alluvial flats under Avondale House, and it doubtless is a portion of one or other of the greenstones just mentioned.

To the S.E. of the Avondale slate rocks on the east side of the river, and in the townland of Ticlash, there is a dyke of dark green diorite, more than

one mile long by 100 yards in width. It contains bronze-coloured mica, the rock becoming flaky along its S.E. wall. On the farm-road through Ticlash and Ballindoyle this diorite is exposed on the former townland, where it is white and micaceous. On the western side of the glen this greenstone extends for the distance of half a mile into the townland of Ballytrasna, where its estimated width is 200 yards. A narrow band of gray slates, with a felspathic ash, separates this run of diorite from an irregular mass of the ordinary greenstone occurring in the townland of Rockstown Lower, to the S.E. of which are two small lenticular protrusions of the same rock, the most southerly of which is well exposed on the Connaree road, at the northern boundary of Sroughmore townland.

On the west side of the Avonmore river, near the southern limit of the map, in the townland of Meetings, several superficial rock sections are seen along the Rathdrum road. These expose flaky felstone on the north, overlaid by a greenish gray ash dipping S.E. at 60°, above which is a thin band of purple and gray slates, with two thin rims of greenstone and greenish ash, which are overlaid by the ordinary pale gray slates of the district. Close to the southern limit of the greenish ash, the slates are traversed by a small elvan dyke, compact and quartzose, with brownish specks, its strike being 60° N. of W. and S. of E. On the opposite side of the Avonmore glen, in the townland of Connary Lower, a small elvan dyke traversing the slates has been cut through by the railway at the edge of the alluvial flat, the dips of the slates being to the S.E. at 60°. Between this point and the road there is a band of trappean rocks, in the green and gray slates, measuring 175 yards across, and consisting of felspathic ash, green slaty ash, a thin felstone, a greenstone, and lastly, a thick band of felstone; all occurring in ascending order as they have been named.

If we now return to Rathdrum we find the district lying to the W. and S.W. of it composed entirely of the ordinary dark gray, greenish, and sometimes black slates, with gritty laminæ, and these traversed here and there by elvan dykes, the position of which is shown on the map. That nearest to the village is only 6 feet wide, and is but seen in a small quarry to the S.W. of the old Flannel Hall, and in the N.E. corner of the townland of Knockadosan. The rock is close-grained and ferruginous, from containing minute crystals of iron pyrites; it decomposes freely, becoming soft and of a whitish-gray colour. The adjoining slates are gray, greenish, and purple in colour, dipping S. 45° E., the elvan traversing them in the direction of 35° E. of N. and W. of S. From the information I obtained, I believe that this elvan course has been traced for more than a mile.

At the distance of two miles to the westward of Rathdrum, Mr. Wyley has noted five elvan courses in the townland of Garrymore, and ten others of greater bulk in the adjoining townland of Ballycarrigeen to the south. All these elvans, in their extension to the S.W., doubtless cross the valley of the Avonbeg river, though but one of them, the most northerly, is marked on the map to the N.E. and E. of the village of Ballinaclash. There are two large isolated protrusions of fine-grained granite, containing black mica and arsenical pyrites. The slates in contact with them on their eastern and western sides have been rendered hard and micaceous, and dip to the S.E. at 70°. This granite is supposed to be continuous to the S. of the village, as indicated on the map.

On the east side of the glen to the S. of Ballinaclash there are several elvan dykes.

(*l.*) *Connary, Kilmacoo, and Westaston Districts.*—The northern limit of the great mining district of the Avoca extends into the mass at its southern margin, and comprises the property of the Connary Mining Company.

Throughout the townlands of Connary Upper, Sroughmore, Rockstown Upper, Ballinabarny, North and South, Kilmacoo, West and East, the rocks

consist of alternations of soft and hard felspathic and compact felstone, and gray earthy slate, measuring considerably over one mile across their strike, the observed dips being all to the S.E. at an average of 65°. The thickest and longest bed of ash is that which extends in a S.W. direction from Ballinabarny Bog to the extreme southern margin of the map, a distance of two miles, with a maximum width of 300 yards, as seen along the road from the miners' cottages at Connary towards Rathdrum. The most important run of felstone is that which strikes N.E. and S.W. through the summit of Connary hill, and which is possibly continuous to the N.E. into the townland of Kilmacoo; which would make its length nearly one mile and a quarter, its maximum width being 150 yards at the engine-house of the mines.

Close to this, on the north, but separated from it by a thin band of pale yellow talcose slate, is a similar and probably more extended run of felstone.

In the townland of Kilmacoo, West, a dyke-like mass of vein quartz, in felspathic ash, is observed close to, and eastward of, the run of felstone first alluded to.

All the various runs of felstone and beds of felspathic ash which appear in the townlands of Ballinabarny, South, and Kilmacoo, West and East, terminate abruptly in their line of strike along the west side of the pass of Kilmacrea—a narrow, though well defined gap, which, like those of the Scalp and the Glen of the Downs, cuts across the dominant ridge of the district, the ash beds dipping to the S.S.E. at 50° to 80°, having runs of felstone interstratified with them.

Along the eastern side of the pass, for the distance of 650 yards at its northern end, the gray slates appear at the level of the road, with rolling dips to the eastward of 70°, and in this manner to *underlie* a mass of hornblendic greenstone, which, with an irregular tongued-like outline, extends eastward for the distance of nearly half a mile, having several small wedge-like masses of slate, altered into a hornstone, stuck into what is now its upper surface.

From the fact that there is no correspondence between the rocks at either side of this narrow glen throughout its northern half, I introduced a fault, striking through the glen, as shown on the map.

That such a dislocation as this is really here present is further proved by the fact that due north of the glen, in the townland of Bolagh Upper, and Kilmacrea Upper, we find in the latter townland a series of beds of felspathic ash 600 yards across, dipping south at 45° to 50°, with gray slates above and below, forming a steep brow, facing the west, and abutting against a mass of hornblendic greenstone, occupying the low ground to the west over a distance of nearly half a mile.

As it is highly probable that the greenstone which extends across the Bog of Bolagh Lower, and that of Ballinabarny, into the N.E. corner of the adjoining townland of Rockstown Upper, a distance of fully one mile, is the western extension of the greenstone of Westaston hill; and if we argue from its superficial width, and allow a dip of 45° to the S.S.E., as that of the associated gray slates, we find that a downthrow of 2,000 feet to the eastward would be sufficient to cause this dislocation, as well as that observed in Kilmacrea Pass, of which it is clearly the northern extension.

To the east of Kilmacrea, in the townlands of Spring Farm and Ballykean, there are seven distinct lenticular depositions of felspathic ash, and the same number of greenstone bosses. The southern ash at Ballykean House is exposed in a quarry to the W. of the road, the bedded character of the rock being well shown, the dip being S.E. at 60°. At the distance of 400 yards to the N. of this on the roadside, near some plantations, is another deposition of ash, harder than the former, as a large boss of greenstone occurs close to it on the north, but the dip being the same. The

hilly ground at the southern end of Spring Farm townland is formed by two bosses of greenstone, occurring in the midst of the felspathic ash, which has thus been rendered very hard. The northern end of this townland extends to near the summit of Westaston hill, on the S.E. slope of which are two small bosses of white felspathic greenstone, a similar variety of diorite occurring as another boss to the S.W. in the eastern portion of Kilmacrea Upper.

Westaston hill is formed of greenstone, the central portion of which occupying a space of half a mile from E. to W., with a width of about 250 yards, assumes a granitic character. Its felspar is often glassy, and it contains both black and white mica. (Minette, or mica-trap?—E.H.)

On the eastern slope of the hill, at the parish boundary, the greenstone (minette?) is white from the decomposition of the felspar, and contains mica.

In the townland of Kilmacurra, West, on the north of Westaston demesne, and to the north of that, in the adjoining townland of Carrigmore, a diorite of a peculiar character occupies a large area. At the former locality this rock is coarsely crystalline, and weathers to a dark-gray colour. The felspar being white at the latter, the rock contains black mica, and in the western side of the townland the mica is bronze-coloured and largely crystalline.

On the south side of the Arklow and Wicklow road, in the townland of Ballynameesda Upper, a large quarry exposes another singular variety of diorite, so finely crystalline as to resemble a micaceous grit. The crystals of mica are small and silvery, the rock being splintery and bluish-gray in colour.

To the south of this, in the same townland, some lofty and rugged ground is formed by pale greenish-gray greenstone, with minute crystals of glassy felspar, and this rock, when it is in junction at its southern boundary with a thin band of hard, dark gray, fine-grained grits, becomes vesicular.

To the south of this is a thin run of greenstone with a hard green and probably chloritic ash above it, over which is a band of slate succeeded by a felspathic ash and a run of felstone. These rocks appear along the western flank of the rising ground to the east of the Arklow road, but they do not cross the valley of the Potters' river to the westward; a fault has, therefore, been here introduced along this valley, and it is traceable to the south for the distance of over one mile, as shown on the map.

Close to and north of the village of Ballycapple the road to Westaston exposes dark gray slates and thin grits, dipping W. to E. at 60°. To the west of the road the ground rises, and is formed entirely of felstone, with a felspathic ash adjoining it on the south, both being traceable for the distance of fully 300 yards. It is manifest, therefore, that here we have another fault striking N. to W.

Between Ballycapple and the Wicklow and the Arlow road, a distance of one mile, the ridge of ground is formed by felspathic ash, with a run of felstone in the middle of it, the gray slates bounding the ash on the north, dipping N. to W. at 70°, which is also the dip of the ash itself. At the eastern end of these beds the ash is seen dipping S. to E. at 70°, and in this way it abuts against the gray slates just mentioned; a fault has been, therefore, here introduced as a branch from that in the glen of the Potters' river. Between this fault and the Roman Catholic chapel of Ballinacor to the south there are three veins of greenstone, two runs of felstone, and three depositions of felspathic ash; that close to the chapel on the north showing a distinct bedding dipping S. W. E. at 65°. About midway between Ballinacor and Redcross, at the junction of the townlands of Ballintim, Kilmurry North, Kilmurry South, Ballygillaroe, and Rahaval, we find in Kilmurry North a dark-gray splintery compact, finely-porphyritic felstone, containing minute crystals of iron pyrites, and in the centre of the quarry a thin layer of gray ash containing pea-like, noduler, and small crystals of felspar. To the south of this is a finely-crystalline greenstone rudely pisolitic near the

farmhouses; and on the roadside to the west of this is an elvan dyke, having gray ribboned slates exposed close to it on the S.W. To the south of this, in the townland of Oghil are green and purple slates, dipping N. and N.E. at 40° to 70°; and in the neighbouring townland of Templegore gray and greenish grits are seen dipping to the N. at 65°, and some of the slaty beds and their joints being saturated and coated with black oxide of manganese. Between the village of Kilbride and Ballymoney House an isolated group of felstones, felspathic ashes, and greenstones forms a hill attaining to 598 feet at its southern end. The apparent outline and general relation of these rocks will be best understood by reference to the map.

(*m.*) *The Castletimon District.*—Within a short mile of the road near Seapark Point, in the southern end of the townland of Blainroe Upper, a somewhat prominent rise of ground exposes fine-grained greenstone in its northern face, and alternations of felstone and felspathic ash along its southern flanks. All these latter rocks are presumed to extend southwards, and some of them do appear in the stream netting at the southern end of the townland of Knockaquirk. Here a few beds of dark, greenish, and hard flaky felspathic ash are intermixed with the felstone, and dip to the eastward at 20°.

The coast from Seapark Point, southwards, for the distance of a mile, exposes gray slates with thin gritty laminæ and irregularly bedded nodular grits, the general dip being to the eastward at 30° to 45°. Ardmore Point, to the south of this section, is formed of alternations of dark gray slaty ash and beds of felstone, one of which is 130 yards thick. The extreme point is formed of hard greenish gray felstone, with some beds of felspathic ash forming the base of the cliff, which is here traversed from N.E. to S.W. by a dyke of porphyritic greenstone, the felspar crystals being a pure white colour, and those of the hornblende a dull olive green, the rock being exceedingly soft and streaky at its junction with the slates.

If we proceed southwards along the west, the next cliff section is at Rockfield, and half a mile in length. Its northern end exposes dark green and gray felspathic ash, dipping N.E. at 35°—the latter weathering white and mottled, thus indicating a rude pisolitic structure; and those beds pass up gradually into a hard felstone, which in places contains layers of felstone breccia.

On the shore under Rockfield House there is a dyke of greenstone in the centre of a conglomeritic breccia, formed of subangular fragments of slate and felstone in a firm crystalline greenish or hornblendic paste. These beds rest on some thin layers of gray slate and grit hardened, and porcelanic, having a contorted dip to the N.E. at 40° to 50°. Three layers are cut off on the south by a fault, the direction of which is W.N.W. and E.S.E., on the southern side of which are some beds of coarse grained whitish felspathic ash in places rudely pisolitic, and dipping to the S.E. at 35°.

The last cliff section is that at the Castle Head south of Jack's Hole. At the northern end this consists of three alternating bands of felstone and felspathic ash dipping E.S.E. at 60°. At the perforated rock called "The Castle," these beds are suddenly twisted round, so as to dip S.S.E. at 55° to 75°, but they soon regain their former dip to the eastward at 75°. At this end of the cliff section the ash beds are rudely cleaved in the direction of N. 55° E. vertical.

To the west of Rockfield, the lofty ground is comprised in the townlands of Cullen Upper, Ennisboyne; Furzeditch West, Dunganstown East, Ballyflanigan, Castletimon, and Ballinacarrig, and occupies an area of about two square miles. The highest point (785 feet) being in the townland of Castletimon, is formed of felstone and felspathic ash, sometimes penetrated and sometimes interstratified by large and irregular bosses and broad lenticular dykelike masses of various kinds of greenstone—vesicular and porphyritic. The felstone itself is frequently vesicular and sometimes nodular when it is observed to be close to, or in contact with, the greenstone; and the felspathic ashes, when observed in a similar position, are rendered exceedingly hard.

The typical exposed section of this district is to be seen along the southern

brow of the rocky ground in the central portion of the townland of Ballynacarrig; here, in an extent of half a mile, we have succession of greenstone, dark greenish gray ash, felstone, and felspathic ash.

Commencing at the S.E. end of the section at the rear of the farm-houses close to the cross-roads, we find a felstone having a bedded aspect, with rotten, or possibly ashy, layers between three beds, and two similar lenticular layers of gray slate in the felstone, the dip being to the S.E. at 70°.

To the N.W., and in junction with this felstone, is the southern end of that great mass of crystalline greenstone which stretches to the north beyond Rockfield House, and which is here 450 yards across. Wedged into this greenstone is a thin lenticular mass of felstone, 300 yards in length, having a narrow wedge of black hornstone, or altered slate, exposed along the N.W. side of the felstone for the distance of about seventy yards; at the back of the farm-houses to the W. of this, a band of felstone breccia occurs in the greenstone.

To the W. of the farm-houses is a band of dark greenish gray ash in the greenstone, with a boss of felstone at its S.W. extremity, and the section terminates by two alternations of greenstone and felstone.

The greenstone forming the summit of Castletimon hill is frequently porphyritic, while the felstone to the south of it is vesicular, the small pea-like hollows being coated by a dark green mineral, supposed to be chlorite, having a radiating structure, the larger vesicles being hollow.

On the W. side of the road in Dunganstown, East, there are some singular and instructive exposures of alternations of clayslate, felspathic ash, felstone, dark greenish gray ash, and crystalline and vesicular greenstone; here, also, the felstone is often vesicular.

I should remark that the boundaries of the felstones and greenstones with the Lower Silurian clayslate are of necessity very frequently hypothetical, and merely suggested by the form of the ground.

The varied outline of the greenstone bosses and irregular dykes in the area alluded to, will best be understood by reference to the map, though its scale is too small to show them with accuracy.

To the south of Castletimon, the two best exposures of the singularly interesting trappean rocks of this district are to be seen in the valley by the Potter's river, and to the south of it, along the by-road from near Ballinacor village to the shore road in the townland of Toulagee. The first section, which is about two miles in length, shows the usual alternations of felstone and greenstone, but at detached localities; except just below the bridge at Castletimon ford and mill, where the greenstone is overlaid by a series of beds of dark greenish gray ash, dipping to E. 15 S. at 65°. Over three beds, and lower down the glen, are repetitions of greenstone and felstone, with a felspathic ash having a cleavage running through it, the direction of which is 20° N. of E. and S. of W.

The last named section, which is two miles and a half in length, is, like the other, made up of detached exposures. Of these, one of the most interesting is that to the east of the Arklow road in the townland of Ballyclogh. It commences at the north of a greenish gray ash grit, with minute crystals of iron pyrites through it, and light gray cleaved felspathic ash, the dip being to the S.S.E. at 80°; then a thick wedge-like mass of finely crystalline greenstone, followed by a pale yellow cleaved felspathic and glossy ash, with thin layers of gray slate, the dip being to the N.N.W. at 85°. The ordinary gray slates of the district now appear as a band 350 yards wide, when a greenstone occurs, having beneath it a felspathic ash dipping N.N.W. at 50°, passing down into a felstone. This again is ended by a felspathic ash, and then by the southern end of the great mass of greenstone occupying the N.E. corner of the townland of Ballinaclea, the northern end of which has lost those tongues of greenstone described as alternating with the felspathic rocks in the valley of the Potters' river just below the

ford of Castletimon. The last exposure of these rocks worth noting is that seen along the road at Brittas flour mill, and to the S.W. of it, just out of the limits of the map, and at the angles of the road in the northern end of the townland of Toulegee. At the former place two thin wedges of felstone, one of which has a small mass of hardened or chirty slate attached to it, are enclosed in the greenstone, and at the latter place four small wedge-like masses of felstone are in a similar manner stuck into the larger mass of greenstone. This fact is very clearly to be seen in a small quarry on the roadside, where the felstone, in the form of a blunt wedge 10 or 12 feet broad, is seen resting on the greenstone.

Mines.

The mines in this district are those of Glendalough and Glendassan, Glenmalure, and the abandoned mine at Ballycorus, all the property of the Mining Company of Ireland, and worked for lead—the company's smelting works having been erected at this latter locality; Connaree Mine, belonging to the company of that name, formerly worked for copper, but at present for sulphur ore or "pyrites," and copper precipitate, with the minor lodes at Lough Dan and Lough Tay.

The description of these mines must necessarily be brief.*

1*st. The Glendalough and Glendassin Lodes.*—The following information regarding these lodes has been supplied by John P. Clemes, esq., commissioner and resident director of the works at Glendalough:—

"The main lode, called 'Glendalough and Luganure lode,' has been proved to extend nearly due north for the distance of two miles and three-quarters from the alluvial flats at the head of the upper lake at Glendalough. Its average width is ten feet, varying, however, from a few inches to twenty feet—its hade throughout being to the west at 70°, or in other words, its dip being to the west at 70°.

"The lode is pure white vein quartz, and it contains gallena in large quantities, blende, occasional specks of copper, with some pyrites, carbonate of lead, sulphate of barytes, and carbonate of lime.

"Beautiful crystals of native silver have been found in this lode.

"At the old mine on the summit of the hill to the S.E. of Lough Nahanagan, this lode is cross-cut at an angle of 10° to the south of the cut, and 20° to the north of it, by the Ruplagh lode, which has been proved for the distance of over one mile, its hade being also to the westward at 20°. The rough lead ore from the principal vein yields four and a half ounces of silver to the ton, and when it is dressed the per-centage of silver is increased to eleven ounces per ton.

"On the northern side of the glen, at the head of the upper lake, the main lode is traversed by two cross courses, that to the north extends 1,325 yards from adit to adit, its direction being 20° N. of E. and S. of W. The southern cross course strikes about 10° N. of E. and S. of W., branching from the northern at the stream three-quarters of a mile west of the lake shore.

"The Vandieman's lode occurs on the southern side of the glen, and is cut by three cross courses, where they unite at the stream; the direction of this lode is N. 5° W., but as it was followed to the eastward it curved round in a short distance, so as to strike about E. 30° S., with a hade of 10° to the S.W.

"The cross courses are of quartz fifteen feet wide and crystallised from the walls, and they were found to contain specks of galena, copper, iron pyrites, carbonite of iron, and specular iron ore.

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* For descriptions of some of the principal mines of Wicklow, see "Records of the School of Mines," vol. i, part iii., by W. W. Smyth, F.R.S. (1853), and Mr. Weaver's Memoir, read before the Geological Society of London (1818). Also Rev. Professor Haughton, F.R.S. "Geological and Statistical Notes on Irish Mines."—*Journ. Geol. Soc., Dublin*, vol. vi.

"The Glendassan lodes are four in number. The most westerly is called the Hero lode, and is exactly half a mile to the east of the main lode; it strikes N. and S., and has been opened up for the distance of about 700 yards on the south side of the glen, its hade being to the W. at 20° to 40°.

"At the distance of 325 yards east of this is 'Moll Doyle's' lode; the strike of which is also N. and S., with a hade of 40° to the W., its extent being about half a mile. Further to the east are the Foxrock lodes, which intersect each other at the distance of 375 yards to the north of the main road traversing the glen; these lodes hade also to the westward.

"Throughout this district all these lodes occur in the granite, and all traces of them are lost when the mica schist is reached."

2nd. Glenmalure Lodes.—The lodes at this locality which come into this district, owing to their unproductive character, have not been worked for many years, and I cannot give any reliable information regarding them.

According to the data on the map (sheet 23, third quarter) they consist of four or five lodes, viz., three on the north side of the glen and two on the south. Amongst the former is the main lode occurring at the distance of of 160 yards N.E. of the old smelting-house, and extending for about three-quarters of a mile, with a strike of 30° W. of N. and E. of S., its hade being to the S.W., but the amount not stated. In the stream course to the N.E. of the old smelting-house this lode is cross cut by a similar lode striking E. 25° N.

To the south of this, at the distance of nearly 250 yards, near the shed for cleaning ore, is another small lode, striking nearly E. and W.

On the southern side of the glen, and directly opposite to these lodes, are two lodes—that to the south is called "the Battery lode," and it strikes W. 30° N.

To the N.W. of this, at the distance of 500 yards, is a large vein of quartz, containing heavy spar.

Unlike the lodes of the Glendalough district, those of Glenmalure traverse both the granite and the tongues of mica schist here embedded in it; and as it would appear that the formation of a good lode depended to some extent on the openness and cleanness of the original fracture which induced its formation, the mica schist, from its fissile character, did not fulfil the requisite conditions to aid in the formation of the lode, but that the granite, from its homogeneous and solid character did so.

3rd. Lough Dan Lode.—This lode occurs on the south side of the alluvial flats at the head of the lake, and 450 yards distant from it; its strike is S. 40° W., and it has been proved into the hill for the distance of 300 yards; it is three feet wide, and contains galena and copper pyrites.

4th. Lough Tay Lode.—A small lode, four inches to one foot thick, occurs at the extreme N.W. corner of this lake, and it is marked on the map as striking W. 20° N.; it contains a little galena with iron pyrites.

The Connaree Mine.—This mine consists of three large sulphur courses or beds of invariable width, occurring in the gray slate, which is interstratified with the felstones and felspathic ashes of the district. Of these the two to the south, and which are close together, striking across the summit of Connaree hill from N.E. to S.W., with a hade of 20° to the S.E., are the most important, and were the first utilised, their proved extent being about half a mile; the main shaft is at the summit of the hill, and is about eighty-five fathoms deep.

It was here that this mine was first worked for copper, which at one time was found in enormous bunches in a quartz lode, but it gradually died out as the works progressed, and eventually became profitless. The sulphur courses cut during this search for copper eventually became of importance, and still continue to yield good "pyrites." The water raised from the old workings yields a profitable precipitate of copper. At the distance of half a mile N.W.

of the old lodes at the summit of the hill is the Sroughmore lode; it has been traced at intervals across the townland whose name it bears for the distance of three-quarters of a mile, and in many instances has yielded most profitable sulphur ore; its strike and "hade" is the same as the old lodes to the S.E. To the N.E. of Connaree, in the townland of Kilmacoo, the supposed prolongation of the old lodes is stated to appear as "gossan" in the roadside in the northern part of the townland. In the extreme N.E. corner of the same townland a sulphur bed is known, and trials have been made in it. If this bed be prolonged to the S.W. in the line of strike of the slates in which it occurs, it would pass to the S.E. of Connaree summit at the old works.

A thick vein of white quartz, striking N.E. and S.W. on the southern flank of the boss of felstone occurring to the N.E. of the old mine, is supposed to indicate the presence of a copper lode, and is possibly the extension to the N.E. of the cupriferous quartz which was originally worked at Connaree.*

Ballycorus and Shankhill Lode.—In the granite on the northern slope of Shankhill, in the townland of Ballycorus, a lode of argentiferous lead was opened up many years since, but subsequently abandoned as unprofitable. The lode extended in the direction of 10° N. of W. and S. of E., for the distance of about 600 yards, its eastern end having been traced into the mica schist.

The Mining Company of Ireland at their extensive smelting works at Ballycorus manufacture sheet lead, lead tubing of all dimensions, red lead or vermillion—and extract the silver from the lead procured at their mines of Glendalough and Glendassan, as well as from that imported from South America and Spain. The Shot Tower on the side of the hill to the south of their smelting furnaces has been erected over one of the old shafts of the Ballycorus lead lode, thus giving a fall of nearly 200 feet for the shot. The flue from the smelting furnaces at Ballycorus extends at a gentle incline up the southern slopes of Carrickgollogan for the distance of over one mile, and the carbonised lead in the form of gray soot which is periodically extracted from it yields a sum of about £1,000 per annum after paying the expense of the reduction of the lead.†

Drift Deposits.—The drift in the northern portion of the district is principally brown clay with numerous well-rounded pebbles of Carboniferous limestone, and it reaches up the flanks of the hills to the height of 1,200 feet over the granite of Kilmashoge mountain.

Between Glencullen House and the village of Stepaside the drift attains an altitude of 900 feet; while at the distance of a few miles of the east of this, between Shankhill House on the south, and Carrickmines on the north, it has been denuded of the granite, which here forms small irregular hoses, the lowest of which is about 200 feet.

The ridge of Carrickgollogan, which to the west of the summit is cut through by "The Scalp," is denuded of this drift to a level of 500 feet along its southern slopes.

In the glen above Glencree barracks the bog lies on the granite to the depth of six to twenty feet, and it is stated that lime roots and stems of fir,

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* My late friend, Mr. Markham Browne, then resident director of the Connaree Mine, informed me that in the year 1855, while examining one of the levels in that mine, at the depth of 64 fathoms, he struck a pick into the side of the gallery, and by the blow removed a mass of iron pyrites, of about 3 cwt., which had been loosened by a joint. In the fissure which he thus exposed he discovered myriads of winged insects, supposed to be midges, in apparently a dormant condition, and these on being thus suddenly brought into the open air, immediately assumed life, and greatly annoyed the miners in their operations.

† Number of men employed at the Ballycorus Smelting Works, 66 to 68; quantity of ore smelted during the year over 100 tons. All the works effected by water-power applied to a turbine engine.

willow, &c., are frequently met with in cutting the peat, though the height is over 1,500 feet above the sea.

In the glen by the small river which bounds the counties of Dublin and Wicklow, and at the S.E. corner of the townland of Monastery, near the road to Old Connaught and Bray (sheet 3-4 and 2 Wicklow), the boulder gravel, with abundant limestone boulders, is covered with from three to seven feet of loam patches, containing land shells (helix) and fragments of bones at a depth of about three feet, and just under Monastery House. The loam and gravel is stated to contain fragments of marine shells at a height of about 350 feet above the sea, and fragments of sea shells are met with in the gravelly clay, forming the sloping banks of the same river above Vallombrosa.

Over the eastern slopes of the granite range, in the district of Lough Bray, the whole country is covered by a thick deposit of granitic detritus and boulders, which latter rapidly decrease in number as they extend across the granite boundary on to the mica schist.

On the road cutting close to Enniskerry on the north Mr. Wyley notes sand and fine gravel, the latter finely stratified, both cemented by carbonate of lime, the sandstone thus formed often exhibiting a surface resembling ripple mark. In the stream cutting to the west of Bushy Park chalk flints and fragments of shells are found in the sandy clay.

Along the sea beech between Bray and Greystones there are low cliffs of marl, with limestone and other pebbles and fragments of shells, over which is a deposit of sand and gravel. Along the shore the pebbles most usually seen are granite, grits and clay slates of various kinds, quartz and quartz rock, jasper, greenstone, porphyry, old red sandstone, limestone, chalk flints, with and without fossils, and rarely, chalcedony.

At Bray Head the brown gravelly drift is well seen at the bar of the Head both in its northern and southern level.

All over the granite district between Lough Bray and Lough Dan the rock is for the most part covered by a coating of bog from three to fifteen feet thick, and it is not till we get to the low grounds along the flanks of the granite range that we observe a drift derived from local rocks close to Drummin Lodge. At the southern end of the Glen of the Downs, and at a height of 316 feet above the sea, the drift is described as "foreign gravel, limestone unusually abundant, parted by nearly horizontal layers of sand, the beds so cemented by the foreign matter as to project five or six inches without breaking." Some of the pebbles are real conglomerates. Close to Newtownmountkennedy the drift, at an elevation of about 185 feet, is rudely stratified, and contains large boulders of limestone, shales, and quartz, while chalk flints are quite common. To the east of this, Leabeg Upper, the sand contains traces of shells along the sea-coast to the east of Newtownmountkennedy. The pebbles are of great beauty and variety, chiefly chalk flints, jaspers, agates, flint breccias. In some places the chalk flints amount to more than 5 per cent. of the pebbles, estimated numerically.

On the comparatively open ground to the west of the Devil's Glen there are some enormous granite blocks, one of which, in the townland of Boleymas Upper, is estimated to weigh 150 tons, the distance from the granite to the west being about five miles. The drift on this district and that to the south, as comprised in sheet 130, is formed entirely of local rocks, including granite. The district about Ballinalea, and to the eastward of the Devil's Glen, is covered here and there by the limestone drift, which at Killadreenan attains an altitude of 200 to 300 feet; the limits and outline of this deposit being shown on the map by numerous fine dots.

Between the granite and the ridge of Carrick mountain the lower grounds are covered with granite detritus, reaching to a height of 1,150 feet at Moneystown hill. Some of the larger granite blocks are of enormous size,

one in the extreme south corner of the townland of Trooperstown measuring 18 yards in circumference.

On the summit of Cronebane hill, 800 feet above the sea, a perched boulder of granite, measuring 15 feet+8+8 feet, and called "The Motty Stone," rests on the coarse gray sandy slate.

In the low grounds to the S.E. of Glenmore Castle, townland of Monduff, and also close to Ashford, on the S.E., there is a pile of granite with greenstone blocks at the height of 250 feet above the sea; these were probably brought down by the glacial agents through the gorge of the Devil's Glen. I believe this is the most easterly limit for granite-drift in the district, the parent rock being fully ten miles distant.

Another local pile of granite blocks occurs on the east side of the valley of the Avoca river, in the townland of Cherrymount, immediately beyond the southern limit of the map, and distant about eight miles from the nearest granite.

As we proceed southwards past Wicklow Head, we find here and there indications of the presence of that brown, calcareous marl containing chalk pebbles, known as the Wexford marl. This is seen to underlie the drift limestone gravel in the eastern corner of the townland of Blainroe Lower (sheet 31, 2nd quarter).* All along the road, and southwards from Wicklow Head, the surface of the rocks where exposed is generally levelled, smoothed, and striated by glacial action. This is particularly well seen to the north of Arklow, on sheet 139.

Glacial Striæ.—The trappean district which occupies the S.E. portion of sheet No. 130, was the only portion of the area included in this, and the adjoining sheet No. 121, which I examined personally. The *striæ* which I noted occur in the townland of Sroughmore, on the northern slope of Connaree hill, where the direction is 10° to 15° W. of N. and E. of S., or directly across the strike of the ridge. I have no doubt but that over the entire district there are many occurrences of glacial striæ.

In the district of Arklow, and to the south of it, I have noted many localities where these *striæ* are well developed and preserved.

March, 1867. GEO. V. DU NOYER.

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* I noticed a small isolated patch of this particular marl in the bed of the stream below the village of Stillorgan, county Dublin, in the cutting made there for the pipes for the supply of the Vartry water to Dublin in 1866.—G. V. DU N.

The following references are some of the observations made on the drift phenomena of the counties of Dublin, Wicklow, and Wexford.—E. HULL:—

Professor E. Forbes, F.R.S.—"On the connexion between the distribution of the existing Fauna and Flora of the British Isles and the geological changes which have affected their area, especially during the period of the northern drift."—Mem. Geol. Survey, vol. i.

Sir Henry James, F.R.S.—"Note on the Tertiary Deposits of County Wexford."—Journ. Geol. Soc., Dublin, vol. iii., p. 195.

Sir Richard Griffith, F.R.S.—"Presidential address to the Geological Society of Dublin, 1836."—Journ. Geol. Soc., Dublin, vol. i., p. 151.

Professor Oldham, F.R.S.—"On the more recent Geological Deposits of Ireland."—Journ. Geol. Soc., Dublin."—vol. iii., pp. 61 and 131.

"On the supposed existence of Moraines in Glenmalure, County Wicklow."—*Ibid.*, p. 197.

"On the Drift Deposits of County Wicklow."—*Ibid.* p. 302.

Dr. J. Scouler.—"On certain elevated hills of gravel containing marine shells, in the County of Dublin."—Journ. Geol. Soc., Dublin, vol. i. part 4.

Mr. John Kelly—"On the Drift of the district about Rathfarn, in the County of Dublin."—Journ. Geol. Soc., Dublin, vol. vi. p. 133.

Dr. J. R. Kinahan.—"On Fossils from the Marine Drift of Bohernabreena, County of Dublin."—Journ. Geol. Soc., vol. viii.

Rev. Maxwell H. Close.—"On the Glaciation of the Rocks in the neighbourhood of Dublin."—Journ. Roy. Geol. Soc., Ireland, vol. i.

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