Memoirs of the Geological Survey.

EXPLANATORY MEMOIR

TO ACCOMPANY

SHEET 36 OF THE MAPS

OF THE

GEOLOGICAL SURVEY OF IRELAND,

INCLUDING THE

COUNTRY AROUND BELFAST, LISBURN, AND MOIRA.

BY

EDWARD HULL, M.A., F.R.S.,

J. L. WARREN, A.B., F.R.G.S.I., AND W. B. LEONARD;

WITH

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

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

SIR RODERICK IMPEY MURCHISON, BART.,

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

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

IRISH BRANCH.

Office, 14, *Hume-street, Dublin.*

DIRECTOR:

EDWARD HULL, M.A., F.R.S., F.G.S.

DISTRICT SURVEYOR:

G. H. KINAHAN, M.R.I.A., &C.

GEOLOGISTS:

W. H. BAILY, F.G.S., L.S. (Acting Palæontologist); J. O'KELLY, M.A., M.R.I.A.;
R. G. SYMES, F.G.S.; J. L. WARREN, B.A.

ASSISTANT GEOLOGISTS:

S. B. N. WILKINSON; J. NOLAN, F.R.G.S.I.; W. B. LEONARD;
H. LEONARD, M.R.I.A.; R. J. CRUISE, M.R.I.A.;
W. A. TRAILL, B.A.; F. W. EGAN, B.A.; E. T. HARDMAN, F.R.G.S.I.
W. E. L'E. DUFFIN, B.A.

FOSSIL COLLECTORS:

ALEX. M'HENRY; EDWARD LEESON.

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 Explanatory Memoirs.

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

Condensed memoirs on particular districts will also eventually appear.

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

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PREFACE.

THE Geology of this Map was investigated by the late Mr. Du Noyer and Messrs. Warren and W. B. Leonard, during portions of the years 1868–69, under the direction of Professor J. B. Jukes, who previous to his decease had also made an inspection of the greater portion of the district.

Under these circumstances, I only deemed it necessary to make a cursory examination of the more important points, especially along the margin of the basaltic table-land; and for this purpose visited Belfast, Lisburn, and Lurgan, in company with Mr. Warren in the Spring of 1869. It will, therefore, be evident that the preparation of this Map and Memoir has been attended with peculiar disadvantages.

The description of the geological details contained in this Memoir has been drawn up by Messrs. Warren and Leonard, with occasional assistance from myself in those portions relating to the Triassic, Rhætic, and Cretaceous Rocks.

EDWARD HULL,
Director of the Geological Survey of Ireland.

Geological Survey Office,
12th May, 1871.

EXPLANATORY MEMOIR

TO ACCOMPANY

SHEET 36

OF THE

GEOLOGICAL SURVEY OF IRELAND.

GENERAL DESCRIPTION.

THIS sheet includes parts of the counties of Antrim, Down, and a small portion of Armagh.

The principal places in the county Antrim are the towns of Belfast and Lisburn, with the villages of Dunmurry, Dundrod, Crumlin, Glenavy Upper, and Lower Ballinderry, Aghalee, and Stonyford. In the county Down there are the towns of Hillsborough and Moira, and the villages Newtownbreda, Drumbo, Mazetown, and Magheralin; and in the county Armagh the town of Lurgan.

The limits of the sheet embrace the eastern shore of Lough Neagh on the north-west, and the harbour of Belfast on the north-east. At the south-westerly extremity the town of Lurgan is situated, and the southern margin stretches in an east and west direction about a mile south of Hillsborough.

1. *Form of the Ground.*

Reaching from Belfast, in a south-westerly direction to the southern limit of the sheet, is the broad, richly cultivated valley of the Lagan, to the N.W. of which the ground rises, at first slowly and then abruptly, into an elevated escarpment. This escarpment enters the district from the north, to the west of Belfast, being a continuation of the ridge of Cave Hill which forms so bold and striking a feature when seen from Belfast, and runs in a general south-westerly direction, leaving the district two miles east of Lurgan. The escarpment, in its northern portion, between Belfast and the White Mountain, is much more striking in aspect than in the vicinity of Moira and Magheralin.

West of Belfast, and stretching in a south-westerly direction as far as the White Mountain, is the bold group of basaltic hills. Towards the north their eastern slopes are rugged and precipitous, becoming more gentle and easier of ascent as we go southward. Their highest points are Divis, 1,367; Black Mountain, 1,272;

Black Hill, 1,184; Collin, 1,081; and the White Mountain 820 feet, respectively. The ground to the west and south-west of this range gradually subsides by undulating hills to Lough Neagh, whose waters are only 48 feet above the level of the sea. To the south of Lough Neagh are extensive tracts of alluvial and marsh lands, on the margins of which rise irregular hills of Drift.

On the south-east of the main valley the ground rises gently, forming the range of Silurian hills stretching from Newtownbreda in a south-westerly direction past the town of Hillsborough.

The south-eastern portion of the district is drained by the Lagan and the Blackwater—the former of which is a sluggish river rising in the district to the south, and entering this district at a height of 110 feet, and after a sinuous course of about 28 miles discharges itself into the sea at the head of Belfast Lough, having a fall of about four feet per mile. The drainage of the western and north-western portion of the district is carried on by numerous small streams and the Crumlin and Glenavy rivers, which empty themselves into Lough Neagh, the former at Lennymore Bay, and the latter about one mile and a-half further south.

The crest of the watershed dividing the waters which drain into Belfast Lough from those which find their way into Lough Neagh, enters the district on the south about one mile east of Lurgan, near Beech Park, and runs in a northerly direction, passing E. of Grace Hall. It then turns to the east, and passes north of Belmont, where it assumes a north-easterly direction as far as Soldierstown Church, from which it proceeds E.N.E., and again N.E. through Maryfield. From this it runs through the trig. points 338 and 339, near Mullaghcarton, and then trending to the N.E. passes north of Brookhill and Kilcorig House, from which it proceeds in an easterly course through the summit of the White Mountain, and thence in a curved line N. of Groganstown and through the summit of Collin, where it bends sharply to the N.W., and passing Priest's Hill on the E. turns N. as far as Standing Stones Hill; from this point it runs E.N.E. to the Head of the Waters and Divis, where, turning suddenly to the N., it leaves the Map between 6°1′ and 6°2′ W. long.

The Geological features of this district have been described by Sir R. Griffith;* Dr. Berger;† Mr. John Kelly;‡ Dr. Bryce;§ Dr. Scouler;‖ Mr. R. Tate;¶ Mr. W. H. Baily.** The observations of some of these authors are further alluded to in the following pages.

* "Geological and Mining Surveys of the Coal Districts of Tyrone and Antrim, 1829."

† "On the Geological features of the north-eastern counties of Ireland."—*Trans. Geol. Soc. London*, 1st Series, Vol. i.

‡ "On the Geology of the County Antrim, &c."—*Proc. Roy. Ir. Acad.*, Vol. vii.

§ "On the Geological Structure of the counties of Down and Antrim."—(*Abstract*) *Rep. Brit. Assoc.*, 1852.

‖ "Observations on the Lignites and Silicified Woods of Lough Neagh."—*Journ. Geol. Soc. Dublin*, Vol. i.

¶ "On the Cretaceous formations of the north-east of Ireland."—*Journ. Geol. Soc. London*, Vol. xxi.; and "On the Lower Lias of the north-east of Ireland."—*Ibid.*, Vol. xxiii.

** "Plant remains from the basalt of Antrim."—*Journ. Geol. Soc. London*, Vol. xxv.

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.*
	Drift Deposits.	*Engraved dots.*
Cretaceous Series.	h^6 Upper Chalk.	*Pale Emerald Green.*
	h^4 Upper Greensand.	*Do. Darker.*
Liassic.	g Lower Lias Clay.	*Chalons Brown and Gamboge.*
Rhætic.	f^8 Penarth Beds.	*Venetian Red and Sepia.*
Triassic.	f^6 Red Marl (Keuper).	*Venetian Red.*
	f^3 Upper Mottled Sandstone (Bunter).	*Do. Lighter.*
	e Permian Beds.	*Burnt Roman Ochre and Gamboge.*
b Lower Silurian.	Caradoc, or Bala Beds.	*Pale Purple.*

Igneous Rocks.

B. Basalt and Dolerite.	*Dark Crimson.*
Tp. Porphyritic trachyte.	*Vermillion.*

b. Lower Silurian Rocks.—These strata occupy the S.E. corner of the Map, and consist of gray purplish and greenish gray grits, sandstones, and flags, often micaceous and coarse-grained, interstratified with beds or layers of green, purple, and gray slates and shales, sometimes gritty and fissile, at other times with gray and dark-gray glossy slates, apparently lying below the former. Though we have no good section exposed in these beds in the district, yet from a comparison of the same strata in the adjoining districts it is probable that they have a very considerable thickness.

The great mass of the beds above described—characterized by the predominence of sandy materials and grayish or greenish colours—are referable to the stage of the Bala or Caradoc beds of North Wales, while possibly there may be also representatives, to a very limited extent, of the underlying Llandeilo series.

Permian Beds.—An isolated patch of thin sandstones and slate breccias, two and a-half miles S.E. of Moira, and near the basal boundary of the New Red Sandstone there, has been supposed by Messrs. Jukes and Du Noyer to be of Permian age. The beds are exposed along the stream crossing the road in a N.W. direction at Fortwilliam; they consist of breccias of gray and purple slate, gray and purple shales, thin gray, purple, and white sandstones, with a few thin bands of white, very earthy magnesian limestone.

f.[a] *Triassic Beds.—Upper Mottled Sandstone* (*Bunter*).—From the strong lithological similarity which the soft red and variegated sandstone of the valley of the Lagan bears to that of the upper division of the Bunter sandstone series in Lancashire and Cheshire, as well as on account of its position immediately below the Keuper beds, we have not hesitated to assign this sandstone to the same geological horizon, under the name of "Upper Mottled Sandstone." The divisions of the "Pebble Beds" and "Lower Mottled Sandstone," which in the West of England are subordinate to the uppermost member of the Bunter series, appear to have no representatives in this part of the country.

The lowest beds of the series seen in this district are yellow shales and flaggy sandstones, above which are some massive sandstones. From these beds up to the Red Marl of the Keuper the strata consist of soft bright red and yellow sandstones, mottled and obliquely laminated, sometimes almost white, interbedded with which there are in places red marly sandstones.

f.[a] *Red Marl* (*Keuper*).—The lowest beds of the Red Marl consist of red and grayish shales, with thin bands of gray micaceous sandstone, containing pseudomorphous crystals of salt (cubes). At the base there are a few thin beds of brownish and yellow carbonaceous sandstones in the marls; these are probably the representatives of the Waterstones (Lower Keuper Sandstone), but they are altogether too unimportant, and contained within too small limits—eight to ten feet—to receive a distinctive colour on the Map.*

The remaining beds of the Keuper division are red and pale gray or green mottled marls, in some places containing layers of gypsum. These beds are probably several hundreds of feet in thickness.

Rhætic or Penarth Beds.—These beds may be regarded as forming a passage between the Triassic and Liassic formations, and have recently attracted much attention in England and the Continent. They are characterized by *Avicula contorta*, a shell first described from these strata in the north of Ireland by General Portlock;† and *Cardium Rhæticum* (*striatulum*).

The locality where these beds are opened to view is Collin Glen, four miles S.W. of Belfast, a deep ravine running up from the plain into the basaltic plateau. In this spot they were first noticed by Dr. Berger in 1814, and their position, with reference to the New Red Marl below, and the Cretaceous beds above, accurately determined.‡ They were subsequently noticed by General Portlock,† and more recently in great detail by Mr. Ralph Tate, who was the first to refer them to the Rhætic series.§

* Notwithstanding that in general the representative strata of the Lower Keuper Sandstone are extremely thin and unimportant, as stated above, yet in more than one locality—as at the New Cemetery on the Fall's-road, Belfast, and at the quarry near Greerstown, Magheragall, there are certain beds of sandstone and marl which probably belong to this series.

† "Geol. of Londonderry," p. 107.

‡ "Geological features of the north-east of Ireland," by J. F. Berger, M.D., with an Introduction by the Rev. W. Conybeare.—*Trans. Geol. Soc. Lond.*, Vol. iii.

§ "On the Liassic strata of Belfast."—*Quart. Journ. Geo. Soc.*, Vol. xx., p. 103.

The section in Collin Glen consists of the following beds:—

	Feet.
3. Tough bluish shale, sandy, and calcareous, with thin bands of limestone, with *Avicula contorta*,	5 to 6
2. Dark blue micaceous shales, with obscure fossils; being the bottom beds of the Rhætic series,	8
1. *Keuper.*—Dull grayish green sandy marl—breaking into cubical fragments,	(more than) 6

Mr. Tate has published a detailed account of this section, which we here insert at length, from the pages of the Journal of the Geological Society of London. (Vol. xxiii.)

SECTION of the AVICULA-CONTORTA ZONE in COLLIN GLEN.

No. of Beds.	Lithology.	Thickness. ft.	in.	Organic Remains.
10	Zone of the White Lias resting on Black Shales.	0	11	Axinus cloacinus, Avicula, Cardium Rhæticum, Placunopsis.
11	Argillaceous Limestone,	0	5	
12	Black Shales,	1	7	Pecten Valoniensis, Modiola, Avicula, Placunopsis Alpina.
13	Marly Shales,	1	3	Axinus cloacinus, Avicula contorta.
14	Blue Argillaceous Limestone,	0	7	
15	Marly Shales,	0	5	
16	Brown Argillaceous Limestone,	0	6	
17	Black Shales,	1	2½	
18	Micaceous Sandstone,	0	1	
19	Soft Shales,	0	9	
20	Argillaceous Limestone,	0	0½	
21	Stiff Shales,	1	9	Axinus cloacinus, Cardium Rhæticum, Avicula contorta.
22	Argillaceous Limestone,	0	2	
23	Shales,	0	6	
24	Soft Micaceous Sandstone,	0	1	
25	Stiff Shales,	0	8	Axinus cloacinus.
26	Compact Calcareous Sandstone,	0	1	
27	Soft Shales,	0	6	
28	Stiff Shales,	0	5	Pecten Valoniensis, Cardium Rhæticum, Axinus cloacinus, Avicula contorta.
29	Compact Sandstone,	0	2	
30	Black Shales,	0	7	
31 to 34	Shales and Micaceous Sandstone,	0	4	
35	Arenaceous Shales,	0	2	Fish-bed.
36	Soft Shales,	0	5	
37	Thinly Laminated Stiff Shales,	0	5	Scattered Fish-remains, Natica Oppeli, Trochus Waltoni, and Avicula contorta.
38	Arenaceous Shales,	4	6	
39	Stiff Black Clay,	1	3	
	Blue Marls of the Keuper below,	—		
		19	9	

g. Lower Lias Clay.—Beds belonging to this formation are found under the Upper Greensand, from the northern limit of the

map to half a mile south of Collin Glen; and consist of dark gray, almost black, argillaceous shales and marls.

h. *Upper Greensand.*—The lowest beds of this group of rocks consist of dark bluish green ("Glaucus") marls, passing up into thick-bedded pale, or buff-coloured, sandy limestone, over which come beds of greensand, the highest forming a hard calcareous rock, containing rounded pebbles of quartz, about the size of a pea, and chloritic grains. This conglomerate bed is locally called "mulatto stone." Where most fully developed, these strata have a thickness of from 70 to 80 feet.*

h. *Upper Chalk.*—In this district there is a considerable gap between the members of the Cretaceous system which succeed each other; for we find the Upper Chalk with flints resting directly on the Upper Greensand, without the intervention of the Chalk Marl and Lower Chalk of England. This break in the succession is indicated by an eroded surface at the plane of junction of the Upper Chalk and Upper Greensand, apparently indicating the denudation of certain strata which had once been deposited. The Upper Chalk is composed of hard, white, compact, and splintery limestone, containing numerous nodules of flint, of all sizes and shapes, generally arranged parallel to the bedding in layers from two to four feet apart, and sometimes scattered indiscriminately through the mass. The Chalk has an apparent thickness of from 50 to over 100 feet; but as its upper surface has everywhere undergone a considerable amount of denudation—we have no means of judging of its original thickness in this part of the country.

Basalt.—In the Geological Report on the counties of Londonderry, Tyrone, and Fermanagh, General Portlock gives an elaborate account of the constitution and character of the great basalt plateau of the N.E. of Ireland, of which the basalt in this district forms a part. The basalt rests on a layer, or bed, of rolled flint gravel, in a gray or pinkish gray clay, from five to six feet thick; and consists of alternations or successive beds of tabular or platy, columnar and globular concretionary basalt, with amygdaloid and clinkstone. The vesicular cavities in the amygdaloid have been filled with minerals, carbonates, and zeolites, formed since the outpouring of the basalt, and so intimately blended with the original rock as now to form part of the mass.

The basalt weathers readily with a pimpled surface to a fine sand or round gravel, while the amygdaloid, from its composition, when exposed to atmospheric agencies, rapidly disintegrates.

The alternations of the distinct varieties seem to point out successive flows, with intervening periods of quiescence, during the long period of volcanic activity; the difference in the character of the rocks forming these successive alternations, being due to the conditions under which the basalt or amygdaloid was erupted.†

* The small dark greenish grains which enter into the composition of the Upper Greensand are composed both here and in England of silicate of iron.

† See Geol. Report on Londonderry, Tyrone, and Fermanagh, pp. 146, 147.

Thickness of Basalt.—The base of the basalt on the east flank of Divis is at an elevation of 750 feet, and the summit of the mountain reaches 1,567 feet, giving us 817 feet as the thickness of the basalt in this locality. Again, the Black Hill and the Black Mountain are, respectively, 1,272 and 1,104 feet above the sea level, while the upper surface of the chalk is 748 feet in the former instance, and 500 in the latter in altitude, thus the basalt has a thickness of 424 feet at Black Mountain, and 684 feet at the Black Hill.

Trachyte Porphyry.—This peculiar and rare volcanic rock is shown in three places in the townland of Ballyknock, about four miles W.S.W. from Hillsborough. It was first discovered and its mineralogical character identified by Messrs. Jukes and Du Noyer during the progress of the Survey in 1869.

With the exception of Tardree, near Antrim, this is the only locality as yet known where trachyte is to be found, while it is uncertain whether it occurs in any other spots in the British Islands. As there are abundant illustrations of the basic varieties of volcanic rocks in this part of Ireland (such as basalt, dolerite, &c.), it is strange that the acidic varieties (such as the trachytes), are of so rare an occurrence.

What may be the relations of this mass of trachyte to the neighbouring basaltic sheets, which approach within a short distance of Ballyknock, we have no means of judging, as the rock is surrounded by masses of Drift which forbid any hope of actual observation of these relations; but it seems not improbable that it may be regarded as a portion of the mass which filled the throat of one of the old vents of eruption of later date, from which masses of trachitic matter may have been poured forth, and subsequently removed and lost to view through denudation.

Mineral Characters.—The trachyte porphyry of this locality differs but slightly in colour and composition from that of Antrim. It consists of a dull gray felsitic base, containing crystals of sanidine, and small crystals, or globules, of quartz.

The best exposure is seen in a large quarry, now nearly filled with water, and the rock itself is overlaid by masses of boulder-clay.

E. H. & J. L. W.

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

Previous to the deposition of the Triassic strata, denudation had carved out the great basin in the Lower Palæozoic rocks, lying in parts of the counties Antrim, Londonderry, and Tyrone, and which is now occupied by the Triassic and Cretaceous formations, overlaid by the great basaltic sheets of the north-east of Ireland.

The high Silurian ground stretching from Newtownbreda to Hillsborough forms part of the south-eastern boundary of this great basin; but though this range of hills is mainly due to denudation, yet that it has to some extent been formed by upheaval, is evident from the northerly dip of the Mesozoic strata.

After the deposition of the Greensand the bottom of the Cretaceous sea must have been elevated, and during the period of the formation of the Lower Chalk of England, was either dry land or else covered by very shallow water, and under conditions unfavourable to deposition, as chalk without flints is altogether wanting in the district; the Upper Chalk resting on the eroded surface of the Greensand. Subsequently this area was submerged, probably to a great depth, and the Upper Chalk containing numerous siliceous nodules, was deposited in a sea prolific of animate forms, and comparatively free from sedimentary materials.*

Previous to the outburst of the basalt, the Chalk must have undergone a considerable amount of denudation, as the upper surface of the rock shows evidence of having been subjected to waste and erosion, before the outpouring of the basalt began. We rarely find the basalt resting directly on its surface, there being interposed between these two rocks a layer of flint-gravel, in a grayish clay, from five to six feet in thickness, which is derived from the waste of the Chalk itself.

At a still more recent, and comparatively modern period, marine, atmospheric, and glacial action appear to have removed large portions of the basalt and chalk. The direction of the ice-flow, during the glacial epoch, is indicated by the transport of boulders from the N. and N.W.; fragments of those rocks being found plentifully in the Drift of the S. and S.E. It was probably during this period that the original limits of the Chalk escarpment were determined; the eroding agents acting more rapidly on the softer materials of the lower members of the Cretaceous formation and the Triassic strata, than on the hard splintery chalk and protecting shield of trap. That the present escarpment is, however, mainly due to subaerial waste and not marine denudation is apparent from the varying altitude of the lower boundary of the Chalk, and also from the fact that no littoral deposits occur at the foot of the escarpment, both which circumstances are inconsistent with the supposition that the Chalk escarpment is due to marine denudation.

* It is scarcely necessary to mention here that the Chalk formation, like nearly all marine limestones, is built up of the shells or skeletons of marine animate beings.

Palæontological Notes.

Localities from which Fossils were collected.

No. of Locality.	Quarter Sheet of 6-inch Map.	Townland.	Situation, Geological formation, and Sheet of 1-inch Map.
		County of Antrim.	Sheet 36.
1	60/3	Boundary of Hannahstown and Ballycullo.	Rocks exposed in stream, at Collin Glen, a little north of Glenbridge, five miles south-west of Belfast; Rhætic beds.
2	60/3	Do. Do., .	In same stream, a little south of Glenbridge; Rhætic beds.
3	60/3	Do. Do., .	In same stream, a little north of Glenbridge; Upper Greensand—Glauconitic sands.
4	60/3	Do. Do., .	In same stream, near preceding locality; Calcareous band in Upper Greensand.
5	60/3	Do. Do., .	In same stream, a little north of Glenbridge; Upper Greensand—"Chloritic sandstone."
6	60/3	Do. Do., .	In same stream, a little north of Glenbridge; Upper chalk—"White limestone."
7	64/3	Aghnahough, . .	Old quarries at "White Mountain," two miles north-west of Lisburn; Upper chalk—"White limestone."
8	63/4	Knocknadona, . .	Quarry at "Limestone Lodge," three miles north-west of Lisburn; Upper chalk—"White limestone."
9	63/4	Ballyellough, . .	Quarry south of Brookhill House, three miles north-west of Lisburn; Upper chalk—"White limestone."
10	67/2	Magheraliskmisk, . .	Quarry half a mile west of Mullaghcarton, three miles north-east of Moira; Upper chalk—"White limestone."
11	67/1	Magherajames, . .	Quarry hill, two miles north of Moira; Upper chalk—"White limestone."
		County of Down.	
12	13/4	Clare, ...	Quarry at Moira; Upper chalk—"White limestone."
13	13/3	Ballymakeonan, . .	Quarry at Magheralin, one mile south-west of Moira; Upper chalk—"White limestone."
		County of Antrim.	
14	58/3 & 4	Ballyvanen, . . .	On shore of Lough Neagh, east side of Sandy bay, two and a half miles south-west of Glenavy; Tertiary.

List of the Species of Fossils collected from the preceding Localities.

The numbers opposite each species refer to those attached to the localities.
The mark × before a number is intended to show the comparative abundance of a species at that particular locality.

RHÆTIC OR PENARTH BEDS.

Mollusca: *Conchifera.*

	Localities.
Avicula contorta, ...	× × × 1, × × × 2.
Placunopsis Alpina, ...	× × 1, × × 2.
Axinopsis (Axinus) cloacinus, ...	× × 1, × × 2.
Cardium Rhæticum, ...	× × × 1, × × × 2.

UPPER CRETACEOUS: UPPER GREENSAND. "Glauconitic Sands."

MOLLUSCA: *Conchifera.*

	Localities.
Exogyra conica,	× × × × 3.
Pecten orbicularis,	3.
Ostrea canaliculata,	3.
Cardita, species undetermined,	3.

PISCES.

Otodus appendiculatus ?	3.

UPPER GREENSAND: *Calcareous band?* "Yellow Sandstone" (Tate).

ANNELIDA.

Vermilia ampullacea,	× × × 4.

MOLLUSCA: *Conchifera.*

Ostrea vesicularis,	4.
Pecten orbicularis,	4.
,, quinquecostatus,	× 4.

UPPER GREENSAND: *Chloritic Sandstone.*

MOLLUSCA: *Conchifera.*

Exogyra columba,	× × × 5.
Ostrea canaliculata,	5.
Pecten, species undetermined,	5.

PISCES.

Otodus appendiculatus?,	5.

UPPER CRETACEOUS: Upper Chalk. "White Limestone."

AMORPHOZOA.

Ventriculites, species undetermined,	9, 11.

ECHINODERMATA.

Ananchytes ovatus (Echinocorys vulgatus),	× × × 8, 9, 10, 11, 12, 13.
Cardiaster granulatus,	8, 9, 10.
Holaster Sandox? *Du Bois* De Montpéreux,	8.

MOLLUSCA: *Brachiopoda.*

Magas pumila,	× 9.
Rhynchonella plicatilis and var. octoplicata,	6, 8, 9, 10, × × 11, 13.
Terebratula carnea,	6, 8, × 11, × × 12, 13.
,, semiglobosa,	6, × 7, 8, 9, × × 12, × 13.

Conchifera.

Inoceramus, species undetermined,	12, 13.
Isocardia, do., do.,	8, 10.
Ostrea vesicularis,	6, 8, 10.
Panopœa gurgitis (Brongniart sp.),	8.
Pecten nitidus,	9, 13.
Pholadomya Esmarki (Nilsson sp.),	8.
,, Stewarti (Tate),	8.
Spondylus spinosus,	8, 13.

Gasteropoda.

Pleurotomaria Mailleana? D'Orbigny,	8.
,, perspectiva,	8.
,, species undetermined,	8, 10.

Cephalopoda.

Ammonites Oldhami,	8.
Baculites anceps,	11.
Belemnitella mucronata,	6, × 7, 8, × 9, × 10, × × × 11, 12, × 13.
Nautilus lævigatus,	8.

MIOCENE.

Lignite deposit between the basalt and chalk, consisting of carbonized wood,	8.
Silicified wood in large and smaller blocks with leaves of coniferous and other trees, from clay and sand deposits on the eastern shore of Lough Neagh,	14.
Lignite deposit with carbonized wood, in a similar mineralized condition to that of loc. 8,	14.

REMARKS ON THE FOSSILS.

The only fossil locality on this sheet of the Map, personally visited by me, was the interesting section at Collin Glen, on the Collin River, five miles south-west of Belfast. At this place the Upper Cretaceous rocks are seen to be immediately superimposed upon the Lower Lias or Rhætic beds. For a description of the section, I refer to the very accurate papers read before the Geological Society of London by Mr. Ralph Tate, F.G.S., "on the Liassic strata of the neighbourhood of Belfast,"* and to a subsequent communication to the same Society "on the Lower Lias of the north-east of Ireland;"† also to a third paper by the same gentleman "on the Correlation of the Cretaceous Formations of the north-east of Ireland."‡

In the list of species given by Mr. Tate from the Rhætic beds, "*Avicula contorta zone*," of the Collin Glen section (mis-spelt *Colin* by that author), he includes *Pecten Valoniensis, Modiola, Natica Oppeli, Trochus Waltoni* and fish remains, in addition to those enumerated in the list of fossils observed and collected by us on our cursory examination of this place.

The Cretaceous rocks of Ireland are referred by Mr. Tate to two formations; the lowest being that termed by him "Hibernian Greensand," equivalent in part to the Upper Greensand of England, resting upon which is the Upper Chalk or "White Limestone," the Lower Chalk or its equivalent being absent.

The Hibernian Sandstone he divides into three zones on lithological and palæontological grounds; the lowest of these divisions he describes as "Glauconitic Sands," the middle "Yellow Sands and Marls," and the upper "Chloritic Sandstone." This series he considers "may more perfectly be correlated with the Etage Cenomanien of D'Orbigny, the term Upper Greensand, as used in England, not being comprehensive enough." The Upper Chalk he groups into two divisions, the lower portion, termed "Chloritic Chalk," the upper "White Limestone."

The "Glauconitic Sands," or lowest division of this Cretaceous series at Collin Glen, we observed to be characterized by an immense number of the shell, belonging to the Ostreidæ, named *Exogyra conica.*

In the middle division—"Yellow Sands and Marls"—to which our "Calcareous band" appears to belong, an annelidan shell referred to *Vermilia ampullacea* and *Pecten quinquecostatus* were found to be the most prevalent fossils.

In the upper division—"Chloritic Sandstone"—a different species of Exogyra from that so prevalent in the Glauconitic sands, *E. conica* abounds in the deposit.

Sharks' teeth, doubtfully referred to *Otodus appendiculatus*, we found to occur in both these upper and lower divisions.

The characteristic fossils of the White Limestone, of which a list is given by Mr. Tate, in the article before cited,§ he remarks, "not only indicate that the White Limestone is of the age of the Upper Chalk, but point to its representing a high stage in that formation, suggesting, in fact, its parallelism to the Norwich chalk."

But few species of Echini were collected; the most prevalent of them being *Ananchytes ovatus*, in chalk, and its casts in the flint. It is

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* Quart. Journ. Geol. Soc., Vol. xx., p. 103.
† *Ibid.*, Vol. xxiii., p. 297.
‡ *Ibid.*, Vol. xxi., p. 15.
§ *Ibid.*, Vol. xxi., p. 27.

included in Mr. Tate's Table of Fossils under its original name of Echinocorys vulgatus. I have doubtfully referred to *Holaster Sandox* (Du Bois De Montpéreux),* another form, which, although in bad preservation, corresponds in its proportions with Agassiz's figures of that species, and also with the imperfect specimens figured and referred to by the late General Portlock in his Geological Report, p. 355, pl. xvii., fig. 1.

Brachiopod shells occur at all the white limestone localities; the smooth forms, *Terebratula carnea* and *T. semi-globosa*, and the plicated ones *Rhynchonella octoplicata*, with its variety *plicatilis*, being equally abundant; some small shells of this class (collected at locality 9), I believe to be identical with *Magas pumila*, a fossil not hitherto noticed from the Irish chalk.

Amongst the conchiferous bivalves, specimens were collected, by Mr. M'Henry of the Geological Survey, of a large shell, which are evidently identical with others in the Portlock collection, (Museum Geological Survey of Ireland,) from localities in the county Londonderry, and I believe rightly named *Pholadomya Esmarki*, a species described by Nilsson,† under the name of Cardita Esmarki, and later more correctly figured by Goldfuss,‡ under its proper generic name of Pholadomya. Mr. Tate has refigured and described this species, believing it to be distinct, giving it the name of *P. obliquissima*.§ The late General Portlock‖ in his Report, p. 442, evidently refers to this shell, which he afterwards correctly identified with P. Esmarki, as the specimens were so named in his collection, now transferred to the Geological Survey.

Another bivalve shell in good preservation, obtained at the same locality, and included in our list of species as *Panopœa gurgitis*, is, like the preceding one, rudely figured by Nilsson¶ as *Lutraria gurgitis* (Brongniart); a more correct figure is given of this fossil by Brongniart** with which our specimen appears to be identical.

The Gasteropoda or univalve shells in this collection are entirely confined to the genus Pleurotomaria, which only occur in the state of casts, the large trochiform species *P. perspectiva* being the most plentiful, especially at locality 8. A species with more angular whirls I have doubtfully referred to *P. mailleana* (D'Orbigny).

Of the Cephalopoda, *Belemnitella mucronata* is the most generally distributed, having been found at all the localities mentioned where the Upper Chalk occurs. *Nautilus lævigatus* and *Ammonites Oldhami* were obtained from locality 8, and *Baculites anceps* at locality No. 11. The two latter species, according to Mr. Tate, described from more northerly localities in the White Chalk of Ireland, not having been hitherto recorded from corresponding strata in the neighbourhood of Belfast.

The mode of occurrence of the lignite deposits, and silicified wood of Lough Neagh has been ably described by Dr. John Scouler, in a paper read before the Geological Society of Dublin, January 11th, 1837.†† With respect to the popular idea as to the petrifying properties of the lake, he gives satisfactory evidence against such an hypothesis in the facts of the fossil wood "being found only in particular localities, and in the interior of the country," and that "none of the stakes which have

* Agassiz Descrip. Echin. Foss. de la Suisse (1839), p. 11, pl. ii., figs. 1–3.
† Petrificata Suecana, Cretaceæ, Part I. (1827), p. 17, pl. v., fig. 8.
‡ Petrifacta Germaniæ, Vol. ii, p. 272, pl. clvii., fig. 10.
§ *Op. cit*, Vol. xxi., p 40, pl. iv., fig. 3.
‖ Report on the Geol. of Londonderry, &c.
¶ *Op. cit*, p. 18, pl. v., fig. 9.
** Descript. Geol., Eno. Paris, p. 97, pl. ix., fig. 15.
†† Journ. Geol. Soc. of Dublin, Vol. i., p. 231.

been fixed in the lake, or the trees which grew on its shores have been in any degree silicified."

"Deposits of lignite," he observes, "are found at different places in clay and sand, around Lough Neagh from Dungannon to Glenavy, forming a circuit of about 20 miles. The bed at Glenavy, containing both lignite and silicified wood, which extends a great way into the lough, consists of a very tenacious blue clay, and contains occasionally small fragments of trap rock and chalk, the silicified wood at this place being associated with the lignite or wood-coal;" the depth of this ligniferous deposit has not been ascertained. The results of borings, made in a fruitless search for coal at Portmore, are quoted by Dr. Scouler, from the statement of Mr. Stewart, who examined this part of the country for the Royal Dublin Society. "They bored through two beds of coal, or what is called black wood, 25 feet thick each, and a third stratum 9 feet thick and 80 yards deep; they bored 18 inches deep into a fourth stratum, having no more rods to go deeper." Dr. Scouler also states that "the alluvial covering which spreads over these beds frequently contains fragments of silicified wood, which may be collected many miles from the shores of the lake. This superficial accumulation on the shore to the south of Glenavy, forming banks from 12 to 20 feet in thickness. The petrified wood in this detritus being usually rounded, and always of a white colour from the loss of its carbonaceous matter, distinguishes it from the specimens found associated with the lignite in the clay, which are of a dark colour." He also alludes to the occurrence of beds of lignite "under beds of trap, and even between two masses of basalt." A similar instance was observed and recorded by the late Mr. Jukes, at locality 8, in the chalk-quarry, three miles north-west of Lisburn; a lignite deposit occurring between the basalt and chalk.*

General Portlock in his Geological Report (before cited), p. 71, describes these tertiary deposits along the south-eastern margin of Lough Neagh, as "occupying in the county Tyrone and the northern part of the county Armagh, a district of ten miles in length by five in breadth, consisting of clay, sand, and irregular beds of lignite and wood coal.

Mr. James Bryce† also alludes to the lignites and Lough Neagh wood.

Associated with the loose fragments of silicified wood, Mr. M'Henry also collected rounded nodules of ironstone which, on being broken open, disclosed leaves in beautiful preservation, and showing the venation quite perfectly.

It is very probable that the lignite beds occurring between the basalt and also between the latter and the chalk may, when subjected to sufficient examination, be found to be of miocene age, like the Bovey Tracey beds alluded to by Dr. Scouler, and the plant deposit described by myself,‡ from beds interstratified with the basalt, observed on the Belfast and Northern Counties Railway, seven miles east of Antrim.

WM. HELLIER BAILY.

May 18th, 1871.

* *Post*, p. 31.
† Geol. notice of the environs of Belfast (1852).
‡ Quart. Journ. Geol. Soc., Vol. xxv. (1869), p. 357.

Detailed Description.

In describing the Lower Silurian strata we shall commence at the N.E., in the neighbourhood of Newtownbreda.

About one mile N.E. of this village the deep gully made by the stream forming the western boundary of the townland of Cregagh has exposed purple and greenish highly micaceous grits, with layers of gray glossy slates. These beds, in the northern portion of the section, dip to the S., but in a short space roll over, and further S. the dip is obscure. Just N. of the waterfall the grits are penetrated by a dyke of hard, black, slightly amygdaloidal basalt, with glittering crystals of augite. Similar beds may be seen in one or two quarries between this locality and Newtownbreda, and in the stream which runs under the road just below the village, beds of much the same character are exposed at intervals for the distance of about one mile.

The next good section is that laid open by the stream which runs through the grounds of Purdysburn House, one mile S.W. of Newtownbreda. Proceeding up the stream, near the weir we find purplish gray micaceous grits with layers of purple slate; higher up, between the main bridge and that for the drive to the house, there are similar strata, but thicker bedded; a short break then occurs in the section, the next rock seen being purplish gray grits of variable thickness, over which comes a considerable thickness of purplish gray iron-stained grits, with brownish gray slaty layers, succeeded by purple and green mottled slates and grit beds; the strata here roll over, and the dip falls from 80° to about 5° or 10°, and close to the corn-mill the beds seem to be horizontal. From this point to Charity-bridge the rocks seen at intervals are purplish gray, generally micaceous grits, sometimes mottled green, with beds and layers of purple and green shales and slates. In one locality, in a quarry on the roadside, there is a fissure filled with a stiff red flucanny clay, which may probably be a line of dislocation. These beds again crop out on the high ground in the vicinity of trig. point 483.

From Charity-bridge, on both sides of the deep ravine running in a south-easterly direction and in the fields to the west, purplish and greenish gray grits of variable thickness, and sometimes coarse-grained, with purple and green mottled slaty beds, are freely exposed as far as the southern boundary of the townland of Knockbrickan. Here we find purple and greenish gray mottled slates, with dark gray earthy shales and gray gritty slates, and where the stream is crossed by a road, grits similar to those seen N. of the slates. About one mile to the east of this point, in the stream running between the townlands of Mealough and Ballycowan, beds, which are probably the continuation of those just described, have been observed. In this stream-course to the east of Moss Vale, a dyke of dark gray basalt occurs, containing crystals of augite and a dark green triclinic felspar, and having vesicular cavities scattered through the mass filled with zeolitic minerals. In the stream lower down, opposite to Morecrofts, Milltown, a dyke composed of a very similar rock occurs, which may possibly be the same dyke as that seen further south, brought in here by a fault.

In a stream a little over half a mile to the west of this locality there is a broken section in beds of quite the same character as those seen in the two last-mentioned sections. A gray basaltic dyke has been observed close to Mount Tober, and another of the same composition penetrates the grits in a quarry south of Farrell's Fort.

The glens, down which run the streams bounding the townland of Ballycarn on the N.E. and S.W., give us the following sections:—At the waterfall, on the south of the road near the Leveroge National School, we find purplish gray fine-grained grits passing down into rotten purple shales, with lenticular masses of gray grits. No rock is then seen for a distance of about 500 yards, when, on the north-west side of the glen, purplish gray grits, often coarse-grained, with purplish slates, make their appearance, dipping S. 60° E. at 65°. Directly below these rocks we find in the stream very similar grits, but inclined S. 10° E. at 60°, so that a fault seems probable between these two exposures.

For one hundred yards to the north-west no rock is now seen, when we meet a bed of purple conglomerate, with subangular pebbles, succeeded by about 400 feet of purplish gray flaky micaceous grits. The continuity of the section is here again broken for about 500 yards, the next beds seen being hard purplish grits, dipping N.W.; the same beds are again brought in by an anticlinal, but roll over again in a short distance, and from this to the northern end of the section the strata dip steadily to the S.E., and consist of greenish and purplish grits, usually more or less micaceous, interstratified with green and purple slates and shales. North of Drumbo Rectory the beds dip to the S.W. at 60°, and a little further south are cut across by a dark gray basaltic dyke, about four feet in width, which weathers spheroidally, and is slightly amygdaloidal.

The section opened up by the stream running through Drumbo Glen is very similar to that just described, the strata exposed in it being the same as those occurring in the stream-course to the north-west; south of the waterfall a dark gray basalt dyke cuts through the Silurian rocks. To the south-west of this point, in the stream north of Belvidere, we find at the waterfall gray micaceous grits and slates, and higher up similar beds, above which are pale gray micaceous grits and gray glossy slates, which are again seen in the road cuttings to the west. Above where the stream is crossed by the road pale gray rotten slates, slightly contorted, have been observed, below which come purplish gray flaggy micaceous grits, succeeded by a considerable thickness of pale gray micaceous grits and dark gray slates, exposed in small quarries and in the stream-course as far S. as the bye-road leading up to the village of Drumbo. These beds are again seen forming a few bosses to the south-west. The only other exposures in this district that need mention are a quarry in the townland of Drumbeg, opened in purplish gray grits, which are cut across by a dyke about nine feet in width, composed of ruddy columnar and vesicular basalt, weathering spheriodally to a brown sand, and some dark purplish gray micaceous grits, with slaty layers, cropping out on the canal bank, less than one mile north-west of Lisburn.

South of Hillhall, which is about one mile and a-half east of Lisburn, forming a large boss of rock, and in a stream section, we find thick beds of gray splintery slates, massive fine-grained grits and micaceous flags; and half a mile to the north-east, in another stream section under Marshal's Place, thick and thin bedded grits, with layers of gritty slates. As we follow the section the beds dip to the south, and above the grits there are gray gritty and glossy slates, with a few thin grit bands; from here to the end of the section the strata roll in sharp curves, repeating these beds.

In the vicinity of Tullyard Hill, trig. point 553, and in a north-westerly direction to where the River Drumbo is engraved on the map, massive gray and purplish grits, with layers of slates, are pretty freely

exposed in detached bosses. Near the Carr National School similar beds are exposed in a like manner; proceeding in a north-westerly direction is an irregularly shaped area, free from drift, the strata forming which are to the north massive coarse-grained grits, containing a few calcareous nodules; these beds are cut near where the road bifurcates, by a small dyke of dark gray basalt slightly amygdaloidal; over these beds we find slightly purplish grits of variable thickness passing up into massive gray grits, with layers of splintery slate, the beds on the south of the road being massive grits with thin beds of slate. Along both sides of the road, running from the western limit of the map in a south-westerly direction through the Temple, we find numerous exposures; a little north of where the main road is crossed by a lane the grits are massive, and have stratified with them layers of slate. These beds, just opposite some farm houses near the roadside, are cut through by a dyke of gray basalt, and on the opposite side of the road, over a quarter of a mile further south, there is another dyke of the same class about six inches wide. Between this place and the point where the main road is met by a bye-road on the west, there are three small road sections, the first two open up gray grits with layers of gray gritty slates, while the most southerly is through dark slates with an occasional thin grit bed, the beds at the southern end of the cutting being slightly contorted. Less than half a mile east of this section, and north-west of trig. point 434, we find gray grits varying from massive to thin bedded, with layers of slates, forming irregular bosses in the fields, and in a stream section to the southward gray grits and earthy slates passing up into greenish gray slates and flaggy grits. During the time the district was under examination a drain which was being sunk here opened up some beds of black graptolite slates. Less than half a mile to the east, massive gray grits, with layers of gray glossy slates, have been observed, and similar beds are frequently seen in bosses in the fields on the east of the road for a distance of about three-quarters of a mile to the southward. The country from this point to the margin of the sheet, and in the direction of Boardmills and Lough Henney, is principally occupied by Drift. In the neighbourhood of the Temple we find thin bedded micaceous gray grits with splintery slates, and at the cross-roads south of the church similar beds are again seen. North of Gill's Lough the strata are gray and purplish fine-grained grits, with slaty layers, the grits becoming coarse as we approach the Lough. West of Bow Lough, on the small road running round a Drift hill, purplish gray grits, with layers of slate, are exposed in many places; in a quarry here a disintegrated basaltic dyke has been observed. In the vicinity of Moorhall, to the north of this, we find gray grits in places containing calcareous nodules, interstratified with gray slates, dipping in various directions at angles ranging between 45° to 80°.

In the Ravernet river the following sections have been opened up;—S.E. of where the river is met by a stream gray grits and slates appear, under which there is a considerable thickness of similar beds of grit, with gray glossy slates; from the point where the stream turns S.W. to that where it again assumes its easterly course no rock is seen, but at the bend coarse-grained grits with layers of slate have been observed; another break now ensues, there being only two small exposures in the distance of a quarter of a mile. We then meet purplish gray grits containing a few calcareous nodules; these beds are intersected by rude joints bearing N. and S., below them are some gray grits with layers of slate tinged red; the continuity of the section is then again broken for about 100 yards, the next beds seen being gray splintery grits with thin

layers of slate. Another break of about the same length now intervenes, when we find thin flaggy grits and slaty layers.

Along the road which runs north of the Ravernet, between Boardmills and the Cargacroy National School there are several exposures of unevenly bedded grits, flags, and slates. In one of these, a quarry behind a farm-house, opened in gray flags, we find a dyke of dark gray amygdaloidal dolerite or melaphyre, the vesicular cavities in which are filled with zeolites or carbonates. At the Cargacroy National School the strata are massive and contain calcareous nodules. One-third of a mile S. of this place, from Bailey's mills to the limit of the sheet, the ground is free from Drift. The strata in the northern portion of this rocky tract are variably bedded gray grits, the massive beds containing calcareous nodules and fragments of shale. South of the cross-roads some beds of gritty slate may be seen, and south of these on the rising ground, near the Presbyterian Meetinghouse, bosses of exceedingly massive grits; and near the limit of the map the strata are generally massive or thick-bedded, with layers and partings of gray slates. The Silurian rocks in this tract are penetrated by three dykes, the most southern of these is a purplish greenstone with crystals of pinkish felspar; the next occurring in a deep drain, forming the boundary between the townlands of Cargacroy and Ballykeel Lougherne, is a hard compact basaltic dyke; the third and most northern is first seen near the roadside in the centre of a field, and can be traced northwards for a distance of 300 yards—it is very similar to the last, but not so compact, and contains many zeolites. A large mound of Drift to the W. of this locality is called Stubby Hill. The next rocks seen are some gray grits just outside the S.E. corner of Larchfield, further on at the gate lodge the road opens up purplish grits with slaty layers, while inside the demesne, near the corner of the plantation, we find pale gray, compact, and slaty grits; these beds curve sharply round so as to dip S. 30° W., but very shortly return to the normal strike; farther on, dark fissile slates and flaggy grits crop out, and where the pathway enters the plantation gray grits and gritty slates have been observed.

The rocky tract occupying the northern portion of Larchfield and the ground to the W. is composed of irregular bosses of massive gray grits, varying in texture from a close-grained rock to a coarsely granular grit, with which are interstratified gray gritty slates. To the S. of this exposure, in a quarry in the demesne S. of the deerpark, the grits and slates are cut across by a dyke of compact basalt. About one mile to the N.E. the Ravernet at the Legacurry mills cuts through gray grits and slates, and just below the flax-mill a thin dyke of dark gray compact basalt has been observed.

Over half a mile E. of Legacurry, lying among Drift hills, there is a small area of solid rock, the strata in which are principally gray grits of variable thickness, with occasional layers of dark gray slates. A deep cut for drainage purposes has here brought to view a dyke of dark gray nearly black amygdaloidal dolerite, the vesicular cavities containing zeolites and other minerals. This dyke weathers spheroidally to a brown sand.

On both sides of the main road, between Lisburn and Saintfield, there are three similarly situated rocky tracts. In the most westerly the strata are towards the N. massive gray grits, with slaty layers, the grits in places containing a few calcareous nodules, while on the S. the grit beds are thin. In the middle area the beds are much of the same character, but rather coarser in texture. Two small road-cuttings to the S. expose gray gritty slates, with gray flags and grits, and farther on fine-grained

gray grits, tinged red, may be seen on the surface of the road in one or two places. The longer axis of the third exposure runs parallel to the strike of the beds, which are massive gray grits, with layers of slate and shale.— J.L.W.

Lisburn and Hillsborough District.—Silurian Rocks.—Less than half a mile S. of Lisburn, in the bed of the river Lagan, gray and green micaceous slates and thin micaceous grits dip S. 10° E. at 60°. One mile E. and S.E. gray flaggy micaceous and shattery grits are freely exposed in bosses and quarries. In the stream passing Homra House, a section is seen from the corn-mill, S. to Watson's bridge. N. of the corn-mill hard and shattery grits and beds of shale dip N.N.W. at 70°. From the joining of the two streams at the corn-mill to where the stream enters the wood dark gritty slates stand vertical. Entering the wood dark gray slates dip S. 10° E. at 75°; these beds are cut through by a dyke of granular gray dolerite containing crystals of augite, labradorite, with zeolite; the direction is N. 10° W., and its width eight feet. Nearly opposite the house, at the turn of the stream, is another dyke of finely crystalline dolerite, containing cells filled with zeolite and striking N.W. and S.E. The beds, shattery grits and shale, here turn sharply and dip N. 30° W. at 70°, but return to S. 30° E. at 80°, and stand vertical at the end of the section.

A mile S. in the townland of Ballykeel, Edenagonnell, massive, thin, and shattery grits and gray shales are freely exposed; the dip of the beds is south-easterly; they are in places ice-rounded and striated; the ice-flow indicated was from the N.W. Similar beds crop out in Hillsborough Park, near the farm-yard, and to the east in the stream passing by Larchmount, the dip is regularly to the S.E. Below the bridge in Millvale, S. of Hillsborough Railway Station, in the stream are gray grits, cut through by a gray dolerite dyke, containing crystals of zeolite. From Millvale, to a short distance S. of the Maze-road bridge, thick and thin gray and purplish gray grits and slaty layers are exposed in the railway cutting; the dip is S. 30° E. at 30°. The direction of the cutting making but a small angle with the strike of the beds. Just N. of the bridge these beds are cut through in a N.W. and S.E. direction by a dyke of crystalline dolerite, showing crystals of labradorite and zeolite; it is four feet in width.

Where the stream crosses the road, S. of the Hillsborough cottages, gray grits and slates contain a small dyke of crystalline dolerite, showing crystals of labradorite and zeolites; the dip of the grits is S. at 70°. Down the stream, above and below the railway, thin gray grits and slaty layers dip S. 10° E. at 40°. About 500 yards still down the stream similar beds turn over and dip N. 10° E. at 40°; a small dolerite dyke ranges E. and W. through the beds; it shows crystals of labradorite and zeolite, and weathers into spheroids. Approaching the road massive and thin bedded gray grits and shaly layers dip N. 30° W. at 60°.

In parallel streams to the S.W. the same beds are exposed at intervals. In a quarry by the roadside, a quarter of a mile N.E. of St. John's Church, thick and thin gray and greenish grits, with beds and layers of gray slate, dip S. 80° E. at 60°, and are cut through by a small nearly compact basalt dyke, weathering spheroidally. N. of St. John's Church gray grits and slates, with some yellow and brown sandstones, are seen.

The Trachyte porphyry, S. of Kilwarlin cottage, has already been described. (See General Description, p. 11.)

In the stream east of Maryvale shattery gray grits and slaty layers stand vertical, and near Fortwilliam gritty slates dip north-westerly.

In a small Silurian basin here lie some beds supposed to be of Permian age; they have been already described (p. 7).— W.B.L.

Triassic Strata.—The whole of the ground occupied by this formation is covered by a thick deposit of Drift, so that these strata are only seen where artificially exposed, or in deep stream sections.

North of Belfast, red yellow obliquely laminated, and very friable sandstone crops out in the low cliff E. of the Grove. East of the Ormeau-road, and just behind Cromac House, in sinking for the foundation of the new gasometer, brick-red sandstone and pale grayish yellow calcareous sandstones, with thin shaly layers dipping to the W.N.W., were met with at a depth of 32 feet, as stated by Mr. Du Noyer.

In the angle formed by the roads W. of the District Lunatic Asylum, the red and green mottled marls of the Keuper division are extensively used in brick-making, for which purpose they have to be first mixed with forge ashes. In Clowney Water, a stream running down W. of these brickfields, the marls are seen at intervals between the Falls-road and the National School; 100 yards south of this school these strata are cut through by a dyke of basalt. Between the National School and the spot where the stream is crossed by the White Rock-road red and pale gray and green mottled marls, having in places veins of gypsum, are well opened up. Running in a parallel direction to the stream in its lower part there is a dyke of dark purplish gray basalt. From the White Rock-road the marls are well exposed in the same stream-course as far W. as the Chalk escarpment, and in the vicinity of Monk's Hill contain veins of gypsum; W. of this point these beds are penetrated by four dykes. The three most easterly ones are thin, and are composed of compact basalt, while the fourth is a wide dyke of the same rock, but columnar. For two miles to the S. the marls may be seen in places at the foot of the Chalk escarpment, and over half a mile S.W. of Christ Church, at the cross roads, red and pale green marls are opened up by the road-cutting.

In a lane off the Falls-road, S. of Beechmount, soft red obliquely laminated sandstones were observed, and above them some beds of whitish calcareous sandstones; and farther S.W. an excavation in the new cemetery has exposed brick-red obliquely laminated sandstones, with thin yellowish sandy layers and partings of chocolate coloured earth; another excavation shows the beds over these to be white compact sandstones, some of them containing flakes of green shale. These latter beds, with those lying under them, at the cottage in the lane, are probably the representatives of the Lower Keuper Sandstones.

The rubble stone of which the wall of the cemetery is built was procured from a dyke in the enclosed space. It is a hard crystalline olive-gray dolerite, and according to information received from the engineer, has a north-westerly course. In the bed of a stream on the opposite side of the road we find pale yellow and brick-red soft and obliquely laminated sandstone, with some friable beds of a greenish colour; these strata are cut through by a basaltic dyke 15 feet in width. At the bifurcation of the roads a small quarry shows soft red sandy layers, with pale yellow bands and chocolate coloured earthy seams, cut across by a rotten dyke of basalt. No rock is now seen for the distance of a mile, till in the stream forming the boundary between the townlands of Ballymoney and Ballydownfine, we find yellow and red obliquely laminated sandstones in several places, and half a mile to the S.W. similar beds are laid open in Ladybrook, traversed by a dyke of compact basalt seven to eight feet wide.

In the vicinity of Dunmurry there are some fine sections opened up in the stream-courses. In that which runs down N. of Seymour Hill we find pale yellow laminated sandstone S.E. of the bleach-mill; two dykes of basalt occur here, and have altered and hardened the sandstone to a considerable degree. Thin bedded pale yellowish sandstone is again seen 100 yards higher up, cut through by a dyke of finely crystalline basalt; another break of 100 yards now occurs, when we find yellow flaggy micaceous sandstone extending for a distance of 180 yards up the stream; in their lower part the beds are cut across by a dyke similar to those just described. Higher up, and E. of the waterfall, there is the remains of an old quarry in thick bedded red and yellow sandstone, with partings of red and purple shale—the beds are from five to ten feet thick. In a stream to the N.E. we find below the beetling-mill soft red and yellow sandstone; 100 yards higher up, in a small cliff, there occurs red and yellow sandstone with bands of reddish purple shale, and at the sharp bend of the stream red and yellow obliquely laminated sandstones, cut by a basaltic vesicular dyke, the vesicles in which are filled with opal and zeolites; above this the sandstones are gray and compact, a change which is probably due to the proximity of the dyke. The next higher beds are of yellow sandstone, in which there is a thin compact basaltic dyke crossing the stream. Above this, similar sandstone has been observed, with thin flags and marly partings, the beds close to the bridge being soft red and yellow laminated sandstone. No rocks are now seen in the bed of stream till we reach a point opposite to the railway station, where we find soft red laminated sandstone passing up into thin bedded sandstone, above which, just opposite to the N.E. end of the mill and as far N.E. as the row of houses there come red and yellow obliquely laminated sandstones. The next beds seen occur in a plantation due N. of this, and consist of deep red friable sandstone, and due E. of Farm Hill red and pale reddish gray sandstone has been observed. No rocks are now exposed for the distance of a mile by this stream, and the strata then seen belong to the Keuper series, so that the boundary between the Bunter and Keuper divisions is here quite provisional. South of Glenville, we find several dykes of basalt with crystals of a bluish gray felspar, and augite, penetrating the red and green mottled marls of the Keuper, and further N. many similar dykes occur. Close to the wooden bridge there is a large dyke of finely crystalline bluish dolerite rudely columnar, the strata near it being red and gray sandy shales contorted close to the dyke, and a little further N. these beds are again cut by a dyke of subglobular basalt. From this point to the lower boundary of the Rhætic beds the Keuper marls where seen are found to consist of red and green mottled marls. Similar beds are seen in one or two places between the bridge across Collin Glen and Collin Well.

A little over half a mile to the S.E., in the stream-course E. of Suffolk, red and yellow sandstones occur at intervals for the distance of 300 yards, and at the corn-mill we find red and green-mottled shales and marls with thin calcareous bands—these belong to the Keuper division—so that its lower boundary can be here determined with considerable accuracy. North of Collin Grove, in the same stream, red and green marls may be seen, cut across E. of the road by a dyke of basalt.

In a stream not engraved on the map, a short distance to the S.W. of the last locality, soft red and yellow sandstones have been observed, which near Wood Cottage are interstratified with red shales. One hundred yards S.W. of where the road crosses the stream, a road-cutting exposes a dyke of dark gray finely crystalline basalt.

North-west of Wood Cottage, in the bed of this stream, red and pale greenish gray marls and pale gray calcareous shales are frequently exposed. Four hundred yards N. of Wood Cottage an excavation has been made along the course of a dyke, of hard compact basalt, weathering in globular masses which, when struck with a hammer, break off in concentric layers like the coats of an onion; it is also vesicular, the cavities being filled with carbonates and zeolites.

North-west of trig. point 202, in a stream and small road section, we find red laminated sandstone with numerous thin yellow strings running through the rock parallel to the bedding; the road section also shows a basaltic dyke decomposing into a brown sand. Over 150 yards above where the stream is crossed by the road, soft red and yellow obliquely laminated sandstones with purple argillaceous beds are met with for the distance of 250 yards.

The beds immediately above the sandstone are here gray and purplish micaceous shales. These beds are cut in two places by dykes of dark gray compact basalt. Above these beds there are pale gray shales and purplish marls, belonging to the Keuper division. This is the first locality in which the boundary between the Upper Mottled Sandstones and the Keuper marls can be accurately determined. Between this point and the foot of the chalk escarpment red and green mottled marls may be seen in the stream in several places.

The next stream to the S. gives us the following section:—Two hundred yards above the alluvial flat, there is a small exposure of soft red sandstone, and about the same distance higher up, where the stream turns N., we find pale yellow and white sandstone; the stream north of this point is crossed by a small road, and from here to where it turns W., we find red, white, and yellow obliquely laminated sandstones, and this character of the rock prevails upwards to the base of the Keuper series.

Just at the junction of the Bunter and Keuper divisions there is a large dyke, forming a well-marked feature of dark greenish felspar and augite, which weathers in globular masses to a brown sand; this dyke is again seen to the S. in a quarry near some farm houses. The lowest beds of the Red Marl are in this section red and grayish shales, with thin bands of gray micaceous sandstones, containing pseudomorphous crystals of common salt—chloride of sodium—(cubes), above which there are pale greenish gray shales. To the E. of this there are two parallel northerly dykes of hard dark gray basalt, composed of dark bluish or greenish felspar (labradorite) and augite.

Returning to the bridge, and one mile and a quarter to the S.E., a short road-section opens up soft red sandstone; a dyke of basalt, weathering to a brownish sand, crosses this cutting nearly at right angles. The sandstone forming the walls of this dyke is very slightly altered, the only change observable being, that it is blanched in colour. Farther W., under some cottages and outside the graveyard, similar beds may be seen. If we now follow the course of the mill-race, which runs in a north-westerly direction towards the spade foundry, we find on both sides of the gully, along the western side of which the mill-race runs, brick-red and yellow mottled sandstone. Behind some cottages, E. of the foundry, there is a dyke of dark gray amygdaloidal basalt, weathering to a brownish sand; in proximity to this dyke the sandstone is hardened, and has its colour changed from yellow to pale gray. From the spade foundry to the corn-mill at Milltown, the strata consist of red and yellow laminated friable sandstones, with layers of reddish purple shale; behind the mill there is a wide dyke of hard gray basalt, made up of a greenish felspar and augite; this dyke is more compact towards the centre than at its walls, a phenomenon which is unusual throughout the district. Close

to the flax-mill an excavation has opened up red and white sandstones, which afford a striking instance of irregular lamination. Between this point and the mill-pond to the N.W., the strata consist of red and yellow mottled sandstones, and just W. of where the stream is crossed by a road we find a narrow dyke of compact basalt. The beds just mentioned are again seen in a stream and road section to the S., where they are traversed by three dykes of hard dark gray compact basalt. Round the margin of the mill-pond before-mentioned, and in the stream S.E. and E. of Hullstown, the beds are soft red and yellow obliquely laminated sandstones, with bands of purple shale. Due E. of Hullstown, these beds are penetrated by a dyke of finely crystalline basalt. The stream here branches; and in the main stream and the branch to the E. we find the following succession of beds :—Soft red laminated sandstones, overlaid by a considerable thickness of red and yellow mottled obliquely laminated sandstone. One hundred yards N. of the junction of the streams the sandstones are intersected by a dyke of finely crystalline basalt, 200 yards to the W. of which there is a similar dyke, and higher up the stream a third dyke of the same rock may be found, close to some farmhouses.

At the base of the Keuper marls, some brownish and yellow carbonaceous sandstones have been observed at the limekiln, and immediately above them in the stream, red and green mottled marls; a band of sandy limestone, two feet thick, was observed in proximity to a whin dyke in the brook section, W. of Fair View Farm.

The beds near the limekiln are probably the representatives of the "waterstones" of the Midland counties of England, but they are altogether too unimportant and confined within too small limits (eight to ten feet) to be marked on the one-inch map.

The red and green marls of the Keuper may be seen in a few places E. of this, in the stream running down from the Chalk escarpment.

To the E. of the Ulster Railway red sandstones have been observed in the bank of the river Lagan, near Lambeg House, and in three localities N. of Wolfender's Bridge.

Two miles N.W. of Lisburn, in a stream-course near Ballymacash, red and yellow obliquely laminated sandstone is exposed; in the northern portion of this section there is a dyke of dark greenish basalt. Less than half a mile N. of this point, S. of the junction of the faults, stiff red marls and pale gray shales have been observed in a deep drain, and to the E. there is a dyke of gray amygdaloidal basalt. In a stream N.N.W. of Ballymacash and S. of the road, we find red and pale greenish gray mottled marls, traversed in two places by dykes of hard gray compact basalt, and farther W. in the same stream soft red and green, or pale gray shales and marls; a dyke of basalt occurs here. To the S.W. of this, in a stream-course which runs through the first L. in Magheragall, red and pale gray shales and marls have been noticed in places; and in the same stream further to the S., where it turns W., red and white sandstones are exposed; 300 yards to the E.N.E. of this, a quarry has been opened in pale greenish gray sandstones, interstratified with flagstones and reddish shales; in this quarry there are two parallel dykes of decomposing basalt; these beds are probably representatives of the Lower Keuper sandstone. Over half a mile to the W. of this, soft red sandstone may be seen dipping due W., and a little over a mile again W., thin-bedded hard purplish sandstones will be found where the arrow is engraved on the map. North of this locality and W. of Magheragall Church red and yellow sandstones are exposed in two places, while S. of Brookmount the stream from the mill-pond has opened up from twenty-five to thirty feet of soft red obliquely laminated sandstone, with occasional white bands; and

to the N. the marls are seen in a few places; as, for instance, in the rivulet N.W. of Streamville, and in the beds of the streams E. and W. of Horsepark. The only other exposures of the Triassic strata are at Balmer's Glen, nearly three miles S.W. of Horsepark, where a deep cut and tunnel for the draining the quarry show the red and green marls of the Keuper, brought into juxta-position with the chalk by a fault, along which a dyke of basalt has penetrated. One mile to the south of Balmer's Glen and close to the outlier of dolerite, in sinking a well, white, red, and yellowish sandstones were met with at a depth of thirty feet. Two miles to the S. of this an old quarry, now abandoned, shows purplish and white sandstones in beds of various thickness, and in another quarry, near the Silurian boundary, we find irregularly bedded purplish gray, brown, and white sandstones, with beds of purple shale.

There are no other exposures of these strata in the district which require special notice.

The Rhætic and Liassic strata have already been fully described (p. 8).

Cretaceous Series.—In describing the occurrence of these strata we shall also unite with them the flint gravel, and the basalt and amygdaloid, found over the Chalk, all along its escarpment. In the northern portion of the district, for the distance of two miles and a half from the margin of the map, the chalk is almost continuously exposed along the outcrop, but to S.W. of Collin Glen is only seen at intervals in quarries opened for the purpose of obtaining the stone for conversion into lime.

Just at the northern limit of the map the Chalk is penetrated by a basaltic dyke, which, however, does not go through to the basalt. The Lower Cretaceous beds, consisting of "mulatto stone" and greensand, are here visible under the chalk. The mulatto stone is a whitish speckled calcareous rock, containing chloritic grains and pebbles of quartz about the size of a pea, and is termed by the quarry-men "freestone." Between this locality and the fault, half a mile to the southward, the chalk is laid open in several places in quarries, and in the natural cliff.

South of the fault, which is a downthrow to the E., the escarpment sweeps round to the E. and then again turns to the S., and from here to the White Rock quarries the Chalk is almost continuously exposed round the scarped flank of the Black Mountain, while the Lower Cretaceous strata are seen in several places, and consist of mulatto stone, under which there are beds of dark bluish greensand, and in one locality a little N. of the quarries, under a cottage, Lias shales have been observed. At the White Rock quarry the beds immediately below the Chalk are mulatto stone, below which come several beds of sandy gray limestone, the lowest strata here being dark bluish glaucus marls; a dyke of basalt, which is black and earthy in the centre, penetrates these beds. From this quarry, for the distance of nearly a mile to the S., the outcrop of the Cretaceous beds is much broken by small faults or slips, mostly downthrows to the E. East of Christ Church, and close to the fault, a section is opened up similar to that seen in the White Rock quarry. In the stream forming the boundary between the townlands of Ballymurphy and Ballydownfine, Keuper marls are found at the foot of the escarpment.

From a point in the escarpment, E. of the summit of the Black Hill, to the fault E. of the Roman Catholic Chapel, the chalk is exposed in many quarries, in one of which near the fault, where a dip of 20° is engraved on the map, greensand just makes its appearance.

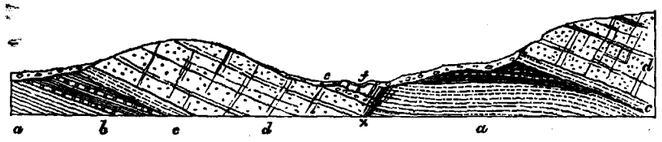
Above the chalk there is a layer of flint gravel in a whitish or pink greasy clay, over which basalt and amygdaloid form steeply inclined and precipitous faces from this point to the northern limit of the sheet.

Two faults, inclined to one another at about 45°, here bring the basalt into contact with the Red Marl in a stream-course near the most western of which we find the black and gray shales of the Lias pretty well seen; the section is exactly the same as that already described as occurring in Collin Glen, but not so extended. To the W. the Chalk sweeps round in a bold curve down Collin Glen. As we enter the Glen we find in the bed of the stream, just above the bridge, a large mass of chalk, which is evidently not *in situ*, but has merely slipped from above; and higher up in the bank of the stream the black and gray Rhætic shales, above which, just where the Collin river is met by a brook running W., beds of greensand and sandy buff coloured limstone are seen resting on these shales; these beds, however, would appear not to be *in situ*, their present position being due to a landslip.

Similar beds again occur in a like manner a little higher up, above which are the Lias shales, over which we find a bed of greensand and glaucus marl succeeded by several thick beds of buff coloured impure sandy limestone. The highest beds of this member of the Cretaceous formation are soft greenish sand and mulatto stone, on which rests the hard splintery chalk, the latter being also exposed in the stream branching to the north-east. A fault, with a considerable upthrow to the west, of which an illustration by Mr. Hull is here given, brings in the red and green marls of the Keuper series, overlaid by a thin band of Rhætic shales, on which the Greensand rests unconformably. These beds are similar to those described on the east side of the fault, and are overlaid by chalk, and ultimately by basalt.* The same series of beds is again laid open in the bed of a stream to the S., and below the Keuper marls the Chalk is brought in by the fault before mentioned.

Fig. 1.

Section in Collin Glen, near Belfast, showing displacement of strata by large fault.



a Keuper Marl. *b* Rhætic Beds, &c. *c* "Glaucus Shales" (Cretaceous). *d* Upper Greensand Rock *e* "Mulatto Stone" (Conglomerate). *f* Upper Chalk. × Fault, ranging N. and S.

Two hundred yards to the S. of this stream the Chalk is shifted, by a north-westerly fault with a downthrow to the west; from here the beds run in a southerly direction for over one mile, and have been opened up in a few quarries, W. of which we find basalt and earthy amygdaloid in many places. The large quarry W. of Collin Well exposes about fifty feet of chalk; the mulatto stone and greensand have been reached in the bottom of the quarry, and may now be seen close to the kiln at the entrance. In the stream to the S. we find above the bridge beds of greensand and buff-coloured sandy limestone, under which, below the bridge, there are glaucus marls. These beds are evidently the continuation of those seen in Collin Glen and further to the north.

The Chalk is not seen *in situ* from this point for the distance of half a mile to the S.W., the boundary being drawn from the form of the ground; here, however, less than 100 yards S.W. of the old kiln, we find the remains of a chalk quarry. Two hundred yards almost due

*Mr. Du Noyer mentions that some of the pale gray sandy limestones (of the Greensand formation) have been used as lithographic stone.

S. of where the H. of Derryaghy is engraved on the map, there is a small exposure of mulatto stone cut by a dyke of decomposing basalt, and exactly S. of where the basalt boundary crosses the main road there is an opening behind a farmhouse showing beds of chalk dipping N.W. at 10°.

One quarter of a mile S.E. of Groganstown, near where three roads meet, there is the remains of an old chalk quarry exposing about twelve feet of greenish gray mulatto stone, containing small pebbles of quartz in such numbers that it might with propriety be termed a fine conglomerate. Over one-third of a mile W. of this quarry the Chalk is faulted, the fault having a downthrow to the E.S.E. North of this fault Chalk was quarried some years ago, and a small portion of it may still be seen in the western corner of the excavation. To the S.W. of this, in the bed of a small stream, red and green mottled marls have been observed, at an altitude greater than that of the upper surface of the Chalk, thus proving the fault. Between this point and the one to the S.E. there is only one exposure of chalk, which is of no importance. Three hundred yards S.W. of the last-mentioned fault, chalk has been opened up in a quarry N.E. of some cottages. The Chalk is here repeated to the N. by the N.E. and S.W. fault which runs at the back of Castle Robin and S.E. of the White Mountain. Along the north-western margin of the small depression which marks the course of this fault, chalk and greensand have been observed in one or two places resting on the red and green Keuper marls.

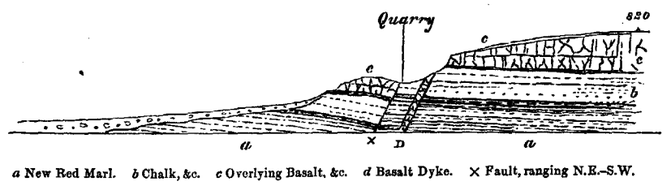
North of the cross-roads, S.W. of Castle Robin, a reddish sandy rock may be seen, containing fragments of *Inocerami*—this is probably the upper portion of the Greensand; on the opposite side of the roads chalk has been quarried in a deep hollow now containing water.

Chalk was proved on the sloping ground to the E. of the road running to Lisburn; and almost due S. of the cross-roads, was found in two places near the side of the road running round the White Mountain; in the most north-westerly of these the overlying basalt may still be seen.

The large fault which ranges along the eastern slope of the White Mountain makes a very distinct feature, owing to the presence of the Red Marl inside the basaltic plateau, and the repetition of the Chalk escarpment. The displacement of the beds may be clearly observed at the quarries, and is illustrated by the subjoined section drawn by Mr. Hull.

Fig. 2.

Section across the northern flank of White Mountain, showing the displacement of the strata by a large fault.



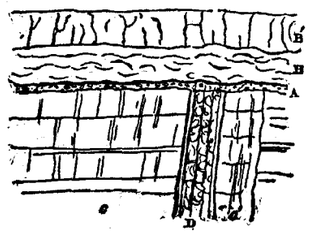
a New Red Marl. *b* Chalk, &c. *c* Overlying Basalt, &c. *d* Basalt Dyke. × Fault, ranging N.E.–S.W.

In the N.E. corner of this quarry the Chalk dips W. of N. at 5°, and is traversed by three large dykes of basalt; these dykes in their passage through the Chalk have indurated it for a considerable distance from their walls, and rendered it useless for burning; it has consequently been left standing by the quarry-men, and now presents a very striking appearance, the basalt of the dykes having in some cases disintegrated

from between their chalky walls, and left them standing like dykes of chalk in the basalt. On the unevenly denuded surface of the Chalk there is about three feet of flint gravel in a pinkish gray pasty clay, the flint nodules being coloured red to a considerable depth from the surface, the discolouration following the contour of the exterior of the flint; over this gravel there is from five to six feet of black amygdaloid, capped by rudely columnar basalt. In the south-western portion of the quarry the flint gravel is fully three feet or more in thickness, and the super-incumbent rock about forty feet. Six feet of hard columnar basalt here rests on the flint gravel, over which comes the black amygdaloid before mentioned as occurring at the opposite end of the quarry; and over all rudely columnar basalt. A fault here, an upthrow to the N.N.W. of about 300 feet in a horizontal direction, again dislocates the chalk. In the quarry W. of this fault the chalk is sometimes of a pearly gray colour, and the basalt has a bearing of from fifty to sixty feet.

Fig. 3.

Sketch at quarry on White Mountain, showing vertical dyke of basalt penetrating the Chalk to the base of the flint-gravel.



A. Flint Gravel. B. Soft Amygdaloid. B'. Harder Amygdaloid.
C C'. Chalk, indurated along the sides of the Dyke. D. Vertical Basaltic Dyke.

Two hundred yards S. of this, and 100 W. of where the roads meet, there is the remains of an old chalk quarry, the rock being only visible in one corner, where it is apparently nearly horizontal. This exposure being at a much less altitude than the quarry last-mentioned, necessitates a fault as drawn on the map. Due E. of this we come to another large quarry, the rock in which dips W. of N. at 5°, and is penetrated by two basaltic dykes. Over the chalk there are two to three feet of the usual chalk gravel, resting on which there is hard dark gray basalt, covered by a considerable thickness of amygdaloid, again overlaid by rudely columnar basalt. A small hollow worn in the surface of the basalt is filled with the usual Boulder clay. From the form of the ground and the difference in elevation of the chalk here, and in the exposure to the W., there must be a fault somewhere in the vicinity of the one coloured on the map.—J. L. W.

In the townland of Knocknadona, in the rear of the Methodist Chapel, on the N. side of the road, a small quarry shows beds of chalk cut through by a small dolerite dyke, striking in the line of dip N. 60° W.

From the S. margin of the road, for a distance of 500 yards in a S.W. direction, the Chalk, with beds of flint, is exposed in great quarries, showing sections from twenty-five to thirty-five feet in thickness; the dip is N. 60° W. at a maximum of 10°; three dykes of dolerite are seen—one of these, four feet in width, cuts through the chalk and is limited by the flint gravel which underlies that formation; the remaining two, six feet each

in width, cut through the Chalk, chalk gravel, and the tabular basalt, being sharply terminated by the Boulder clay.

The flint gravel here varies from two feet to six inches in depth; the flints enclosed in a pale gray clay are crushed, and in places red to the core. Over this is a bed of lignite and dark fireclay, varing from two inches to one foot in thickness.* This is succeeded above by from one to eight feet of fine amygdaloid, the majority of the cells being filled with carbonate of lime. The whole is surmounted by about twenty-five feet of rudely columnar basalt. The mulatto stone and greensand has been reached in some of the quarries near Limestone Lodge; here also is to be noted the rudely columnar basalt, resting on the flint gravel, the lignite and amygdaloid being absent.

South of Kilcorig House some beds of chalk are seen in a small quarry, to the west of some rudely columnar basalt. No other exposures are seen between this and Brookhill, the boundaries being drawn along the unmistakeable escarpments of the Chalk and basalt.

South-east of Brookhill House, along the boundary of the demesne, chalk is freely exposed; it dips north-westerly, at angles varying from 3° to 10°, and, owing to a fault shown on the map, striking against fine amygdaloid on the opposite side of the road in the cutting of the proposed Lisburn and Antrim Railway; the cutting extends from the eastern to the western boundary of the demesne in a line parallel and close by the road. The north-western end of the cutting shows rudely columnar basalt over the amygdaloid. About thirty yards along the road to the N.W. from the gate lodge and on the S.W. side, beds of chalk dip W. and S.W. against the basalt exposed sixty yards to S.; these beds of chalk are cut through by a much-weathered dyke of basalt. The same fault probably disturbs the relation between the red marls and sandstones as indicated on the map; the former may be seen in the stream S. of the "B" of Brookmount, and the latter in the mill-race, S. of the "t" of the same name, as engraved. At the National School of Mullaghcarton, and for a distance of several hundred yards S., chalk has been worked under a great thickness of rudely columnar basalt; throughout the hamlet basalt is freely exposed. North-east of Murraystown chalk beds are seen to dip N.N.W. at 5°, under the basalt at trig. point 323. At the "M" of Mullaghcarton, on the N. side of the road here, these beds again dip N.N.W., and a small valley to the N. shows angular chalk fragments as far as N. of the small alluvial flat, where much-weathered basalt is exposed in the stream.

South-east from trig. point 339 chalk is opened up in large quarries for a distance of several hundred yards.

At the N.E. end of the quarries thirty feet is laid bare, the beds dipping W.N.W. at 3° to 5°; this chalk is neither covered by basalt nor drift; toward the S.W. extremity the dip increases to 10° and 12°, and the Chalk is covered by from seven to eight feet of boulder clay. Mulatto stone and greensand were reached here, and in the stream to the E. red mottled Triassic shales are seen.

The Chalk continues to be visible at intervals along the escarpment in small quarries, as far as Balmer's Glen, where it is largely quarried. Here it has not so many layers of flints as beds previously noted, but fine specimens of the large sponge-like form, called locally "paramoudra," are obtainable† (Fig. 5, p. 34). About forty feet of chalk is exposed, and from information received, the Lower Cretaceous beds (those rendered

* See "On the Chalk of Antrim," by Mr. J. B. Jukes, in *Geol. Mag.*, Vol. v.

† These enormous flints were described in 1816 by the Rev. Dr. Buckland, who mentions Moira as a locality remarkable for their abundance. The origin of the name was probably accidental.—See *Trans. Geol. Soc. Lond.*, Vol. iv. (1st series), p. 413. E.H.

unfit for use from the presence of Silicate of Iron), have a thickness of five feet; the dip of the beds is W. and W.S.W. at 5°. The lime is sold at about 10*s.* a ton. The Chalk is surmounted by flint gravel and rudely columnar basalt.

In the working of the quary into the escarpment two isolated columns were left, because of a dyke (or dykes) of basalt running through the chalk; the direction of the dyke is N. and S. The southern mass gave a view of two dykes uniting at the top—the northern, two pipes, feeders to a surmounting cake of basalt. By the side of the same mass, in a deep cut for the drainage of the quary, a small fault is visible.

This line of dislocation is filled with trap dolerite. On one side of the dyke are seen the red marls of the Keuper, whilst on the other lies the Chalk. The course of the fault is E.S.E. and W.N.W. across the quarry, through the Chalk, but there are no exposures near the head of the quarry, by the road, to show us if it is continued into the columnar basalt above.

About half a mile E., S.E. of Maghaberry, another large quarry shows fifty feet of chalk; greensand and glaucus shale were both said to be reached in the lowest part of the quarry; the dip is N. at 2°. The chalk is cut through by a dyke of hard dark basalt, 15 yards in width, striking N.N.W.; two similar small and nearly parallel dykes are seen to the S.W.

By the side of the large dyke a fissure is filled with chalk and basalt rubble. In this part of the quarry the chalk is left behind in working, because of its being altered and hardened by the dykes. A fine smooth slickenside occurs, striking N. 10° W., but no dislocations of note were observed. The super-incumbent basalt is rudely columnar, five or six feet in depth, resting on the chalk directly—the usual gravel being absent or represented only by three or four inches of purplish marly clay; the whole is capped by seven or eight feet of Boulder clay. N.E. of the hamlet of Soldierstown a very large quarry or rather set of quarries, all now abandoned, show beds of chalk dipping N.N.W. at low angles, under twenty feet of rudely columnar basalt. The chalk in places contains patches of decomposing basalt, and is also cut through by much-weathered dykes of the same rock. The chalk boundary from Soldierstown to Moira is provisional, but still pretty certain, using as guides the form of the ground and the evidence afforded by old quarries, fragments of the local rocks, and supplied information.

Three small outliers of chalk, occurring through the Keuper marls, are noted on the map. The evidence for that S. of Soldierstown, is an old quarry, exposing some few beds. At Trummery House, a large quarry, opens up twenty feet of chalk, with numerous layers and beds of flints, and near Berwick Hall, chalk has been found as the subjacent rock in sinking.

The main street of Moira shows chalk, but near the Glebe House basalt makes its appearance, thus determining the boundary of both. A short distance more than 500 yards along the road to the S.E. from Moira and on the S.W. side, a large quarry shows from forty to fifty feet of chalk, with layers of flints; the dip is N.W. at low angles. Mulatto stone is in places exposed, and the greensand is said to have been reached; a small boss of weathered basalt is found toward the S.E. end of the quarry; more into the escarpment a winding basalt dyke, striking generally E. 70° N., and twelve feet in width, cuts through the chalk and the flint-gravel—it was possibly a feeder.

From the presence of the flint-gravel over the chalk, together with the rapid rising of the ground toward the Presbyterian Chapel, Mr. Hull believes in the existence of a small outlier of basalt; cups in the

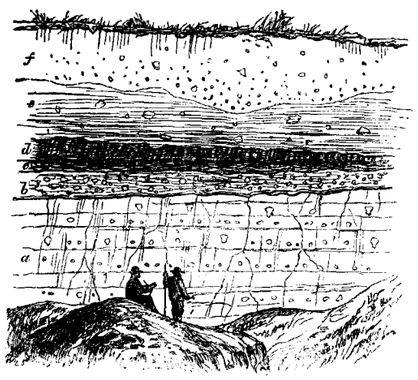
chalk-gravel filled with basalt point in the same direction. Some beds of chalk are exposed at Magherahinch House dipping N.W. at 5°. Before following the Chalk escarpment toward Magheralin another probable outlying mass of the great Miocene volcanic flows is to be noted. About two miles E. of Moira, between Thornbrook and Broomhedge, on each side of the road, are several exposures in bosses and quarries of crystalline dolerite, exactly similar to that of Scrabo Hill, Newtownards, and traversing strata on the same geological horizon, lower Keuper sandstones having been reached in several well-sinkings in the neighbourhood.

Half a mile S.W. of Moira, near Waringfield House, beds of chalk with large flints dip N.W. at 5°. By the roadside, near Reilystown, similar beds occur, capped with a small thickness of decomposed basalt. Chalk is largely worked in a quarry half a mile N.E. of Magheralin, the dip of the beds is N.W. at 5°. About 40 feet is laid open, capped by chalk-gravel and a thin band of fireclay similar to that noted in the townland of Knocknadona, three miles N.W. of Lisburn; a thin layer of amygdaloid, two or three feet of rudely columnar basalt, and Boulder clay. Two dykes of dolerite were observed.

The following is a sketch by Mr. Hull, with his notes on the general features of the quarry:—

Fig. 4.

Sketch in Magheralin Quarry, near Moira.



a White chalk with very large flints, sometimes two to three feet in diameter ("Paramoudras").
b Chalk-gravel—of flints in a yellowish clay or marl.
c Soft dark decomposing trap or amygdaloid, passing downwards into red ditto; two to three feet.
d Basalt, at one part rudely columnar; two or three feet thick.
e Dull red boulder clay, with blocks of dolerite, felstone trap, Silurian grits, syenite, &c., the first predominating. No appearance of bedding; twelve to twenty feet in thickness; pebbles frequently ice-worn and scratched.
f Red clay, with chalk-gravel and a few pebbles of trap rocks; twelve feet in thickest part; apparently resting in a hollowed portion of the boulder clay.

The two following figures by Mr. Hull are the so-called "paramoudras." "Each of these has a cylindrical perforation down the axis filled with white hard chalk; the remainder is flint." They were considered with much probability to be fossil sponges by Dr. Buckland.

Fig. 5.—"Paramoudras."—From Magheralin Quarry.

One of these flints measures 30 inches by 18; the other 15 inches by 25.

Several old quarries, half filled in, occur at Magheralin, N. of the village; twenty to thirty feet of chalk is capped by three or four feet of rudely columnar basalt, and cut through by two dykes of similar finely crystalline dark rock.

At Springfield, near the margin of the sheet, in some old quarries beds of chalk show a dip of W.N.W. at 5°.

W. B. L.

Basalt.—The magnificent exposures of this rock over the chalk escarpment between Belfast and Collin Glen have already been alluded to when treating of the Cretaceous rocks, along with which has been included an account of the basalt as seen in the numerous quarries along the outcrop of the chalk to the S.W.; so that it now only remains to describe the principal rock exposures over the part of the basaltic plateau included in this map.

Though the hills on the eastern portion of the district formed of the basalt are free from drift, yet a thin covering of sand and gravel derived from the disintegration of the subjacent rock affords a sufficient sustenance for the stunted heather and pasture which conceal the rocks on their slopes and summits. Decomposing basalt and amygdaloid, however, appear in all the subsoil cuttings and stream courses. The Tipperary Rocks, close to the sheepfold, and less than half a mile S.S.E. of Armstrong's Hill, consist of hard dark gray finely crystalline basalt, and the crags three quarters of a mile S.E. of this point are formed of hard gray basalt with beds of amygdaloid. Along the N.E. side of the road running in a north-westerly direction past the Roman Catholic Chapel E. of Collin Glen,* the basalt is well exposed; the rock is of an olive green colour, has a rough uneven fracture, and weathers to a brown sand, and in one locality is associated with red ochreous beds, locally termed bole, and very like *Laterite*.† In the stream course S.E. of the Hannahstown National School, and in the bed of the stream and deep gorge between Tornaroy bridge and Collin Glen, the basalt has been well opened up to view.

On the roadside, S. of Standing Stones Hill, basalt decomposing, with a pimpled surface, to a brown sand may be seen in one or two places; and along the townland boundary and on the summit of the hill, the same rock has been observed, having a very rough fracture, and decomposing to a gravelly sand. One mile to the N.W. of this, at Budore Hill, situated in the townland of the same name, basalt and amygdaloid come to the surface in several places. W. of this for over three miles, and as far N. as the limit of the map, the ground is covered with a thick deposit of brown sand, marl and gravel. One mile W. of

* This road is not engraved on the one-inch map.

† As this rock is described by Sir C. Lyell. (*Students' Elements of Geology*, p. 493.)

Standing Stones Hill, near M'Gowan's or Chapman's Hill, there are two quarries in hard finely crystalline basalt containing geodes of zeolites; and half a mile further to the W., N. and W. of Bohill House, we find an exposure of basalt weathering to a sand so soft that in it are numerous rabbit burrows. South-west of this locality there is a quarry in hard crystalline basalt massively jointed. Basalt is also seen in several places between this and Knockcairn, and in the bed of the stream at Knockcairn bridge we find finely crystalline basalt, and 300 yards lower down in the same stream decomposing basalt with geodes of steatite, (?) under soft amygdaloid. Over one mile S. of Knockcairn, and 300 yards S.E. of the Y. Bridge, there is a quarry in black compact micro-crystalline basalt, with distinct lamination, dipping N.W. at 10° to 20°; this rock has a smooth conchoidal fracture, and gives out a ringing sound when struck with a hammer, and resembles the rock called "Clinkstone." At Cairns Hill, and in the vicinity of Longstown, the same rock is seen in two quarries, and has here associated with it in one or two places gray finely crystalline basalt. Nearly two miles E. of this locality we find rather massive hard crystalline basalt at the Roman Catholic Chapel.

Half a mile E.S.E. of the village of Stonyford the river exposes basalt, with beds of earthy amygdaloid, which are in some places either of a purple or red colour, and the basalt here weathers in spheroidal masses to a brown sand. At the Priest's Hill, one mile and a half to the E.N.E. of this, we find in a quarry platy basalt, with beds of red amygdaloid, and on the summit of the hill hard crystalline basalt.

Along the south-eastern slopes of the hills between Collin Glen and the White Mountain the basalt is well seen; on the summit of Collin the rock is hard, crystalline, and rudely columnar, and is intersected by joints running N. 10° E. In the vicinity of Groganstown, and over the plantation on the hill side to the W., the basalt is gray, hard, and finely crystalline, having associated with it red and purplish gray amygdaloid; the former rock being cut by two sets of joints, the principal ones bearing N. 10° E., with secondary ones almost at right angles to them.

From this point to the road running to Stonyford similar rocks crop out in many places, and on the flanks and summit of the White Mountain the basalt is hard and finely crystalline, sometimes rudely columnar or amygdaloidal, with which in places there is associated amygdaloid.

The whole of the ground within a radius of several miles about Glenavy and Crumlin is covered by a thick deposit of Boulder clay, the subjacent rock being only seen in widely separated localities, as for instance in the Crumlin river, where basalt and amygdaloid full of minerals may be seen in several places, and in the railway cutting S. of the village decomposing amygdaloid containing large geodes of steatite (?) and decomposing spheroidal basalt. In the bed of the Glenavy River W. of Leap-bridge, hard finely crystalline basalt is also laid bare, and N. of Glenavy in the same river basalt is again observable. In the gorge made by the stream forming the boundary between the townlands of Ballymote and Carnkelly Upper, basalt has been opened to view, under a considerable thickness of brown gravelly clay, while at Carnkelly Hill the same rock will be found just beneath the surface of the soil. Over half a mile to the W. there is a quarry on the roadside in massively jointed crystalline dark gray basalt decomposing along the joint planes; a mile and a quarter to the W. of which several exposures occur of hard dark gray finely crystalline basalt. From a quarry in this locality the stone used in the construction of Tunny bridge was obtained.

The rocks in the district lying around Portmore Lough, Ballinderry,

and Aghalee are for the most part concealed by Drift deposits, but are rather more frequently seen than in the country to the northward. West and south of Roses Lane Ends, hard dark gray finely crystalline basalt is exposed in many places in the townlands of Lurgill and Ballymaclose; and from a quarry in the first-mentioned townland the stone used in the construction of several of the bridges on the Lisburn and Antrim Junction Railway was obtained. Less than one mile and a half S. of Roses Lane Ends, and less than half a mile W. of Dromart bridge, hard finely crystalline basalt and amygdaloid is found in the bed of the stream, and nearer the bridge gray basalt weathering to a brown sand; in this rock there is a small fissure about two inches wide, the walls of which are lined with aragonite of the colour of amber.*

From this point to the bridge the rocks are either gray crystalline basalt or purplish amygdaloid, the first-mentioned variety being laminated, the plates dipping W.N.W. at from 5° to 10°, while above the bridge there are alternations of hard crystalline basalt and amygdaloid as far E. as Donnellystown, to the S. of which, after a short break in the section, we again find similar rocks. One mile to the E. of this locality two small quarries have been opened near the roadside in finely crystalline basalt, and half a mile to the N.E., in the townland of Brackenhill, gray crystalline basalt has been observed in one or two places. Further N.E., on the side of the main road to Glenavy, there is an old quarry in a rock of the same character as that just described; and 500 yards again N.E. a small stream lays open fine-grained basalt and earthy amygdaloid. In the townland of Temple-Cormac the same class of rocks may be seen, and in the stream flowing S. of the Temple-Cormac Graveyard and W. of the Ballinderry Glebehouse, rocks are exposed at intervals for the distance of about a mile, consisting of gray crystalline basalt sometimes rudely columnar, and N. of Crooked Bridge, weathering in large globular masses to a brown sand or gravel, and from here to the southern end of the section the rock preserves the same characteristics. One mile S.W. of the Glebehouse, in a stream-course W. of Mount Hendrystown, there is hard gray basalt in places weathering to a brown sand; and half a mile to the W. of this, basalt again crops out. Waters Rocks lying to the N. of the last locality and W. of the Roman Catholic Chapel, consist of hard finely crystalline basalt, while two-thirds of a mile further W. on both sides of the road between Aghalee and Ballinderry, we find the same rock, but here massively jointed, the joints running N. 40° W.

In a drain on the roadside, just outside the northern end of the village of Aghalee, basalt and amygdaloid have been observed; and in the bank of the canal, E. of the lock, and in a quarry close at hand, fine-grained jointed basalt, the rock being coated along the joints with a white mineral. Massive basalt is also seen in a quarry about half a mile to the W.S.W., and in the high canal bank at Gorman's Wood, fine dark gray basalt is overlaid by coarse amygdaloid; the vesicular cavities are filled with carbonates and zeolitic minerals. Three-quarters of a mile E.N.E. at the rocks the basalt is rudely columnar and of a dull purplish gray colour, and in a locality to the S. is intersected by two sets of joints, the principal ones bearing N. 40° W., with the secondary ones at right angles to them. In the remaining portion of the ground occupied by this rock the only exposures worthy of record are those opened up in the quarries in the Chalk along the S.E. margin of the basalt, and these have already been noticed.

J. L. W.

* As determined for us by Professor O'Reilly, of the Royal College of Science, Dublin.

Drift Deposits.

Recent.	Fresh-water and Fluvio-marine— Alluvium. Peat. Lake deposits. Gravels and marls.
Post-Pliocene.	Variegated clays. Eskers. Boulder clay.

The Boulder Clay.—This deposit consists of a brown, reddish brown, or gray clay, containing ice-scratched boulders and fragments of basalt, silurian grit, sandstone, chalk, and flints, with, more rarely, fragments and boulders which must have travelled farther—such as mica schist, gneiss, quartzite, crystalline limestone, &c.

The boulder clay, to a certain extent, partakes of the character of the subjacent rock; over the basaltic plateau it is a brown ferruginous clay with basalt boulders predominating; over the area of the New Red Sandstone formation it is a very bright red and sandy clay, while over the Silurian area it is gray or dark brown clay with grit boulders and fragments largely predominant.

The best exposures of the boulder clay are those artificially laid open along the chalk and basalt escarpment, where it has been frequently noted as capping the basalt by a thickness of, in places, thirty feet. It is also well exposed in numerous stream sections over the basaltic plateau, in cliffs along some parts of the shore of Lough Neagh, by the river Lagan, and the canal connecting Lough Neagh with Belfast Lough, along the Ravernet, and other streams feeding the Lagan from the S.E. The boulder clay does not extend over the highest summits of the basalt hills to the W. and S.W. of Belfast, nor over some small hills of silurian rock in the S.E. part of the district; these are covered by a few inches of local *débris*.

Esker Drift.—A tortuous ridge of sand and gravel can be traced from Red Hill two and a half miles W. of Lisburn easterly to that town, and northerly along the railway as far as Dunmurry. Its sides are in places steep, as at Causeway End, W. of Lisburn, where they slope at an angle of nearly 30°; in others low, and the course of the ridge often broken as approaching Dunmurry. The general arrangement of the layers of sand and gravel seems to be that of a saddle, the layers inclining at each side at right angles to the direction of the ridge; this is the arrangement in the best sections as exposed between Lisburn and Dunmurry. Irregular accumulations of fine sand and gravel occur at the Maze racecourse, near Lisburn, Giant's Ring, Newtownbreda, S. of Belfast, &c. At the mouths of the rivers Lagan and Blackstaff, and at each side of Belfast Lough—viz., county Antrim and county Down sides—we find later arrangements of the drift.

Half a mile N. of the Belfast and Northern Counties Railway, at the Grove near the margin of the sheet, in excavations for the waterworks, a variegated marl, from 100 to 150 feet above the level of the sea, described by Mr. J. M'Adam, F.G.S., contained *nucula oblonga* and other shells.* A marl exactly similar, on the same horizon, and containing the same shells, has been noted near the Knock, county Down,

* Rep. Brit. Assoc., 1852, p. 53.

on the other side of the lough (see Explanation of Sheet 37). This marl is supposed to be of newer pliocene age.

The following ridges are of more recent formation :—

County Down.—Terrace of gravel and sand from mouth of Con's Water towards Holywood, and S.W. for a distance along the E. bank of the Lagan.

County Antrim.—Terrace of gravel and mud at the Botanic Gardens, and S. between Lagan and Blackstaff rivers.

County Antrim.—Terrace of silt and sand W. of Belfast, N. toward Carrickfergus, and S. along the Blackstaff.

It is in these old river gravels or Fluvio-marine gravels that the worked flints are found (see Explanation of sheet 37).

The alluvium underlying Belfast consists of mud or sand with beds of shells and marine peat.* Up the valley of the Lagan the alluvium is sand and gravel or red marl. A few miles along the river Lagan southerly from Lisburn there is about thirty feet of a beautifully laminated marl used as a brick earth ; it contains numerous fantastically shaped clay concretions. Over the basalt plateau the boulder clay is often re-arranged into a brown marl, and supplies the material for brick-making. A considerable tract S. of Lough Neagh is covered with peat.

W. B. L.

The lake deposits around Lough Neagh have been already alluded to in the Palæontological remarks.

* Mr. J. Grainger: Rep. Brit. Assoc., 1852, p. 43.

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