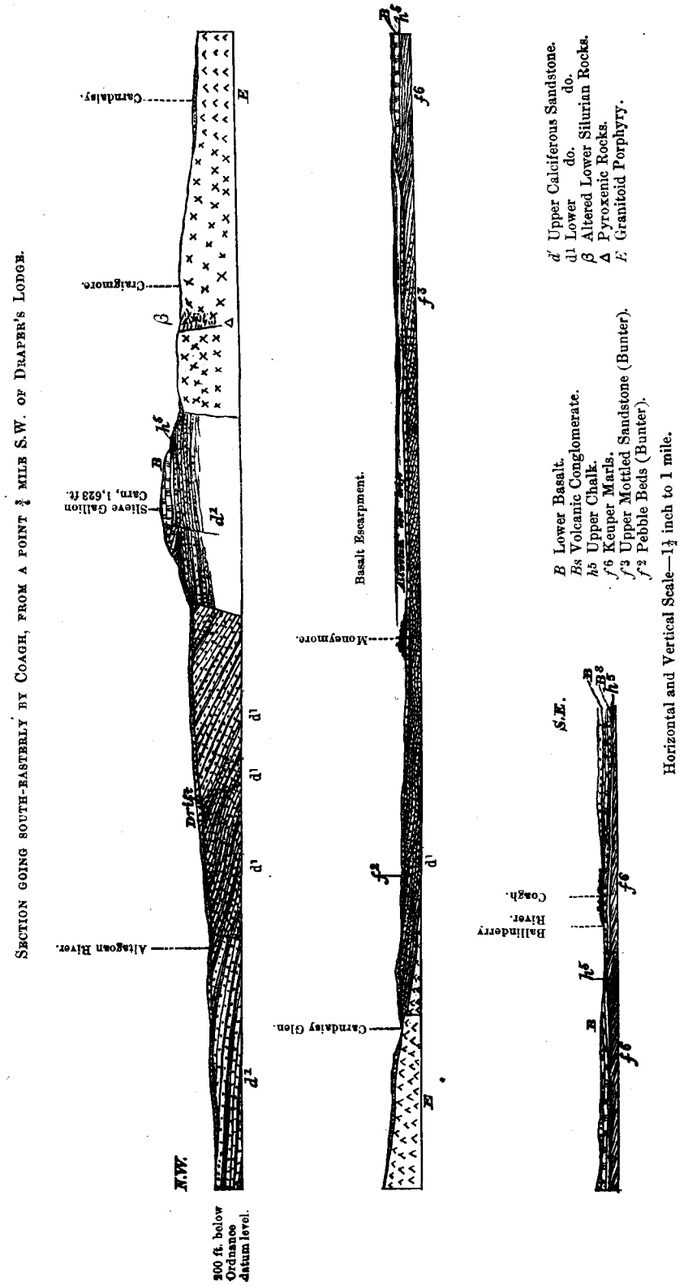

Memoirs of the Geological Survey.

EXPLANATORY MEMOIR

TO ACCOMPANY

SHEET 27 OF THE MAPS

OF THE

GEOLOGICAL SURVEY OF IRELAND,

INCLUDING

MAGHERAFELT, MONEYMORE, CASTLEDAWSON,
DESERTMARTIN, CURRAN, AND BALLYRONAN,
IN LONDONDERRY;
COOKSTOWN AND COAGH, IN TYRONE;
AND TOOME, IN ANTRIM.

BY

F. W. EGAN, B.A.,

WITH

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

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1881.

PREFACE.

THIS District is remarkable for its physical features and geological structure; and is one in which the results of metamorphic action may be advantageously studied. The geological details have been ably elucidated by Mr. Egan, the author of this memoir, who carried out the Survey during the years 1878-79, under my supervision, and has in these pages clearly described the geological phenomena of the district entrusted to him.

EDWARD HULL,
Director.

Geological Survey Office,
Dublin, Feb., 1881.

THE

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

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

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

Condensed memoirs on particular districts will also eventually appear.

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

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EXPLANATORY MEMOIR

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GEOLOGICAL SURVEY OF IRELAND.

CHAPTER I.

PHYSICAL GEOGRAPHY.

THE district about to be described embraces portions of the counties of Londonderry, Antrim, and Tyrone, the greater part being situated in Londonderry. The towns and villages are:—Magherafelt, Moneymore, Castledawson, Desertmartin, Curran, and Ballyronan in Londonderry; Cookstown and Coagh in Tyrone; and Toome in Antrim.

The most elevated ground lies principally in the granitic and metamorphic region along the western margin, and includes Slieve Gallion Mountain, with its two summits, one 1,623 feet above the sea, distinguished by a carn; the other a mile and a half farther S.W., rising 112 feet higher; Tintagh Mountain, immediately east of the latter, 1,567 feet; Crocknamohil, 1,127 feet; Glenarudda, 1,622 feet; Slievemoyle, 1,138 feet; and Clagan Rock, S.S.W. of the last, 631 feet.

The ground for about a mile S.S.E. of the carn summit of Slieve Gallion is broken and irregular, and includes the smaller rocky hills known as Craigmore, Drummuck, and Windy Castle.

The higher portion of Slieve Gallion is composed of metamorphic rocks of a hornblendic type, which, as they merge into the more highly crystalline hypersthene and diallage rocks of the district lying to the west, have been with them classed under the comprehensive term *Pyroxenic Rocks*.

The upper part of this mountain is almost bare of drift, which deposit, on the northern side, in the low country west of Desertmartin, lies deeply over the Carboniferous strata, and on the south covers more thinly the granitic and Triassic rocks. The lower hill, on which the carn is situated, forms a bold feature in the landscape, especially when viewed from the north and north-east, the basalt which forms the upper part being bounded on the east by a steep rounded escarpment, part of which has slipped away, leaving a rugged precipitous face of bare rock, from the foot of which the surface of the Chalk and Carboniferous Sandstone, covered by drift and fallen *débris*, descends at a lower angle.

The streams that flow down the northern and southern slopes of Slieve Gallion have in some parts worn deep gulleys which

afford favourable sections in the granitic and pyroxenic rocks; and in the lower ground occupied chiefly by the strip of Carboniferous Sandstone east of the granitic area, these beds and the granitoid porphyry are well exposed to view in small picturesque ravines running eastward towards the valley through which the railway passes.

Along the eastern side of this valley, which traverses the country from north to south, the boundary of the basaltic area, with the outcrop of the Chalk, is generally indicated by a rounded escarpment, which becomes more prominently marked to the south of Moneymore, where it rises abruptly from the low-lying Triassic ground. East of this escarpment the average level falls towards the large depression of Lough Neagh and the flat alluvial lands margining Lough Beg and the river Bann; while in the area lying east of Toome there is a general rise northward and eastward from the same low levels.

That the surface of the country has undergone generally a process of abrasion by the action of ice is evident from the smoothly worn and scratched condition of the rocks which is observable in all directions, striæ being found at various heights, from about 50 to 1,150 feet above sea level. Those on the northern shore of Lough Neagh, south of Toome, are very distinctly so marked.

The position and the general aspect of these glaciated rocks close to the lake, and the fact that the direction of the striæ coincides closely with that of its greatest diameter, would suggest that the basin owes its formation mainly to glacial action, as is the case in so many other lakes; but, as pointed out by Mr. Hardman,* there is strong evidence that this hollow is rather part of an ancient and more extensive pre-glacial depression, the joint result of a series of dislocations which took place after the pouring out of the basalt, and of sub-aerial denudation.

Of the disturbances here referred to there are numerous indications in the district under immediate consideration, throughout the portions occupied by the Mesozoic and Palæozoic strata; and doubtless many others might be observed in the Tertiary area, if it were not for the extensive covering of drift, the difficulty being increased by the generally similar, and at the same time individually variable, character of the outflows.

The space covered by peat bogs and alluvial flats is considerable, especially in connexion with the large bog west of Curran, which stretches away into Sheet 19 for three miles to the N.W., and the alluvial clays and sands that form the delta of the river Moyola. The latter are in some parts covered by several feet deep of peat, containing roots and trunks of fir and black oak, branches of willow, &c.

The greater part of the drainage finds its way more or less directly to Lough Neagh, and thence by the Lower Bann to the sea, the exception being that of an area of about 22 square

* "On the Age and Mode of Formation of Lough Neagh." Journ. Roy. Geol. Soc., Ireland, vol. iv., part 3 (new series).

miles east of Castledawson, which falls into the Bann north of its exit from the lake. In the Londonderry division of the sheet the northern part is drained by the Moyola and its tributaries, the southern by the Ballinderry River, the Lissan Water, &c.; while the water from a central portion, extending east and west from Ballyronan to near Moneymore, and four miles in greatest width from north to south, flows directly to the lake along several lesser streams. In the county Antrim the southern drainage, over an average width of about two miles north of the shore, falls into the lake; of the remainder, east of Kincaidstown it goes to the lake by the river Main (Sheet 28), the portion west of that being included in the exceptional area mentioned as lying east of Castledawson.

The boundary of the basin of the river Bann, which constitutes the principal watershed in this district, enters the north of the sheet near Annaghaboggy, passes by Hillhead, and turning eastward through the flat lands to Toome, proceeds in the county Antrim by the north of Alderburn, bends northward at Kiddstown, north through the bogs from Kincaidstown, and out of the sheet at the north-east of Grange Corner.

Chapter II.

Rock Formations and Divisions.

Name.	Aqueous Rocks.		Colour on Map.
Recent,	Freshwater Shingle,		*Red dots.*
	Bog and Alluvium,		*Chalons brown and gamboge.*
Post-Pliocene (Drift.)	Boulder-clay, Sand and Gravel,		*Engraved dots.*
Pliocene.	Clays with Lignite,		*Sepia.*
Cretaceous,	Upper Chalk with Flints,		*Pale Emerald green.*
Triassic,	Keuper,	Red and Green Marls,	*Venetian red.*
		Sandstone and Conglomerate.	*Do. with wash of Indian ink.*
	Bunter,	Red and Upper Mottled Sandstone.	*Venetian red (light).*
		Pebble Beds,	*Do. with wash of yellow.*
Carboniferous.	Upper Limestone,		*Dark Prussian blue.*
	Lower do.,		*Light do.*
	Calciferous Series,	Upper Group,	*Do., with wash of Indian ink and yellow dots.*
		Lower Group,	*Do., with darker wash, do.*

Igneous and Metamorphic Rocks.

Miocene,	Basalt Sheets (Lower Series),	*Burnt carmine.*
	Volcanic Conglomerate and Ash,	*Do., with white dots.*
Basaltic Dykes,		*Burnt carmine (dark).*
Altered Lower Silurian Rocks,		*Pale purple, with a wash of carmine.*
Pyroxenic Rocks,		*Burnt carmine (dark).*
Granite,		*Carmine.*
Elvanite and Granitoid Porphyry,		*Do. (dark).*

Altered Lower Silurian Rocks.*

The term *Altered Lower Silurian* is here applied to those rocks which, while they graduate into the highly metamorphosed pyroxenic rocks, yet retain something of the original bedded character and internal structure; being in some places true foliated schists, more or less argillaceous, in others less schistose and more quartzitic, while to a large extent they assume the character of dark indurated slate, sometimes containing fine strings of serpentine. They extend over small areas on the north and south sides of the high ground occupied by the granitic and pyroxenic rocks, all being situated in the extreme eastern part of the great metamorphic region that stretches westward to Donegal Bay, and northward to Malin Head, containing a series of schistose strata, which, both from their position and general character, appear to be the prolongation of those of Lower Silurian age in the Highlands of Scotland.†

On the south side of the higher ground these beds consist chiefly of argillaceous mica-schist, merging into gneiss, while on the north they are of a different type, and present greater varieties in the form of imperfect quartzites, baked slates having something of the aspect of felstone, and rocks not far removed in character from the earthy grits of the Lower Silurian formation. At the west margin, north of Slieve Gallion, they assume a decidedly schistose texture and a talcose appearance, the latter disappearing southwards, as seen along the White Water, where occur darker rocks with less clearly defined forms. The passage into the crystalline rocks is accompanied by so many minute changes, and by different conditions so variously combined, that the determination of the boundaries is often a matter of some difficulty.

The indurated Silurian beds, as seen along a stream N.N.W. of Glenview, between Moneymore and Desertmartin, consist sometimes of a light greenish quartzite with purple stains; but they are often more earthy, changing in colour from greenish to blue, purple, and red, the last occurring near the boundary of the granitic rocks, which is here quite concealed. Several varieties were found in a well at the house 300 yards north of Glenview, some being very hard, and penetrated by veins of sulphate of barytes. The rocks along the stream contain similar veins, with some of quartz and carbonate of lime. An obscurely marked structure, supposed to be bedding, dips N. 20° E. at about 30°. Tirgan Rock, two-thirds of a mile west of the locality just referred to, affords examples showing the passage from comparatively little altered Silurian rocks of a slaty character to dark crystalline rocks on the one hand, or, on the other, to those assuming a gneissose appearance, with the development of red crystalline particles of orthoclase, indicating a passage into the adjacent

* There is some uncertainty about the age of these rocks. Mr. Kinahan considers them to be "Cambrian" (Proc. Roy. Irish Acad., 2 ser., vol. iii., pp. 343–5); on the other hand, as the Pomeroy beds are of "Caradoc" or "Bala" age, those which are older may be of "Llandeilo" or "Arenig" age.—E. H.

† Hull, "Physical Geology and Geography of Ireland," page 19.

granitoid porphyry. Similar changes are observed at Carncose Rock, a little N.N.W. of Tirgan Rock.

The observations made here so far bear out the remarks published by Portlock* with reference to the same district, confirming his conclusions as to the connexion between the original bedded rocks and the crystalline rocks of granitic and hornblendic or syenitic types.

Further and equally instructive examples are found in the lower portions of the rocky ground lying about a mile S.E. of Slieve Gallion Carn, where there are schistose beds, some argillaceous, others forming a species of hornblendic gneiss, such as occurs in the stream flowing eastward at a point one mile and a quarter S.E. of the carn.

The rising ground S.W. of Crocknamohil is composed chiefly of talcose-looking schists, which form the lower beds of a series of talcose and micaceous quartzose schists that are more extensively developed in the district to the west. These, as before stated, change southward to rocks allied in character to the altered beds near Glenview, retaining, like them, traces of bedding, and merging as they approach the granitoid porphyry into the compact green pyroxenic rocks.

The Altered Lower Silurian beds near Lissan are exposed along the Lissan Water, and, where it enters the sheet, consist of crystalline schistose rocks containing green mica and a little hornblende, with some yellowish gneissose beds. Where the stream comes near the road, they are more gneissose, and may be described as bluish and greenish mica-schists, passing into coarse gneiss of a greenish colour, containing abundance of white mica. Blue mica-schist occurs in the stream flowing eastward by Lissan; and in the plantation at the Derry side of it there are schistose beds, some slightly micaceous, and others like a dark clay-slate with greenish and purple colours, containing strings of epidote. The same varieties are observed along the stream 500 yards E.N.E. of Lissan Church. At about 400 yards N.W., and 650 yards N.E. of Lissan Chapel, there are fine-grained hard granitoid schists which belong to this series.

Pyroxenic Rocks.†

The description of these rocks naturally follows that of the Altered Lower Silurian, from which they have clearly been derived by a metamorphic process, carried to so high a degree as to produce others of a very different character. The latter are, as a general rule, of types distinctly pertaining to those of the coarser diallage rock and hypersthenite, although in the greater number of examples in this sheet they consist of compact varieties in which the crystalline structure is not at once apparent, and which frequently pass into rocks more properly allied to diorite, the

* Geol. Report, Londonderry, &c., page 494.

† The term as here used is intended to include the varied group of rocks in which hornblende, hypersthene, diallage, and augite are essentials, and which are sometimes indistinguishable in the field and often pass into each other.—E. H.

passage to a largely crystalline form being better exhibited in the adjoining sheet to the west.

The rocks of Tintagh and Slieve Gallion generally have a compact or finely granular dark green felspathic base, weathering nearly white on the surface, which is sometimes pitted from the occurrence of felspar crystals, with small vesicular cavities containing calcite. Iron pyrites is generally present in small cubes, and crystals of hornblende become apparent, especially in approaching the granitic rocks. There are occasionally veins of white quartz, and in their vicinity small cavities lined with minute quartz crystals. Strings of epidote also occur in a few places. By the more abundant development of hornblende portions of the rock merge in the vicinity of the granitoid porphyry into a finely crystalline diorite, and, by the addition of quartz grains, accompanied by crystals of pink felspar, into a kind of syenite. These phenomena, examples of which occur at 600 yards S.W. of Tintagh summit, and in the small patch a little to the south, as well as in other places, show a passage into forms allied to the granitoid porphyry, and shall be further noticed in treating of that rock.

The prevailing forms found at Drummuck, Craigmore, and Windy Castle, S.W. of Slieve Gallion Carn, resemble in general character those of Slieve Gallion and Tintagh, and consist chiefly of a dense fine-grained greenish felspathic rock of an obscurely schistose-looking texture, weathering very light, and containing faintly discerned crystals of hornblende, with specks of iron pyrites. It becomes in some parts highly vesicular, the vesicles being elongated, and some filled with calcite. A very hard cherty-looking dark greenish rock (*petrosilex*) weathering quite white, probably an altered felstone, is found on Drummuck cutting as a dyke through the other rocks with a W.N.W. course, and appears in other spots in the same line to the west. Jasper and jaspery iron ore also occur in the latter locality, obscurely associated with, and probably forming veins in the metamorphic rocks.

Passing to the metamorphic area south of the granite, we find in a quarry west of the road at two-thirds of a mile W.S.W. of Lissan, hard hornblendic rocks of varying character, from compact to crystalline, containing red felspar, a little iron pyrites, and veins of epidote, serpentine, sulphate of barytes, and a granitoid-looking compound of quartz and pink felspar. West of the quarry the rocks become compact, in part resembling slightly altered fine Silurian grits; and close at hand, outside the sheet, there are clear examples of a passage into the finer forms of the diallage rock which about here becomes prevalent.

Changes, similar to those just referred to, occur in the boggy ground west of the granitic area near Lissan, green rocks with strings of epidote passing to a fine diorite. The same takes place at 700 yards farther south, and at the junction with the Carboniferous beds along the stream 1,000 yards west of Unagh Cottage a largely crystalline fibrous structure becomes developed in a rock having a dark reddish and green quartzose base.

Granite.

Granite of a typical character, that is, the highly siliceous compound of quartz, felspar, and mica, in which these minerals can be easily distinguished, and which weathers with the peculiar rough aspect not found in the granitoid porphyry, occupies the lower portions of the southern flanks of Slieve Gallion, and extends into the comparatively flat drift-covered ground near Lissan.

The granite is perhaps best seen in the drift-denuded area west of Knockadoo Bridge, which is traversed by streams that have laid bare many sections. The coarsest variety is found in the northern part, where it is very quartzose, and contains white and pink orthoclase and dark green mica, the quartz being, as is general in this district, of a whitish colour, and promiscuously intermingled with the more crystalline felspar. A little south of this, in a deep section along the more easterly stream, the granite becomes in part less micaceous, and the mica of a lighter green colour; and in Clagan Rock (marked 631 feet) there is a very quartzose granite, which becomes highly felspathic, and passes into the granitoid porphyry. This contains also a little hornblende.

Three hundred yards E.N.E. of Lissan Chapel there is a granite abounding in dark green mica, and immediately north of it is a small prominent mass composed of darker coloured grayish finely crystalline granitoid rock containing some hornblende and specks of iron pyrites, with but little quartz. The felspar is principally orthoclase, but a small quantity of finely banded felspar, probably oligoclase, can also be recognised. This rock is traversed by strings of epidote and veins composed of white quartz and largely crystalline orthoclase. It passes into a more typical red granite on the south side, as also in occasional spots throughout the darker portion.

Granitoid Porphyry or Elvanite.

The more compact and highly felspathic rock into which the granite passes is here distinguished from it by this name, and on the map by a deeper red colour. It is in general as largely crystalline as the granite, and of the same composition, but the mica is less abundant, and frequently disappears. The quartz occurs to a large extent in distinct sub-crystalline particles, and in some of the more compact varieties becomes glassy, and disposed in small blebs embedded in the felspar.

That these porphyritic rocks are connected with the pyroxenic rocks higher up, and are another and further product of metamorphic action, seems conclusive from an examination of their relations to each other. Sometimes the two occur together in such a manner as to make the porphyry appear to have acted to some extent intrusively among the pyroxenic rocks, a very probable result of an intense degree of metamorphism. In such cases the line of junction is marked by a greatly broken condition of the rocks, and by the occurrence of a quantity of highly

ferruginous red earthy matter, with occasionally pure red hæmatite; mixed throughout the finer soft *débris*. Examples of this occur at the S.W. side of Slieve Gallion, at Glenarudda Mountain.

In ascending the stream that passes west of Fairview House, the granitoid porphyry is abundantly met with, close-grained, and of red and purplish colour, the felspar forming crystals sometimes half an inch in diameter, and the quartz grains giving a whitish mottled appearance to the surface, which is well seen where it has been worn smooth by the action of the water. The mica is scarce, and sometimes cannot be detected; it occurs principally in light green hexagonal scales, but partly also in minute colourless flaky particles. At times it is red, from its being, in common with the mass of the rock, stained with iron oxide, an accompaniment of the veins of red hæmatite which, in a more or less pure form, traverse both the granitic and the pyroxenic rocks. Here, as elsewhere, portions of the rock become very compact, and there are masses composed of finely granular pink felspar, with minute grains of quartz, which appear to be partly intrusive in the coarser rock, and partly to graduate from it. Examples of this occur in the stream going S.E. from the top of Slievemoyle, where the finer rock is probably connected with a larger mass north and south of the road at Crockatryna, a little N.E. of Clagan Rock.

The granitoid porphyry along the stream west of Carndaisy plantation (west of Drumcormick) varies a good deal in character. The quartz is sometimes in tolerably regular crystalline grains, up to a quarter of an inch in diameter, and the mica, which is scarce, is in light green hexagonal scales. In the vicinity of the vein of red hæmatite, which has been worked here, the felspathic base in part asumes a dark dull purplish colour.

In a stream at the east of Carndaisy plantation there are compact and finely granular quartziferous felstones, variously tinged with purple and light green, and merging clearly into a very fine-grained reddish granite containing iron pyrites.

In Quilly Glen, about half-way eastward from Drumcormick to the Desertmartin-road, the rocks are exposed continuously for nearly 500 yards along the sides of a stream flowing through a narrow ravine that reaches a depth of fifty feet. They occur in considerable variety, being in part very fine-grained, and in a decomposed condition resembling a red earthy grit; then becoming course, with grains of quartz, and in some of the coarser parts, numerous small flakes of light green mica, with a little of a darker colour. Above the waterfall the rock is generally solid; below it is greatly broken up, and contains an amount of light green steatitic-looking mineral, partly infused through the rock, but more especially coating the joints.

Another interesting section in the granitoid porphyry occurs in the west part of Carndaisy Glen, where portions are very ferruginous from the presence of red hæmatite and a little iron pyrites. In some cases it becomes more like ordinary granite, but a greater variety is seen in the stream flowing S.E. to the lower part of the

Glen, where, above the waterfall, it partly changes to a very hard red felsite with minute grains of quartz.

The porphyry on the north side of Slieve Gallion and Tintagh is compact, and contains well-marked crystals of quartz and of red and greenish felspar, and, rarely, a little dark-coloured greenish mica. The dark green metamorphic rocks in its vicinity become marked with red felspar, in a more or less crystalline condition, quartz grains appearing at the same time in some parts. This shows the passage from one to the other, though here, as in other places where the same conditions exist, the general character changes so abruptly that there is no difficulty in drawing a boundary line.

The following remarks, quoted from the late General Portlock* show that observer's conclusions regarding the relations between the hornblendic and the granitic rocks. Referring to a locality on the Kildress River, not far west of Cookstown, he says—"The greenstone itself, near the junction, exhibits characters of transition, crystals of red felspar assimilating it to the granite, a circumstance which may be noticed in almost all the localities, and respecting which it is right to observe that, in such changes as have been here described, it must not be supposed that the passage is necessarily effected by the gradual transmutation of one rock to another in a manner so insensible that no lines of demarcation can be drawn. Such, certainly, appears the case on a large scale, when it is seldom possible to note the exact termination of one, and the commencement of another, variety; but when the point of such change can be noted, it will be often found marked by a definite line of separation, and specially by a variation in physical characters; for example, the more perfectly formed derivative granite cleaves into rectangular, and the indurated semi-crystalline rock into rudely angular or prismatic fragments. This abrupt change, which sometimes produces the appearance of dykes, is consistent with reason, and may be illustrated by the chemical doctrine of definite proportions, the rock on arriving at a certain point in the metamorphic change, being so altered in its conditions as to assume a new and definite form." Again, at p. 522, "Though the relations between the granitiform and the hornblendic or greenstone-like rocks cannot be satisfactorily made out, still the occurrence of granitic veins in the hornblendic rocks appears to afford a proof that the granite, at least in its present state, is the result of a cause continuing to act subsequently to the formation of the hornblendic rocks."

At page 535 he remarks—"Schistose rocks are here observed on the one hand to graduate into hornblendic rocks, which finally assume a very distinct greenstone character, and on the other hand to pass, by equally varied gradations, into the granites."

Lower Calciferous Sandstone.

The basal beds of the Carboniferous formation, consisting of red sandstones, sandy shales and conglomerates, with coarse

* Report, page 516.

pebbly grits, are found in this sheet resting on the granitic rocks along their south-eastern boundary, and are exposed to view in section in several localities. These beds, which pass upwards into sandstones and shales of quite a different type, appear to represent the Lower Calciferous Sandstone series of Scotland, and are here accordingly described under the same name.

At the east of Carndaisy Glen, below the waterfall, there are red shaly grits made up chiefly of the ingredients of the granitoid porphyry, and in some parts liable to be mistaken for decomposed portions of that rock.* They contain broken fragments of it, up to several inches in size, with pebbles of mica schist; and interstratified with them are thin discontinuous beds of red shaly sandstone. The latter is found above them, a little down the stream, forming a series of thin beds with micaceous surfaces, and containing small fragments of the same rocks, with a few quartz pebbles. They are again seen along the boundary a little farther west, on the southern slope of the glen.

In the avenue leading eastward from Carndaisy Glen to the public road, these red beds are overlaid by a coarse white grit below light reddish-coloured conglomerate containing round quartz and quartzite pebbles, with some of hard shales; and on the main road, 260 yards south of the avenue, purple, red, and gray sandstones appear below gravelly drift. These again occur along the stream that passes 400 yards north of Lower Town; among the lowest being thin bands of light red calcareous sandstone, and red sandy shales with yellowish streaks. Sulphate of barytes occurs in the highest beds in this section, which consist chiefly of a light reddish conglomerate similar to that in the avenue.

The Carboniferous beds are seen along the small river that flows S.E. by Moneymore, at the point where it leaves the area of the granitoid rocks. In a section along the southern bank they consist of purple pebbly grits and thin layers of hard light red shale, the former being in some cases cleaved, the dip S. 20° E. at 30° to 55°. They occur again on both sides of the river at 400 yards to the south; and at different places within 400 yards of the Triassic boundary there are beds of the same character, with some very hard tough purplish sandstones containing obscure laminæ of red shale with green markings; and, close to the boundary, light brown and yellowish sandstones. Near this, at the west side of the fault, and in close proximity to it, are very delicately laminated hard light red and chocolate-coloured sandy shales, finely micaceous, with a disturbed dip of 50° N.N.W. Near these, in the lane, are fine micaceous purple sandstones, below which, by careful searching may be found in a drain the red basal beds, made up largely of granitic debris from the underlying rock. These hard shales again occupy a small patch resting on the porphyry half a mile to the west, on the north side of the valley.

* Portlock fell into the pardonable error of supposing that "in almost any of the glens along the eastern face of Slieve Gallion" there is a passage "from well-marked sandstones into crystalline rocks." See Report, &c., page 513.

At the S.W. corner of Gortanewry plantation, a little south of Glenview, there are red micaceous sandstones, with others of a harder nature, and of a whitish colour stained purple. Slightly to the north, underlying these, is found, resting on the granitic rocks, a coarse brecciated conglomerate, the pebbles consisting of purplish and variously coloured indurated shales like those in the well at Glenview, with granitoid porphyry, a few of quartz, &c.

The basal red conglomerates and earthy sandstones occur near the west end of Reuben's Glen for about 150 yards along the stream, above them being whitish, purple, and red sandstones; and higher up, forming a steep slope on the south side of the stream, dull gray and yellowish sandstones, greatly broken up and having their dips quite obscured. These probably lie along a line of fault. The basal beds and the overlying white and variously coloured sandstones occur along the stream south of the bend of the glen. In one place whitish sandstones are cut through by a basalt dyke, in the immediate vicinity of which they have been indurated, and in part become assimilated in colour to the dark trap.

East of the road in Reuben's Glen there is a coarse red breccia containing fragments of porphyry reaching a foot in diameter. This is probably brought up by a fault, running N. and S., as the beds appear to belong to the lower part of the series. Overlying it are red and purple grits, seen in several places near the railway.

The lower sandstones occupying the large space south of Desertmartin occur in frequent sections along the principal streams, and present persistent N.N.W. dips, the beds being often broken, however, by slight faults. At one mile and a half S.S.E. of the village, a section on the railway shows conglomerates and coarse pebbly sandstone with red shaly sandstones interstratified, dipping easterly at 20° to 30°, but broken and dislocated as above described. The underlying red shales and conglomerates are found at a short distance to the west.

Rounded pebbles of the granitic rocks, in no place numerous, become more common in the red conglomerates S.W. of Desertmartin. These beds, which, with red earthy sandstones, occupy nearly half the width of the area here spoken of, are overlaid by a series of sandstones, occasionally whitish, but generally purple or red, more or less variegated, and striped with green. It is impossible to calculate their thickness, cut off as they are on the north and south by faults, and moreover so affected themselves by minor breaks; but the following general section in ascending order will afford a sufficient description.

Along the stream flowing northward at nearly half a mile east of Inniscarn Bridge:—Red conglomerates with beds of red earthy sandstone, the former containing round pebbles of quartz, quartzite, mica-schist, hard red sandstone, a few of jasper, and of granitoid porphyry, up to six inches diameter. Above these, in the stream passing under Inniscarn Bridge, are soft red sandstones, variegated green, with thin bands of gray and purple sandstone; reddish conglomerates and sandstones with layers of greenish, dark gray,

and red shale; whitish pebbly sandstone overlaid by gray and greenish shales and thin beds of nodular limestone; light gray, purple, and yellowish sandstones; alternating beds of purplish sandstone, red shaly sandstone with greenish stripes, and yellowish white sandstones with quartz pebbles. The section continued through the plantation along the stream that runs N.E. from near the carn on Slieve Gallion contains purple sandstones, and red and white sandstones with a little conglomerate. Probably above these are, in ascending order from a point 800 yards S.W. of Desertmartin, purplish brown sandstones, white sandstones more siliceous, red earthy pebbly grits and fine-grained red sandstones with white streaks, white sandstones, tough purplish gray sandstones, red sandstones with green markings, dark gray beds with a few quartz pebbles, thin shaly red sandstones with yellow markings, overlaid by more massive and siliceous beds.

On the road leading up to the Chalk quarry S.E. of the carn summit of Slieve Gallion. the sandstones are in part very red, some soft and marly, and variegated light green and yellow; others are hard grits, variegated pink and white, similar to some of those that accompany the conglomerates in the streams to the east. Among the uppermost beds, immediately under the Chalk, are some which have been considered by Portlock to belong to the Trias, but which would seem rather to belong to the Carboniferous series. Due north of the summit, as seen in section in the stream, the Chalk rests on red sandstones with light greenish markings, like many of the Carboniferous beds met with in the low ground to the S.E.; and in a quarry a little west of this section the Chalk overlies dark red and purplish grits, undoubtedly Carboniferous. From about 300 to 400 yards farther west, there appear fine-grained pink and brownish Carboniferous sandstones, some of the latter micaceous and very fissile, with fine conglomerates, all of which probably come directly under the Chalk, though here they seem to have slipped out of their place.

An inspection of the map will explain the position that the Lower Calciferous Sandstone north and east of Slieve Gallion occupies in relation to the beds of the Upper Series. The latter have clearly been brought down by a fault ranging in a north-easterly direction. Below them the red conglomerates, &c., are found along two streams north and west of Crocknamohil. North of that hill there is a nearly uninterrupted section for about 550 yards, showing red earthy sandstones, some of them calcareous, and fine red conglomerates, the former often marked yellowish, the latter containing pebbles of granite, quartz, jasper, &c. Some of the sandstones contain strings of calcareous spar. They are clearly cut through by a narrow dyke of basalt in the place indicated.

West of the hill the same beds appear, rolling and broken; they in part become more siliceous, and of a browner colour, when about to pass into those of the Upper Series. The sloping ground between these two sections is mostly covered by a deep deposit of red gravelly boulder-clay.

Upper Calciferous Sandstone Series.

The sections in these strata are not so complete as those in the Lower Series, as they lie to a great extent along the strike. The various beds are, however, sufficiently exposed to afford an accurate knowledge of their character. In the large area N.W. of Desertmartin, bounded on the south by a fault, they are completely covered by Drift, and the same obscurity prevails in the adjacent portions of the sheet lying to the north (Sheet 19); but there is every reason to suppose that they underlie the Desertmartin limestone. The low and frequently reversed dips, where they come to view in Sheet 19, suggest that there is no great additional thickness up to the bottom of the limestone.

The beds in the stream S.W. of Altagoan Bridge compose the lower part of the Upper Calciferous Series, the characteristic red and purple colours of the Lower Series prevailing in those next below them. The lowest consist of whitish sandstone and coarse grits containing white quartz pebbles. Higher up there are, in ascending order—similar beds associated with blue shales and bands of impure limestone; blue and dull reddish brown calcareous shales with thin bands of grit and arenaceous limestone; blue calcareous shales and very thin dark gray finely-laminated calcareous sandstones with silvery mica, the shales enclosing nodules of hard argillaceous limestone with strings of calc spar.

The beds along the Altagoan River, which are a good deal broken and faulted on a small scale, consist, in the part nearest to the bridge, of dark bluish gray and black calcareous shales; light gray thin-bedded highly calcareous sandstone or arenaceous limestone, and some purplish brown shales. A little farther south appear dark shales with fossiliferous calcareous nodules, thin seams of argillaceous limestone, and a bed of calcareous tufa. The remaining part of the section, extending for a mile south of the road, exhibits beds generally similar, some of brown siliceous sandstone, and many of dull gray micaceous sandstone.

A pit was very many years ago sunk in these strata in search of coal, by Captain Rennie, at the west side of the stream, three-quarters of a mile south of Altagoan Bridge, and other trials have been made in various places, but without encouragement. There are occasionally thin imperfect partings of coaly matter, and there is a very suggestive appearance in some of the shales and soft clays, which bear a resemblance to those of the Coal Measures, yet it is not likely that coal-beds of any value exist.

The light-coloured sandstones, &c., which form the lower part of this group, are extensively developed in the area lying due west of Desertmartin. They come to the surface in the hill called Crocknamohil as white pebbly sandstones and quartzose conglomerates. In Gortahurk, one mile and a quarter W.N.W. of the village, there are finer beds opened up in a quarry, for the supply of building-stone, kerb-stones, &c., consisting of fine white sandstone with silvery mica, partly discoloured with brown and red stains, and containing markings of dark carbonaceous matter.

An unsuccessful trial for coal by means of a bore-hole was made here by Captain Richardson.

In the same townland, 600 yards N.W. of the Chapel, there are undulating beds of hard fine-grained whitish sandstone with shell and plant remains, above shale and shaly limestone. The next that appear above these are in the stream 700 yards to the south, and consist of broken beds of yellowish white sandstone and dusky brown grits. Westward up the stream, the yellowish sandstones prevail, with some blue shales. At 1,400 yards S.W. of the Chapel, pits were sunk in search of coal by Captain Rennie, and more recently by others. In the latter case a parting of impure coal, two or three inches thick, was found.

At 600 yards west of the trial pits there are yellowish sandstones containing iron pyrites and carbonaceous matter, some obliquely laminated, and among them is a band seven feet thick, of blue and brown shales. A little farther west there is a bed of blue arenaceous limestone with quartz pebbles, overlaid by a thin band of dark gray shale and light sandstone, and this by a gritty conglomerate. Below these is a comparatively pure compact blue quartzose limestone containing *Productus* and coral remains; the same is found in a bed three feet thick, with gray quartzose conglomerate and shaly partings, at 700 yards south of Crocknamohil. A bore-hole was put down in search of coal at about 400 yards south of the Chapel, where there are white and yellowish grits with shaly partings, and thin shaly limestone bands. Some of the sandstones contain carbonized plant remains, and coaly matter in the crevices. Similar remains occur in the sandstones quarried at half a mile to the east, where also a thin parting of coal is said to have been met with. At 1,000 yards W.N.W. of Slieve Gallion Carn summit there occurs, among whitish sandstones with plant remains, a band of dark blue and gray fossiliferous shales with ironstone nodules.

The highest visible portion of the Upper Calciferous Series consists of white pebbly sandstones and dark blue shales, above which are the limestones marked at nearly a mile S.S.W. of the Chapel. These limestones, which occur at the boundary of Cullion and Boveagh, are probably the basal beds of the lower limestone, and identical with the lowest beds of that division at Desertmartin, the overlying portion at Cullion being removed by denudation, the whole having been previously brought down by the E.N.E. fault, which, with the adjacent great W.N.W. fault, has severed the connexion of the limestone in the two localities.

The strata occupying the ground west of Cookstown consist of a great variety of conglomerates, pebbly grits, red marly sandstones, white sandstones, purple and light reddish variegated sandstones and shales, and a few bands of light-coloured limestone of varying thickness. While they differ in general character from those north of Slieve Gallion, they resemble them in many respects. A striking peculiarity lies in the great prevalence of reddish tints, due to these beds having associated with them a large proportion of ferruginous matter, which is extremely abundant in some of the shales. The rocks due west of Cookstown are spread out over a large area in beds dipping at low changeable angles, with a prevalent direction eastward. In the northern part, one mile and a half N.W. of Cookstown, they dip more steadily eastward, and here they are separated from the metamorphic rocks by a nearly N. & S. fault, along which they are thrown down to the east.

The supposition that these beds belong to the Lower Carboniferous Sandstone is based on the fact that they come in regular succession over others which appear to be beyond doubt the lowest beds of the Carboniferous formation in the district that stretches southward; and since a little to the west they are underlaid by red conglomerates and earthy sandstones generally similar to the Lower Calciferous Sandstones already described, they are included in the upper group of the same series. The Cookstown limestone, which they clearly underlie, is therefore, on this supposition Lower Limestone.

The arrangement of these strata has always been imperfectly understood, but light has recently been thrown on it through the sinking of shafts and bore-holes by the Barrow Mining Company, and the ascertained sections have kindly been made here available. A marked feature is the occurrence of a deposit of red ferruginous shale, containing hollow nodules of brown hæmatite, lumps of red hæmatite, and a small quantity of manganese ore, resting on one of the limestone bands above referred to. Mining operations were carried on in ancient times, probably upon this ore bed, and it was also worked to a slight extent a few years ago. The more thorough examination of the locality by boring &c., which was recently commenced, will, no doubt, lead to a fuller knowledge of its probable value as a source of iron.

The lowest strata of the group, as they occur in this sheet, are to be seen along the Ballinderry River, the bed of which is composed of dusky gray, greenish, and purplish pebbly sandstones, earthy grits, and conglomerates, the pebbles consisting of harder portions of similar rocks, with white quartz and quartzite. Among them are thin bands of red sandy shale, with light green markings, and of fine-grained red sandstone, and two or three thin irregular beds of pink-coloured arenaceous limestone. They are further found, with bands of white and gray sandstone, in the stream that flows to the river W.S.W. of the workhouse, along the bank of which there are several well-exposed sections a few feet deep. Those in the river are occasionally broken and slightly dislocated.

At 2,000 yards west of the north end of Cookstown, south of the main road, coarse quartzose sandstones were bored through for eighty feet, below forty-two feet of Drift.

At the bend of the river close to the west of the sheet, a section on the south side shows, below boulder-clay, reddish and greenish gray sandy shales over pebble beds and dark gray finely-laminated sandstones. Close to this, on the same side, a trial pit was sunk in fine-grained very white sandstone above red arenaceous limestone, passing below into a purer light-coloured bed. Opposite this, half-way between the river and the road, red shales con-

taining solid worn pebbles of earthy red hæmatite were found below fifty-six feet of red and green shales, some of them very delicately laminated in blue, green, and purple colours.

This ferruginous shale was passed through in two pits on the very edge of the sheet, in the following section:—

	Feet.
Red clay and gravel,	5
Tough heavy red shale, enclosing pebbles of red hæmatite, &c.,	8
Whitish and reddish shales, with flatly-worn pebbles of red hæmatite disposed along surfaces of beds,	10

Three hundred yards N.E. of these pits, fifteen feet of soft red shales, variegated green, overlie similar beds, but stiffer, having worn pebbles of red hæmatite, some soft and earthy, others harder; and below this are shales of various kinds.

Above the variegated beds just spoken of, there are calcareous white sandstones, sometimes tinged with red. These were passed through in a bore-hole S.W. of the fever hospital for sixty feet, and for about 100 feet at a point 250 yards S.E. of it, on the other side of the fault.

Limestone crops up at 400 yards S.S.W. of the hospital, and a bore-hole put down early in 1877 at a similar distance S.W. of the workhouse, passed through twelve feet of limestone over shales and pebbly sandstones, these latter being bored for eighty feet.

The lighter-coloured sandstones which exist in the upper part of the series are opened in a quarry at the workhouse, where they dip E. to N.E. at 5°. The exposed beds, which reach about three feet in thickness, are in colour whitish, generally streaked with red and purple, some containing scattered pebbles of quartz. Below them are said to be harder, close-grained red sandstones, and below these a fine white sandstone. Another quarry opened up in similar beds at three-quarters of a mile N.W. of the workhouse supplied stone for the building of Killymoon Castle. In a well-sinking immediately north of the quarry they are found to be overlaid by thin limestone, probably the beds which crop out on the road 400 yards north of the workhouse. Again, at about 600 yards north of the quarry a boring passed for upwards of 300 feet in alternating beds and groups of red and whitish sandstones and shales, with occasional pebble beds.

The band of limestone on which the principal bed of ferriferous shale rests is laid bare in an old quarry in the east part of Tullycall, one mile and a half N.W. of Cookstown. It extends beneath the plantation in Unagh, where the ancient workings were carried on, and dipping eastward at a low angle, it appears from the sinkings to rise again shortly, so as to form a shallow synclinal depression sloping down gently to the north-east. The rock is generally compact, and slightly arenaceous, and in some parts stained red or purple, resembling in general appearance many of the beds of limestone near Armagh. In the top portion it is rubbly, and contains shell remains. One bed in the lowest part was known to the quarrymen from its peculiar colour as "liver limestone," and below this are white sandstones, and white and red

sandy shales, &c. The limestone is traversed by fissures, some of them accompanied by slight displacement; these bear principally N.E., or thereabouts, and contain in some cases clay and shaly matter with nodules and solid angular lumps of brown and red hæmatite, with a little manganiferous earth.

The strata over the limestone at Unagh, which reaches a maximum thickness of about fifteen feet, ascertained from a bore-hole fifty yards east of the plantation, are as follows:—

	Feet.	Inches.
Red and yellowish soil and brown clay,	15	0
Red sandstone,	6	0
White do.,	8	0
Red do.,	6	0
Purple shales,	21	0
White sandstone,	15	0
Red clay (shale) with pure ore,	1	0
Do., less ferruginous, and having mixed with it a little black manganiferous earth (*black muck*),	6	3
Limestone,	14	9
White sandstone and red shales,	–	–

In other sections in the vicinity these thicknesses vary, and the white sandstones are sometimes more or less pebbly. The manganiferous earth occurs in some cases as a separate thin layer, becoming harder and more solid, and breaking up with glossy surfaces. It is derived, no doubt, from the decomposition of the manganese ore, which, as shall be further on noticed, is associated in small quantities with the brown hæmatite.

It has been found by boring that a large thickness of sandstones, shales, and conglomerates, with bands of limestone in the lower portion, occupies the rising ground south of Unagh Cottage. They are similar in character to the beds near Cove Bridge, and between it and the Cottage; and the observed levels confirm the existence of the synclinal depression just now mentioned.

From the foregoing observations it will be seen that the Lower Carboniferous sandstone extends over a larger area near Cookstown than has been supposed; and there can be little doubt that its position with regard to the Cookstown limestone is that which is shown on the map, the intervening fault affording a solution of what has hitherto admitted of, at best, a very unsatisfactory explanation.

Lower Limestone.

The Lower Limestone is exposed in a quarry close to the railway terminus at Cookstown, and consists of beds of limestone, ranging in thickness from about one inch to four feet, in various shades of pink and gray, some of the lowest being decidedly red. All contain remains of corals, encrinites, and shells. One layer, about two inches thick, consists almost wholly of coral (*Lithodendron junceum*). The rock is generally somewhat crystalline, in some beds very compact and showing a conchoidal fracture; others are darker and more shaly.

The same beds, with those next above and below them, are

exposed along the road to Little Bridge, and in a neighbouring cutting on the Dungannon and Cookstown Railway. In the latter place, where they probably underlie the beds at the terminus, the lowest consist in great part of blue semi-crystalline limestone containing *Productus giganteus* and other shells, with various corals, some of which form large bunches. The upper beds are lighter coloured and more variegated.

The strata at Desertmartin consist of rubbly limestone having bluish and brownish colours with purple stains, overlying more solid finely granular light yellowish gray limestone in which are scattered well-rounded pebbles of quartz. The joints are regular, striking principally N.E.; in some cases marked with a well preserved slickenside, nearly horizontal. Particles of red hæmatite were observed adhering to the walls. The yellowish beds are dolomitic, and have been used for the production of hydraulic lime for works on the River Bann. Fish remains (*Psammodus, &c.*) identical with those in the Armagh limestone, are occasionally met with, besides various shells. Some of the lowest beds are arenaceous, and resemble in this respect, as well as in their containing quartz pebbles, the limestone of Cullion about two miles to the W.S.W.

At the S.E. of Drumbally Hill, about a mile N.W. of the village (marked 313 feet), there is a large quarry containing beds which apparently underlie those of Desertmartin. They consist chiefly of light gray semi-crystalline purple stained limestone, and among them is a band containing a bed of blue compact limestone fourteen inches thick (said to yield stronger lime than the others) and thin layers of black shale and shaly limestone. The purer limestone exists in beds from two to four feet thick, and is, like that at Desertmartin, magnesian, having supplied hydraulic lime for the construction of bridges over the Bann at Coleraine, Portglenone, and Toome. The shales, which form layers varying from one inch to five inches thick, contain large masses of corals (*Lithodendron*), crinoid stems, shells (*Productus giganteus*, &c.) They contain also cubes of iron pyrites, and the limestone is traversed by fissures containing bitter spar.

The limestone appears in several other places, and is in general more or less magnesian and fossiliferous. The most easterly exposure is at 1,000 yards N.E. of Heath Dale, where it appears in the surface of a lane.

Upper Limestone.

From observations made in the adjoining sheets to the west and south it would appear that the limestone south of the east and west fault at Cookstown belongs to the uppermost division of the Carboniferous Limestone, in which case its position with regard to the Lower Limestone of Cookstown is due to that fault, which has a downthrow to the south. It is slightly exposed at about 300 yards east of the town, and consists there of thick beds of purplish crystalline limestone with some impure arenaceous beds.

Triassic Rocks.

Middle Bunter Sandstone (Pebble Beds).—The group which in some of the western counties of England constitutes the middle division of the Bunter Sandstone, seems to be here represented by a series of loose pebble beds and sandy breccias that occupy the area so represented on the map. The lower portions are composed of a coarse sandy red breccia with some thin layers of sandstone, the former containing fragments of the underlying granite and schists, and a few quartz pebbles. Higher up they become finer, and less compacted; and at top they become quartzose, and assume the form of a fine conglomerate, with interstratified beds of sandstone.

The basal beds are found in the Lissan Water, close to Lissan House, near Cookstown. The largest of the pebbles, some of which are rounded, are those of granite; and there are smaller fragments of the local micaceous schists. They are again found farther down the stream, with beds of somewhat variegated sandstone. These strata have low southerly dips, with variations to the east and west. Some of the more sandy beds are seen in section along the stream in the plantation N.E. of the bend of the river at Lissan. At a mile east of this point these rocks occur along the edge of a stream, exhibiting low south-easterly dips. The lowest contain fragments of granite up to more than a foot in diameter, and the finer beds, with seams of reddish sandstone, are seen higher up. Other exposures of these strata occur in the stream at 400 yards west of Drumard Hill, and in several places along the stream that flows under the road. The same arrangement is here observed, the lowest beds being coarse, while the highest, at about 1,000 feet east of Drumard Hill, are finer and more quartzose.

Beds of fine quartzose conglomerate with layers of red sandstone are laid bare after heavy floods in the river bed 1,100 yards west of Boherboy Cottage, N.W. of Moneymore, and in a less consolidated form along the bank which skirts the flat land south of the ruins of Desertlyn Church.

The extension of the Triassic beds to a point immediately north of Cookstown, a fact hitherto unknown, has been proved by the sinking of a well close to the old Lissan road, at 800 yards from its commencement. The section here gave (below thirty-four feet of sand and gravel and boulder-clay) twenty-nine feet of brecciated conglomerate containing fragments of granite, metamorphic rocks of the district, and quartz; and some beds, six to fifteen inches thick, of red sandstone. Below this, one foot six inches of red gritty sandstone overlying the same with quartz pebbles. These beds are found farther to the S.E. overlying the limestone in the railway cutting east of Cookstown.

Upper Mottled Sandstone.—This division of the Bunter Sandstone occupies here by far the largest portion of the Triassic area. Some of the lowest beds are hard sandstones, occasionally ripple-marked, and having dull red and brownish colours; these pass upwards into the more marly and variegated forms that characterise the Upper Mottled Sandstone in other districts.

The lowest exposed beds are found in the stream at about 200 yards south of Dunman Bridge, between Cookstown and Moneymore, and again at 1,500 yards N.N.E. of this, where they were at one time quarried. In the former place they consist of thin bedded and fine grained delicately laminated red sandstones with ripple marks, some layers containing flat water-worn pebbles of red shale, and separated by thin seams of coarse quartzose sandstone. The finer beds, upon being exposed to the air for some time, split asunder in laminæ as thin as one-fortieth of an inch or less. The beds N.N.E. of this, where they are marked with a dip of 20° E. 10° S., were quarried for the building of Muff Glebe House and several bridges. So far as now seen they consist of hard finely laminated and ripple-marked sandstone. The space west of this, cut off by the fault, is obscure, and without rock exposures except in the northern part, where red sandstones dipping westerly at very low angles are exposed in the stream that flows north of the Mullans.

In a quarry next the stream S.W. of Boherboy Cottage there are thick-bedded brownish red sandstones; also thinner beds, sometimes ripple-marked and generally of brighter colours, with green laminæ, containing flat pebbles of shale. The joints are in some parts coated with calc-spar. They occur again at the west of Boherboy Cottage; and in the mill-race one-fourth of a mile farther N.E. there is a variety of decomposed beds of brown and red marly sandstones with light gray and greenish laminæ. The beds above those just described appear in several of the railway cuttings between Moneymore and Cookstown. They are generally soft, of bright red colours more or less variegated, micaceous on the laminated surfaces, which are sometimes obliquely disposed, and they are in some places separated by thin partings of red or purplish shale.

In a quarry at a short distance from Moneymore, by the road to Coagh, there is under the Chalk a red sandstone with bands of scattered pebbles of red shale. At the surface, and for an average depth of about two feet, it becomes of a dull whitish colour. These beds, which are calcareous, appear to be the uppermost of the Bunter Sandstone. They are again exposed in the stream immediately south of the quarry, where the red sandstone becomes marked towards the top with white streaks, and gradually passes into whitish sandstone, in contact with which the lowest bed of the Chalk is seen two feet higher up. The same change is seen in a lane west of the road to Magherafelt, 800 yards N. of Rockspring Cottage, where the Triassic beds are exposed below the Chalk.

Keuper Sandstone.—The lowest beds of the Keuper Sandstone are slightly exposed in the demesne of Spring Hill, S.E. of Moneymore, where chalk-rock is found resting on a pale red sandstone, below which is a fine reddish pebbly grit passing into a white conglomerate. Below these, which are seen to be about six feet deep, are the bright red sandstones of the Bunter series. These beds, the true position of which was recognised by Professor Hull in a visit to this locality, are limited in extent, and appear to form merely a small band that quickly dies out.

Keuper Marls.—The red and green marls of the upper part of the Keuper series are but little exposed to view. They have been met with, however, in a shaft and bore-hole sunk at the south side of the Ballinderry River, three-quarters of a mile S.S.W. of Coagh, where a depth of upwards of 250 feet is said to have been passed through in a search for coal. These strata here contained a considerable quantity of fibrous gypsum, as is shown in the following section given by Mr. Hardman* as approximately correct :—

	Feet.
Clay, soil, &c., about	10
Alternating red and green shales or clays, in thin layers,	80
Red and green laminated shales, containing many irregular beds of gypsum, in large lumps, varying from 1 to 5 inches thick,	15
Total sunk,	105
Bored—Red and green variegated shales, containing gypsum still in some quantity, but apparently not so plentiful as above,	175
Total bored and sunk,	280

The red and green marls appear at the surface, north of the river, to the N.N.E. of Coagh, and in a lane half-way between Maple Lodge and Rockspring, west of the road from Coagh to Moneymore.

Cretaceous Beds.

Upper Chalk.—The Chalk forms a narrow belt of varying thickness along the escarpment of the basalt, separating that rock from the underlying Triassic or Carboniferous sandstones, as the case may be. It also occupies a wider expanse where the basalt has been denuded away at about midway between Moneymore and Magherafelt. It consists of a pure, very compact, white limestone, containing layers of flint nodules, and is quarried in several localities both for building and agricultural purposes. It is generally fossiliferous, and remarkably so in some of the lower beds.

The Chalk occurs to the south of Coagh overlying the Keuper Marls, and is exposed at the west side of the river near where the shaft was sunk in the gypsiferous beds. It was also met with in sinking the foundations of a chimney, &c., a little north of this, and it is well seen in a quarry at the bend of the river N.N.E. of Coagh, where it is about thirty feet deep over the Keuper Marls. In this place, and in others to be mentioned further on, the lowest part consists of a pebbly bed containing chalk fossils.

In excavating chalk-beds at a house 650 yards N.W. of Silver Hill, a crevice about three feet wide was met with, containing several fragments of deers' horns. Similar remains are said to have been found at the south of Silver Hill, mixed with the gravelly débris of the Chalk.

* On the Occurrence of Gypsum in the Keuper Marls, near Coagh, county Tyrone, by Edward T. Hardman, of the Geol. Survey of Ireland, Assoc. R.C.S.I. Jour. Roy. Geol. Soc., Ireland, vol. xiii., part 3 (new series).

Resting on the Triassic beds, in a stream south of the large quarry N.W. of Spring Hill, the lower part of the Chalk is a compact white mass finely speckled with minute grains of quartz, and containing water-worn pebbles of quartz, quartzite, and quartz porphyry. The arenaceous portion is confined to a depth of about six inches, but scattered pebbles are found for some distance higher up, embedded in the ordinary compact chalk, into which the arenaceous part seems to pass gradually. In the adjacent quarry the chalk-rock is found to reach a depth of about thirty feet over the Triassic rocks.

The broken condition of the strata, already alluded to in connexion with the Carboniferous rocks as an accompaniment of the greater disturbances that affected the whole district, extends upwards into the Chalk. The latter is often fractured and penetrated by fissures containing crushed flints &c., and sometimes lined with calc-spar or minute crystals of quartz, large crystals of the former mineral also filling up nests in the rock. These phenomena are especially met with in the comparatively wide area between Moneymore and Magherafelt, as, for example, in the quarry at its N.Eastern extremity, and along the line of fault to the S.W. In these places the beds are regularly jointed, the joints principally inclining at high angles, from W. to W.N.W., and some distinctly slickensided. In the quarry just spoken of, some of the beds contain nodules of ironstone, the largest of which are said to be about the size of an egg.

West of Spring-lane Cottage, at the junction with the Triassic rocks, there is an irregular nearly vertical fissure in the Chalk reaching four feet wide, which affords a constant outlet for the water that disappears below the surface in the higher ground to the east. A little north of this the rock is greatly broken up and faulted, one overhanging wall especially exhibiting slickenside marks, and having much crushed chalky and flinty matter adhering to it. Calc-spar is here somewhat abundant in nests and fissures.

The Chalk along the basalt escarpment at Slieve Gallion has a thickness of about fifteen to twenty feet, where it is quarried S.E. of the carn. It is separated from the basalt by a thin layer of red earthy débris containing red and yellow flints. The rock is very full of flints, and encloses numerous Belemnites. Here, as in the locality last alluded to, there are cavities containing calc-spar, frequently in large well-developed crystals. Cavities in the flints also, are lined with very small pyramidal quartz crystals, as was observed in the vicinity of Moneymore. In one of the yellowish flints from the top of the Chalk was found a hollow lined with small semi-transparent crystals of stilbite in sheaf-like groups. This mineral is mentioned by Portlock as existing (rarely) snow-white in the cavities of yellowish jaspery flints at Donald's Hill, N.E. of Dungiven.

The Chalk is clearly seen resting on Carboniferous sandstone in the stream due north of Slieve Gallion Carn, the lowest part being highly fossiliferous, and consisting of a compact white mass containing pebbles and minute grains of quartz, similar to the beds

over the Triassic rocks at Moneymore. Portlock mentions the Chalk here as graduating down into the indurated Greensand, and it would seem correct to consider this bed, which in some parts contains minute dark-green specks very like the chloritic grains of the "mulatto stone," as a connecting link between the two formations, classing it with the former on account of the abundance of Chalk fossils which it contains.

Perrennial springs issue from the Chalk in various places, as, for example, at its southern extremity near Slieve Gallion Carn, at the large quarry S.E. of Moneymore, and in other positions farther north along its outcrop.

The manner in which this rock dies out near Magherafelt is rather obscure, owing to the Drift. It is said to have been met with, and to some extent quarried close to Old Town. The boundary on the map is approximately correct.

Volcanic Conglomerate.

At the village of Coagh, and at different localities to the S.W. of it, there is found, overlying the Triassic and Cretaceous strata, a volcanic conglomerate, with occasional ashy beds. This, together perhaps with solid basalt that is said in one place to have been found below it, forms here the basal portion of the basaltic series.

This deposit is composed of irregularly rounded fragments of various rocks, by far the greater number of them belonging to the basalt, bound together, along with coarse sand of the same materials, in a dark augitic base, which has a soft soapy feel. Many of the pebbles are of much the same nature as the base, but harder, and resemble certain modified forms of the basalt which are met with among the harder beds of the series. The base is sometimes made up in great part of very closely cemented particles, more or less angular, of red bole and whitish zeolite, and may be described as seeming to consist of the materials of the basalts and amygdaloids pounded up and closely re-united. Many of the pebbles are of finely granular felstone, a few of quartz porphyry, and there are occasional flints from the chalk. They generally present a water-worn appearance, those of basalt exhibiting at the same time for a small depth a concentric structure, which causes them to peel off in thin layers. These are probably masses of lava which became solidified in falling, and which, having been with the other ejected materials either precipitated into water, or subsequently exposed to its wearing action, were with them united in consolidated beds.

Sections were opened in the excavations for the new river bridge at Coagh, showing a horizontal bedding, with two thin intercalated beds of finely laminated ash or volcanic dust. The conglomerate occurs at the mouth of the mill-race at the east bank of the river, south of the bridge; also in section along the mill-race N.E. and S.W. of the bridge, where it came out in slab-like iron-stained masses in the cleaning out of the race. It is found resting on the Chalk, with low southerly dips, at the south side

of the river, 800 yards E.N.E. of the town, where some of the contained fragments reach a foot in diameter. At three-fourths of a mile S.S.W. of Coagh the conglomerate is seen in the bank bounding the flat strip north of the river; and at Flood Lodge, the house S.W. of this, where it exists in the mill-race and in the river, it is said to overlie solid basalt. Here it contains some chalk flints, and the larger sized pieces of basalt.

The occurrence of this rock throughout the area assigned to it on the map has been proved in various wells, as at 550 yards S.E. of Ballygonny Bridge, where there was a "rotten black rock with pebbles" found at sixteen feet six inches below the surface. At the east end of Coagh there is a large depth of drift over a "black gravelly rock," said to be the same as that in the river; and in the main street it was reached below twenty to thirty feet of clay, and is said to have contained at top a quantity of iron pyrites in nodular lumps and detached cubes. That this mineral was met with is certain, but there is some doubt as to whether it was embedded in the clay, or, as one workman affirmed, from below a thin hard layer that formed the top of the conglomerate.

The conglomerate is succeeded by basalt with ashy beds, and this merges upwards into the ordinary basalt, the transition taking place, for example, at the south of Urbal House, where there is seen in section along the road decomposed basalt with reddish coloured beds of an ashy character, while the conglomerate is found near at hand, to the east of the gasometer. Its thickness at Coagh Bridge is known to exceed fifteen feet, and it is probably not much more.

Lower Basalt.

The basalt frequently comes to the surface in slightly elevated patches and more prominent bosses in those areas in which the drift has been removed by denudation. It is in general a dark finely crystalline or compact compound of augite, triclinic felspar, and titaniferous iron, with some olivine, and occasionally, as an accessory, a little iron pyrites. The rock is sometimes vesicular; the cavities containing zeolites, at times calc-spar, and rarely quartz or calcedony. Highly vesicular masses (amygdaloids) crowded with zeolites, and frequently of a reddish colour, form irregular beds at intervals among the more solid beds of basalt. The latter occasionally weather with a globular, or finely spheroidal, structure, and a rudely columnar form is sometimes apparent.

Along the escarpment of the outlier at Slieve Gallion, S.E. of the summit there is exposed a gray spheroidal fine dolerite, six feet deep, overlying the red earthy layer which separates it from the Chalk; and above this about twelve feet of amygdaloid containing zeolites, some radiated, and filling small round vesicles, and others lining irregular cavities in the form of small whitish rhombohedral crystals. In ascending the mountain from this point, amygdaloid is again found a short distance higher up, succeeded by grayish basalt or fine dolerite, which, as a hard platy scarped rock, forms the summit of the hill.

In a large quarry by the railway N.W. of Magherafelt there is blue compact massive basalt traversed by many narrow fissures filled with fine radiated zeolite; and in a well sunk at 900 yards N. of Dunarnon House the same was met, together with amygdaloid containing beautiful groups of white zeolite in opaque crystals (*Apophyllite*) with modified rectangular forms.

To the west of The Cluster, S.W. of Magherafelt, the basalt presents scarped faces, and that step-like arrangement which is characteristic of the trap rocks. Here it is finely crystalline and platy, with escarpments ranging up to fifteen feet high, and running in a N.N. westerly course, the dip inclining gently eastward. The same features are observed in the drift-denuded area south of Magherafelt, and less remarkably in other places.

In the locality just mentioned, and to the west of Ballyronan, as also along the escarpment south of Maple Lodge, the basalt is very ferruginous, and often finely spheroidal.

Rock appears along the lake shore at the south of Ballyronan, and more extensively in the county Antrim southward and eastward of Doss Bay. In these places the bedding is distinctly marked, showing low S. Easterly dips. At Ballinamullan school, N.E. of the Three Islands, it contains a well-marked bed of laterite or bole, passing into red amygdaloid, the cavities of which in some cases contain calc-spar. S.E. of this, about Conn's Point, the rock extends a considerable distance into the lake, and it comes close to the surface all along the narrow portion of flat ground that skirts the lake from Doss Bay to the east of the map. At the old Church west of Cranfield Bay, large crystals of calcite of a waxy yellow colour, and up to about two inches in size, are dug out, when cleaning out a well, from a cavity in the basalt. This operation takes place once a year, when they are secured by the people of the neighbourhood, who attach to them some peculiar charm, and suppose that they grow suddenly on a certain night in the year (11th May or "Old May Eve").

In the railway cutting north of Claremont, and where the railway leaves the map eastward, the basalt and amygdaloid are well seen, occurring in thin beds with imperfect layers of bole. Some of the vesicles contain calc-spar and aragonite, with zeolites; and there are fissures lined with light brown carbonate of lime.

The basalt in the remaining part of the Antrim division of the sheet is generally more solid and massive than that close to the lake. There is often present a well-marked platy structure, and, as in the massive basalt at Rock Cottage, N.E. of Toome, a rude columnar form.

West of Hillstown there is compact platy basalt containing flat oval-shaped vesicles disposed parallel to the planes of cooling, and also a more crystalline rock weathering to small iron-stained spheroidal masses like that west of Ballyronan &c. Fragments of ash were excavated from a drain at Fair View.

The basalt is rarely seen along the shores of Lough Beg, but it is not far from the surface. It occurs at the edge of the lake

west of Milltown on the Antrim side, and on the opposite side at the surface in the hill north of Long Point. At Toome it occurs below about forty feet of gravelly clay.

Basaltic Dykes.

Amongst the dykes worthy of notice the principal are, a mass of dolerite occurring among the Triassic rocks east of Cookstown; and one composed of finer rock cutting more clearly through the Chalk N.N.E. of Coagh. The former, which varies in horizontal width from about 150 to 400 yards (though probably very much less in true thickness), is best exposed in a quarry at the bend of the road from Coagh to Little Bridge, where, from the manner in which some of its constituents are arranged, as well as from the position of some of its divisional planes, it resembles a bedded rock having a low S. Easterly dip. Thus there are white particles of zeolite filling small irregular vesicles disposed in planes generally inclined in that direction; but, although the texture of the rock varies, there do not seem to be distinct flows, and it appears to be an intrusive sheet among the Triassic strata. The rock is a crystalline compound of augite and white felspar, generally more or less vesicular; it exhibits a coarser texture at 500 yards south of the quarry, where it comes again to the surface, and has been pierced for a depth of twenty-nine feet in sinking a well; in both places it weathers spheroidally. Immediately north of the quarry this rock appears in two patches projecting a little from the surface of the bog. The joints here are remarkably regular, striking principally N. 30 W., with others E. 40 N.

The dyke N.N.E. of Coagh is composed of finely crystalline columnar and spheroidal dolerite, and is seen cutting through the Chalk, the beds of which dip down against it on the east side. The width on the square is twenty-eight feet where it is cut by the quarry road, and perhaps more a little to the north. A narrow crevice between the dolerite and the Chalk contains a grayish or somewhat slate-coloured magnesian earth, having a flaky structure parallel to the wall of the dyke. An analysis of this, by Dr. Apjohn,* gives the following formula, which shows it to bear some analogy in composition to meerschaum:—

$$3Al_2O_3,\ 4SiO_3 + 9(MO,\ 2SiO_3) + 62HO,$$

in which MO represents magnesia, lime, and protoxide of iron.

Probably the same dyke, or a branch from it, occurs at the N.W. of Rockspring, where in a lane S.W. of the school the red and green Keuper Marls are found in a crushed condition against a dyke of basalt, the width of which is not seen. Near the outer part it is a soft mass of light gray colour. The interior is dark and very tough, and weathers concentrically. Between the basalt and the marls there is a small quantity of flinty débris adhering

* Portlock's Report, page 115.

to the former. At 150 yards S.E. of this it again appears, less disintegrated, with the red marls in contact with it on the east side.

In the same general direction, and appearing to mark a line of special igneous activity, other basalt dykes occur as follows:—In the large Chalk quarry S.E. of Moneymore, one, four feet wide, cuts through the rock, hading S.W. at 80°; another, not now exposed, but noticed by Portlock, and remembered by some of the present inhabitants, among the Triassic beds in the quarry S.W. of Boherboy Cottage; a third met with in sinking a fence south of this place. The dyke due west of Boherboy Cottage is not exposed, but was found below the surface at the N. side of the road.

The basalt dyke in Quilly Glen, N. of Lower Town, is only two feet wide, and is plainly marked cutting through the granitic rocks, as well as a smaller vein a few feet farther west.

A dyke of dark nodular basalt, the weathered portions of which are finely spherulitic, crosses the whitish Carboniferous Sandstone at the south of Reuben's Glen, as before observed (p. 17). The beds in contact with it are indurated and changed in colour.

It may be assumed with much probability that the large intrusion at Coagh, and the others which penetrate the Chalk, are of Tertiary age, and form some of the numerous feeders to the sheets of basalt that cover the country to the east. The same would apply to those in the Triassic district N.W. of Moneymore, as all appear to belong to one system; and it seems not improbable that all the basaltic dykes in this sheet may be referred to that age.

Pliocene Clays.

Certain coloured clays, containing lignite, which are met with along the lake shore south of Ballyronan, and along the Ballinderry River, may without hesitation be considered as the representatives of the Pliocene Clays that form more extensive deposits at the south of Lough Neagh.

At 1,200 yards east of Ballinderry Bridge, there is a stiff variegated clay of dull greenish and bluish colours, below several feet of fine sand. A light brown stiff clay, variegated red and yellow, below the alluvium at the river, east of Scotchtown, probably belongs to these deposits; as also a hard concretionary ferruginous clay of yellow and rusty brown colour, at 600 yards west of the mouth of the river, on its northern bank.

Portlock mentions a bluish stiff clay resting on finely crystalline basalt at the mouth of the Ballinderry River, underlying six feet of alternate layers of sand and imperfect lignite. This section is not now exposed, but it no doubt belongs to the deposits in question. There is a section about eight feet deep, east of the bend of the river near its mouth, showing beds of sand and sandy clay with a little gravel, below which is a varying thickness (up to four feet) of sandy clay, charged with black ferruginous cementing matter, and containing small particles of lignite. Below this is fine and coarse whitish sand with imperfect laminæ of scattered pebbles. This sand encloses fragments of peat, and below it

again is a deposit made up of softened pieces of wood, black, whitish, and reddish, with hazel-nuts. Underneath this probably comes the blue Tertiary clay mentioned by Portlock.

A bluish variously shaded stiff clay is found below the top soil at Stanierd's Point; and at 400 yards south of Salter's Castle there is a similar clay containing many fragments of brown and black soft lignite, which latter becomes hard by exposure to the air. Some of the smaller of these fragments are water-worn, while others, which are said to reach three feet in length, appear as pieces recently broken from a large mass. The clay here lies below a depth of from six inches to three feet of brown drift clay, and was only obscurely seen in a small pit used by the people of the neighbourhood to obtain the lignite for fuel.

Many fragments of lignite occur along the shore at about one mile and a quarter north of Ballinderry River; also nodules of clay-ironstone such as are associated with the clays in other localities, and there are some pieces of dark brown silicified wood, either angular, or but slightly water-worn. Of these last, the surfaces are in most cases white, or of a light yellowish brown colour, which extends inwards for a small depth as a thin skin-like coating, but sometimes to half an inch in depth. In some specimens this bleaching is absent in places where they have evidently been broken since the whitening took place. The dark fibrous mass of which the interior is composed bears a strong resemblance to the lignite, not only in appearance, but in the fact that when it is heated before the blowpipe, there is emitted a smoke having the peculiar odour that the lignite gives out. The white surfaces are sometimes coated with minute crystals of quartz, which are also found lining cavities or forming fine strings through the dark interior. The surface portions so coated are the sides of cavities laid bare by fracture. As the specimens about the lake have been but little worn since the bleaching took place, this seems to have been probably effected in the locality, a supposition that is strengthened by the fact that while here the fragments exhibit many stages of discolouration, at a distance from the lake they appear to be in all cases either deeply or thoroughly whitened.*

That the fossil wood is more or less directly connected with the lignite seems to be generally admitted, but there has existed a diversity of opinion as to the nature of this relation. Dr. Barton (1757) speaks† of a "stratum of black wood, soft enough to be cut with a spade, but in part harder, and affording blocks that are found to consist more or less of stone," a description which when taken in conjunction with some of the observations just now made, seems to come very near that given by J. A. Phillips‡ in writing of silicified wood and silicified lignite from California. Speaking of the two substances, the latter says:—"Both specimens were obtained from the trunk of the same tree, found in the auriferous drift under a volcanic capping, near Nevada city. . . . The transition from silicified wood to silicified lignite was exceedingly gradual, one end of the log being black with a somewhat hackly fracture, while the colour of the other end was yellowish-white, and its fracture conchoidal; both distinctly retained their original woody structure."

* A specimen eighteen inches long was found in stratified gravel at Coleraine, the most northerly point, it is believed, hitherto recorded. It was very dark in colour, except for about half an inch from the surface, where it became white.

† Portlock's Report, page 75.

‡ Geological Magazine, vol. x., part 3.

Dr. Barton's observations are to the following effect:—That in a section at Ahaness on the eastern shore of Lough Neagh, "the upper stratum was a bed of red clay, three feet deep; the second, a stratum of blue clay, four feet deep; the third was a stratum of black wood, four feet in thickness, which reposes on another stratum of clay. This stratum of wood is of one uniform mass, and is capable of being cut with a spade. Sometimes the wood will not easily break, in that case it requires the aid of some other tool to separate it from the mass, and may, if properly done, afford a block of two, three, or four hundred pounds, which being carefully examined, is found to consist more or less of stone."

Dr. Macloskie* suggests that the silicification took place through the action of river water containing silica in solution, on logs of trees, which were subsequently buried beneath the outflows of basalt.

Mr. Hardman† supposes that the silicified pieces of wood had their *locus* in the basalt, and that the silicification is due to the percolation of water through the porous and easily decomposable rock. That this process does take place, at least to some extent, appears from a note appended to Dr. Macloskie's paper, referring to a specimen of partially silicified lignite found intercalated between beds of trap at Knocknagor, near Banbridge; and specimens are said to have been found in the heart of silicified blocks at Lough Neagh, resembling the mineralised lignite of Knocknagor and the Giant's Causeway.

Post Pliocene (Drift).

Lower Boulder Clay.—The drift is principally Lower Boulder Clay, consisting of dark stiff clay containing numerous stones and boulders often of large size, but there is also a considerable area covered by stratified sand and gravel, which probably belongs to the Interglacial Period.

In certain parts of the low ground lying near the lake from Toome southward to the Three Islands, and eastward for about two miles, it has been ascertained by well-sinkings that there are stratified gravels, clayey sands, and fine laminated muddy clay, resting on the basalt, and passing upwards into a light brown gravelly boulder-clay, the latter being spoken of in the district as "red till." These fine deposits, whether they are to be regarded as interglacial, or as marking the earliest stage of the Glacial epoch, appear to occupy a former extension of the lake, being

* On the Silicified Wood of Lough Neagh. By Rev. George Macloskie, M.A., LL.D., Journ. Roy. Geol. Soc., Ireland, vol. iii., part 3 (new series).

† See note, page 8.

bounded eastward by somewhat higher ground, in which the rock comes up to or near the surface. This stratified condition is probably due to the deposition having taken place in a depression containing water from which there was no ready outlet, and the same explanation accounts for the decidedly bedded character that often exists to a limited extent at the bottom of the lower boulder-clay. On the lake shore, S.S.E. of Ballynamullan School, where the basalt approaches the surface, and at a point that seems to be on the boundary of the extensive area above spoken of, these conditions are found dying out. Here, below twenty feet of boulder-clay, and underlaid by two to three feet of compact stony boulder-clay, is a set of sandy beds about five feet thick, consisting for two feet from the top of brown laminated sand containing scattered pebbles and fine gravel, some of the laminæ being made up to a large extent of particles of lignite. The hard boulder-clay at bottom shows in part a bedded structure, and contains pebbles of basalt, chalk, granite, lignite, &c. That above the sandy beds is apparently without any structure.

Immediately south of the school the rock on the shore is overlaid by fourteen feet of boulder-clay, and this by stratified sand and gravel. The former is a brown sandy clay, devoid of structure except at the bottom, containing basalt boulders up to one foot or more in diameter. It encloses also a few fragments of chalk, fossil wood, lignite, &c. The bottom part, which follows the shape of the rock surface is very compact, and contains water-worn nodules of iron-stone, &c. Some specimens afford examples of lignite converted into iron ore, retaining more or less obscurely their fibrous structure, and portions of it emitting before the blowpipe the smell of burning lignite.

The northern boundary of the lake east of Ballynamullan is generally a low shelving shore, having the rock close to the surface, and skirted by boulder-clay, which appears in sections up to about fifteen feet in height. The surface is in some places thickly covered with basalt blocks from the subjacent rock, and there is frequently washed up by the lake a fine gravel of coloured flints, pebbles of quartz, chalk, mica-schist, iron-stone, &c.

The following section was met with near the point of land lying south of Pullan Bay:—

At top,	6 feet,	"Red clayey till."
	14 „	"Blue slaty clay," in thin layers, containing finely-laminated flat nodular pieces, indurated and highly calcareous, of bluish-gray colour, weathering nearly white.
	2 „	Gravel, resting on basalt.

At 100 yards east of this, the blue clay occurs below four feet of soil; it has a leafy structure, and contains nodular portions as described above.

A section in a well 500 yards north of Ballynamullan School is given as follows:—

4 feet,	"Till, with a few rolling stones."
15 „	Do., darker.
— „	Dark stiff clay, with parts gravelly and sandy, "same as on the lake shore at the schoolhouse."

The "till" in this section is no doubt the "red clayey till" just described as overlying the nodular clay at the south of Pullan Bay, and in the latter place it was found, in excavating for a building, to be overlaid by gravel and sand, with an intervening layer made up almost wholly, it is said, of pieces of silicified wood, or "hone stones," some reaching a length of three feet.

A well at 300 yards E.N.E. of Alderburn is said to have passed through—

21 feet,	"Red till" above.
— „	Stratified bluish clay, water being found at the junction.

The following is from a well at Ballydugennan House, in descending order; thickness not known:—

(1) "Red till;" (2) Blue sandy clay; (3) Gravel.

At 1,400 feet N.E. of the last, water was reached upon meeting with what was supposed to be the solid rock below thirty-eight feet, consisting of "red till" in the upper part, and in the lower a more sandy clay free from stones, coming out in "slates," and of a dark blue colour at the bottom.

Again, at 600 yards N.W. of Milltown, there were found thirty feet of fine bluish coloured clay with fine gravel through it, except at the bottom, where it came out in beds. At 200 yards further west there were 24 feet of "till with round stones," above gravel "like river gravel." Seven hundred feet due west of Milltown there were forty-four feet of boulder-clay, with nothing else so far; and 260 yards to the W.S.W. gravel occurs under forty feet of the same.

At Toome there were met with in sinking the public pump:—

About 40 feet,	"Reddish till."
7 or 8 „	Dark coloured gravel and clay.
10 „	Sunk in basalt.

In examining the drift in the cuttings on the railway between Cranfield Bay and Toome, it is found to consist of stiff boulder-clay the same as the "red till" before spoken of, being in colour light brown, with blue markings caused by an admixture of darker-coloured very stiff unctious clay, apparently in thin obscure laminæ. It contains small basalt boulders, a few clay-ironstone nodules, occasional pieces of fossil wood, and pebbles of red granite and trachyte porphyry. Large flints from the chalk, and also blocks of mica-schist like that in the district eighteen miles to the N.W. occur about Staffordstown, Leitrim, &c.

Of the boulder-clay in the county Derry division of the sheet, the deepest sections are found in spots on the flanks of Slieve Gallion and the adjacent hills; as, for example, along the stream between Slieve Gallion Carn and Crocknamohil, and east of that, where it has been naturally cut through for depths of thirty feet or more. and is found to be a reddish gravelly clay containing blocks of all the local rocks, many of them glaciated. In a deep cutting on the N.N.W. side of the latter hill, where it is particularly well exposed, some of the blocks are of a large size, one glaciated boulder of granite measuring ten feet in diameter.

The drift has an appreciable thickness up to a height of about 1,400 feet on the east side of Slieve Gallion Carn, and traces of it are found higher up, where granite fragments and pebbles of quartz, &c., lie scattered on the surface almost up to the summit.

In districts occupied by sandstones and conglomerates, the boulder-clay being made up chiefly from the underlying rocks, is of a very sandy or gravelly nature, and may sometimes be easily mistaken for a portion of the rock itself; and on the other hand disintegrated portions of the rock may be mistaken for drift. Seventy feet of "red gravelly till" are said to have been passed through without coming to the rock (red conglomerate, &c.), at Holly Mount, S.S.W. of Desertmartin. There is a considerable depth of boulder-clay in parts of the Triassic area south and south-west of Moneymore. Close to the Rectory it contains very many glaciated boulders of hard granite, diorite, basalt, &c., some of them of large size; one composed of granite being said to have weighed fifty tons (a weight represented by a cubic block of granite having sides nearly eight feet nine inches square). In the hill half a mile N.N.E. of Tullyboy Bridge there are said to be sixty feet deep of red sandy till with many boulders of granite and of the metamorphic rocks from the district to the north-west.

Sand and Gravel.—The stratified sand and gravel already noticed as belonging probably to the marine drift of the Interglacial period, is abundantly found to the N.W. of Desertmartin, over the greater part of the Carboniferous area east of the Altagoan River, and extending from the northern margin south to the Chapel, beyond which the boulder-clay rises up from beneath it. Its presence determines the form of the ground, which is unevenly and rapidly undulating compared with the more extensive and less abrupt irregularities of the boulder-clay. The latter is often overlaid by small patches composed of these beds, where they have escaped denudation.

In the area here alluded to, the prevailing material is a fine red sand, with seams of gravel composed of granite and metamorphic schists, comparatively few of chalk and chalk flints, with quartz, &c. Boulders of hard hornblendic rocks from the metamorphic region to the south are occasionally found resting on the surface, or slightly embedded in it; and small boulders are frequently contained in the gravelly portions, which predominate towards the south of the area. The former are probably remnants of the Upper Boulder Clay.

The Carboniferous sandstone in the quarry in Gortahurk, W.N.W. of Desertmartin, is covered by eighteen feet of coarse, rudely stratified sand and sandy clay, with gravel and boulders; and the limestone at Desertmartin underlies about ten feet of sandy clay, sand, gravel, and shingle interstratified.

The cuttings on the Derry Central Railway, N.W. of Magherafelt, pass through stratified sands and gravels on the margin of the basaltic area. The same deposits are found more or less abundantly skirting both sides of the valley between that and Moneymore, and occasionally farther south towards Coagh, in the form of fine laminated sand with thin seams of red clay.

Recent and Post-Glacial.

(*Bogs and Alluvial Flats, Brick Earth, &c.*)

Associated with the bogs, and underlying the peat and alluvium, there are sometimes light coloured sands, and in a few places brick clays, of Post-Glacial age. At one mile and a half east of Castledawson the peat rests on a bluish gray clay, with sometimes an intervening layer of sand. The clay, which has been somewhat used for making bricks, becomes at a little depth thinly laminated with sand and a dark stiff clay in alternate leaves. This stiffer portion is said to be good tile-clay. It is here about three feet deep, over boulder-clay. The same beds are seen in the flat ground N.E. of Leitrim House, where brick-making is now carried on; and a little farther up the stream there is a stiff yellowish brown brick-clay. At a short distance north of Hillhead bricks are made from a light brown and bluish sandy clay, sometimes variegated red, below two to three feet of whitish sand; while throughout the same bog to the north of Castledawson, there is a large depth of peat over earthy sand full of small gravel of quartz, sandstones, mica-schist, chalk, and flints. In these localities the peat abounds in trunks and erect stumps of fir and oak, with some of willow, &c. In the large bog west of Curran the peat overlies a whitish and reddish clayey sand. There is also at Little Bridge, below the peat, a stiff brown clay with sandy seams, used for brick-making.

Sections ten to fifteen feet deep along the river Moyola, S.E. of Castledawson, show two to four feet of brown sandy alluvium overlying laminated sand and clay, the latter sometimes very stiff, and in places farther south containing imbedded trunks of oak. North of Burrowhill there are exposed about ten feet deep of brownish gray sandy laminated calcareous clay, overlaid by the same depth of fine brown sand, in part obliquely laminated, and containing gravelly seams.

The flat land to the south of Lough Beg consists generally of a thin covering of sandy alluvium over peat and peaty clay enclosing leaves with numerous trunks and roots. Below these are supposed to be extended the more ancient clays of the Moyola, just described, all forming a delta of that river.

At the present day the river is carrying down a fine whitish silicious sand, with gravel composed chiefly of coloured flints, quartz, basalt, and mica-schist, such as are found covering the lake shore in the vicinity, and forming banks in some places along the channel itself.

Below the peat to the west of Church Island there is a gray alluvial clay which weathers white when dry. This is common along the river Bann farther north, and also between Lough Beg and Toome, from which it is locally known by the name of "Bann Clay."

The peat in the bog at the lake shore east of Coagh is underlaid by whitish and light brown clays, more or less sandy, containing pebbles of basalt, quartz, flints, ironstone, &c. These

are said to rest on the boulder-clay, which forms patches of higher ground at Mullan Point, Stanierd's Point, &c., and below which, a little east of Newport Trench, there is said to be a "stiff clay without stones," probably some of the Pliocene clays already spoken of.

Portions of deers' antlers have been found in the clay forming the flat land along the streams at the N.W. of Moneymore, and near the same place, at the surface, a flint hatchet-head. Pieces of antlers were also found in the bog east of Lough Beg; and, occasionally, masses of butter preserved in the peat, and gold coins.

Shell marl occurs in a small peaty patch of ground two miles south of Desertmartin.

Chapter III.

Mines, Minerals, Principal Faults, &c.

Faults.—The faults of Post-Tertiary age, which have probably, as suggested by Mr. Hardman,* played an important part in the formation of Lough Neagh, here traverse a country that had been to some extent previously subjected to disturbances of a like nature. To the latter class the large fault passing by the south of Desertmartin, with a downthrow to the north, seems to belong, as it does not appear to affect the basalt. This break explains the simultaneous occurrence of the limestone at Desertmartin and the Lower Carboniferous sandstone south of that town, as well as the complete change of dip that takes place. Further indications of is direction and effects are found in the sheet west of this, (Sheet 26), while the structure of the intermediate district is extremely obscure.

Of the leading faults, perhaps the best marked is one which strikes S. westerly from the alluvial flat west of Desertmartin, the sandstones on the north side dipping persistently against the lower beds which lie on the south. There is thus a downthrow to the north, the amount of which it is not easy to calculate, especially as the Calciferous Sandstones are very variable in thickness and extension. It seems probable that this fracture, as well as the parallel one to the N.W. which is also proved by the relative positions of the Upper and Lower Sandstones, is of an age contemporary with that of the fault first spoken of.

The nearly E. and W. fault passing under the basalt near Slieve Gallion Carn is of Pre-Cretaceous age, as demonstrated by the unchanged level of the chalk on both sides. Of its existence there is at first sight a suggestive indication in the remarkably straight piece of soft spongy ground that marks the boundary between the Carboniferous and the older rocks. The manner in which the sandstones strike towards the indurated Silurian beds north of Glenview goes to prove its presence at that point; while

* See note, page 8.

immediately east of the basalt of Slieve Gallion the two classes of rock maintain their respective positions with regard to each other with a degree of uniformity, notwithstanding considerable alterations of level by denudation, that could hardly take place without the intervention of a fault. West of the Carn hill it brings down the red or lower sandstones against the metamorphic rocks, as may be seen along the stream, the course of which it traverses for a short distance.

The nearly N. and S. fault west of Slieve Gallion Carn, with a downthrow to the east, has brought the chalk and basalt down on that side, while the metamorphic and granitic rocks immediately adjacent on the west maintain a higher position. There is further evidence in the displacement of the porphyry boundary along its course southward. South of the granitic area the boundary of the Carboniferous rocks is shifted for at least 750 yards, and it is not unlikely that this well-marked fault is continued across the Triassic ground, appearing again at Rockspring and at Coagh, in both of which places the basalt has been thrown down on the east.

The fault running nearly north and south at the E. of Cookstown, with a downthrow to the east, is proved by the abrupt manner in which the limestone boundary terminates; Triassic beds being found where the arrow is shown on the map, and again in a well 420 yards to the N.N.E.; also by the fact that these beds are composed of marly sandstones belonging to a horizon above that of the pebble beds which rest on the limestone to the N. and N.E. of the town. It probably extends across the Triassic rocks into the granitic area, where there are indications of a break having much the same direction, on the east of which portions of the Carboniferous sandstone have been brought down, and remain in narrow patches as shown on the map.

A result of the nearly parallel fault west of Cookstown is seen in the sudden change from the thick series of limestone beds that lie under the town, to the sandstones which have been proved to occupy almost exclusively the ground for about a mile north of the workhouse, as well as that to the south of it.

The fault with a N.N.E. direction from the south-west corner of the map has a downthrow to the east, of uncertain magnitude, but sufficient to account for the hitherto paradoxical positions of the sandstones and limestones in that locality, as the fault last mentioned does in the case of the strata near Cookstown. Evidence of the former break is found in the sudden cessation of the limestone close to Unagh school, half a mile N.W. of Unagh Cottage, as shown by bore-holes; and in the great depth of sandstones and shales there met with, 190 feet deep at least having been proved in such close proximity to the granite as to preclude the supposition of an adequately rapid fall in the surface of that rock.

With regard to the fault passing E.N.E. by the south of Cookstown, though just there the ground is obscure, yet to the east and west there are evident indications of a break along that line. There is clearly a shifting of the dolerite N.E. of Cloghog House,

while E. and W. of Coagh the basalt and volcanic conglomerate have been thrown down on the south.

Mineral Veins.—The metalliferous veins marked on the map are but of little importance, as these lines for the most part represent merely small strings of red hæmatite, or fissures containing that mineral in very variable quantities, and chiefly in an impure earthy form. They serve here, however, to indicate the prevailing tendency of such veins to run in N.N. westerly courses, corresponding to that of the *cross veins* in the mineral districts of the north of England.

The principal one is that which has been lately worked a little at the N.W. of Carndaisy Plantation, west of Drumcormick, and also in former times by Rennie, the sites of whose pits are still to be seen. One of these is about 300 yards northward from the corner of the plantation, and close to this the vein was opened up in 1875, when it was found to hade at an angle of about 20° from the vertical. It is said to vary in width from four to seven feet, but it soon turned out unpromising, and the work was abandoned. It occurs again at about the same distance farther north along the stream, as a nearly vertical lode about four feet six inches wide, containing, as in the other place, a quantity of rich fibrous hæmatite (*kidney ore*) embedded in a red earthy mass. Small branch veins also exist, some of which were probably worked in Rennie's pits, the sites of which occur close at hand to the west of the stream.

A vein containing sulphate of barytes and earthy red hæmatite is laid bare among the metamorphic rocks in a stream at about 250 yards N.N.W. of Glenview, and appears to have a N. easterly bearing. The occurrence of sulphate of barytes in the altered Silurian rocks a little to the east has been already noticed. The same minerals are contained in a narrow nearly vertical vein, exposed in the stream west of the road at 1,450 yards W.N.W. of Glenview. Another, having a N. westerly course, and containing at least a small amount of very pure hæmatite, has been proved in the place indicated on Slievemoyle. The gangue here also is sulphate of barytes. Ferriferous quartz, accompanied by a small quantity of pure ore, is found in a vein about four feet wide in the granitoid porphyry west of Slieve Gallion Carn; and the ferruginous quartzose rock before noticed as occurring in a hollow at the south of that hill is even less promising as a source of iron. The veins in the prophyry along the stream that passes down from Slieve Gallion by Fairview House, are mere strings reaching a thickness of about one inch and a half, and in some cases a few occur together in two or three feet thick of broken rock.

The ore bed resting on limestone N.W. of Cookstown consists, as a general rule, of two distinct portions, the lower being a friable mass composed of brown hæmatite mixed with clay and manganiferous earth, and containing some of the hollow brown hæmatite nodules. The upper part is a soft red ferruginous shale with similar nodules and irregular lumps of red hæmatite, a few of the latter also finding their way into the lower portion.

The origin of the nodules, which reach several inches in diameter,

(in some cases measuring one foot), is obscure; but the suggestion put forward by Mr. Hardman* in a paper read in May, 1873, affords a very probable explanation; namely, that the brown hæmatite is a "kind of pseudomorphous product, the result of the chemical action of water carrying various substances in solution, on nodules of clay-ironstone, the former occupants of these shale beds;" the inside portion, which often consists of a thin coating of fibrous and mammillated limonite, being deposited from solution on the less pure hæmatite. Mr. Hardman also gives the following analysis, made by him, of a specimen picked up at this place:—

Fe_2O_3,	74·56
FeO,	a trace
MgO,	0·044
CaO,	a trace
SiO_2, &c.,	9·42
Al_2O_3,	3·51
Water combined,	10·24
,, hygroscopic,	2·90
MnO_2,	a trace
CO_2,	a trace
P_2O_5,	a trace
	100·674
Metallic iron,	52·20

Adhering to the inner surface of the nodules, there are sometimes found small quantities of an ore of manganese, or wad, somewhat crystalline, and of a nearly black or dark steel gray colour.

Bog iron ore occurs occasionally, but it is impure, and of no economical value; it is dug up in small quantities at about a mile west of Moneymore, near the road to Lissan; also close to the fault at two-thirds of a mile N.N.W. of Lissan. It is found overlying white and brown sands in the boggy land between Coagh and Ballinderry Bridge, and at about 600 yards S.E. of the latter.

Ice-markings.—The ice-worn condition of the rocks has before been occasionally alluded to, those along the lake shore south of Toome being mentioned as affording examples of well preserved striæ. Here the basalt presents flat smooth surfaces worn down to nearly the average level of the lake, the waters of which cover it during wet seasons. The striæ have bearings between 15° and 35° E. of S. and W. of N., but the actual direction of the ice-flow cannot be decidedly determined.† There appear to be two sets of striæ at the N.N.W. of Cratty, the one bearing N. 30 W. and S. 30 E., and the other 25° nearer to N. and S. In the latter case they are few in number, and comparatively faint, and appear to represent an earlier movement of the ice. Traces of ice-moulding

* On the Occurrence of Siliceous Nodular Brown Hæmatite (Göthite) in the Carboniferous Limestone Beds near Cookstown, county Tyrone; with Analysis, &c., by Edward T. Hardman, Assoc. R.C.S.D. Journ. Roy. Geolog. Soc., Ireland, vol. xiii, part 3 (new series).

† Professor Hull has shown from a number of observations made over this part of the country, that the movement of the ice-sheet was northwards.—*Phys. Geol. of Ireland*, p. 237.

are preserved in the rocky ground north of the lake near the east margin of the sheet, and striæ bearing N. 5° W. and S. 5° E. are found in the railway cuttings just outside it, where the boulder-clay has been removed; and others a little farther north, bearing more nearly E. and W. by 35°.

In the county Derry division the glaciation is best marked in the localities shown in the map; but the rocks are more or less ice-worn in other places, as, for example, the basalt near the Carn on Slieve Gallion, N.W. of Ballyronan, &c. &c.

Palæontological Notes, Sheet 27.

Localities from which Fossils were collected.

No. of Locality.	Quarter Sheet of 6-inch Map.	County and Townland.	Situation, Geological Formation, and Shee of 1-inch Map.
		County of Londonderry.	Carboniferous Limestone, Sandstone, and Shale.
1	41/1	Drumard, .	Rocks in Altagowan River, half a mile south of Altagowan Bridge, one mile and a half south-east of Draperstown; dark gray shale. "Calciferous Sandstone, upper group," on map.
2	41/3	Cullion, . . .	Bed of stream about half a mile north of Slieve Gallion Carn, about two and a half miles south-west of Desertmartin; white sandstone. "Calciferous Sandstone, upper group," on map.
3	41/4	Knocknagin, . .	Quarry at village of Desertmartin; compact red limestone. "Lower Limestone" on map.
		County of Tyrone.	
4	29/4	Tullygarve, . .	Quarry on road from Cookstown to Coagh, half a mile east of Cookstown Railway Station; compact red limestone. "Lower Limestone" on map.
5	29/4	Clare, . . .	Cutting on Dungannon and Cookstown Railway about three-quarters of a mile east of Cookstown; compact gray limestone. "Lower Limestone" on map.
6	29/4	Augliah, . .	Trial shaft of Iron Ore Company, one and a quarter miles south-west of Cookstown; purple shale; Lower Limestone shale.
		County of Londonderry.	Cretaceous.—Upper Chalk.—"White Limestone."
7	41/3	Iniscarn, . .	At Slieve Gallion Carn east, side, three miles south-west of Desertmartin.
8	41/3	Boveagh, . .	At Slieve Gallion Carn, north side, half a mile north of preceding locality.
9	46/2	Carmean, . .	Quarry close to Railway, about two and a quarter miles north of Moneymore.
10	46/4	Moneymore, . .	Quarry on Coagh road, quarter of a mile south-east of Moneymore.
11	46/4	Do., . . .	Old quarry, a little east of R.C. Chapel, Moneymore.
12	48/2	Ballydawley, . .	Quarry at Crosspatrick, about two miles south of Moneymore.
13	49/3	Lower Rusky, .	Quarry at Tamlaght, quarter of a mile north of the village of Coagh.

List of the Fossils collected from the Localities mentioned in the preceding Table.

The numbers opposite each species refer to the places at which they were collected, and the mark × placed before them denotes their comparative abundance.

CARBONIFEROUS LIMESTONE, SANDSTONE, AND SHALE.

	Localities.
Plantæ.	
Plant stems longitudinally striated and branching, .	1.
" " coarsely ribbed, ...	2.
Actinozoa: *Zoantharia*.	
Lithodendron affinis, ...	4, 5.
" striatum, ...	5.
Zaphrentis or Cyathophyllum, . . .	5.
Mollusca: *Brachiopoda*.	
Orthis resupinata, ...	
Productus giganteus, ...	4, 5.
" punctatus, ...	5.
" semireticulatus, ...	4, 5.
Rhynchonella pleurodon, ...	4.
Spirifera bisulcata, ...	4.
***Lamellibranchiata*.**	
Aviculopecten megalotus, ...	4.
Modiola Macadami, ...	× × × 1.
***Crinoidea*.**	
Crinoid joints, ...	× × 5.
Crustacea: *Ostracoda*.	
Leperditia Okeni, ...	× × 1.
Pisces.	
Psephodus magnus (palatal tooth), . . .	3.
Helodus lœvissimus (do.), . . .	6.

Cretaceous.—Upper Chalk.—"White Limestone."

Actinozoa: *Zoantharia*.	
Parasmilia centralis, ...	7.
Echinodermata.	
Galerites abbreviatus, ...	7, 8.
Annelida.	
Ditrupa, sp., ...	11.
Mollusca: *Polyzoa*.	
Heteropoda, sp., ...	9.
Reptomulticava (D'Orb.), sp., ...	7.
***Brachiopoda*.**	
Megerlia lima, ...	7, 9, 11, 13.
Rhynchonella limbata, ...	7, 8, 9, 10.
" octoplicata, ...	7, 8, 11, 12, 13.
" plicatilis, ...	7, 8, 9, 11, 13
Terebratula carnea, ...	7, 8, 11.
" semiglobosa, ...	7, 8, 9, 10, × 11, 12, × 13
Terebratulina striata, ...	7, 11, 12.

	Localities.
MOLLUSCA : *Lamellibranchiata.*	
Cardium, sp.,	11.
Inoceramus, sp.,	7.
Lima, sp.,	10.
Ostrea semiplana,	7.
Pecten, sp.,	7, 9.
Cephalopoda.	
Belemnitella mucronata,	12, 13.
PISCES.	
Lamna acuminata,	9, 10.

REMARKS ON THE FOSSILS.

The fossils collected within the area of this sheet and submitted to me for examination, do not present any special features of interest; those from the Carboniferous series, described on the map as "Calciferous Sandstone, Upper Group," locality No. 1, are dark gray shales with fossils of characteristic Lower Carboniferous Limestone types, such as *Modiola Macadami* and the small Crustacean *Leperditia.* In a white sandstone described as of the same series, plant remains were the only fossils. At localities Nos. 3, 4, and 5, compact red and gray limestone contain corals, shells, and fish palates very similar to those of Armagh.

WILLIAM HELLIER BAILY.

March 19*th*, 1881.

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