THE

GEOLOGICAL SURVEY OF THE UNITED KINGDOM

IS CONDUCTED UNDER THE POWERS OF THE

8TH & 9TH VICT., CHAP. 63 —31ST JULY, 1845.

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

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

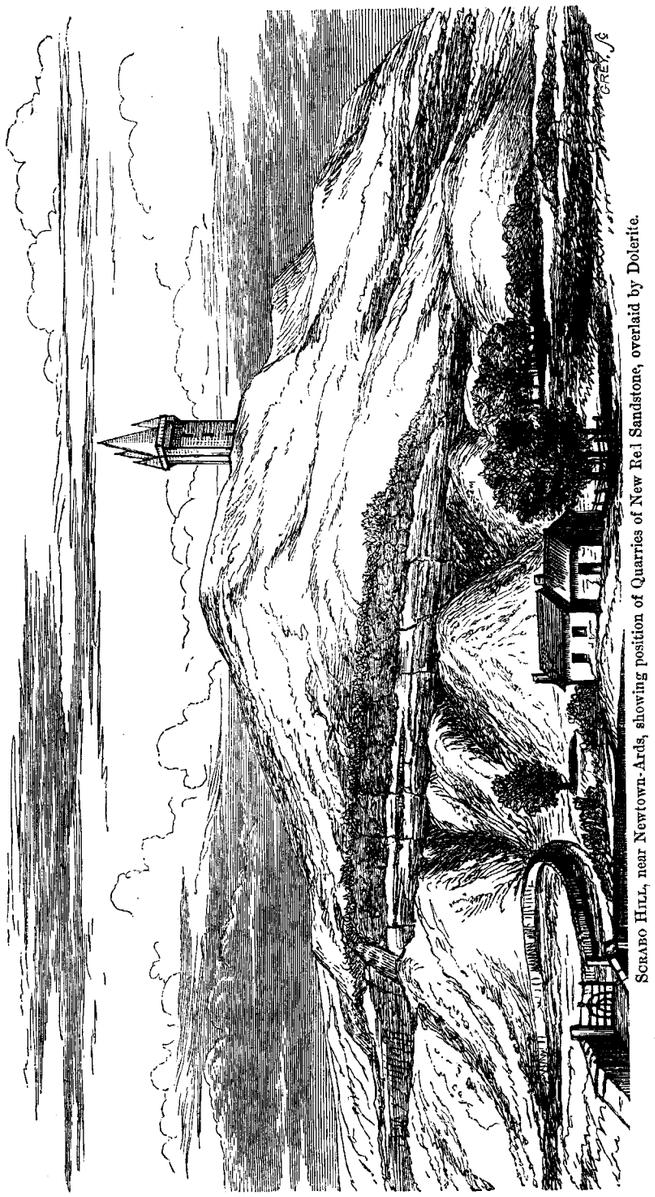
Longitudinal sections, on the scale of six inches to the mile, and vertical sections of coal-pits, &c., on the scale of forty feet to the inch, are also published, and in preparation.

Condensed memoirs on particular districts will also eventually appear.

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

AGENTS FOR THE SALE OF THE MAPS AND PUBLICATIONS:

Messrs. LONGMANS, GREEN, & Co., London;
Messrs. HODGES, SMITH, & Co., Grafton-street, Dublin
ALEXANDER THOM, Printer and Publisher, Abbey-street, Dublin.



Scrabo Hill, near Newtown-Ards, showing position of Quarries of New Red Sandstone, overlaid by Dolerite.

Memoirs of the Geological Survey.

EXPLANATORY MEMOIR

TO ACCOMPANY

SHEETS 37, 38, AND PART OF 29

OF THE MAPS OF THE

GEOLOGICAL SURVEY OF IRELAND.

INCLUDING

THE COUNTRY AROUND BANGOR, NEWTOWNARDS, COMBER, AND SAINTFIELD, IN THE COUNTY OF DOWN.

BY

EDWARD HULL, M.A., F.R.S., &c., J. L. WARREN, B.A., F.R.G.S.I., AND W. B. LEONARD.

With Palæontological Notes by W. H. BAILY, F.G.S., &c.

Published by Order of the Lords Commissioners of Her Majesty's Treasury.

DUBLIN:
PRINTED FOR HER MAJESTY'S STATIONERY OFFICE.
PUBLISHED BY
ALEXANDER THOM, 87 & 88, ABBEY-STREET;
HODGES, FOSTER, & CO., 104, GRAFTON-STREET.
LONDON:
LONGMANS, GREEN, READER, AND DYER.
1871.

PREFACE.

THE northern portion of the district here described, contained in Sheet 29, lying along the shore of Belfast Lough, was surveyed by Mr. Du Noyer, under the direction of Professor Jukes, and previous to publication was partly revised by myself in company with Mr. Warren, in the spring of 1869. The southern portion of the district, comprising the whole of Sheet 37, was partly surveyed by Mr. Du Noyer, but principally by Messrs. Warren and W. B. Leonard, and inspected by Mr. Jukes. As both Messrs. Jukes and Du Noyer were removed by death before they had an opportunity of drawing up the usual descriptive memoir, its preparation has devolved on the authors, who have availed themselves of the information obtained by previous observers, both those connected with the Geological Survey or otherwise.

EDWARD HULL,
Director of the Geological Survey of Ireland.

Dublin, 21st April, 1871.

EXPLANATORY MEMOIR

TO ACCOMPANY

SHEETS 37, 38, AND PART OF 29 OF THE MAPS

OF THE

GEOLOGICAL SURVEY OF IRELAND.

GENERAL DESCRIPTION.

THE area described in this memoir lies altogether in the county Down.

The principal places in Sheet 29 are the small towns of Bangor and Donaghadee, with the villages of Holywood, Crawfordsburn, Conlig, and Groomsport; and in Sheet 37 the towns of Newtownards, Comber, and Saintfield, and the villages of Dundonald, Ballygowan, and Killinchy; all lying to the E. and N. of Strangford Lough. In the promontory of the Ards there are the villages of Mill Isle, Carrowdore, Grey Abbey, Ballywalter, Kircubbin, and Ballyhalbert.

1. *Form of the Ground.*

The district under consideration is bounded along the north and east by Belfast Lough and the Irish Sea, extending southward about a mile S. of Saintfield, and westward to within a mile of Ballymacarret. It is intersected near the centre by Strangford Lough—an arm of the sea of no great depth, considering its large expanse, which extends from the southwards to the town of Newtown-Ards, and the base of Scrabo Hill. In consequence of this position of the Lough, the eastern portion of the district forms a promontory extending, with a curved outline, in a southerly direction—called the promontory of "The Ards." The average breadth of Strangford Lough in this district is about three miles, but at its southern outlet it contracts to a channel at Portaferry, less than half a mile in width; while the maximum depth—about 30 fathoms—is attained at a point about a mile beyond the margin of the map, S.W. of Long Island (Sheet 49.)

East of Holywood the ground rises rapidly, forming the group of heavy Silurian hills which lie between that village and the town of Newtownards; the highest points being Carrowreagh Hill (580 feet), Carngaver (720 feet), and Helen's Tower (479 feet). The southern and northern slopes of these hills are indented by many deep glens and ravines, running far up, in which deposits of boulder drift are found. N. and E. of this, in the direction of Donaghadee and Bangor, the ground is covered with a thick deposit of boulder clay, forming low, undulating hills; whilst to the south the ground falls rapidly towards the rich valley through which

run the Belfast and County Down Railway and the main road between Newtownards and Belfast. This valley is divided into two, a little E. of the village of Dundonald, by the high, irregularly-shaped basaltic plateau of Scrabo Hill; one branch trending N.E. and then E., in the direction of Newtownards; while the other and principal one, turns S.E. towards the town of Comber.

The basaltic plateau before alluded to has an average elevation of 350 feet, its highest point being Scrabo Hill, whose summit is 540 feet above the sea level.

The high Silurian ground bounding the Belfast and Newtownards valley on the S. enters the district about two miles S. E. of the Knock railway station, and runs in an easterly direction as far as the Dundonald station, on the same line; it then turns to the S.W., and runs down a little S. of Comber.

The remaining part of the district to the S. and E. of Comber, as far as the western limits of the map, presents no features of interest, being, except in a few isolated places, covered with a thick deposit of boulder drift, which forms well-rounded and undulating hillocks. The drainage of by far the greatest portion of this area is effected by numerous small streams and rivulets, flowing in various directions, and eventually finding their way into Strangford Lough. Of these, the most considerable is the small river Blackwater, which rises in the townland of Killinure, near the western limit of the map, and after a sinuous course of fourteen miles, falls into Strangford Lough at the village of Ardmillan, having the extraordinary high fall of twenty-eight feet per mile.

In its upper portion Strangford Lough is extremely shallow, with low, shelving shores, and further S. is studded with numerous islands formed of drift.

To the E. of Strangford Lough lies the promontory of the Ards, on each side of which there is an irregular, undulating ridge of drift hills, the centre of the promontory being principally occupied by a series of bogs. These bogs are on the crest of the watershed, the drainage being carried off by numerous small streamlets, flowing westward into Strangford Lough, and eastward into the open sea.

The line bounding the catchment basin of Strangford Lough enters the district at the S.W. corner of the map, close to 5° 52′ W. long., and proceeds in an almost direct N. and S. line for about seven and a half miles; it then turns near Grove Cottage to the N.E., and runs in that direction for about two miles, when it reassumes its northerly course, till, in crossing the Belfast and County Down Railway, about one mile W. of the Dundonald railway station, it bends to the N.E., but immediately again runs N., passing about half a mile E. of Stormount Castle. A little further N. it curves round, so as to go through the trig. point 659, and then turning sharply to the E.S.E. crosses the top of Carngaver hill in a sudden bend to the N. From here it sweeps round through Clandeboye Demesne and Helen's Tower, crosses the Donaghadee branch of the County Down Railway, nearly two miles N. of Newtownards, and runs down the centre of the Ards promontory, leaving the district at about 5° 29′ W. long.

2. *Formations or Groups of Rocks entering into the Structure of this District.*

AQUEOUS ROCKS.

		Name.	Colour on Map.
Recent.		Bog, Alluvium, or other Superficial Covering,	*Pale Sepia.*
Post Pliocene.		Drift Deposits.	*Engraved dots.*
Lower Mesozoic.	Triassic Rocks.	f⁵ Lower Keuper Sandstone,	*Venetian Red (darker).*
		f³ Bunter Sandstone,	*Venetian Red.*
Upper Palæozoic.		e Permian Beds,	*Burnt Roman ochre and gamboge.*
	Carboniferous.	d² Lower Limestone,	*Prussian blue.*
		d¹ Lower Limestone Shale,	*Prussian blue and Indian ink.*
Lower Palæozoic		b Lower Silurian,	*Pale purple.*

IGNEOUS ROCKS.

B Basalt, and Dolerite,	*Dark purplish red.*
F Felstone,	*Orange crome and carmine*

AQUEOUS ROCKS.

Lower Silurian Rocks.—The rocks of this formation consist of gray, purplish, and greenish-gray grits, sometimes massive and often micaceous, interstratified with flagstones, coarse sandstones, and conglomerates, with beds and layers of gray, red, and green slates, and occasional bands of black carbonaceous shales, containing graptolites.

The beds have the usual strike of the Silurian rocks of this part of Ireland, from S.W. to N.E. nearly, and dip at angles ranging from 25° to 90°.

Although in places the strata are concealed by a covering of drift, and subjected to minor undulations, nevertheless we can trace a leading synclinal arrangement of the beds across the district. The axis appears on the coast at the village of Mill Isle in the promontory of the Ards, and runs in a south-westerly direction, crossing Whitehill, and disappearing under the Triassic beds in the northern corner of Mount Stewart demesne.

On the opposite side of Strangford Lough the axis of the curve must be somewhere in the townland of Ballydrain, about one mile S. of Castle Espie; as farther inland, and just where the "T," of Tullynakill is engraved on the map, it is again observable, and runs from this in the direction of the Ballygowan railway station. There the beds undulate a good deal, so that it is very difficult to determine its exact course; it seems, however, to sweep down to the south-westward, passing through the demesne of Saintfield

House, and then turning to the W. leaves the district about a quarter of a mile N. of Hogg's Lough.*

It is impossible to estimate with anything like accuracy the thickness of this group of rocks, as there is no visible section of the beds in which we can be certain that the succession is unbroken throughout the entire distance. The best section is that afforded by the coast line, and here there may be concealed faults and plications even besides those that are visible, bringing up and repeating the same beds. It is certain, however, that these beds have a thickness of several thousands of feet.

Carboniferous Series.

d¹ *Lower Limestone Shale.*—These strata occur on the shore of Belfast Lough at Cultra, about one mile N.E. of Holywood, and consists of dark gray and black shales full of *Modiola Macadami*, hard gray limestone with red and yellow shales and calcareous grits, the lowest beds being red and green calcareous sandstones, with thick bedded brick red sandstones and fine conglomerates.†

How far these beds extend under Belfast Lough it is of course impossible to ascertain, so that their thickness cannot even be conjectured.

At the lime-works of J. Murland, esq. at Castle Espie, about two and a half miles S.E. of Comber, the quarry from which the limestone is procured has exposed a set of beds consisting of dark purplish red and green mottled shales, which are evidently the representatives of the lower limestone shales in this part of the district. At the time the country was under examination they had been penetrated in the engine shaft to a depth of six feet without reaching the Silurian rocks.

d² *Lower Limestone.*—The limestone at Castle Espie is red or salmon-coloured, and finely crystalline, in beds of variable thickness, with layers and partings of light green shale, being at the quarry thirty-five feet thick, and at the engine shaft forty-one feet.‡

Permian Beds.

The strata belonging to this formation are found on the southern shore of Belfast Lough, east of Cultra Pier—occupying but a small area—and resting upon strata of lower carboniferous age. Attention was first drawn to these beds by Dr. Bryce, F.G.S., and they are of peculiar interest, as showing that the limits of the Permian sea extending from England included this portion of the north of Ireland.

As shown by Professor King, the beds at Cultra are the true representatives of those in the north-east of England of Permian age, but they may be more properly paralleled with those fragmentary tracts which are found in west and north Lancashire.§

The Permian beds of Cultra are terminated to the eastward by a basaltic dyke which coincides with a line of fault,‖ while their

* It is interesting to observe that this north-easterly trend of the Lower Silurian rocks is continous with that of the same beds in the hills of the south of Scotland.—E.H.

† Probably the representatives of the calciferous sandstones of Ballycastle and Scotland at the base of the Carboniferous series.—E.H.

‡ For this information we are indebted to —— Bagnall, esq., C.E.

§ As at Bispham near Ormskirk, Stank, &c.

‖ Traced on the maps of the Survey by the late Mr. Du Noyer. *See* Fig. 1, p. 22.

lower margin, after stretching along the shore in a S.W. direction for a short distance, bends round towards the west and strikes out seaward. To the east of the dyke, Lower Carboniferous beds are brought up, and extend along the shore for a distance of nearly a mile. These and the Permian strata are only to be observed during the ebb of the tide.

Historical Sketch.—The first mention of these beds was made by Dr. Bryce in 1835, in a paper read before the Geological Society of Dublin, in which he stated that they were dolomitic, and bore a striking resemblance to the magnesian limestones of the N.E. of England,* and in 1852, at the Belfast meeting of the British Association, added that the few fossils found in them, bear out as far as they go the conclusion that we may regard these beds as of Permian age.†

At the same meeting of the Association, Professor King, Queen's College, Galway, showed that the fossils contained in the Cultra beds were identical with *Schizodus, Schlotheimi, Pleurophorus costatus, Bakevellia antiqua,* and other species common to the Permian rocks of England and Germany.‡ Subsequently in a paper read before the Geological Society of Dublin, the same author compared these beds and their fossil contents with others occuring at Artrea and Tullyconnell Hill in the county Tyrone, and also showed the close agreement in the chemical composition of the magnesian limestone of Hartlepool, on the coast of Durham, with that of the limestone forming the beds from which the fossils had been obtained at Cultra and Tullyconnell. Furthermore Professor King remarked on the palæontological resemblance of the fossil forms of upper Permian beds of the coast of Durham to those found in the strata at Cultra and Tullyconnell; from these facts drawing the conclusion that the Irish "fossiliferous dolomite" of Cultra belongs to the highest member of the Permian system, as developed in the N. of England.§ These beds are also referred to by Sir R. I. Murchison.‖

Mineral Characters.—As the dip is everywhere out to sea at angles varying from 25° to 40°, the highest beds are only to be seen at low water mark, and even then the section is obscure. They consist of yellow dolomite—formerly quarried and exported to Glasgow for the manufacture of sulphate of magnesia, as mentioned by Sir R. Kane.¶ Below these are red marls resting on thin fossiliferous limestones and shales of Carboniferous age. Amongst the beds are occasional breccias formed of angular, or slightly rounded pebbles of Silurian grits and slate, which may be regarded as the remains of an old sea-beach of the Carboniferous period. Fuller details will be found in the Detailed Description further on (page 20.)

E. H. & J. L. W.

Triassic Rocks.

These strata occupy a depression, or old valley, in the Palæozoic rocks, stretching from the shore of Belfast Lough in an easterly

* *See* Jour. Geol. Soc. of Dublin, vol. i., part ii.

† *See* 22nd Rept. Brit. Assoc., 1852, p. 42. ‡ *See* ibid, p. 53.

§ *See* Dub. Geol. Soc. Jour., vol. vii., p. 67. ‖ "Siluria," 4 edit., p. 335.

¶ Kane, "Industrial Resources," p. 170.

direction, gradually verging southwards, and continued under the waters of Strangford Lough. The strata being soft, the old valley has been partially re-excavated; the mass of Scrabo hill, with its capping of dolerite, having been preserved to a greater extent than those portions lying to the west and east of this position.

The representatives of the Triassic series consist of the fragments of Bunter and Keuper divisions, for the lower beds of the former, and the upper beds of the latter, consisting of the red marl, are not represented in this district, though well developed on the opposite coast. There can be no doubt, however, that the red marl originally extended over this area, but along with, probably, the Cretaceous rocks, was denuded away ere the sheets of Tertiary volcanic rocks were spread over the same tract.

In order to determine the definite position in the series, of the Triassic strata in this district, it is necessary to have recourse to those very complete sections which are laid open in Lancashire and Cheshire, and have determined the succession of the beds as adopted by the Geological Survey.* Adopting the divisional arrangement of the strata in England, it would appear that in this district we have only the representatives of the upper member of the Bunter (or the "Upper Red and Mottled Sandstone)," and of the the lower member of the Keuper series (or the Lower Keuper Sandstone). The beds which form the base and flanks of Scrabo hill and vicinity, answer exactly to these divisions, both in regard to relative position and stratigraphical and mineral characters. The beds which lie immediately beneath the dolerite, and are so largely worked for building purposes, have a remarkable resemblance to those of the Lower Keuper Sandstone in the neighbourhood of Liverpool and Birkenhead; while the subordinate softer strata of bright red sandstone on which they rest are similar in every respect to the Upper Mottled Sandstone of Lancashire and Cheshire, which is so finely laid open in the railway sections near Ormskirk.

There is, however, one feature of dissimilarity between the rocks of the district now under comparison which ought not to be left unnoticed. In England the junction of the Keuper and Bunter divisions bears evidence of erosion and of unconformity.† There is no passage of the beds of the lower division into the upper.‡ On the other hand, we have been unable to determine any definite line or plane of demarcation between those beds on the flanks of Scrabo hill, which are the apparent representatives of the two divisions of the formation; and though several reasons for this present themselves to our minds, such as the want of completeness in a vertical direction of the sections—yet we refrain from entering into the discussion of them here. Having now stated the grounds on which we have adopted the names for the beds, as represented on the Geological map, we now proceed to describe the beds themselves.

f^3 *Upper Red and Mottled Sandstone (Bunter).*—When seen

* "The Triassic and Permian Rocks of the central counties of England," p. 10, Mem. Geol. Survey, 1869.

† *Ibid.* "Geology of Wigan, Lancashire."—Mem. Geol. Survey, p. 85-7.

‡ That there can be no true passage is clear from the consideration that the Muschelkalk of Germany (not represented in Britain) occupies an intermediate position.

in the district, this division is found to consist of soft, fine-grained, red and mottled sandstone, sometimes obliquely laminated. Though weathering into a soft sand, only fit for foundry purposes, it is sometimes quarried for building, as at Ballyurn, or "Red Stone" quarry, on the Belfast and Newtownards road. Good sections are shown here and along the eastern base of Scrabo hill.

f^5 *Lower Keuper Sandstone.*—This division is finely opened out in the large quarries along the eastern flank of Scrabo hill. The beds consist of white, brown, and light purple sandstone (or freestone), largely employed for building purposes, and having a thickness of about 120 feet. The beds are sometimes massive, at others flaggy, with blotches and thin partings of red marl or shale. They are often rippled, micaceous, and exhibit the appearance of sun-cracks and pits of rain-drops, so characteristic of their contemporaneous beds in Cheshire. Oblique lamination is sometimes to be observed.

In the quarry near Ballyalton House, by the road-side, the sandstone is interstratified with layers of red, purple, and blue jaspideous stone, somewhat peculiar, and at first sight difficult to explain. They are clearly, however, only bands of shale, which have been indurated by the heat of the once superincumbent dolerite.

At Dundonald railway station there is a small patch of the lower Keuper sandstone, with a conglomerate base resting on the Bunter sandstone.

The drift and alluvium do not require separate mention from that which will be found at the end of the detailed descriptions.

Igneous Rocks.

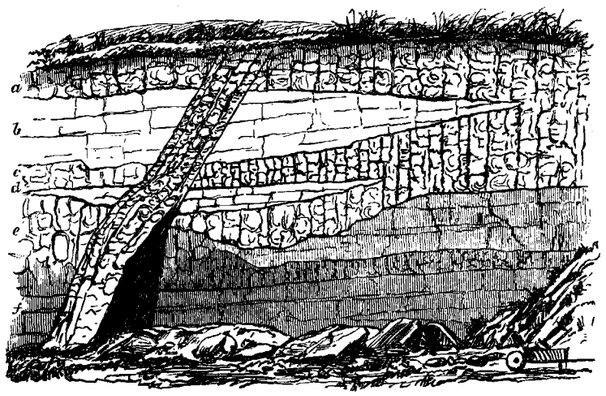
Dolerite and Basalt.—Sheets and dykes of these rocks occur both at Scrabo hill* and Dundonald, and in the former position are laid open in magnificent sections along the face of the quarries for a considerable distance. The phenomena here presented are various and interesting; for we find the trap rocks not only overlying the Triassic sandstones, and capping the hill, but intruding horizontal sheets through the mass of the sandstones, which again are traversed by vertical dykes of later date. These phenomena are well exemplified in the south quarry. (*See Fig.* 1.)

The trap of Scrabo consists of, for the most part, largely crystalline dolerite, weathering into the globular form, and decomposing into a coarse, brownish sand. In some places it is finely crystalline and amygdaloidal. Considering the enormous masses of rock, which in a molten state have overflowed and penetrated the beds of sandstone, these latter appear to have undergone but little alteration, some of the beds beneath the sheets of trap being only somewhat indurated.

The late General Portlock viewed the trap rocks of Scrabo and Dundonald as outliers of the large basaltic sheets of county Antrim. This is an opinion in which we fully concur, and it has been further strengthened by comparing the trap itself with that of some parts of Antrim.

* The late General Portlock correctly inferred the basalt of Scrabo hill to be an outlier of the great basaltic district of Antrim; but it is impossible to concur in the view he expresses that there were "successive flows of basalt during the deposition of the sandstone;" the geological ages of the two classes of rock being altogether different. See "Journ. Geol. Soc., Dublin," vol. i., p. 253.

Fig. 1. Section shown in South Quarry at Scrabo Hill.



Nearly horizontal beds of purple and white sandstone of the Trias (*c. f.*) overlaid, and penetrated by sheets of amygdaloidal dolerite and basalt, weathering into large spheroidal masses—the whole traversed by a nearly vertical dyke of dark amygdaloidal basalt—also showing spheroidal weathering.

The dolerite of Scrabo is a crystalline granular compound of labradorite and hypersthene, according to the determination of Mr. A. Gages, who kindly examined a specimen from the neighbourhood, and is identical in composition with the rock which forms the cliffs of Fair Head, in the Antrim coast, and in all probability of other districts in the same tract. The identification, on mineralogical grounds, therefore, corresponds with those based on stratigraphical considerations; and as it is now known that the geological age of the Antrim trap is Miocene, we are thus able to identify that of their representative masses in this district.*

Felstone.—Along the shore south of the village of Ballyhalbert, there occur a great number of dykes of greenstone, minette, and felstone, the latter being almost all intruded along the planes of bedding. These need no particular mention here, as they will be fully treated of in the detailed description.

3. *Relations between the External Form of the Ground and its Internal Structure.*

To the north and south of the depression occupied by the New Red Sandstone and continued along the valley of Strangford Lough, the Silurian rocks rise into rather elevated ground, one portion of which has in consequence received the name of "The Ards."

This depression, originally formed by denudation at some period preceding the Carboniferous, was afterwards filled in with strata of this age, which doubtless covered large areas of the Silurian rocks, but are now only represented by the small patch of Castle Espie and Cultra. The Carboniferous rocks (along with the subordinate Silurian beds) have therefore themselves been subjected to terrestrial disturbances, and been largely denuded; and thus the

* The rock of Scrabo might, with propriety, be called "Hypersthene Rock," from its composition; but as hypersthene is a species of augite, and as the structure, mode of weathering, &c., of the rock resembles that of ordinary basalt or dolerite, we prefer to retain these names. See Analysis of this rock by Mr. A. Gages, M.R.I.A., p. 44.

old depression in the Silurian rocks was to some extent reproduced after the Carboniferous period.

A similiar series of events appear to have been reproduced at a later period, for the depression was again filled in by Triassic strata, which at the close of the Triassic period probably covered nearly the whole surface of the country. Their disappearance is also due to denuding agents, by which they have been swept from off the more exposed tracts, and have only been preserved in the line of the old valley already described, where the beds were in some degree protected.

An additional protection against the denudation of more recent times was afforded by the overflow of the dolerite, which extended from county Antrim across the area now occupied by Belfast Lough, to the flanks of the Silurian hills, which form the southern margin of the old Triassic valley. This was probably the limit towards the south of the great sheets of Miocene volcanic rocks.

Previous to the deposition of the Carboniferous rocks, the Lower Silurian rocks appear to have undergone much disturbance—accompanied by denudation, and probably received their prevalent north-easterly trend.

The Carboniferous rocks, both at Castle Espie and Cultra have also been subjected to a considerable amount of disturbance as well as denudation, for they are found dipping at considerable angles in both localities.

The Permian rocks which remain on the shore of Belfast Lough, were probably limited in a southernly direction by the Silurian rocks of Carrowreagh and Carngaver, as there are no traces of them along the margin of Strangford Lough. They also have been subjected to considerable disturbance.

On the other hand the New Red Sandstone is but slightly removed from the horizontal position, except in one or two spots, as at Dunlady House. During the formation of these beds the sea was often very shallow, and probably tidal, as evidenced by the formation of sun-cracks and rain-pits. No traces of reptiles or other animals have as yet been found in these beds.

During the glacial period this country seems to have been overspread by an ice-sheet, as under favourable circumstances, the rocks are found to retain a glaciated outline, and present instances of ice-action. When protected by a covering of boulder clay these phenomena are generally well shown, but even on some of the higher and more exposed situations, such as the basaltic plateau of Scrabo Hill, the contour of the naked rocks is suggestive of ice-moulding, although the marks and scoring of the rock have disappeared.

The boulder clay which overspreads much of the country contains fragments of rock, such as lias, chalk, &c., which have been derived from localities lying to the north of this district, and which indicate the generally northerly source of these materials.

At Clandeboye the direction of the striæ is a little West, and east of North, and indicates the general direction, for this part of the country; but one observation gives W. 10° N., which seems abnormal, and may belong to a second system of striæ.

4. *Palæontological Remarks.*

LIST of LOCALITIES at which FOSSILS were collected from the Southern portion of Sheet 29 and the adjoining Sheet No. 37.

LOWER SILURIAN LOCALITIES.

No. of Locality.	Quarter Sheet of 6-inch Map.	Townland.	Situation, and Sheet of 1-inch Map.
		County of Down.	SHEET 29.
1	1/2	Craigavad, . .	In Holywood and Bangor Railway cutting, a little N. of the Church, two and a half miles N.E. of Holywood; Black slates.
2	1/2	Ballygrot, . .	Rocks on shore at Helen's Bay, a little S. of Grey Point, three miles W. of Bangor; Black slates.
3	1/2	Ballykillare, .	Rocks on shore, a little N.E. of Crawfordsburn House, two miles W. of Bangor; Black slates.
4	1/2	,, . .	Rocks on shore at Swineley Point, a little E. of preceding locality; Black slates.
5	2/1	Carnalea, . .	Rocks on shore at mouth of stream, N. of Carnalea House, one and a half miles W. of Bangor; Black slates.
6	2/2	Orlock, . .	Rocks on shore near Coast-Guard Station, E. side of Orlock Point, three miles N. of Donaghadee; Black slates.
7	3/3 & 4	Ballyvester, . .	Rocks on shore at "Coal Pit Bay," half a mile S. of Donaghadee; Black slates.
			SHEET 37.
8	6/1	Ballyharry, . .	In Belfast and County Down Railway cutting, three-quarters of a mile N. of Newtownards; Black slates.
9	16/3	Glasdrumman, . .	Cutting in the same railway, half a mile N. of Saintfield; Black slates.

CARBONIFEROUS LOCALITIES.

			SHEET 29.
10	1/3	Ballycultra, . .	Rocks on shore a little S. of Cultra Quay, one mile N. of Holywood; Lower Carboniferous shale.
11	1/1	,, . .	Rocks on shore near low water-mark, a little S. of Dalchoolin landing place, one and a quarter miles N. of Holywood; Lower Carboniferous shale.
			SHEET 37.
12	11/3	Castle Espie, . .	Quarry on S. shore of Strangford Lough, a little E. of the Quay, two miles S.E. of Comber; Carboniferous limestone.

PERMIAN LOCALITY.

			SHEET 29.
13	1/3	Ballycultra, . .	Rocks on shore at low water, a little N. of Cultra House, one mile N. of Holywood; Yellow and Red Sandy shales.

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

The numbers opposite each species refer to corresponding ones in the list of localities indicating the places at which they were collected.

The mark × before a number is used to denote the comparative abundance of a species at that locality.

LOWER SILURIAN FOSSILS.

CÆLENTERATA.—*Hydrozoa.*

	Localities.
Cladograpsus capillaris?	×××7.
Dendrograptus Hallianus?	7.
Dicranograptus ramosus, ...	1, ××2, 8.
Didymograpsus affinis?	5.
,, flaccidus, ...	1, 2, ××3, 4, 5, ××6, ×××7, ×8, ×9.
Diplograpsus folium, ...	7.
,, mucronatus? young of pristis, . .	1, 2, 7.
,, pristis, ...	1, ×××2, 3, 4, 5, ××6, ×××7, ×8, ×9.
Graptolithus Becki, ...	×1, 7.
,, Hisingeri, ...	2, ? 4, 7, 9.
,, Sedgwickii, ...	7.
,, tenuis, ...	5, ×××7.
Rastrites peregrinus, ...	1, ×××7.
Goniosphores of species, ...	7.

CARBONIFEROUS FOSSILS.

Lower Carboniferous Shale—all from localities 10 *and* 11.

PLANTÆ.

Sphenopteris linearis?	10.
Sagenaria Veltheimiana (Knorria) . . .	10.

MOLLUSCA.

Rhynchonella pleurodon.	
Modiola Macadami, ...	××× .
Orthoceras cinctum.	

CRUSTACEA.—*Entomostraca.*

Of the genera, Leperditia, Cythere, &c., the species of which are undetermined, ...	×××10 and 11.
Beyrichia multiloba (Jones), ...	11.
Estheria striata?	11.

Carboniferous Limestone Fossils—all from locality 12.

ACTINOZOA.

Cyathophyllum ceratites.	

ECHINODERMATA.

Crinoidal fragments, ...	× Limestone and shale partings.

MOLLUSCA.—*Brachiopoda.*

Athyris ambigua, ...	××× Shale only.
Orthis resupinata, ...	do.
Productus giganteus, ...	××× Principally confined to the Limestone.
,, longispinus, ...	× Principally in the shale, occasionally in the Limestone.
,, semireticulatus, ...	In shale.
Rhynchonella pleurodon, ...	In Limestone.
Spirifera bisulcata, ...	do.
,, glabra, ...	do.
,, striata, ...	do.
Streptorhynchus crenistria, ...	Limestone and shale.
Strophomena analoga, ...	do.

Conchifera.

	Localities.
Aviculopecten Forbesii, ...	In shale.

Cephalopoda.

Actinoceras giganteum.

PERMIAN FOSSILS—*all from locality* 13.

Productus horridus.	
Bakewellia antiqua, ...	××.
Schizodus Schlotheimi, ...	×.
Arca like tumida.	
Turbo helicinus.	

In the determination of the foregoing species of fossils upwards of 800 specimens were examined. 528 of these were from black (graptolite) slates, of the Lower Silurian rocks, principally from beds on the south coast of Belfast Lough, at various stations ranging from a few miles north of Holywood to Donaghadee, two localities only having been observed on sheet 37, both on the line of the Belfast and County Down Railway, at the northern and southern extremity of the sheet. From the "Lower Carboniferous shale" on the shore at Cultra, a little north of Holywood, 110 specimens were collected, and ninety specimens from Permian strata at the same place, on sheet 29. The Carboniferous limestone quarry at Castle Espie, near Comber, including over 70 specimens.

The graptolites collected from the black slates are according to "Siluria" (Appendix to Fourth Edition), Llandeilo species. Those from locality 7 (the place marked on the six-inch map as "Coal Pit Bay") yielded the most perfect forms and greater number of species, amongst them *Rastrites peregrinus*, *Graptolithus tenuis*, and *Diplograpsus pristis*, were particularly abundant. The smooth and finely laminated slates at this place can scarcely be distinguished from those of Dumfries-shire, on the opposite coast of Scotland, agreeing both in identity of specific forms and lithological character of the rock on which they are impressed.

The "Lower Carboniferous shale," or Lower limestone shale, as it has been formerly called, which occupies about a mile of the coast a little north of Holywood, contains an abundance of the characteristic lowest carboniferous fossils, such as *Modiola Macadami*, and the small entomostracan crustacea, *Cythere*, *Leperditia*, &c., together with very perfect examples of a *Beyrichia*, allied to *Klædeni*, but differing in certain particulars, which may prove to be a new species. Large plant stems, referred to *Sagenaria* (formerly called *Knorria*), were observed by me on my visit to this place, in a green and red conglomerate, on the shore under Dalchoolin Lodge. Portions of branching stems of these plants measured between four and five feet long, by five inches in diameter, covered by the alternating scale-like markings (cicatrices of leaves) peculiar to this genus. Other large stems were seen to be longitudinally ribbed, and probably belonged to the same plants, which are common to the Lower Carboniferous and upper Old Red Sandstone of the south of Ireland.

Carboniferous limestone has only been observed at Castle Espie, a little south-east of Comber, on sheet 37, where there is a fine quarry of a red or salmon coloured crystalline limestone, from which many fossil shells in good preservation were obtained. Although it resembles the red limestone of Armagh, so prolific in fish remains, no fossils of this character were observed at Castle Espie, the organic remains consisting principally of molluscan shells, mostly of the class Brachiopoda, some of them, especially *Productus giganteus*, being found of large size.

The cephalopod shell, *Actinoceras giganteum*, called, not inappropriately, "pillars," by the quarrymen, is also found here of an enormous size, an imperfect specimen in the collection measuring two feet four inches in length, is one foot in diameter at its widest and upper part, decreasing gradually to six inches diameter at its lower extremity.

A single species of the turbinated coral referred to, *Cyathophyllum ceratites*, was the only example of the class observed in the limestone of this locality.

Fossils, although better preserved in the limestone, are most numerous, but smaller, in the interpolated shales. *Arthyris ambigua*, *Orthis resupinata*, and *Productus longispinus*, are the prevailing forms in the shales; *Productus giganteus*, *Sperifera bisulcata*, and *Streptorhynchus crenistria* in the limestone; the entire assemblage of fossils indicating that the beds in which they occur belong to the lower limestone.

Fossils of Permian age have been found on one small exposure only, in close proximity to the lower carboniferous shales at Cultra, a little north of Holywood, on sheet 27, where they occur in red and yellow sandy beds, visible at low water, the prevailing characteristic species being *Bakewellia antiqua* and *Schizodus Schlotheimi*, together with *Productus horridus* and *Turbo helicinus*, which are not so abundant. These fossils, from their occurrence in a more arenaceous deposit, are not so well preserved as those of the other Irish Permian strata found in the harder and more marly strata of Tullyconnell, Tyrone.

WILLIAM HELLIER BAILY.

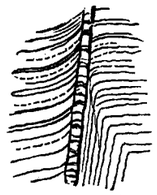
April 20th, 1871.

DETAILED DESCRIPTION.

Coast Section.—On the low flat shores of Belfast Lough, in the N.W. corner of sheet 37, red sandy shales and flaggy sandstones may be seen at low water; no rock is then exposed for the distance of two miles, till on the shore a little N. of the village of Holywood rocks again crop out. The beds first met with are brownish red shales and flaggy sandstones, succeeded by a few beds of pale greenish gray sandstones, passing up into brownish red obliquely laminated sandstones. These beds belong to the upper mottled sandstone of the Bunter. Further E., near the quarry, we find reddish brown and yellow sandstones, with bands of marl passing up into thinly bedded micaceous rippled sandstones and sandy marls. These latter beds, Mr. Hull considers to belong to the Lower Keuper series of the midland counties of England. These beds are traversed by three trap dykes; the most easterly is a dark greenish gray basalt, about seven feet wide, and has altered the colour of the shales and sandstones from red to a dark purple. The next dyke is very similar in mineral constitution, and runs in a parallel or north-easterly direction. The third and most easterly dyke is also closely allied to the others, but weathers spheroidally into a fine brown sand. Two hundred yards S.W. of the quay at Cultra, a nearly north and south fault (an upthrow to the E. of about 300 feet) brings in the lower limestone shales, the beds consisting of dark gray, nearly black, fossiliferous (shales full of *Modiola Macadami* and other well known carboniferous species, as determined by Mr. Baily) and gray calcareous sandy grits and flags. Several dykes occur in these shales, all very similar in character, the rocks composing them being a gray or dark greenish finely

crystalline basalt, frequently containing minerals belonging to the zeolitic family. A little further north, and immediately under Rosavo, a series of beds occur below high-water mark, dipping seawards. The highest beds are yellow and buff-coloured earthy magnesian limestone, below which are red marls, the lowest beds being thin bedded fossiliferous limestones and red and gray shales. These strata on the S.W. are sharply contorted, and then slightly rolling, while close to the fault they dip steadily seaward at about 20°. From the fossils obtained from them, these beds have been identified as of Permian age. Two small dykes occur here similar to those already described. At the foot of the low shore cliff, just inside these strata, there are seen red and yellow Carboniferous shales, containing great quantities of the *Modiola Macadami*. On these beds the Permian rocks appear to lie unconformably. A little farther north the carboniferous strata are brought into juxtaposition with those of Permian age by a nearly north and south fault, along the line of which there is a dyke of gray finely crystalline basalt. (See Fig. 2.)

Fig. 2.—Basalt Dyke in line of Fault, Shore of Belfast Lough.



The woodcut shows the beds on either side of the dyke to be bent out of their regular course.

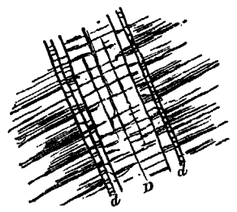
The lowest beds of the carboniferous rocks exposed east of the fault consist of thick red sandstones and conglomerates, which are overlaid by gray, yellow, and reddish brown shales, and thin sandstones interstratified with thin earthy semi-calcareous layers of a pale gray colour, probably dolomite. Professor Hodges kindly analysed this rock for the late Mr. G. V. Du Noyer with the following result. 100 parts were found to consist of*—

Carbonate of lime	48·33
,, ,, magnesia	44·11
Phosphate of lime	0·41
Oxide of iron and alumina	2·25
Silica and clay	5·00
	100·00

Over these beds are dark gray and black fossiliferous shales, full of *Modiola Macadami*, along with other well known carboniferous forms. About 50 yards N.E. of the gate lodge of Dalchoolin the shales are cut across by two dykes of dark gray finely crystalline basalt, the smaller dyke about one foot and six inches, and the larger four feet and six inches wide. On each side of the latter, and separated from it by a few inches of hardened shale, run two thin parallel dykes of the same composition as represented at Fig. 3.

* Some uncertainty appears whether the dolomite analysed was of Carboniferous or Permian age. From Mr. Du Noyer's notes it seems to have belonged to the former.

Fig. 3.—Parallel Basaltic Dykes, traversing Carboniferous Beds.



D, dyke of finely crystalline basalt, or dolerite, 4 feet 6 inches wide.

d d, narrow dykes of similar composition.

The next exposure of the lower Carboniferous shales occurs immediately N. of Ardnalee House. The highest beds here are red and green mottled highly calcareous sandstones, passing down into fine conglomerate, below which there is a thick pale yellow sandstone. These two beds are probably the same as those seen under the low cliff close to the Dalchoolin gate-lodge; the layers of dolomite and beds of sandstone which overlie them there being represented here by the mottled calcareous beds.

Under the thick yellow sandstone before alluded to there are several beds of red and green mottled calcareous sandstones followed in a descending succession by about 100 feet of hard red grits, with red and yellow mottled shales, the lowest bed of this group of rocks seen being a whitish finely crystalline limestone; all belonging to the lower Carboniferous series.

Though the actual junction between the lower limestone shales and Silurian strata is not seen, still beds belonging to both these formations occur in such close proximity that the boundary can be drawn with the greatest accuracy.

The first Silurian rocks exposed occur in a boss, and consist of red grits and slaty beds, mottled green; no rock is then seen for a distance of about 100 yards, when gray grits, lying under black graptolite slates, are met with; to the east of these, there is a nearly north and south fissure, probably a line of fault. On the east side of this fissure are some pale gray and yellowish sandy grits, hæmatitic near the fissure. This hæmatitic rock has been pronounced to be siderite, or carbonate of iron, by Mr. A. Gages, and seems to occur as a lode along the east side of the fissure.

Proceeding for a distance of 300 yards to the N.E., we pass over hard gray grits in places finely conglomeritic and micaceous. These beds are cut at about 100 yards from the fissure or fault by a dyke of dark olive-green basalt, amygdaloidal in the centre, and weathering spheroidally towards the walls; it is very similar in character to one of the dykes seen in the railway cutting to the S.W., of which it is probably an extension.

Almost due N. of Craigavad House, and directly under Craig Owen, seaward of the beds just described, there are fine-grained hard pale-gray massive grits. In these there is an undulating structure developed, which looks extremely like stratification, and being nearly at right angles to that of the Silurian rocks, gives to the observer the idea of an unconformability. From the position of these strata being at the bottom of the section, and also from their look and weathering being dissimilar to that of the Silurian rocks all over the district, the late Mr. G. V. Du Noyer who examined this coast considered that they might be the representatives of the Cambrian rocks.

Rocks similar to these occur also in a detached boss N.W. of Rockport House, and further E., close to the quay and bathing house. On the shore side of these last mentioned beds we find gray flaggy grits and thin beds of slate, which are undoubtedly of Silurian age, but the junction between the latter and the supposed Cambrian strata is not seen except in the locality already noted.

Between the quay and the stream which flows into Belfast Lough W. of Craigdarragh, evenly-bedded grey micaceous grits with layers of slate occur, below which are thick greenish-gray grits. From the dip of the beds, and the change in the nature of the strata, there is probably a fault just where the stream enters the sea. In the little bay north-west of Craigdarragh the beds consist of red and grey slates and grits, and about fifty yards to the N.E., where the townland and coast line intersect, there is a small dyke of dark-gray basalt about eighteen inches wide.

Between the townland boundary and the coastguard boat-house the strata consists of gray grits, with layers of slate. A fault is supposed to break the continuity of the strata somewhere a little W. of the boat-house, as a band of black slates seen on the opposite side of the inlet does not seem to come through to the W. A little N.N.W. of the supposed line of fault the beds curve round, and run parallel to the coast line as far as Grey Point. The higher beds are gray grits slightly micaceous, with thin beds and layers of gray slates and shales. To the W. of Grey Point the beds become coarse grained and sometimes finely conglomeritic, and at the Point are vertical, and consist of gray and dark-gray grits, with slaty layers.

The coast line now turns sharply to the south, and crossing the strike of the beds nearly at right angles gives us the following section :—About 300 feet of dull greenish and purplish irregularly-bedded grits, with bands of slate, overlaid by a thin course of black carbonaceous shale containing graptolites, which is in its turn succeeded by about 150 feet of gray grits, over which is another band of graptolite slates, the next higher bed being a conglomerate formed of rounded fragments of felstone in a pale purple and greenish arenaceous paste.

A boss of rock composed of pale greenish-gray massive grits, hard and very like the rocks before stated to have been considered of Cambrian or pre-silurian age by the late Mr. Du Noyer, occurs immediately south of the conglomerate from which it is separated by an east and west fault. This boss is about seventy-five feet in thickness, a parallel fault bringing in black carbonaceous graptolite shales about 100 feet thick. A third fault running a little N. of E. again brings up rocks of the supposed Cambrian type. These faults occur within such short distances of one another that it was impossible to insert them individually on the one-inch map.*

Along the shore of Helen's Bay for the distance of one quarter of a mile no rock is seen, till at Quarry Port we meet with a series of beds, the lowest being smooth slates and thin grits, over which come dull red and gray grits, red and pale gray fissile slates, with thin gritty layers, the whole section exposing a thickness of about 850 feet.

Another break now occurs in the section, the rocks being covered with sand or shingle till a little N.W. of Crawfordsburn House, where

* The rocks supposed by Mr. Du Noyer to be possibly of Cambrian age were visited by Mr. Jukes in the year 1868, who did not concur in Mr. Du Noyer's views on this question. We think it proper, however, that Mr. Du Noyer's views should be recorded in case future investigation should tend to corroborate them.—E. H. & J. L. W.

beds of gray ribband slates and dark gray flaggy grits, with thin slaty layers, crop out; these beds dip at first to the N.W., and then curving sharply round almost at right angles, dip N.E. at 60°.

To the W. of the little bight where the star is engraved on the map, there are two bands of graptolite shale, succeeded by gray micacaceous grits dipping S.E. Between these and the last-mentioned beds there seems to be a fault or break, though for want of definite evidence one has not been marked on the map.

In the small bay W. of Swineley Point there is a bed of graptolite slates evidently the same as that seen further to the W., brought to the surface here by a synclinal curve. Between this Point and the town of Bangor the strata appear to dip to the S.E. The first beds we meet being also the lowest, are gray micaceous grits, with layers of slate, having a thickness of about 1,050 feet, over which there is a band of graptolite slates seen just where the boundary between the townlands of Ballykillare and Carnalea meets the coast line. Above this band come gray micaceous grits with slaty layers, the cleavage in the finer beds running about N.E., inclined to the S.E. at 80°. The next beds in ascending order are pale gray glossy slates and thin grits overlaid by pale gray micaceous grits and glossy slates. The beds between the last-mentioned band of graptolite slates and those occurring at the head of Smelt Mill Bay have a thickness of about 1,900 feet, which, added to the thickness of the strata over the graptolite slates, would give us 2,950 feet as the total thickness of the Silurian rocks between Swinely Point and the head of Smelt Mill Bay.

About 100 yards N. of Swinely Point, where the stream which forms the western boundary of the townland of Carnalea enters the bay, a thin seam of galena was discovered some years ago.

On the E. shore of Smelt Mill Bay the beds are similar to those already described as occurring on the opposite shore. The coast line now trends to the E., the section thence to Wilson's Point showing the following succession of beds—dull reddish-purple and hard-gray micaceous grits, with gray glossy slates; nearer the point the grit beds disappear, the strata consisting of gray ribband slates. Along this part of the coast there are several fissures which may be lines of fault, upthrows to the W., bringing up and repeating the same set of beds.

From Wilson's Point to the town of Bangor the beds dip steadily to the S.E.; the lowest are pale gray micaceous grits and gray glossy slates, above which come several thick coarse-grained grits, with gray glossy slates. As we rise in the section, the grits disappear, being replaced by slates, till at Man-of-War Gullet thick grits, with specks of black mica, come in and pass up into finely-conglomeritic beds containing granules of quartz and flakes of black slate. The strata maintain this character to within a short distance of the end of the section, where we find pale gray micaceous grits, with layers of slate. In a quarry on the town side of the bathing-place, the joints are found to be coated with a red haematitic-looking substance.

The thickness of the beds exposed between Bangor and Wilson's Point is about 750 feet. Now, supposing that the strata at the Point are the immediate successors of those at the head of Smelt Mill Bay, a supposition which, from the lie and character of the rocks, is not at all improbable, we should then have 4,700 feet as the total thickness of the strata exposed in this section.

On the opposite shore of the bay N. of Bangor the first beds we meet are thin gray micaceous grits, with layers of slates below which are smooth gray and dark gray slates, and similar beds of grits; and at

Luke's Point some beds of fine conglomerate have been observed containing granules of quartz and some flaky fragments of black slate. These conglomerates are probably identical with those seen on the W. shore of Bangor Bay, due E. of Seaview. The beds seen on the shore between Bangor and Luke's Point crop out again on the W. shore of Ballyholme Bay. No rock is now seen till we reach the opposite side of the bay, when we meet gray micaceous grits and gray slates extending for a distance of 400 yards, resting on a bed of coarse granular grit, with flakes of black slate, evidently the same as that we mentioned as occuring at Luke's Point and to the W. of Bangor Bay. From this conglomerate, as far N. as Ballymacormick Point, the strata consist of gray micaceous grits, and glossy slates. The direction of the cleavage in the slates is at first N. 30° W. and N. 50° W. inclined, to the S.W. at 50°; it however bends round in a short time, becoming due E. and W., with a dip to the S. of 75°, and at Ballymacormick Point returns to its first direction with an inclination of 70°.

The little promontory on which is situated the Groomsport Coastguard Station consists of red fissile slates, and gray micaceous and red slaty grits. Between these beds and the rocks at Ballymacormick Point there seems to be a break, since we do not find the representatives of the red beds in the section on the E. shore of Ballyholme Bay. The strata lying between the Coastguard Station and the village of Groomsport are gray micaceous grits and pale gray slates. The grits are at first thick bedded, but as we approach Groomsport get thin, and are often even flaggy.

The coast line between Groomsport and Orlock Point runs in a zigzag manner, so that we cross and re-cross the same set of beds, consisting of gray micaceous grits, sometimes flaggy, with layers of gray and purplish slates. In a little inlet N.E. of the Coastguard Station there is a synclinal curve, a band of red slates occupying its axis with beds of black graptolite slate on either side. Due E. of the Coastguard Station the beds again roll over, so that the black slates ought to appear near at hand to the S.W. As such, however, is not the case there is probably a fault between the slates and the gray grits which seem to underlie them. South of the inlet the beds roll considerably, and are gray and dark gray micaceous grits, with layers and beds of slate. These beds at the inlet bend right round, and are again seen on the shore W. of the demesne of Portavoe House.

Three hundred yards N. of the Cow and Calf Rocks we get into a new set of beds, thin alterating layers of grit and slate, the Cow and Calf being formed of lenticular beds of hard gray grits and dark gray slates, and at Kitty's Altar we find dark gray slates and thin grits. South of this point, to within a short distance of Foreland Point, the strata are of a very similar character, and are often sharply folded and contorted. Massive gray grits, with calcareous nodules, some of the beds being coarse-grained with an occasional layer of slate, form the large boss of rock at Foreland Point. From this point S. to Rocklin Cottage, we find hard-gray micaceous grits and gray slates, the former often flaggy; and in the vicinity of the cottage irregularly bedded above these beds are some hard red grits and shaly slates; and eighty yards further S. the strata consist of very red grits, and red and green mottled shales. These beds bend suddenly to the southward; and a little N. of the Presbyterian Meeting House there are some dark gray grits with slaty layers in the line of strike of the red beds, but dipping in a contrary direction, so that a fault, though not seen, seems highly probable here. A branching dyke of pale-gray felspathic trap, containing crystals

of bronze-coloured mica in places, traverses these rocks below Shore-street, in the town of Donaghadee. The rocks in the immediate vicinity of the dyke are gray grits, and red and gray slaty shales passing up into evenly-bedded flaggy dark gray grits, with thin slaty layers.

At Dorman's Point, and as far S. as the artificial basin, the strata are contorted, irregularly bedded, and massive gray grits in places containing calcareous nodules, the beds there being gray grits, often micaceous, with layers of slate. Similar beds are found along the coast between Robby's Point and Coal Pit Bay, where a band of black carbonaceous slates full of graptolite remains has been observed. Immediately S. of the slates the beds are intersected by a dyke composed of a pale gray finely crystalline calcareous rock, about six feet wide, branching into three as it goes seaward. South of the dyke another band of graptolite shales occurs, over which are gray grits, becoming massive as we go south, with layers of gray slates. Due E. of Galloway's-bridge the beds curl round and dip almost E. against these beds, others are seen having the normal strike brought in by a fault. North of the fault there is a dyke of pale-gray felspathic trap from one to eighteen inches wide, which cuts through the Silurian beds.

For a distance of 350 yards S. of the fault the beds consist of evenly-bedded gray grits, with slaty layers passing up into reddish-gray slates.

The section is now broken, the next rock being two bosses of gray grit, visible at low-water. East of Templepatrick Graveyard gray micaceous grits, with slaty layers sharply contorted, occur, and the Kinnegar Rocks to the southward are of a like character. The next beds seen are those that come in just N. of the southern limit of sheet 29 at James's Point, and are massive gray grits, finely conglomeritic in places.

J. L. W.

The massive conglomeritic grits of James's Point are succeeded above by purple and green mottled slates, very much contorted. These beds are in the axis of the great synclinal curve already noted. Opposite the mouth of the Mill Isle stream the beds of the Bavan rock consisting of dark gray grits and slaty layers, dip N. 40° W. 80° to 85°. At Woburn House, a mile to the S., contorted dark glossy and green slates are seen occasionally enclosing lenticular masses of grit. Near the Coastguard Station flaggy grits and glossy slates show a very pretty anticlinal and a synclinal curve. At one side of each of these curves the surfaces of the beds are reversed, because of the dip throughout remaining northward, and the anticlinal is broken through by a small fault, having a throw to the S. of twelve feet. S. of the Coastguard Station, E. of the trig. point 61, gray micaceous grits, with red, green, and gray slates, commence to undulate; and just S. of the townland boundary are cut through by a dyke of hard greenish finely crystalline greenstone, showing crystals of pink felspar, and striking N.W. and S.E. The cleavage of the slates is vertical, and striking N. 55° E.; the dip is N. 30° W. at 80°. At Ballyferris Point massive gray grits and great beds of slate dip N. 20° to 30° W. at 70°, the cleavage is N. 60° E. These beds are cut through by a dyke running E.S.E., and varying from twelve to sixteen feet in width; it is a dark green highly crystalline minette, showing crystals of flesh-coloured felspar, with black mica and quartz. At Greystone the beds undulate as indicated on the map. They consist of dark-gray slates and flaggy grits. One mile S. of Greystone, S. of Craigbrain Rock, dark gray slates are seen arching over thick bedded grits. The slates are in places

contorted, and the relation of the strike of the cleavage to that of the bedding is constant throughout—thus, in beds striking E. 20° N. the strike of the cleavage was E. 50° N.; in beds striking E. 10° S. the cleavage was E. 20° N. The angle of the cleavage plane with the horizon was always 90° independent of the dip of the beds.

Opposite Blackrock these dark-gray slates are cut through by a greenstone dyke, enclosing fragments of Silurian grits and vein quartz in a brownish gray matrix. The direction of the dyke is N. and S. It is exposed in places from twelve to thirty-six feet in width, but the inner (western) wall is not seen.

S. of the dyke dark slates and thin grits dip north-westerly, but are contorted in the line of strike. The grits show calcareous nodules weathering out, and the slates contain numerous nodules of grit.

N. of Ballywalter massive coarse grits and great beds of gritty slate stand vertical. The Ballywalter Pier is built along the axis of an anticlinal curve. The beds are massive fine grits, gray and green slaty beds. From the pier to the end of the exposure thin grits and hard dark slates undulate into series of small curves, the axis of the ridges and troughs dipping under the sea at low angles.

At the headland, a mile to the S., and for a distance of half a mile, the rocks are freely exposed. They consist of gray and greenish gritty slate, dark shales with flaggy and thin grits. They are cut through by several diorite and a few felstone dykes.

At the boat-house, N. of Bank Lodge the beds dip N. 20° W. at 60°; the cleavage of the slates is vertical, and striking N. 60° E. A dyke here, six feet in width, strikes N. 20° E.; it is a purplish-gray minette, containing plates of mica and numerous very small crystals of iron pyrites. A short distance to the S. the slates are cut through by two small felstone dykes of a pale-gray colour, compact in texture, and containing small crystals of marcasite. Under the Bank Lodge houses the slates are beautifully cleaved. The bedding is N. 10° W. at 60°, the cleavage vertical and striking N. 60° E.

These beds are cut through by a dyke of brownish-gray porphyritic vesicular melaphyre, four feet in width, and striking nearly with the bedding.

Opposite the Coastguard Station the dip of the beds is N. 30° W. at 85°, but it lowers again to an angle of 60° to the S.

The large greenstone dykes here form ridges among the softer slates. The most northern varies from nine to twenty, and in places to forty, feet in width.

Though the general strike of the dyke is with the strike of the beds, in places it is seen to lie on or overlap their edges. It is a brownish gray finely crystalline diorite, showing small crystals of hornblende, with mica and embedded pebbles of vein quartz. The two remaining dykes in the section are similar, and six and nine feet respectively in width.

The rocks are not exposed to the S. until approaching the Burn Houses N. of Ballyhalbert. Thick and thin grits, with gritty slates, show two anticlinal curves; the thin grits having ripple-marked surfaces. Near the end of the little section, opposite the standing-stone by the road-side, flaggy grits dip N.E. at 20°, and are cut through by a dyke in the direction of the dip. This dyke encloses a large piece of Silurian grit, is seven feet in width, and branches to the N. It is a brownish, finely porphyritic diorite, with crystals of hornblende.

Sheet 38.

From about one mile S. of Ballyhalbert to the margin of the sheet the rocks continue to be exposed; they alternate with greenstones, felstones, and felstone ashes, and are cut through by numerous felstone, greenstone, melaphyre, and minette dykes.

From the commencement of the exposure as far as the Coastguard Station, the rocks, thin-bedded grits, with layers and beds of gritty slate, dip N 30° to 45° W. at 70° to 80°.

The first dyke is a brownish-gray diorite, slightly tinged green, porphyritic and vesicular in places, containing crystals of hornblende and black mica, and enclosing fragments of vein quartz and Silurian grit. The general strike of the dyke is N.N.W. and S.S.E., but it gives one branch to the S. and two to the N.E., one of which branches again to the S.E.; at its greatest width the dyke measured about thirty feet.

Near Burial Point are two beds of diorite, containing crystals of hornblende, and about nine feet each in width; between these two beds is a dyke of later date, cutting across the bedding, and branching N.W. and S.E. It is more highly crystalline than the two beds, and is about five feet in width. At the Coastguard Station gray slates and massive grits turn over and dip S.E. at 70°. These beds are cut through by two parallel dykes striking N.W. and S.E.; they are diorites similar to those just described. The largest is about ten feet in width. A little S. of the Coastguard Station the beds return to their north-westerly dip, and contain a bed of granular, gray diorite, showing crystals of hornblende. Consequent on this turn we find again the two diorite dykes noted at the station. Here they are porphyritic and vesicular in places; the crystals of black mica being often very large. The largest dyke measures from eighteen to twenty-five feet in width. From opposite Burial Farmhouses as far as Half-ebb Rock, near the entrance of a bay, a distance of about half a mile, the beds continue to dip from N. 40° to 50°, W. at 80° to 85°. They are thick and thin gray grits with flaggy beds and gray and green slates.

The thick grits contain numerous calcareous nodules, weathering into holes. Within this space about fifteen dykes are noted. Opposite Burial Farmhouses five occur; the first is a small minette dyke, six to twelve inches in width, of a dark-gray colour, containing crystals of black mica; the second, three feet wide, is a compact gray felstone; the third, four to six feet wide, a purplish-gray, porous-weathering, felstone; the fourth, a brownish diorite, containing crystals of hornblende, and a zeolite; it is six feet in width; and the fifth, four feet wide, a greenish, finely crystalline diorite, with small, needle-shaped crystals, of a white colour, knitting among each other, probably tremolite. They are all apparently interbedded, and have probably been erupted along the planes of bedding.

Nearly opposite the houses of Butterlump Bræ are two narrow parallel dykes of finely crystalline minette, from two to three feet wide each, containing minute crystals of mica and marcasite. Opposite the houses is a branching, brownish-gray crystalline diorite, nine feet wide, and containing crystals of hornblende and black mica.

A little S. of this dyke is another, striking N.W. and S.E., and about twelve feet in width. It is a brownish-red crystalline minette, showing crystals of black mica.

Approaching Butterlump Rock (a basalt boulder, perched high near low-water mark) is a band of purplish felspathic ash or tuff, varying from one to two feet in thickness. At Butterlump Rock is another brownish ash, about five feet in width, hard and tough, and having

smooth, black patches. Two minette dykes are also seen here; they are dark-gray or brown, and show crystals of black mica; in places they enclose vein quartz and Silurian fragments. The largest is fifteen feet wide.

Just entering the bay is another felstone ash, similar to the one above noted. It is also about five feet in width.

Along the shore of the bay, where the first road terminates, is a large dyke, fifteen to eighteen feet wide, of a brownish-gray crystalline diorite, containing crystals of hornblende and black mica; and a smaller dyke, three feet wide, of gray minette. The beds here turn over, and dip S. 50° E. at 80°; they are massive gray grits and slates of various thicknesses. The massive grits contain calcareous nodules, weathering out. In the innermost part of the bay is a small dyke of gray felstone, breaking through the grits; it is about one foot wide; and a similar dyke, one to two feet wide, near the headland leaving the bay. The beds here are in places contorted. A small anticlinial is seen near Johnsport. At the headland are five gray or purplish diorite dykes, containing crystals of hornblende, and varying from one to fifteen feet in width. Some of these dykes lie in the planes of bedding; the others are smaller, winding through, or cutting across, the beds, and are more highly crystalline. S. of these dykes gray flaggy grits and slaty layers are contorted, and dip N.W. at 90°. At the little headland N. of a hamlet here marked on the map, are two beds of felspathic ash and three gray diorites, showing crystals of hornblende; two of the latter are narrow, tortuous dykes, striking in the line of dip. At the hamlet a reddish-brown diorite, containing crystals of hornblende and black mica, strikes N. 30° W. In the strike of the hamlet is a bed of pinkish felstone, fifteen feet in width; in close proximity to this is another of grayish diorite, containing hornblende crystals; and a short distance still S. is a diorite dyke, striking across the beds, and having black mica as an accessory.

One hundred yards S. of the termination of the road there is a small dyke, one foot in width, of pale felstone, striking N.E., and cutting the beds in its course. The dip of the beds, gray and green slates, is N. 30° W. at 50° to 60°, but the dip reverses itself towards the limit of the exposure, and becomes S. 65° E. at 85°. These beds are cut through by a great breccia dyke.

This dyke has a brownish matrix, with crystals of hornblende, and contains Silurian pebbles. A short distance S. thin bedded gray grits, dipping N. 55° W., at 90° contain a bed of heavy pink felstone about fifteen feet in width.

At Kelly's Rocks, thin bedded gray grits and slaty layers dip N. 45° W. at 85°. These beds are interbedded with a pink porous felstone, fifteen feet wide, at each side of which are two others of minette, four and five feet in width respectively.

At the termination of the road from the school-house are two gray diorite dykes, one winding through, and the other terminating in, the beds. A little S. are two dykes of felstone porphyry, green crystals of felspar in a gray matrix; they each vary from four to six feet in width.

The Pate Rocks to the S. are thick and thin gray grits, with layers and beds of slate. The dip is S. 50° E., at 70°. At high-water mark is a great branching purplish diorite showing crystals of hornblende, it is about thirty-five feet in width. Towards low-water mark is a narrow dyke of felstone porphyry, shifted in its course by a small break, and a great bed of felstone porphyry from thirty-six to forty feet in width. All these dykes lie in the plains of bedding. The last great bed of felstone porphyry occurs half a mile to the S.W., on the shore opposite the cross-

roads of Ringboy. This curvature of the shore to nearly the strike of the beds re-exposes the rocks just described. The dykes and beds of trap are even more numerous, but are the same, or similar to those described. Some of the diorites show crystals of oligoclase, hornblende, and mica, and the minettes in places contain long, narrow plates of black mica nearly an inch in length.

W. B. L.

Copeland Island—The beds seen at Horse Point on the S. side of the island are gray grits, with slate layers; over them are slightly micaceous gray grits, often coarse-grained, succeeded by flaggy gray grits and reddish slates. From this point as far N. as the head of Chapel Bay, we find flaggy grey grits and slates, and from Chapel Bay to the most northerly point of the island the beds are very uniform in character, being gray, slightly micaceous grits with layers of slates. The total thickness of the beds exposed in this section is upwards of 4,000 feet.

Light-house and New Islands.—These islands are formed of gray micaceous grits, with several layers and partings of slates of various shades, principally gray, or dark gray, but sometimes of a purplish tinge. Any one glancing at the map will at once observe that, while the strata in the islands dip steadily to northward, those in the mainland directly opposite, have a general dip to the southward, seeming to suggest a fault somewhere in the channel between the mainland and the Copeland Island.

In describing the Silurian strata in the northern part of the district, it will be simplest to divide it into two parts, first giving some account of the rocks seen in that part of the country lying W. of the Bangor and Newtownards road, calling it the Newtownards, Holywood, and Bangor District; and afterwards mentioning the principal rock-exposures between Newtownards, Bangor, and Donaghadee.

Newtownards, Holywood, and Bangor District.

Between Newtownards and the village of Conlig the country is bare of drift, so that the strata are well exposed, and are found to be massive gray grits, generally micaceous, and sometimes containing earthy calcareous nodules, with layers and occasional bands of dark gray gritty slates. Similar beds are seen on both sides of the road which runs N.N.W. from Newtownards past the Glen Corn Mill; also in several bosses of rock, 500 yards N. of Milecross Lodge, and further W. in some quarries in the townland of Ballybarnes. The rocks in the last-mentioned locality are intersected by two sets of joints; the principal ones run N. and S., and are vertical; the second set crossing them at right angles, and being inclined to the S. at 45°.

About one mile N. of this locality pale gray flaggy calcareous grits and earthy slates, crop out in the surfaces of the small occupation roads, and in adjoining fields; in the townland of Ballyskeagh, a little further W. there is a large boss of rock called on the six-inch map Craiganee, which is formed of dark-gray earthy slates; the cleavage is vertical, and runs N. 10° E. These beds have been extensively quarried, but afford only small slates of inferior quality.

On the southern and western slopes of Carngaver Hill, and in the fields N. of the road which runs from the Ballyrogan National School to that of Craigogauntlet, thick and thin bedded gray grits, dark-gray ribband slates with some micaceous purplish beds frequently crop out. On both sides of the road, N.W. of the Craigogauntlet School we find gray flaky

grits slightly micaceous, and sometimes calcareous, with layers of gray slates. In the quarry on the roadside slickenside surfaces on the E. and W. joints have been observed. East of Carrowreagh Hill by Stormount Castle, and in a northerly direction towards Holywood, the principal exposures are afforded by the deep ravines by which the southern and eastern slopes of the silurian hills are indented. The beds seen in these sections are generally gray grits often micaceous with layers of gray fissile slates. In the stream E. of Dunlady House, N. of the village of Dundonald, and just at the junction of the Silurian and Triassic formations, two dykes of dark-gray finely crystaline basalt occur. Between this and Holywood, rocks frequently crop out on the surfaces of the roads and in the fields; the beds are of the same character as those just described, except at one place. East of Cron's Hill, where the anticlinal is marked on the map, we find thin, gray micaceous flags, which have been extensively quarried. Two hundred yards nearer Holywood and close to the roadside a thin basaltic dyke has been observed. This dyke is again seen in a quarry a quarter of a mile further on, where it weathers spheroidally, and is associated with another parallel dyke of similar mineral composition.

The strata hereabouts consist of gray flaggy grits with gray, smooth black slates, these beds again crop out a little over half a mile to the N.E.

Close to Woodside bridge, on the Holywood and Bangor road, a rotten dyke very like those just mentioned cuts through the grits and slates.

Half a mile E.N.E. of the Craigavad railway station a cutting exposes black graptolite shales, which close to the accommodation bridge are traversed by two parallel dykes, composed of dark olive-green trap, slightly amygdaloidal in the central portions, and weathering spheroidally along the walls.

The remainder of the district in the vicinity of Bangor and Clandeboye is covered with a thick deposit of drift, the exposures of rock being few and of such minor importance as to need no comment.

Newtownards, Bangor, and Donaghadee District.

The strata in the northern and eastern portions of this part of the country are concealed by a covering of boulder clay of considerable depth, while the middle part of the southern portion is occupied by a great expanse of bog. The principal exposures are those afforded by the cuttings of the Donaghadee branch of the B.C.D. railway, and a few quarries opened for obtaining road metal or other economic purposes.

Immediately W. of the Groomsport railway station a cutting opens up dark-gray glossy slates and thin grits sharply contorted at the W. end of the section. About half a mile N. of this cutting there are the remains of extensive workings for roofing slate in glossy dark-gray finely laminated beds, not cleaved, and affording but a small slate, or more properly speaking, thin flags of inferior quality. About a mile W. of the Groomsport station a cutting exposes massive micaceous grits over which are dark glossy slates with thin grits both above and below. In a lane which the railway here crosses we find gray ribband slates, overlaid by gray micaceous grit and layers of gray slate. No section of any interest occurs between the Groomsport station and the fifteenth mile-post, where a cutting opens up the following section—about 300 feet of massive micaceous and flaggy grits, much contorted, with beds of dark brown and bluish-gray slate, above which are some massive gray grits containing a few calcareous nodules. A little S. of the centre of the

cutting there is a dyke-like mass of crushed grits in a flucanny clay probably caused by a fault.

Between the end of this cutting and the fourteenth mile-post there are several exposures of beds of the same character, and in one place a few beds of black graptolite slates are shown.

J. L. W.

East of Newtownards, and 300 yards east of Bootown Lodge, in the fields south of an old road, is a coarse conglomerate made up of Silurian and quartz pebbles in a slightly calcareous matrix. On each side of this are beds of coarse grit; these beds can be traced to the limits of sheet 37.

About half a mile to the E.N.E. at a forking of the road the beds in question are very well exposed; and on the opposite side of the main-road in the fields to the N. from the turn behind the houses, the Silurian pebbles are as large as a child's head; one measured 10 × 6 × 3 inches. Turning to the N. along the bye-road which leaves the main-road at the letter N. in National School, at the first group of houses the conglomerates are exposed on each side of the road. The dip of the rocks here is from S. 20° to 40° E. at angles varying from 85° to 50°. A little to the north where a stream crosses the road, and in a field to the west, dark-gray slates dip S. 40° E. at 85°. Along the same stream to the N.E., S. of a small bog, a number of quarries were opened in similar dark-gray slates. The dip is S. 20° E. 85°; the cleavage S. 20° E. at 70°. No good slates were obtained; they were coarse and shattery. To return to the conglomerate; it is next seen in a field N. of the old road, N. of △ 148, and again on the western edge of the large bog west and a little south of the houses on Potsden Island near the limits of the sheet. Here only quartz pebbles were observed, which weather out of the matrix. In going along the road south-easterly from Bootown Lodge, the rocks are exposed in bosses and quarries. They consist generally of massive gray grits, sometimes micaceous, often conglomeritic, with flaggy beds or slaty layers, and an occasional bed of brown slate. The dip is S.S.E. and S.E. at high angles. At the Loughriscourse National School the beds flatten to 40° in dip, and become more flaggy, with beds of gray slate. One mile E., at the Presbyterian Chapel, and N. and S., gray grits are interstratified with thick beds of glossy shale, or much cut-up dark slate. Another mile E., at the Ballyblack National School, the beds change to massive coarse grits, with dark slaty layers; and near the cross-roads still E., and on the edge of the bog E. of Wolf Island, rounded very massive coarse grits contain pebbles of quartz nearly the size of peas. The dip throughout, as indicated on the map, is steadily S.S.E. and S.E. at angles varying from 50° to 80°.

To the S.E. on entering the village of Carrowdore, the rocks are exposed in numerous quarries and a few bosses; they consist of gray grits, sometimes fine-grained, sometimes finely conglomeritic, occasionally flaggy, with beds of gritty ribbon slates. The dip is changed to N. 40° W. at angles of 80° to 60°. This northern dip continues throughout the large exposure of rock from Mourne View, S. of Carrowdore, westward to Ballygrangee, and south to Grove Cottage. At Mourne View the large bosses of rock consist of thick-bedded and massive coarse grits and flaggy micaceous beds, with thin slaty layers. At Ballygrangee flaggy gray grits and shattery slates are prevalent. At Grove Cottage the beds are fine, hard, thick-bedded, or flaggy, with beds of gritty gray slate. On entering Grey Abbey to the south, and a little north of that place, flaggy micaceous grits dip S. 40° E. at 60°. Along the road N. from Grey Abbey gray grits and slates to the west dip N. 30° to 40° W. at 75°, and

to the east of the road similar beds dip S. 40° E. at the same angle. To the N. at the cross-roads, east of Ballydoonan Big House, the Grove Cottage beds come in again, massive gray grits, sometimes micaceous, and dark and gray slates. The dip is N. 30° W. at 75°. In Grey Abbey, at the entrance to the church, and on the opposite side of the road, a large quarry is opened in fine gray grits and slaty layers dipping N. 30° W. at 65°.

East, along the road to Ballywalter, and at the road branching to the N.E., conglomeritic and micaceous grits dip N. 40° W. at 80°. To the S.E. from here, along the eastern boundary of the Grey Abbey demesne, several quarries were opened to procure roofing slate. The beds consist of thick, gray, green, and red slates. The dip is from N. 30° to 50° W. at angles varying from 70° to 85°. The cleavage everywhere coincides with the bedding. Similarly, large quarries were opened on the opposite side of the road in the townland of Tullykevin, where exposures may occasionally be seen through the heaps of slate rubbish. The dips show the presence of several anticlinal curves in these beds, though the angle seldom descends from 80°.* Near the corn mill and on the opposite side of the road one of these high anticlinal curves is well seen in a large quarry where the beds are also much crumpled. Gray grits are occasionally interstratified with these shales. North of Tullykevin school-house conglomeritic and massive gray grits with beds of gray shale dip S. 40° E. at 60°, but to the N. the same beds immediately turn N. 40° W. at 80°. One mile S. of Grey Abbey, along the Lough Strangford shore-road, east of the corn mills, the rocks continue to be exposed; they are massive and flaggy grits, sometimes very coarse-grained, with slaty layers; they dip to N. 40° W. at 60° to 75°. By the road-side a little S. some quarries show micaceous flaggy grits and shattery beds, the joints coated with peroxide of iron. The grits themselves in places weather red, probably from the oxydation of constituent iron. Cubes of iron pyrites are common in these grits. The dip of the beds here is S. 40° E. at 45°.

To the E. bordering on a bog, and S. to the church, the rocks are exposed in great bosses. The beds are massive, coarse, or fine-grained grits, occasionally shattery, with beds of gray ribbon slate.

Along an old road to the E. a high anticlinal curve is seen in massive gray grits and ribbon slates. The dips over the exposure indicate another curve.

Kircubbin District.—S. of Kircubbin the rocks are well exposed along a much indented coast line. On the N. side of Doctor's Bay gray, green, and dark slates dip S. 20° E. at 60°. In the innermost part of the bay a low anticlinal is observed in gray and purplish gray grits, which can be traced for a distance along the southern shore towards the point. The beds, thin grits and thick gray slates, are cut through by three or four dykes. The first is a winding dyke having a general strike with the bedding. It is about ten feet in width, and is a gray crystalline diorite, showing crystals of oligoclose and hornblende. A branch at right angles to its course is darker and more highly crystalline.

The second has a N. 10° W. course from the shore, and again occurs on a small island in the centre of the bay. Its general width is twenty feet. It is a greenstone breccia, with numerous and very large fragments of vein-quartz in a gray crystalline matrix. The third, striking N. 10° E., is ten feet in width, and is a heavy gray crystalline diorite,

* An instance in which the geological examination of a country would have saved useless expenditure.

showing crystals of felspar. The fourth, near the point, is the continuation of No. 1. The cleavage of the slates here was observed to be vertical, and striking E. and W., and the dip of the beds S. 30° E. at 70°. On the opposite side of the bay to the S. the beds are gray grits, dipping S. 30° E. at 70°. Two dykes of trap cut through these. The first is a brownish gray diorite or minette, but in its course to W.S.W. becomes gray and crystalline, showing crystals of felspar, hornblende, and mica. It is four feet in width.

The second, a little S. and inland of this dyke, is also a heavy gray finely crystalline diorite. It is six feet in width. Near the point gray and green slates dip S. 10° E. at 80°, in which there is a small dyke of decomposing gray minette. The rocks on the northern shore of the next bay are massive gray grits, with a few beds of gritty slate. At the point the grits are cut through by a small felstone dyke. Although the general course of this dyke is with that of the beds, in places it is seen to cut them. It varies from five to eight inches in width, and is a pale gray or dove-coloured compact felstone, containing very minute crystals of marcasite.

On the promontory to the S. nothing of note is seen. The rocks are massive gray, in places coarse grained, and thin grits with some beds of slate. The contortions of the beds are indicated by the arrows on the map.

On the northern shore of Horse Island similar beds show two high anticlinal, with their consequent synclinal curves. A little S. from the most western part of the island, a dyke of minette, twenty feet in width, strikes E. 40° N. through the grits.

On the southern shore the grits continue to be massive gray and greenish gray, with a few beds of dark gritty slate; the dip is S. 30° E. at 70° to 80°. Four apparently interbedded dykes were observed here. The most northern is a bronzy gray crystalline minette with numerous small crystals of black mica and marcasite. It is four feet in width.

The second is a heavy gray crystalline diorite or minette, showing small crystals of mica and hornblende. It is about eight feet in width. The third is similar, but more finely crystalline, and the fourth has a brownish-gray matrix, presenting only crystals of hornblende. It weathers spheroidally, and is ten feet wide.

To the S. the rocks of Gransha Point, and to the margin of the sheet, the beds consist of thin gray grits, with slate or slaty layers. The position of these beds may be understood by consulting the map. Some of the anticlinal curves indicated are very prettily exposed.

W. B. L.

Braniell's Hill, Comber, and Moneyreagh District.—The chief rock-exposures in the N. of this district will be found in the courses of the streams which flow down in a N. and N.E. direction from the high Silurian hills on the S. of the Dundonald Valley. The beds here consist of dark purplish-gray grits, often micaceous, and finely conglomeratic, with bands and layers of gray and purple, or green mottled slates. The surface of the beds and joints of these strata are frequently stained with a red haematitic looking substance. Good instances of this phenomenon, which is common over the whole district, may be seen in the neighbourhood of the Dundonald Railway Station.

A probable explanation of the occurrence of this haematitic substance, is that at the period when the Triassic rocks overspread the Silurian strata, water found its way through the porous sandstone, abstracting some of the peroxide of iron, which forms a per-centage of

that rock, and then percolating along the highly inclined bedding-surfaces and vertical joints, left the deposit as we now find it.

About five miles E. of the town of Comber, in the townland of Lisnabreeny, just where Grove Cottage stands, there is a small area free from drift, composed of dark gray grits with earthy and glossy slates. Drift obscures the strata generally over the remaining northern part of the district, but when seen, whether in quarries or naturally exposed, they are of the same character as those just described. The localities in which dykes occur are the following:—Less than half a mile S.W. of the Dundonald Railway Station, where the Silurian boundary forms an elbow, in the side of a sunk fence there is a small dyke of dark gray compact basalt. Nearly two miles S.E. of the last mentioned locality a dyke of yellowish highly felspathic trap occurs; and one mile S.W. of this, in a quarry on the road-side, a little N. of where the name "Irish Hill" is engraved on the map, and in another quarry on the Glen Road, half a mile W. of Comber, dykes of dark-gray finely crystalline dolerite, slightly amygdaloidal, have been observed. In describing the southern portion of this district we commence on the E., and going W. mention in detail the principal rock-exposures.

In the two townlands of Clontonakelly, in the neighbourhood of the farm house called Lough Hill on the map, gray or purplish grits of variable thickness, with gray slaty layers, are pretty freely exposed in bosses, and in many places in quarries.

In the S.W. corner of the triangle formed by the roads near the Sheltered Farm, in a quarry, and on the opposite side of the road, beds of gray purplish and greenish-gray grits have been observed, penetrated by a compact basalt dyke about three inches wide. The road between this point and the cross-roads E. of the village of Moneyreagh runs nearly parallel to the strike of the beds, which, where seen, are gray and purplish-gray massive grits, interstratified with layers of purplish glossy slates. The strata exposed in the rocky tract W. of Moneyreagh are very similar to those occurring in the townland of Clontonakelly, and are probably an extension of those beds. Though no glacial *striæ* have here been preserved, still the contour of the rocks suggests the idea of the former action of ice.

One mile S.E. of Moneyreagh, in the townlands of Tullyhulbert and Ballycreely, there are several exposures of gray massive micaceous grits, occasionally interstratified with layers of dark earthy slates, and in one locality with thin-gray flags. In the neighbourhood of Hill Head dark gray micaceous grits form a few detached bosses, and just S. of Ballyalloly Lough, gray or purplish grits, with layers of purple slates, form similar bosses.

South of Comber there are several rock cuttings on the railway. The first we enter is through purplish-gray grits, coarsely granular, near the southern end. These beds are penetrated by five dykes; the four northern run in a parallel north-westerly direction, while the remaining one has a north-easterly course. They are all of the same character, being composed of hard dark-gray dolerite, slightly amygdaloidal in some cases, the vesicular cavaties containing zeolitic minerals. The dyke seen in the glen to the S.E. is probably a continuation of one of the north-western ones. About 120 yards further S. there is a second cutting, in which the first beds exposed are evenly-bedded purplish-gray grits, which, fifty yards from the N. end of the cutting, are inverted. Further S. there is a fissure filled with Silurian fragments in a purplish clayey stuff, looking like a fault. The strata towards the centre become coarse-grained and massive, and are overlaid at the S. end by a considerable thickness of

purplish earthy fissile slates, the highest beds being purplish-gray grits.

Just N. of where the railway is crossed by a small road, beds similar to the last mentioned are exposed, and half a mile S. of this another cutting shows gray flaggy grits, with fissile slates; and again half a mile S. there are a few bosses of dark-gray micaceous grits. In a small quarry close to the farm-house, called on the map the Hollow, there is a dyke of dark-gray dolerite, the rock is finely crystalline and slightly amygdaloidal, and contains some zeolites.

From the National School, N.E. of this quarry, along the ridge of high ground, massive purplish grits with a few flaggy beds are freely exposed for the distance of half a mile; the massive beds in one instance contain a few calcareous nodules. Directly S. of the limestone quarry at Castle Espie, hard dark-gray finely conglomeritic thick and thin-bedded grits are seen in quarries, small road cuttings, and in bosses in the adjoining fields. A little over a mile to the S. of this, in a quarry on the road-side there occurs a dyke of hard dark-gray compact basalt, which is again seen 200 yards to the N. in the stream course forming the boundary between the townlands of Leghorn and Lisbane.

In the northern corner of the townland of Lisbarnet and thence to the southern limit of the district, the ground is free from drift, the strata occupying this area being gray, purplish, and greenish-gray grits, often massive, conglomeritic, and micaceous. A dyke of dark-gray basaltic looking rock weathering to a brown sand has been observed in the side of the lane less than half a mile N. of the Lisbarnet National School.

Ballygowan District.—In the N.W. corner of this district gray grits, greenish flags, and dark earthy slates are exposed at intervals on both sides of the road, between the Lisbarnet National School and half a mile S. of Asphalto Cottage, while similar beds occur in like manner along the road running N.E. from Drumreagh Bridge.

The strata forming the irregularly shaped rocky tract W. and N. of the hamlet of Ballygowan are for the most part massive, and thick-bedded gray grits with here and there some thin grits interstratified with layers of gray gritty slates. N. of Ballygowan the grit beds, however, are in places conglomeritic and interstratified with dark-gray glassy slates, as in the quarries on the side of the railway about half a mile N. of the railway station.*

An extensive tract of bog lies to the S.W. and W. of Ballygowan, while to the S. for the distance of over two miles the ground chiefly consists of large rounded bosses and irregularly shaped patches of rock. The best sections in the northern portion of this rocky tract are afforded by the railway cuttings; 300 yards W.S.W. of the railway station we meet massive gray grits crossing the line at a low angle under which are some coarse-grained beds interstratified with very dark grits; a break of about 150 feet then occurs, and from the stream to the end of the cutting the beds consist of massive gray grits coarsely granular in places. Four trap dykes penetrate these beds; the first three of these are identical in aspect and mineral character, being hard black basalt, amygdaloidal towards the centre, but the fourth is purplish-gray in colour, chiefly made up of mica; it is a typical minette, and weathers freely to a bronze-coloured flakey sand. About 300 yards S.W. of this, there is a second cutting, at first through gray massive coarse-grained grits; in the centre, however, they become compact and flaggy, and at the southern

* The stone from these quarries is used for paving, road-metal, and pitching, for all which purposes it is extremely well suited, being both hard and tough.

end are coarse and purplish in colour. Two dykes occur here; the most northern is a gray crystalline minette (or mica trap) weathering into a soft flakey sand; and the second is composed of a yellowish-gray felspathic matrix with enclosed fragments too small for identification.

On the N.E. and S.W. slopes of Killaney Hill, the strata consist of massive gray and purplish-gray grits generally micaceous and often conglomeritic, and S. of Ravara House similer beds form immense rounded bosses and hummocks.

The country to the W. of Ballygowan is for the most part covered with a thick drift deposit, the only exposures of any importance being the section in the stream course N. of Tullygarvan House. The first beds met with in this section are black carbonaceous shales,* under which are dark-gray earthy slates and gray flaggy grits. The beds now roll over, and a break of about 200 feet occurs in the section, the rocks seen at intervals being purplish and gray grits. Dark-gray slates and grits make their appearance round the lower margin of the mill-pond; and from the top of the pond to the Ballyknockan Mills there is a rounded ridge of massive gray grits in which no bedding is observable. Between the Ballyknockan Mills and the bridge of the same name the rocks seen at intervals are hard-gray grits with beds and layers of gray earthy slates. Somewhat more than a quarter of a mile S. of Monlough, in an excavation opened for farm purposes, there is a small dyke of minette; this rock is exceedingly tough, in colour brownish, and seems to be almost entirely made up of bronze-coloured mica.

The rocks in the vicinity of Hollycroft are gray, finely micaceous grits, with thin beds and layers of slate.

Saintfield District.—From Saintfield, in a westerly direction to the limits of the map, the strata are well exposed, being on the N. of the area gray or purplish grits, for the most part massive and coarse, interstratified with which there are layers of dark-gray slates. The great synclinal of the district repeats these beds to the southward, and further S. the beds below these are similar in character. To the S. of Saintfield, in the townlands of Creevyloughare and Drumaconnell, East, we find massive, generally coarse gray grits, with, in places, thin slaty beds, of a dark brown colour, forming immense ice-rounded masses. The same set of strata are also seen at intervals in the railway cuttings.

In the neighbourhood of Saintfield House the rocks are concealed by drift, and N. of Saintfield the railway has exposed near the mills dark-gray grits, with layers of gritty slates, and a qarter of a mile further N. black splintery shale and gray grits.

From Liberty Hill △ 323 about two miles N.N.W. of Saintfield, as far W. as the Drumreagh School-house, there is an extension of the rocky tract of the southern portion of the Ballygowan District. The strata near Liberty Hill are massive gray micaceous grits, and slates becoming near trig. point 266 finely conglomeritic, and W. of the Drumreagh School-house being interstratified with flags and dark-gray slates.

The small patch at Priests Bridge, about one mile and a half E. of Saintfield, from which the drift has been removed, consists of hard-gray coarse grits, with greenish-gray flags, the latter becoming the predominating character of the strata towards the S., where the flaggy beds are interstratified with grey gritty slates.

East of Aughnadarragha Lough there is a similar rocky tract, the

* A shaft was sunk in these shales some years ago in search of coal, it is needless to say without success, and is only another instance of the expenditure that would have been prevented had a geological examination of the strata been resorted to.

rocks being generally ice-rounded, though the striæ have not been preserved. The beds here to the W. are hard-gray micaceous grits with layers of gray fissile slates; further to the S.E. we find gray grits sometimes flaggy, and in the vicinity of Threetown Rock, and N. of the small bog the strata are very similar.

About one mile N. of Threetown Rock, behind the Kilcairn graveyard, there is a small dyke of tough brownish minette weathering to a micaceous sand.

About Darragh Cross we find hard-gray, sometime massive, grits passing down into thin gray flags, dark-gray micaceous grits and dark-gray gritty slates. And one mile and a half N.E. of the cross-roads, on the side of the road running nearly due south-east of Ballymacashin Lough, these beds again make their appearance from under the drift. Over one mile S. of this locality, and close to the southern margin of the map, dark-gray massive grits have been observed; these beds are cut across by a dyke about forty feet wide; composed of a pinkish-gray finely crystalline but highly felspathic rock, which, in places, weathers to a sand, and would probably be most correcly termed a diorite.

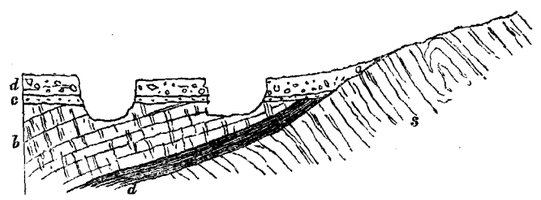
Killinchy and Ardmillan District.—In the S.E. corner of this district, near Carrgullian Lough, the rocks are gray, coarse-grained, and micaceous grits, with layers of gray slates. Similar beds occur just S. of the village of Killinchy, the beds below which are there massive, sometimes coarse. Towards the middle of the section a considerable thickness of purplish and greenish-gray flaggy grits, flags and slates, come in under which are hard dark greenish grits with slaty layers. From the Balloo Corn Mills to the village of Ardmillan the rocks are pretty freely exposed, being on the S. gray ribband slates and flags, passing up into gray fine-grained splintery grits, above which are purplish-gray micaceous beds, and E. of Rose Vale gray flaggy grits.

South of Ballymartin Lough there is a small exposure of greenish-gray flags, thin grits and slates. The other exposures in the district do not require special mention.

Lower Carboniferous Shales.—An account of the Lower Carboniferous shales at Cultra has been included in that of the coast section, while a description of those at Castle Espie will be given along with that of the limestone occurring there.

Carboniferous Limestone.—This rock occurs at Castle Espie, near Comber, and is a red or salmon-coloured finely crystalline limestone, the beds varying in thickness from four feet to six inches, and separated by thin partings of light-green shale. Interstratified with these beds there a few layers of green and mottled shale, from three to four inches thick, in which fossils are most abundant. Immense *Orthoceratites* and *Productidæ* are also obtainable from these quarries.

Fig. 4.—Section in Limestone Quarry at Castle Espie.



s Lower Silurian grits, &c., highly inclined and contorted.
d Reddish and Blue Shales, at base of Limestone.
b Carboniferous Limestone. *c* New Red Sandstone. *d* Boulder Clay.

The limestone in the quarry rests on a bed of dark purplish red shale, and in the engine shaft, on a reddish sandstone. These latter beds are the representatives of the lower limestone shales (Fig. 4).

Permian Rocks.—These strata have already been described in the explanation of the coast section (page 20).

Upper Red and Mottled Sandstone (*Trias*).—The space occupied by this subformation being altogether covered by a thick deposit of drift, we have few good sections visible. The railway cuttings E. of Scrabo Hill, and the cuttings for the incline up to the quarries, show beds of soft bright-red obliquely laminated sandstone; and in the cutting opposite the goods store at the Newtownards railway station, red and yellow beds belonging to the same division of the Triassic series have been opened up. On the roadside at Bootown Lodge, half a mile E. of Newtownards, soft red sandstone is exposed within a short distance of Lower Silurian Rocks, while on the shore, two miles S.E. of the same place, we find red and yellow obliquely laminated sandstones.

For about 500 yards along the shore, in the vicinity of Ballyhaft Cottage, beds of pale yellow sandstone may be seen. These beds are cut through by several branching dykes of gray basalt, weathering spheroidally to a dark-gray sand. Soft, bright red and yellow sandstones obliquely laminated, and red sandy shales make their appearance just S. of the Mountstewart Schoolhouse.

The remaining exposures of strata belonging to this subdivision are those which occur in the neighbourhood of Dundonald and the Knock. More than a mile E. of Dundonald, an old quarry called the Red Stone Quarry, has brought to view bright red micaceous and marly sandstones.* To the N. of this similar beds may be seen in a small cutting for the new road between Belfast and Newtownards.

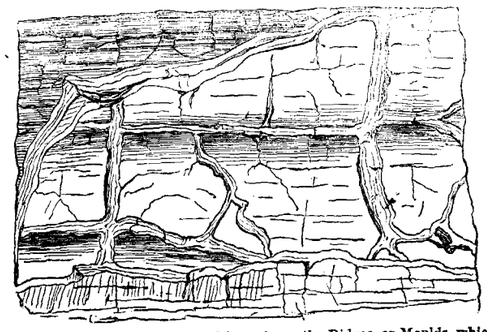
North of Dundonald the stream courses E. and W. of Dunlady House, expose soft, red, and yellow sandstones, and red sandy shales; in the latter locality the beds are penetrated by a dyke of greenish-gray basalt.

Less than two miles S.S.E. of the Knock railway station in Carnamuck Glen and in the little stream to the W. soft red sandstone may be observed. In the last-mentioned instance the rock contains chips of slate and rounded pebbles of quartz.

Lower Kenper Sandstones.—In describing the occurrence of these strata in detail, it will be most convenient to commence with the most southern of the quarries on the E. flank of Scrabo Hill. The phenomena here presented to our view are most interesting and instructive. The sandstones are evenly bedded, yellow and red in colour, obliquely laminated, and sometimes micaceous, the surfaces of the beds being also frequently rippled, suncracked, and pitted as if by rain drops, interstratified with thin partings and layers of green and purple shale. These beds are traversed by both horizontal, branching, and vertical dykes, of dark-gray dolerite, the horizontal ones being closer in texture than the vertical. A great vertical dyke about fifteen feet wide, composed of a rock very like the overlying dolerite, but slightly amygdaloidal not only cuts through the sandstones and branching dykes but can be distinctly seen penetrating the superincumbent dolerite itself (see Fig. 1, p. 14). About one hundred yards N. of this dyke there is another about thirty-five feet wide, inclosing angular fragments of sandstone and dolerite, in a pale yellowish felspathic matrix. A dyke of the same constitution, but of much smaller dimensions, has been observed between the two just mentioned.

* The stone from this quarry was used in the construction of the new docks at Belfast.

Fig. 5.—Moulds of Sun-cracks on Slab from Quarry of Lower Keuper Sandstone, Scrabo Hill.



The raised portions which interlace and branch are the Ridges, or Moulds, which filled the Sun-cracks formed on the underlying bed of Sandstone,

North of this quarry several others have been opened in the same beds in all of which the sandstones are traversed by vertical and branching dykes of fine dolerite. The branching dykes vary in thickness from four to five feet, to two or three inches, and in some cases run out altogether.

In the little bay formed by the boundary of the dolerite, near the Ballycullen National School, a quarry has been opened in pale yellowish and white, very fine-grained sandstone, interbedded with bands of purple shale.* At the old entrance to the quarry there is a dyke of amygdaloidal dolerite in its upper portion, bending over to the E., and dying out before coming to the surface. The Glebe quarry, a mile to the S. of this exposes beds of red and yellow sandstone, and bands of purple jaspidious shale, the latter being probably hardened by the heat of the overlying dolerite, though it is a fact worthy of note that the sandstones do not seem to have undergone any change.

In the quarry near the Dundonald railway station the dolerite has been removed from off the surface of the sandstone, exposing beds of yellow sandstone, changed into fine-grained or compact quartzite. And the section made by the stream forming the boundaries between the townlands of Ballybeen and Ballyhaywood shows, below the gray dolerite, several thick beds of brown and yellow sandstone, not altered to any appreciable extent by the proximity of the dolerite; under these beds there is a yellow conglomerate containing pebbles of white quartz, and angular chips of greenish slate which rests on a bed of red sandstone with oblique lamination.

These conglomerates, Mr. Hull thinks, are probably the basement beds of the Keuper sandstone, though they are not visible round Scrabo Hill.

Dolerite.—This rock is well seen resting on the sandstone in the large quarries on the E. flank of Scrabo Hill, where it is a gray crystalline, sometimes amygdaloidal aggregate weathering spheroidally into a brown sand, and generally contains some zeolites.

The summit of the hill and the space included between the quarries and the eastern boundary of the townland of Ballyalton, is occupied

* The stone from this quarry is much used for ornamental work on buildings, for which it is well suited, being of a good colour, fine-grained, and easily worked.

almost entirely by hummocks and bosses of gray finely crystalline dolerite, in general aspect showing evidence of the action of ice, but not preserving the striae on account of the facility with which the rock weathers.

In the vicinity of Ballyalton House, situated on the narrow neck which connects the mass of Scrabo Hill with the main mass of dolerite, the rock is finely crystalline, and in one instance rudely columnar; and rocks of the same character form an irregular band from this locality to within about 200 yards of Rockfield. North of Rockfield, in a quarry by the roadside, we find a pale-gray coarsely crystalline rock. Five hundred yards further N. there are two small outliers of decomposing dolerite or basalt.

On the slopes of the high ground S. and S.W. of the Ballyrogan National School, there are numerous exposures of gray and dark greenish-gray crystalline dolerite, which, in the vicinity of the windmill stump, S. of the school, weathers in globular masses to a brown sand. The exposures on the S. of the main mass are of little importance.

The dolerite in the quarry near the Dundonald railway station is a gray crystalline rock, and contains crystals of black glittering angite, and a dark-green felspar, and in the railway cutting to the E. is dark gray, sometimes rudely columnar, and weathers in places to a brown sand. To the W. the rock forming this outlying patch is of the same character. In all probability the components of the dolerite in the district here described are hypersthene and labradorite, as the minerals are generally similar to those contained in a specimen examined by Mr. A. Gages, to which reference has already been made.

Post Pliocene or Drift.—The whole of the district, with the exception of the high Silurian ground to the N., and some isolated tracts free from drift to the S., together with the areas occupied by bog and alluvium, is covered by a deposit of Drift which we may divide into three kinds. Firstly, the reddish or reddish-brown boulder clay, containing more or less ice-worn and scratched blocks of the lower Silurian strata; boulders of basalt and dolerite, fragments of chalk, and in one or two localities, rolled Lias and Chalk fossils. This class of Drift occupies by far the larger portion of the district, and is probably the most ancient. Secondly, the deep accumulation of red sand and marl which we find in the neighbourhood of the Knock, and at the base of the high ground towards Sydenham, derived from the erosion of the Triassic strata. Thirdly, the rounded gravel and sand occupying the ground to the N. and N.W. of Comber, and forming the Esker Ridges in the neighbourhood of the village of Dundonald.

In the northern portion of the district the best sections in the boulder clay are those afforded by the cuttings of the Belfast, Holywood, and Bangor Railway, where we find brown and reddish gravelly clay, containing fragments of the local rock and small pieces of chalk.

In the neighbourhood of Bangor striæ have been observed in one or two places bearing from N. to N. 20° W. About Clandeboye brown and red argillaceous clay, containing chalk fragments, forms low undulations. In a small quarry in the demesne the surface of the Silurian rocks are scored by two sets of striæ, bearing, respectively, N. 30° E. and N. 20° W., the latter being the more recent. To the north of this, the country is covered with a similar deposit of boulder clay to that occurring about Clandeboye.

Striæ have been noticed in several quarries on the side of the road between Bangor and Donaghadee. One quarter of a mile S.E. of the Haw, the surface of the rock is deeply grooved by ice, some of the scorings being one foot three inches long, one inch wide, and half an inch in depth,

and have a bearing of from N. 40° to 50° E.; while in another quarry close at hand the polished rock surface shows fine striæ bearing N. 10° W. Two miles further W. the direction of the striæ is N. 20° W.

To the south there lies an extensive tract of bog, surrounded by and enclosing rounded drift hills.

J. L. W.

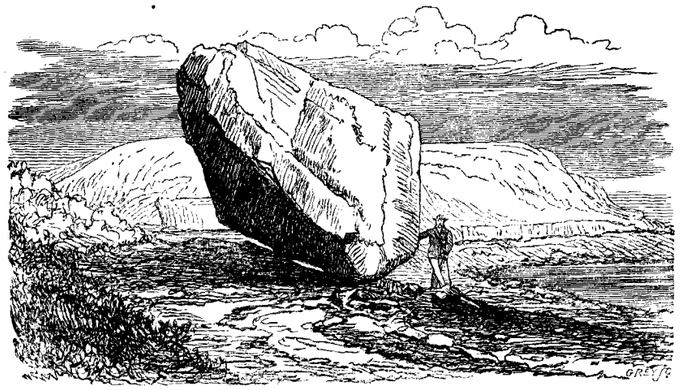
The irregular line of hills skirting the shores of both Lough Strangford and the Irish Sea are made up of boulder clay, reddish-brown clay, with pebbles and blocks of Silurian grit and basalt. By the edges of the line of central bogs this drift is re-arranged into well-washed sands and gravels, and the beds of some of the largest bogs consist of blue marl, with *Lymnæa* and other fresh-water shells. Surrounding rock-hills, and exposures, we have the local drift—a reddish sandy clay and sub-angular fragments of the local rocks. At intervals along the eastern shore are hills of blown sand, often stretching into the country for considerable distances.

About Newtownards, besides the boulder clay and its ice-scratched blocks, there is a deposit of sand and gravel, with chalk, flints, &c.

For a considerable distance S. along the shore, the Drift partakes of the character of the subjacent rock (Bunter Sandstone); it is a bright-red clay, red sand, or red marl. Near Ballyhaft Cottage a large block of basalt, similar to that crowning Scrabo Hill, is picturesquely situated on a floor of red sandstone. The following sketch was taken by the late Mr. Du Noyer. (Fig. 6.) The block measures 20 × 12 × 8 feet. Further S. another block measures 30 × 15 × 15 feet. On the eastern shore S. of Ballyhalbert, at low-water mark, another basalt boulder is perched on some high grit beds; it is called "Butterlump Rock," measuring 20 × 15 × 15 feet and is easily rocked.

W. B. L.

Fig. 6.—Butterlump Rock.



Boulder of Basalt on Floor of New Red Sandstone.
(From a Sketch by the late J. V. Du Noyer.)

The islands in Strangford Lough are formed of mounds of boulder clay, alike in character to that of the Ards promontory, but frequently containing immense blocks of limestone, of the same character as that of Castle Espie.

The remaining portion of the Silurian ground, with the exception of

the rocky tracts in the vicinity of Killinchy, Saintfield, and Ballygowan, is also occupied by the same deposit, which constitutes rounded hills and irregular undulations. In the hollows between these are numerous small bogs and alluvial flats.

At the limestone quarries at Castle Espie the boulder clay is from 40 to 50 feet in thickness, and is so consolidated that blasting has to be resorted to in removing it. Rolled Lias fossils are not uncommon here, and the surface of the limestone exhibits glacial markings, bearing N.W. and S.E. Now, as the nearest beds containing Lias fossils occur on the northern shores of Belfast Lough, and from the general bearing of the striæ in this and other localities, it is evident that the direction of the ice-flow was from the N. and N.W.

The second kind of drift occupies the ground west of Dundonald, that in the vicinity of the Knock, and is found round the base of the Silurian hills, almost as far N. as Holywood.* It consists of red sand and gravel, with occasional deposits of red, marly clay, which is in some instances, as at the back of Ballyhackamore House, near Sydenham, beautifully stratified and laminated.

During the construction of the B. C. D. Railway numerous shells were obtained from the cuttings through this drift, and in 1850 Mr. MacAdam discovered a deposit in the vicinity of the Knock, containing shells, the most abundant of which is the *Nucula oblonga*.† Mr. Du Noyer obtained oyster and other marine shells from a gravel pit between Kennel Bridge and Garnervill, more than a mile N.W. of Sydenham. The succession of the drift deposits in this district, therefore, appears to be as follows :—At the base, and resting on a glaciated surface of rock, lower boulder clay or till, succeeded by water-formed sands and gravels, and these last by Esker ridges.

Raised Beaches.—Skirting the shores of Belfast Lough, between Holywood and Donaghadee, we find a deposit of marine sand gravel, the maximum elevation of which is about twenty feet above the level of high water. In this deposit, artificially formed, flint flakes were discovered some time back, of which Mr. G. V. Du Noyer, in a communication addressed to the Secretary of the Royal Geological Society of Ireland, thus writes :—"I may remark that, when these singular flakes were first discovered in the district round Carrickfergus, about five years since, their mechanical origin was questioned. Indeed, I myself thought at first, that they were due to the crushing by natural causes (the weight of the basalt) of the flint nodules, forming the original drifts over the atmospherically eroded surface of the chalk. The chippings around the edges of the flakes can, however, only be accounted for by artificial means, as they afford clear evidence of design in their forms and mode of occurrence.

"Subsequent examinations clearly showed me that every flake, no matter how rude its form, or how sharp its edge, exhibited at one end a flat surface, transverse to the longest axis of the flake, and from this surface a blow was given at a point on it, which caused a flake to come off from the original nodule, and this flake, below the point of concussion, exhibited a conchoidal fracture and a 'bulb of concussion' features which could only be formed by, and were the result of, 'an intelligent blow.'" And further on, he says :—"The conclusions which my present information on this subject leads me to arrive at with regard to the origin and

* In a paper read before the Geol. Soc., Dublin, Mr. S. MacAdam, F.G.S., stated that he had observed several beds of shells at the Kinnegar, near Holywood, at elevations of from fifteen to twenty feet. Also that shells were found in a terrace behind Holywood, which has an elevation of eighty feet, and from a similar terrace at about the same elevation in the valley between Belfast and Comber.

† See Report British Association, 1852, p. 53.

explanation of the mode of formation of these flint flakes are these :—During the period of formation of our present raised sea beaches, the men of that period resorted to the out-crop of the chalk for flint nodules, from which to manufacture their mallets, hand-axes, knives, rude spear and arrow-heads, and other implements, and these are the *rejecta* of that manufacture during an unknown period, the localisation of the raw material conducing to the localisation of the worked implements, lost or rejected over an area which was then covered by the sea, but which is now the land skirting the present coast line." These flakes are generally found close to the upper surface of the drift gravel, but at Ballyholme Bay, near Bangor, they occur at a depth of from six to eight feet from the surface, in stratified sand and gravel. Below this sand and gravel there is a layer of blue marl one foot six inches to two feet thick, resting on ferrugenous sand, containing fragments of slate. On the beach under the cliff there is a submerged bog, with stems and roots of trees visible at low water.

Worked flint flanks are also found on Reagh Island, in Strangford Lough, in a raised beach, on the north of the island. About one mile N. of Ballywalter, near Ballyferris Point, is a raised beach, consisting of stratified sands and shells; it is about three feet above high-water mark.

J. L. W.

Conlig Lead Mine.—The lode which has been worked under this name lies north of Newtownards, and has been proved to extend for the distance of over a mile in a general northerly direction; in its southern portion the lode runs N. 15° W. for about 500 yards, and then trends more to the N., having throughout the remainder of its course a bearing of about N. 3° W. This mine was abandoned in 1865, so that at the time the district was under examination, it was impossible from the state of the workings to make a personal inspection of the lode; the following details, however, were gleaned from persons who had either been engaged in the working of the mine, or were on the spot when the mining operations were being carried out.

From their account it would appear that the lode hades to the west at the rate of about one foot ten inches in the fathom, and coincides along its entire length with a dyke of dark-green diorite, usually appearing along its walls, whilst the gangue of the lode is a fine angular breccia of Silurian rock, in a pale-gray felspathic matrix, through which there are strings of heavy spar, containing crystals of galena and minute quantities of copper pyrites, and peacock ore; some of these lead-bearing veins attaining a thickness of about ten feet.

Of the gangue of this mine, Dr. Haughton, in a paper communicated to the Geological Society, Dublin, in 1852, thus writes :—"During a recent visit to Conlig lead mine, my attention was attracted by the peculiar appearance of the gangue of the lode, particularly by the asbestiform streaked appearance of the dark-green crystals forming the walls of the lode. This mine has been very rich in galena for some time past, and was formerly very productive; but from about the 60 fathom level to the 90 fathom was compartively unproductive. The gangue of the lode presents the same appearance from the surface to 120 fathom deep; it crumbles when exposed to the action of the air; is full of joint surfaces, which are coated with a mineral of the same chemical composition as the gangue itself, crystalised in an asbestiform manner, as shown by the accompanying specimens. The specific gravity of the gangue is 2·751; it fluxes readily before the blow-pipe into a black clay, and behaves in general as an ordinary trap rock."

Dr. Haughton gave the two following analyses, made by himself and the Rev. J. A. Galbraith, from different specimens of the gangue. In both analyses the mineral was fluxed with carbonate of soda and potash, as it was found not to be completely decomposed by strong muriated acid.

No. I.

Weight = Grains. 25·85	Per Cent. 100.	Atoms.	—
Si O_3 = 11·35	43·88	0·969	1·256
$Al_2 O_3$ = 3·82	14·77	0·287	
Fe O = ...	12·98	0·360	1·255
($Fe_2 O_3$) = 3·73			
Ca O = 2·64	10·19	0·364	
Mg O = 2·81	10·88	0·531	
H O = ...	8·00	0·888	
	100·70		

This analysis may be well represented by the rational formula :—

$3[(Fe O, Ca O, Mg O,) (Si O_3, Al_2 O_3)] + 2 H O.$

No. II.

Weight.	Grains. 30·00.	Per Cent. 100.	Atoms.	
Si O_3	13·13	43·76	0·966	1·194
$Al_2 O_3$	3·52	11·73	0·228	
Fe O	...	14·34	0·398	1·258
($Fe_2 O_3$)	4·83			
Ca O	2·716	9·05	0·323	
Mg O	3·225	10·75	0·537	
H O	2·40	8·00	0 888	
	29·82	97·63		

This gives the same rational formula as before. The mineral has, therefore, the composition of an hydrated aluminous hornblende. Besides the constituents given above, a small quantity of chrome iron was found present in both specimens.

The Conlig lead mine is the only instance which has come under Dr. Haughton's observation of a pure hornblende constituting the gangue of a lead mine.*

The other localities in which minerals occur, have been already mentioned in the detailed description of the Silurian rocks.

No. III.

Analysis of the Scrabo Hill dolerite, by Mr. A. Gages, M.R.I.A., Curator of the Royal College of Science, Dublin.

Labrador hypersthene rock. Density, 2·976.

Mean composition. Labrador felspar, 48–50 per cent.
Hypersthene, 46–48 „

Composition of the hypersthene :—

4 Si O_2, 2 Fe O, 2 Mg O, Ca O.

Titaniferous magnetic iron in variable quantity.

* Journ. Geol. Soc. Dublin, vol. v., p. 203.

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DUBLIN: Printed by ALEXANDER THOM, 87 & 88, Abbey-street,
For Her Majesty's Stationery Office.