Memoirs of the Geological Survey.

EXPLANATORY MEMOIR

TO ACCOMPANY

SHEET 59 OF THE MAPS

OF THE

GEOLOGICAL SURVEY OF IRELAND,

INCLUDING THE

DISTRICTS OF NEWTOWN HAMILTON, KEADY, AND CASTLEBLAYNEY.

BY

F. W. EGAN, B.A.,

WITH

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

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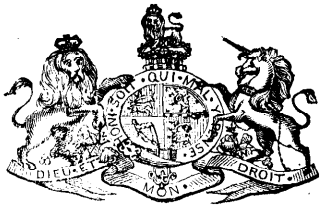

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NOTICE.

In 1872 I had the advantage of examining part of the country comprised in sheets adjacent to No. 59, with Professor Hull and Mr. Traill, and was struck with the skilful manner in which the origins and different ages of the granitic masses had been determined. The following explanation of Sheet 59, by Mr. Egan, is of great interest, involving as it does an account of part of Lower Silurian and Crystalline Rocks of an area, in which the history of the metamorphism of Silurian strata into granite, and the Geological dates of various igneous rocks, has been clearly illustrated by the author.

ANDREW C. RAMSAY,
Director-General.

June, 1877.

PREFACE.

The following Memoir by Mr. Egan is descriptive of a portion of one of the most remarkable districts in Ireland, as illustrating the results of volcanic and metamorphic action in past-geological time, and the varieties of pyroxenic and felspathic products resulting from vents in close proximity, and which were in action at nearly the same period. Thus there is reason to believe that the micaceous dolerite of Slieve Gullion passes into, or is represented by, hypersthene dolerite with anorthite felspar in Carlingford mountain, as also by an ordinary dolerite in the hills immediately north of Dundalk Bay; and lastly, by diorite at Trumpet-hill, N. W. of Dundalk. The felspathic products, which are generally of more recent date, have resulted in the formation of quartziferous porphyry, felstone porphyry, and felstone with scarcely any free silica, and are in all probability the representatives in time of the granite of Mourne.

EDWARD HULL,
Director of the Geological Survey of Ireland.

4th June, 1877.

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

TO ACCOMPANY

SHEET 59

OF THE MAPS OF THE

GEOLOGICAL SURVEY OF IRELAND.

CHAPTER I.

PHYSICAL GEOGRAPHY.

The greater part of the ground described in this Sheet is situated in the county of Armagh. About thirty-four square miles in the south-west are in Monaghan, and a narrow strip along the eastern margin lies in the county Down. It contains the towns of Keady and Newtown Hamilton, with the villages of Mountnorris, Belleek, Camlough, and Cullyhanna in Armagh; and the town of Castleblayney in Monaghan.

The south-eastern corner includes the most elevated points, the highest being the summit of Slieve Gullion Mountain, which rises with somewhat gentle slopes to a height of 1,893 feet above the sea. Three and a half miles N.N.E. of it, Camlough Mountain attains a height of 1,385 feet; and, adjoining the latter on the south-east, Ballymacdermot, 1,019 feet. Of the remaining area the highest levels exist in the hilly portion lying north and north-west of Newtown Hamilton, including Carrigatuke, 1,200 feet, and Deadman's Hill, 1,178 feet. Mullyash Mountain, four miles W.S.W. of Newtown Hamilton, is 1,034 feet high.

Slieve Gullion is partly surrounded from north to west, at a distance of about three miles from its summit, by a range of comparatively low hills with broken outlines, varying in height up to about 900 feet above the sea. These hills rise with rugged slopes above the adjoining drift-covered ground, some of them, when viewed at a distance of a few miles, presenting a striking appearance, as they stand out in abrupt knolls against the more gently rounded mass of the mountain.

The northern and western portions of Slieve Gullion are made up chiefly of an amorphous mass of dolerite protruded through the granite, which latter forms the principal rock in the neighbourhood. Both these are in turn penetrated by a large outburst of granitic rock, which now, in the form of elvanite or quartziferous porphyry, constitutes the highest part of the mountain. This elvanite also occupies a separate lower-lying tract adjoining Slieve Gullion on the north, and makes up the main portion of the smaller hills mentioned above, the broken outlines of which are due chiefly to a series of faults, marked by small valleys, which

cross the hills in a north-westerly direction. The majority of these faults are of trifling extent, but some are accompanied by a considerable dislocation of the rocks, so as to materially affect the form of the ground, by bringing into juxtaposition rocks which are in different degrees capable of resisting denuding agents.

The elvanite, occurring in large irregular dyke-like intrusions, appears to have to a great extent selected for its course either lines of junction of the older rocks or bands of incompletely metamorphosed Silurian rocks contained in the granite.

With the exception of the eminences above referred to, and the uneven tract in which the lead mines are situated, at the west of the sheet, the country is chiefly covered with drift, arranged in mounds which give the surface a smoothly undulating character.

A few instances occur of lake basins hollowed out in the rock apparently by ice. The best example is Cam Lough, which occupies a narrow basin about 1¼ mile long, between Camlough Mountain and the high ground at the northern extremity of Slieve Gullion. The glaciated rock surfaces, in some parts planed down and striated, especially on the eastern side of the lake, afford abundant evidence of glacial denudation. A large fault passes through the hollow, and the action of the eroding force of the ice was no doubt facilitated along this line of fracture, which happens to lie almost exactly in the average direction of the ice striæ of the district. The basin, begun to be excavated in the line, possibly of a pre-existing valley, was in process of time scooped out by the ice to its present form, and the dimensions of the lake subsequently augmented by the piling of moraine matter across its southern extremity upon the retreat of the ice. The detritus thus accumulated contains large angular local blocks, and rises up gently southward at that point, and then gradually slopes down towards the low ground in the south-east of the sheet.

Throughout the area occupied by Lower Silurian strata, that is, over the greater part of the sheet, there are no features of special importance. The principal heights, such as Carrigatuke, Mullyash, &c., exhibit the generally rounded contours due to ice.

In all parts the beds have undergone a great amount of disturbance, as is evident from the fact that they almost universally dip at angles considerably removed from the horizontal, and are frequently folded and crumpled up, so as to form anticlinal and synclinal curves, the axes of which chiefly run E.N.E. and W.N.W.

The valley through which the Dublin and Belfast railway passes, in the north-east corner, lies partly along the line of a main fault, and forms a well-marked boundary between the counties of Armagh and Down.

Bogs and alluvial flats are numerous, but none of them are very extensive. The largest peat-covered tracts occur in the neighbourhood of Newtown Hamilton, and stretch with varying levels across hollows and up the slopes of adjacent hills.

The greater part of the drainage is conveyed in two principal

directions, northward to Lough Neagh, and southward to Dundalk Bay. In the former case it partly flows to the river Blackwater by means of the Callan and smaller streams to the west (Sheet 47). The other portion of the northern drainage is conducted by the Cusher and minor rivers to the Bann (Sheet 47). The area thus drained has Belleek at its southern limit, its eastern boundary passing two miles east of that town, and three miles east of Mountnorris.

The water which flows to Dundalk Bay is conveyed by many small streams, of which the principal are known in this sheet as the County Water (separating Armagh and Monaghan), the Dorsy, Ummeracam, Ballina and Forkill Rivers. A small area in the east, extending from Camlough Mountain to the northern margin, discharges its drainage into Carlingford Lough by means of the Newry Water.

The crest of the principal water-shed, dividing the northern drainage area from the southern, proceeds from the summit of Slieve Gullion, and passing westward at the south of Belleek, bends northward through the large bogs east of Newtown Hamilton; then eastward over Deadman's Hill and Carrigatuke, through Tullynawood Lake and the bog south of Straghan's L., and out of the sheet near lat. 54° 14′.

CHAPTER II.

Rock Formations and Divisions.

Aqueous Rocks.

Name.		Colour on Map.
Recent.	Bog and Alluvium.	*Chalons brown and gamboge.*
Post Pliocene.	Lower Boulder beds and gravel.	*Engraved dots.*
Lower Silurian.	Caradoc or Bala beds. / Llandeilo beds.	*Pale purple.*

Igneous and Metamorphic Rocks.

Basalt of Miocene age.	*Burnt carmine (light).*
Basalt and Dolerite in dykes (supposed Miocene age).	*Do. (dark).*
Felstone and Minette (mica-trap).	*Orange chrome and carmine.*
Volcanic Agglomerate (of Palæozoic age ?).	*Do. lighter, dotted with carmine.*
Felstone Porphyry.	*Orange chrome and carmine.*
Elvanite (Quartziferous Porphyry).	*Carmine (dark).*
Dolerite (of Slieve Gullion, &c.)	*Burnt carmine (dark).*
Diorite.	*Do.*
Dolerite in dykes (supposed Carboniferous age.)	*Do.*
Granite.	*Carmine (light).*
Altered Silurian Rocks.	*Pale purple, with a wash of carmine.*

Lower Silurian Formation.

This formation is here composed of irregularly alternating beds of gray grit and compact gray flags, often micaceous, with darker shales and slates disposed either singly or in groups of various thick-

ness. The grits are frequently of a bluish shade, and sometimes green, or slightly tinged with purple. In some parts they occur at intervals in massive beds among the shales and thinner grits, occasionally exhibiting a very coarse texture, and containing large grains of quartz and flaky fragments of shale.

The beds supposed to be of Llandeilo age are represented by dark carbonaceous shales with graptolites, and a few bands of grit; they are often pyritous. The rest belong to the Bala or Caradoc group.

The occurrence of Llandeilo beds in this district can be explained only on the supposition that they have been brought up by faults or sharp anticlinal folds—an idea which is somewhat supported by the fact that the shales alluded to are very often crumpled up and crushed, so as to indicate an unusual amount of disturbance in the localities in which they appear.

Various traditions are held respecting the occurrence of coal among these rocks, and in a few places search has been made, but, as might be expected, without success. It may, however, be possible that a bed of anthracite exists, such as is found among the Llandeilo beds near Kilnaleck in the county Cavan.*

A section from the north-west corner of the Sheet to Cashel Lough, at the south margin, embraces all descriptions of the Silurian rocks in this district. For about 10 miles the prevailing dips are south-easterly, and vary in amount from nearly horizontal to 80°. They then become reversed till within a short distance of the granite, when they change to the east and assume a direction towards the latter rock. It will be seen that farther north the dips close to the granite are, for the most part, north-westerly.

The low ground west of Maddan Church (north-west of Keady), is studded with low ice-moulded bosses composed of finely laminated grits and compact flags, with a few layers of blue shale.

On the hill one mile west of Keady, there are fissile flags with various shades of blue and gray, and frequently of a very dark colour. The same beds appear along Carryhugh Glen, where the College Mines are marked. Above them are massive grits, which are quarried at half a mile south of Keady. Here they are traversed by quartz veins and regular joints; the latter principally bearing N. 40° E. Similar beds occur at the south part of Keady, with groups of flags; the latter appearing at the surface in Market-street and Main-street. A band of dark glossy pyritous shales overlying these grits is cut through by the road to Armaghbrague, half a mile south-east of the town.

South of Clay Lake the beds are chiefly of fine grit, with layers of shale and cleaved slates. Some of the grits are, however, coarse and brecciated, and the same is better observed at the west of Aughnagurgan Lake, between which and Tullynawood Lake the rocks are extensively exposed.

Mullyash, a conspicuous blunt-ridged hill, 4½ miles north-east of Castleblayney, consists also of gray grits with shaly bands. In the low ground, at a point N.E. of the summit, dark gray

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* See Memoir of Sheets 78, 79, 80; pp. 16, 31, &c.

and blue shales were quarried at one time in the hope of reaching true slates suitable for roofing, but the experiment proved fruitless. The beds come out in large flags, and are divided by unusually regular joints, principally bearing N. 30° W., with others bearing E. 35° N. Graptolites were found in very ferruginous black shales along the stream west of Mullyash, and similar beds occur in the stream at 500 yards south of the plantation. On the hill itself, south-west of the Carn, the fine grits contain strings and veins of quartz varying in thickness from one-fiftieth of an inch or less to nine inches; the larger ones, which chiefly bear N.N.W., being crossed by the others in innumerable fine threads.

The rock is greatly exposed over the ground north-west of the Fews Barracks (3 miles south of Newtown Hamilton). It consists principally of gray compact flags with micaceous surfaces, fissile shales, and, among the uppermost beds, some of which have ripple-marks, blue and purple cleaved slates. Thin beds of bluish fine grit are interstratified, and a few massive, coarse, brecciated grits. Thin flags from this locality have been, in time past, used for roofing houses in Newtown Hamilton, but they are too heavy for the purpose. The occurrence of numerous joints prevents these beds from yielding large flags.

Besides the above examples of the Silurian rocks, which have been selected from a general line of section across the dip from the north-west corner, a few more require to be noticed. The railway cutting south of Castleblayney contains a good section in dark shales, with a few thick beds of grit and lighter coloured shale, traversed by quartz veins and fissures filled with ferruginous débris. The shales in some parts contain iron pyrites. The dip here is generally south-easterly, at 40° to 50°, but sometimes as high as 90°, occasioned by contortions. Grits become prevalent in the upper part of the section. Graphite occurs in the black shales east of the market-house in Castleblayney, in the form of small spangles mixed with white quartz, interposed between the laminæ. This substance appears to enter largely into the composition of some of the beds, the powder of which soils the fingers like so-called "black lead."

Another railway cutting, west of Corrinshigo L., exposes dark shales closely mottled with ferruginous markings—a character common among these beds in that part of the district west of Castleblayney. Towards the west of the cutting there are thick beds of hard fine-grained grit, and blue glossy schists with large crystals of iron pyrites. Coarse quartzose grits occur at the east end. Quartz veins are frequent in these rocks, some being of large dimensions.

A band of black, purple, and greenish ferruginous shales, about 40 yards wide, occurs midway in the large cutting at the west end of the tunnel on the Newry and Armagh Railway, among grits of various thickness, with shaly and slaty layers and partings. A short cutting, 1,100 yards farther west, contains also very dark pyritous shales, which, when decomposed, taste strongly of alum.

The débris lying in heaps on the surface at the several shafts along the tunnel consists of green and blue glossy shale, generally mixed with hard gray and purplish grit, both containing more or less iron pyrites in cubes and strings, and occasionally enclosed in veins of quartz and carbonate of lime. In the large cutting near the eastern end of the tunnel, there are chiefly dark shales with a little pyrites. Near the bridge are grits, somewhat metamorphosed, and south of the bridge the beds are crossed by a vein of calcite with white iron pyrites.

Ineffectual trials for coal were made near Ballylane Lough, west of Mountnorris, and near Enagh Lough, west of Goragh Wood. In the former case the experiment appears to have been suggested by the presence of dark grits and shales in the stream west of Coulter's Bridge—in the latter a pit was opened in dark pyritous shales. Two small shafts were sunk also in the hollow west of Lisummon Chapel, and tradition says that coal was found in one and burned in a neighbouring forge. The beds here too are pyritous shales, from the decomposition of which the peat in the adjacent hollow is impregnated with sulphur.

In the following additional localities the idea prevails that coal exists:—In Drumnahoney, nearly two miles north of Belleek, and at the northern part of Drumcrow, where a slight search was made; in a boss of similar rock (dark shales), in the vicinity of Gibson's L., near Mountnorris; north-east of Lislea Cottage (west of Keady), where the site of a pit is pointed out which is said to have yielded, in ancient time, a quality of coal sufficiently good for blacksmiths' use.

It is commonly believed in the district that there is a bed of coal a few feet below the surface in Annyart, N.N.E. of Castleblayney; and at the east of the County Water, N.N.E. of Mullaghduff House, a good quality of "black glossy hard coal" is said to have been met with about ten years ago, below a few feet of the alluvium; and also thirty years ago in sinking the foundation of the adjoining house. Should there exist a band of anthracite in this district, it would probably be found at the two last-mentioned localities, but no traces of it were observed.

Granite and Altered Silurian Rocks.

The granite appears to be all of metamorphic origin, and to be derived from the Silurian rocks by a transition through mica-schist and gneiss. It is composed essentially of quartz, orthoclase, and black mica, with hornblende frequently as an accessory, and occasionally a green mineral, which is probably chlorite. The texture, which is usually finely crystalline, becomes coarse in a few places. The rock is also in part porphyritic, containing numerous crystals of orthoclase compactly imbedded in a fine-grained mass with a bluish gray shade. In the majority of these crystals the form is badly developed, and they appear like irregular blotches mottling the surface. Though the granite frequently exhibits a schistose texture near its junction with the Silurian rocks, this is not always apparent.

The most interesting section is at Goragh Wood Station,* where the granite is exposed for 450 yards in a steeply receding face, about 70 feet in greatest height, and covered by drift from 2 to 6 feet deep. It is traversed by a very regular system of joints, bearing N. 20°-30° W., and hading easterly at 70° to 80°. Some of them divide the rock into slabs as thin as quarter of an inch, but the average distance apart is about 2 feet, though often 4, and occasionally much more. These are crossed promiscuously by others having a tendency to a uniform arrangement nearly at right angles, and with a high northerly inclination. The granite here is chiefly of the character above first described; but close to the station, for a width of 100 feet, and a little farther north for 80 feet, it becomes porphyritic. The crystals of orthoclase vary from a very small size to quarter of an inch in diameter, and rarely to 1 inch. The dark colour is due to the presence of black mica in a finely divided form, but it is also present in larger scales. Hornblende exists also in distinct crystals, and there is a little iron pyrites. Quartz occurs both intermingled obscurely with the felspar and in the form of minute gray crystalline grains. The porphyritic granite (which is locally called "blue granite") gives place gradually, though rapidly, to the more common description ("white granite"). At the station it ceases abruptly against beds of micaceous and quartzitic schist, along the junction with which it has been quarried for the height of the section. This line crosses the bedding at a slight angle, a fact which is often elsewhere observed at the junction of the Silurian beds with the ordinary granite, even in cases where the metamorphic origin of the latter appears to be placed beyond all doubt.

The indurated rocks just spoken of form a band 62 feet wide, in which some of the beds have been converted into quartzite. Three similar bands occur farther north in the section, one of them 53 feet wide, and the others less. Some of the altered grits are hardly distinguishable from very fine granite, and examples occur here of masses of granite, a few inches thick, lenticularly enclosed in the schist. In all cases where such bands were observed the dips correspond with those which prevail in the adjacent Silurian district, and the bedding exhibits no such disturbed condition as should be expected to accompany the occurrence of an extensive mass of granite had it acted intrusively.

The porphyritic granite near Bessbrook resembles that at Goragh Wood, and like it occurs to a limited extent among that of the other description. It has been opened up in a large quarry, and furnishes stone for similar ornamental purposes, &c.

Reddish-coloured felspar is common in the granite in the vicinity of the Church, W.S.W. of Goragh Wood, and also in that which is exposed in the railway cuttings to the east, as, for example, east of Rocky Hill. Here the rock is evenly divided by

* The porphyritic granite at Goragh Wood is quarried for ornamental work, such as polished columns, monuments, &c., for which it is well adapted on account of the large unbroken blocks in which it can be procured, and its susceptibility of a high polish. The dressing is facilitated by a slightly schistose texture, which causes the stone to break most readily in a certain direction, coinciding generally with that of the plane of incipient foliation.

close joints, hading 60° E. 10°-20° N. In the adjacent cutting on the Newry and Armagh Railway the granite, which is deeply covered by drift, nearly disappears on the eastern side, while laid bare for about 25 feet on the other. This is owing probably to the cutting being situated on the side of the great fault which passes about here, the section at Goragh Wood being due to the same cause. The rocky space north-east of the Church contains Silurian bands in dyke-like masses in the granite. Similar examples may be seen in section in the cutting half a mile north of Goragh Wood, on the Newry and Armagh Railway.

A fine-grained clear whitish granite is quarried for gate-posts, paving stones, &c., north of Craigmore House, and in other places near. Small but well-defined crystals of hornblende are not unfrequent in it. In the railway cutting south of the road from Newry to Camlough some of the joints in the granite are coated with calcspar.

Between Camlough and the lake the rock is in a few places of a much coarser texture than usual. The mica is very abundant, and sometimes occurs in perfect hexagonal plates. That which composes the upper part of Camlough Mountain is close-grained and highly felspathic, and very regularly jointed. The felspar is to a great extent porphyritically imbedded in white irregular crystals, as at Goragh Wood, but the rock is here less quartzose, and its very felspathic nature causes it to weather away readily; the surface peeling off in thin white flakes. The mica is very finely divided, but there are larger scales thinly scattered. Thin veins of segregation are of frequent occurrence both here and generally in the granite south-west of Camlough Village.

North-west of the top of Camlough Mountain the granite contains gneissose bands merging into harder and more solid granite. Again, in the hill marked 746 feet, east of the mountain, where the granite is similar, though in places nearly losing its mica, there is an unmistakeable passage from micaceous schists, dipping N. 20° W. 70°, into foliated granite.

Indurated and micacized Silurian rocks, passing into obscurely foliated granite, occupy a narrow space along each side of the intrusion of elvanite in its course across Camlough Mountain. For nearly a mile eastward from the lake the stratification is distinctly preserved. Further east they take more commonly the form of massive quartzite.

The granite forming the south-western part of Camlough Mountain contains a large quantity of hornblende, the mica being sometimes almost absent. In this case it is described as "Syenitic granite." The hornblende decreases in quantity across Ballymacdermot, but it appears to be never altogether absent.

The granite flanking the elvanite hills is somewhat foliated, and in some parts very incompletely formed, one mass being often made up partly of little altered Silurian grit, existing either in thin flakes or in a more massive condition obscurely mixed up in the granite.

The hill about a mile south-east of Belleek, though chiefly formed of Silurian rocks, contains small patches of granite in its

lower part, on the north and east. Some, too small to mark on the map, are found along the road going south from the "Four-mile House." The larger patch near the elvanite is in some places incompletely metamorphosed. Dark gray and blue schists, passing into gneiss with a crumpled lamination, occur between this and the elvanite.

An analysis of the granite of Goragh Wood has been made by the Rev. Dr. Haughton with the following results:—*

Silica,	62·08
Alumina,	15·92
Peroxide iron,	7·72
Lime,	5·52
Magnesia,	2·16
Potash,	2·19
Soda,	3·34
Loss, &c.,	0·89
	99·82
Sp. gravity,	2·695

Diorite.

This rock occupies merely a small area at the southern margin, being a narrow projection through the granite, proceeding from a larger mass which occurs south-east of Cashel Lake, in Sheet 70.

It consists of a crystalline compound of hornblende and waxy-looking felspar, the crystals of the latter being in some parts very numerous.

Though the diorite here seems to be clearly of more recent formation than the granite, yet there appears to be evidence in the adjoining sheet that it was formed previously to the metamorphism of a portion of the Silurian rocks.

A small mass of diorite occurs south of Clay Lake, but it does not appear to come to the surface elsewhere. It consists of crystalline hornblende and felspar mixed together, the latter generally of a light flesh colour, and sometimes exhibiting the delicate striping of the plagioclastic felspars.

Micaceous Dolerite (of Slieve Gullion, &c.)

This rock is of a dull bluish gray colour, and varies considerably in texture, from very finely to coarsely crystalline. Black mica is frequently, and perhaps always present, but it can sometimes be recognized only in the disintegrated portions of the rock, when it becomes bronzy in colour. Of essential constituents the augite abounds in a largely crystalline form in the coarser varieties, and in the finer descriptions large detached crystals are not uncommon. Of felspar there may be different kinds, but the more conspicuous tabular crystals are probably of labradorite. Olivine, or what appeared to be such, can occasionally be detected, and the constant presence of magnetite is indicated by the readiness with which specimens act upon the magnet.

The dolerite nearly always exhibits a globular structure in weathering, and that often on a large scale. This internal

* Quart. Journ. Geol. Soc., Lond., vol. xii., p. 202.

arrangement can sometimes be traced throughout completely disintegrated masses of the rock.

On the western slope of Slieve Gullion, near the south of the Sheet, the dolerite is coarsely crystalline and micaceous. It is sometimes penetrated by veins from the neighbouring elvanite, while examples also occur in which the converse is clearly the case; so that, although in this immediate district the greater amount of evidence is in favour of the earlier formation of the dolerite, yet on the whole the two rocks may be regarded as contemporaneous.*

West of Calliagh Berras L. the texture becomes in part porphyritic, and the rock contains occasionally thin veins of compact basalt. On that part of the mountain which lies west of The Cottage the texture is in most cases finely crystalline, as also in the lower ground west of the main road, where the rock is largely exposed.

Six hundred yards north-west of the lake just named the dolerite appears in a prominent mass, having a north-easterly trend, with a precipitous face on the west, where the jointing is seen to be pretty regularly disposed in two principal directions, N.N.E. and E. and W., the former inclined westerly at 80°, the latter vertical.

The decomposed dolerite is exposed for several feet deep along the stream which flows down the mountain east of The Cottage. It is cut by a few dykes of basalt, or, probably in some cases, dyke-like portions of the undecayed rock, and also by veins of elvanite. It is in the form of a brown sandy earth, the particles of which have a flaky arrangement, and in many places it is of a very light colour owing to the quantity of felspar which remains not quite disintegrated.

Largely globular decomposed micaceous dolerite is well exposed in a quarry half a mile N.N.E. of The Cottage, overlaid by the elvanite, which forms a large boss to the east.

In the immediate vicinity of the elvanite, the dolerite is traversed by a large number of thin veins, which appear to be true intrusions from the former, as they bear an exact resemblance to others which are undoubtedly so. These may be observed in the steep plantation east of The Cottage, but they are very abundant at the north of it, close to the elvanite, where they often form a net-work through the hard dolerite.

Westward up the hill from the ruins of Killeevy Church the dolerite is highly crystalline and micaceous; and along a stream midway between that and Killeevy Lodge there are good sections, twelve to fifteen feet deep, which show the elvanite and dolerite in contact, both appearing to act intrusively, but the former unquestionably so, the result being the tongue-like protrusions marked on the map.

The dolerite which forms a patch at the north of Camlough

* This agrees, so far as these rocks are concerned, with the conclusion already formed by Professor Haughton, that the granitic and the syenitic trap rocks of the Carlingford district (including Slieve Gullion), are practically contemporaneous.—Journ. R.G.S.I., vol. iv., p. 3. (New Series).

Mountain is in some parts of a light colour, the felspar and augite appearing to be in equal quantity, and coarsely mingled. It is in general, however, darker, and the constituents more finely divided. It weathers light brown, with crystals of augite sometimes projecting from the surface.

Elvanite (Quartziferous Porphyry).

The elvanite composing the upper part of Slieve Gullion is frequently laid bare near the summit, but lower down is greatly concealed by a shallow covering of soil overgrown with heath. It occurs chiefly in flat or gently rounded bosses, weathering almost white, and traversed by regular joints, generally in two prevailing directions, which continue more or less persistent over the whole area. One system gives the appearance of bedding inclined north-westerly at 40° to 80°, and these are crossed by others at angles of about 100°.

The elvanite is finely crystalline granular, consisting of a felsitic paste, enclosing crystals of felspar, grains of quartz, together with minute hornblende, and in some instances black mica, crystals. Thinly scattered prisms of hornblende are also generally to be found. On close examination the quartz is seen to occur to a great extent in small blebs or crystalline grains, but it is sometimes difficult to distinguish them. In a few instances, as, for example, half a mile east of Calliagh Berras L., small but very perfect double six-sided pyramids of smoky quartz were found. North-west of the lake the rock in part becomes coarser, and like a close granite with plenty of black mica, while north of this again, at the parish boundary, it is extremely fine-grained. Half a mile north-east of the lake it is also in some places coarse and very granitoid, the same being observed in the tongue-like masses to the east. Down along the stream midway between Killeevy Lodge and the old church it is in some parts so compact and siliceous that upon first acquaintance one might fail to identify it with the felspathic rock higher up.

The elvanite throughout the area which stretches westward from Cam Lough is chiefly of a fine texture, but contains many comparatively large crystals of felspar, which in weathering out give the rock a pitted surface. The quartz can often be easily recognized in small grains. Here also the joints are numerous and regular, and have the same general bearings as those already noticed south of this. Along the southern boundary the elvanite forms sharp elongated bosses projecting into the dolerite, and separated from one another by narrow ravines thirty or forty feet deep. South of this, isolated patches stand out also, with more or less prominence, from the surrounding dolerite. These are portions of intrusive masses laid bare and weathered.

The intrusive character of the elvanite in contact with the dolerite is well seen at about a quarter of a mile W.S.W. of Calliagh Berras L., where, along a highly inclined face of the latter rock a vein of the former, visibly two feet six inches wide, sends out strings which vary in size from mere threads to four inches

thick. Another good example occurs at the junction of the two rocks, upwards of a mile west of The Cottage, where a dyke from the elvanite, several yards wide, sends off similar branching veins.

Protrusions of elvanite into granite may be seen to advantage at the road-side about a mile and a half west of the top of Slieve Gullion, where at one point two veins, six to twelve inches wide, of finely granular rock, varying in colour from light gray to a darker bluish gray, branch through the granite from a larger mass. The granite has an overhanging surface, from which the dyke has been stripped away, leaving it closely studded over with small angular projections of the elvanite, a circumstance frequently observed in the district. Other examples are found east of Garvagh L., where numerous veins, from six inches or less to four or five feet wide, are projected into the granite, in directions often nearly horizontal. This tendency to a horizontal course is common in the elvanite veins, and may be noticed in some of the larger dykes of quartziferous porphyry. Irregular veins of very compact elvanite, from a few feet wide to 80 yards, occur in the granite north-east of Garvagh L.

In following the course of the elvanite across Camlough Mountain, and south-west along the hills from the northern end of the Lough, different varieties as to texture and composition are met with. The more compact form is generally a hard felsitic mass, bluish gray in the interior, but weathering light, and often containing many distinct crystals of felspar, which weather out on the surface in lighter shades of pink and brown. In this condition the rock passes into an ordinary felstone porphyry. In many places these crystals are crowded together so as to make up nearly the whole mass. Where they are more sparingly distributed, crystalline grains of quartz are generally detected with ease, and in some spots these are very numerous, and give the interior a finely mottled aspect. Examples of this occur on Ballymacdermot mountain, where also the hornblende, which generally exists in small specks, becomes occasionally developed. Some miles west of this, at the E.N.E. of Garvagh L., the rock becomes extremely compact, glistening with fine blebs of quartz, imbedded in a dark felsitic matrix which weathers white, with a porcelanic appearance.

On Sturgan Mountain and Sugarloaf Hill, N.W. of Camlough, the elvanite, which is there for the most part compact, becomes more granular in the upper portions, and west of the small lake on the former hill it is of a rich light brown colour, finely speckled with particles of hornblende, while the grains of quartz can rarely be seen except on the weathered surfaces. It is here divided with extraordinary regularity by joints hading N. 20° W. 45°, and breaks up in thin even slabs.

Mica in a well developed form is of rare occurrence in the elvanite, but small perfect black scales of this mineral were noticed in the valley south of Davitt's cross-roads. East of this valley, on the hill marked 920 feet, the rock is compact, abounding in crystals of felspar, many of which are as long as half an

inch, with quartz blebs and crystals, from a very minute size to one-fifth of an inch in diameter.

Dykes of quartziferous porphyry exist in the granitic and Silurian districts. There seems to be no reason to doubt that these are connected with the elvanite mass below the surface, to the various compact forms of which they bear a strong general resemblance. The granite between Camlough and the lake contains veins from a few inches to several feet wide, some precisely similar to those which proceed directly from the large mass, others differing from them by the appearance of mica. The conspicuous dyke which bears E.N.E. from the eastern side of the lake, presents various forms, being in some parts composed of a finely granular felstone with a little imperfectly developed mica; in others it is an extremely fine granitoid felstone porphyry, containing crystals of orthoclase, scales of black mica, and grains of quartz. The interior generally, however, is like the more granitoid specimens of elvanite in the large tracts. Close to the granite it is often schistose, this texture being very clearly marked. The average width of the dyke is 5 feet.

The dyke of quartziferous porphyry in the railway cutting on the main line, south of Goragh Wood, is about 8 yards wide, and consists of a hard light gray felsitic base, faintly streaked with red and green shades. It contains many crystalline grains of quartz, and a few crystals of felspar; also short prismatic crystals of a dull dark mineral which may be hornblende. The dyke does not appear on the east side of the railway, but occupies part of the western slope of the adjacent cutting to the east, for a depth of 25 feet, the rocks about here having evidently been disturbed by the fault hard by. Fragments of dark greenish pitchstone were found in a crevice in the granite opposite the dyke on the main line.

In the railway cutting south of Gerald's Pass a flatly inclined dyke of quartziferous porphyry cuts through granite, and appears there in a wedge-shaped form, sloping up gently northward, and dying away to a disintegrated mass 1 foot thick, with the granite above and below it. It occupies the whole depth of the cutting for more than 40 yards in length, exhibiting a distinctly columnar structure from the regularity of its joints. The rock is chiefly of a greenish gray colour, breaking with a rough fracture, and speckled with blebs of quartz and crystals of felspar, the latter being generally a good deal decomposed. This dyke appears at different places at the surface in the Silurian area, exhibiting varieties of texture according to the distribution of the quartz grains and felspar crystals. Of the former, those of larger size often retain indistinctly the shape of double six-sided pyramids. In its partially disintegrated state the rock is divided into small columnar masses cut by transverse planes, which structure, when exposed endwise at the surface of the ground, produces the appearance of a fine irregular pavement.

The changeable character of these quartziferous porphyries may be studied in tracing the dyke which cuts through granite in a pit at the road-side a quarter of a mile E.S.E. of Camlough. Here

it is weathered away to a soft granular felspathic rock of light brownish gray colour, glistening with fine spangles of light bronze-coloured mica, and containing very small grains of quartz, with dark particles which appear to be hornblende. North-east of the church, where it is less disintegrated, it is a finely granular quartziferous riband porphyry, with a few felspar crystals, and having a finely spotted texture. A section close to the corn mill shows it to be 7 feet wide, and here it is closely spotted with small crystals of felspar in a darker base, and contains thinly scattered minute quartz grains, and a few scales of black mica. Where decomposed it resembles the soft felspathic rock in the pit at the road-side. It also appears in the yard of the flax mill where it is in part compact and finely spotted, and in part close grained and granitoid. In the latter form it occurs in wide connected veins in the granite at the north of Camlough school-house, where, besides black mica and flesh-coloured crystals of orthoclase and quartz grains, small crystals of triclinic felspar were discerned.

Felstone Porphyry.

This term is applied to the rock which forms a hill at the east of Cashel L., at the south of the sheet. It graduates from the elvanite, from which it here differs little, consisting of a light bluish felspathic base containing crystals of quartz and orthoclase, with hornblende, and sometimes black mica. As it is traced southward, however, into Sheet 70, it assumes a quite distinctive character. It is accompanied by an agglomerate, which shows that it was protruded at or near the surface, and is therefore to be distinguished from the elvanite, which, though forming part of the same mass, was cooled at a greater depth.

The dyke of felstone porphyry on Camlough Mountain is little exposed *in situ*. It is a compact, tough, dark gray rock, containing many crystals of orthoclase, and weathering quite white.

Volcanic Agglomerate.

This rock, which has just been referred to as being associated with the felstone porphyry in the ridge S.E. of Cashel Lough, is here too imperfectly seen to afford a true idea of its nature; but it may be generally described as a felspathic paste containing fragments of the neighbouring rocks, quartz porphyry, granite, diorite, Silurian slate, &c., confusedly mixed together, but having one kind sometimes so greatly predominating, as to make it difficult to recognize its fragmentary character. It will be described in more detail in the Memoir to accompany Sheet 70, in which district it is fully developed under strange and varied forms.

Felstone and Minette.

Dykes of felstone and of minette (or mica-trap) are met with cutting through the Lower Silurian beds. The felstones are finely granular, chiefly of a pale colour, weathering light brown, and sometimes containing iron pyrites. The minette contains black mica, with crystals of felspar, in a pinkish gray felspathic base. In one example the mica is in small colourless hexagonal scales.

It is impossible to say anything with regard to the age of these rocks, except that they belong to a later period than this stage of the Lower Silurian formation, none of them being found interbedded.

In the railway cutting two miles west of Castleblayney two dykes penetrate the Silurian grits and shales. One of them, 1 foot 2 inches wide, consists of a dark gray felspathic rock with a few scales of light-coloured mica. The other, 2 feet 6 inches wide, is a very tough light gray close-grained felstone with minute cubes of iron pyrites. The dyke in the bed of the river Callan, near Mill-view House, resembles the latter.

The dyke at Carrickaslane Lough, three miles N.N.W. of Castleblayney, is a finely granular felstone of a light bluish gray colour, weathering white, and occurs in bosses a few yards wide. East of the road it is partly exposed in section, together with blue fissile shales, along the bedding of which it appears to have been here protruded.

The felstone dyke 2 miles north-west of Belleek is exposed in a quarry west of the road, cutting through dark pyritous shales and thick grit beds. It is 5 feet 3 inches wide, and has a course nearly along the bedding. North-east of this it appears with a width of 10 feet, and it here seems to have been protruded along the plane of bedding. This rock is a bluish gray finely granular mass with a little iron pyrites.

Mica-trap occurs in a boss of Silurian rocks three-quarters of a mile east of Prospect House, near the north-west of the sheet; and again in the bed of the White Water, half a mile N.W. of Newtown Hamilton. In the former case it is finely crystalline, of a pinkish brown colour, and contains rhombic scales of black mica, weathering bronze-coloured: in the latter it is compact, and the mica is in small colourless scales, some of which are perfectly hexagonal.

In the small tract of Syenite S.S.W. of the summit of Slieve Gullion, and in another locality one mile and a half west of the same point the rock contains a large quantity of slender acicular crystals of a bronze colour which are most probably Disthene. This remarkable rock is described by Professor Hull in his Microscopical Notes.

Basaltic Dykes of various ages.

Of the numerous basaltic dykes which traverse this part of the country, while many are manifestly of more recent date than the elvanite, which they are seen to penetrate, instances occur in which they end abruptly at its margin, and have, therefore, been irrupted previously to its formation. Only one well-marked example of this occurs here, namely, at the south of the elvanite, north of Heath Hall, but it is more conclusively seen in the sheet to the east (Sheet 60). Occasional thin veins of basalt occur in the dolerite of Slieve Gullion, and a dyke of porphyritic dolerite containing nests of marcasite penetrates the felstone porphyry at Cashel plantation, east of the hill near Cashel Lough.

Of the age of the basaltic dykes little further can be said; but

it seems natural, bearing in mind the distinction as to age of those in the Mourne and Carlingford districts,* to suppose that the older here may be contemporaneous with those of supposed carboniferous age in that area, while the others, and that probably the greater number, represent the great volcanic outburst which took place during the Miocene period.

A few of the most interesting examples in the granite, Silurian rocks, and elvanite shall be here noticed.

South-east of Garvagh Lough, a dyke of dark bluish tough spheroidal dolerite, several feet wide, traverses the granite and elvanite, and sends veins of a few inches in width into the latter.

The dyke running nearly east and west between Heath Hall and Ballymacdermot is about 20 yards wide where it crosses the road, west of which it decreases to 4 feet. It is compact, with many imperfect crystals of white felspar, which in weathering out leave the surface pock-marked. In some parts these crystals are almost absent, and then suddenly become numerous, the change being distinctly marked along well-defined lines. At the north side of the road the rock becomes largely porphyritic, with crystals of augite and felspar. One of the former was found to measure very nearly two inches in length, and one of the latter one inch and a half, but such cases are exceptional. North of Heath Hall it contains a little iron pyrites, and here it cuts across a vein of felstone. It again appears with a width of 6 yards farther to the east.

The dyke in the granite immediately south of the top of Ballymacdermot is, in its greatest exposed width, 16 yards across. It is porphyritic with crystals of glassy felspar, and weathers with a dimpled surface.

West of Hill House the railway cutting contains dykes of various widths, from a few inches to several feet, cutting through the granite. These are generally compact or finely crystalline. A section close to the more northerly of the two bridges shows the basalt to be compact for 2 feet from the outside, and to become crystalline in the interior.

A tolerably perfect columnar structure is exhibited in some of the basalt dykes, as for example, near the meeting-house three miles north-east of Mount Norris. Here the rock is compact for 2 feet from the walls of the dyke, and finely crystalline inside, with a columnar structure at right angles to its course. Its width is 20 feet. A rude columnar structure is also apparent in the dyke which runs nearly east and west by Castleblayney, as is seen in a quarry a mile and a quarter west of the workhouse, where it has a width of 15 feet.

The mining district is traversed by several dykes of basalt, one of which is traced for a considerable distance into the drift-covered country to the east, by its occasional appearance in the lower grounds. At the road side, south of Glencarn, it is well seen in a quarry, cutting across gray flags and schists, having a width of

* Demonstrated in a paper communicated to Section C., Brit. Association, Edinburgh, 1871, by Professor Edward Hull, F.R.S., and W. A. Traill, B.A.

10 feet, and weathering spheroidally. At half a mile south of Blackquarter Fort its southern wall is exposed along a fence, for a height of 7 feet, and shows a columnar structure. The branch from this is seen in a section by the road south of Blackquarter Fort, where it has been quarried. Here it is a highly crystalline rather light coloured dolerite, with large crystals of glassy felspar, and weathering away to flatly rounded masses, and in part to small sandy nuclei, and then to a greenish earth. The olivine here, and in some of the dykes before described, was visible to a small extent.

Of the three dykes that are shown south and west of Carrigatuke, the most northerly is a coarse and largely porphyritic dolerite, and appears in a mass 14 feet wide up the rising ground east of the road. The central dyke is probably the same which occurs in the White Water near Newtown Hamilton, where it is seen in widths varying from 9 to 30 feet, among Silurian flags. It is finely crystalline, of a bluish colour, and in parts vesicular and amygdaloidal.

The course of the dyke which crosses the road at 700 yards north of Armaghbrague House is particularly well marked. East of the road there it is exposed in a quarry for a thickness of nineteen feet, its total width being about twenty-eight. The outer eastern portion for nine feet consists of dark compact basalt, weathering to spheroidal balls. In the remaining ten feet it is coarse, and abounds in large crystals of glassy felspar, and weathers to large flatly rounded masses. West of Carrigatuke this dyke can be traced for 700 yards in a broken ridge, and further on for 300 yards, where it shows a thickness of five yards. In the bed of the River Callan, south-east of Glenville House, the dolerite is also porphyritic, and becomes very compact in the outer portions. It is in part finely vesicular, some of the cavities being filled with faintly opalescent quartz.

Bedded Basalt (of Tertiary Age).

The inconsiderable area of basalt which projects into the map at its northern margin belongs to the great sheet that overspread a large part of the country during the Miocene Period. Little can be learned here from the obscure way in which it occurs, but the rock is more extensively exposed in the adjoining sheet (No. 47). Its position immediately above the Silurian rocks indicates that it belongs to the Lower Basalt, to which, as seen to great advantage throughout the counties of Antrim and Derry, its bears a general resemblance in its amygdaloidal character and in the beds of bole which it contains.

The basalt appears at the surface in a decomposed condition at a house close to the northern edge of the map, half a mile west of the railway, and was reached in a well at half way between that and the National school, and in one or two other places.

Post Pliocene (Drift).

With the exception of a few patches of stratified sand and gravel, which are of too small extent to be marked separately on the map, the drift which overlies the rocks in so considerable a quantity belongs to the Lower Boulder-clay or Till, and consists of clay possessing different degrees of stiffness, and generally abounding in gravel and large rounded and subangular fragments of the rocks of the country. Lower Silurian blocks, many of which are worn and scratched by ice, are always to be found, and occasionally limestone, mica-schist, and diorite; but in any given locality fragments of the subjacent rocks are the most abundant. The patches of sand and gravel are probably remnants of the interglacial beds, or those which were formed by marine agency between the periods of the Upper and Lower Boulder-clays.

The mounds formed by the drift generally have an evenly rounded outline, and especially those detached hills or *drumlins* which in some parts give a special feature to the surface. About Castleblayney, however, and through the surrounding district, their sides are frequently less curved, and unite at top in a blunt ridge, the outline of which is more or less broken.

The best openings into the Boulder-clay are in the natural sections along the banks of the larger streams, as the Ballymacone and Corran rivers, north of Carrigatuke, where the compact clay overlying the Silurian rocks contains a few fragments of limestone resembling that in the Armagh district, in addition to those of basalt and Silurian grits.

Large polished and scratched Silurian blocks are found in the railway cutting west of Mullaghmore Lough, with a few rounded basalt boulders.

The clay of the drift, cleared of the larger stones, is in some places used to a small extent for making bricks of an inferior description; but tolerably good bricks are made near Castleblayney from a dark bluish stiff clay which appears to exist as a thin band in the boulder-clay.

Vestiges of the Boulder-clay were observed *in situ* at a height of about 1,100 feet up the slopes of Slieve Gullion, in the form of rounded and ice-scratched Silurian pebbles and boulders in a shallow covering of clay over the dolerite.

A small irregular mound, composed of coarse gravel and small boulders obscurely stratified with a little sand, is heaped against the Boulder-clay in Annyart, near Castleblayney, and contains the following descriptions of rock, the names of which are here arranged approximately according to their relative proportions:—Lower Silurian rocks, most numerous, many of the boulders somewhat ice-scratched; Carboniferous sandstones, resembling the Calp sandstones at Benburb (Sheet 47); Carboniferous limestone; Carboniferous and Permian conglomerate; basalt; mica-schist; syenitic and various felsitic rocks; fragments of chalk, chalk flints, hard red shale, &c.

Fine closely compacted and distinctly laminated sand, containing a few seams of clay and gravel, is opened up in a large pit half a mile south of Vermont, near Keady.

Sections along the stream east of Connstown, south of Newtown Hamilton, expose very regularly bedded and finely laminated bluish sandy clay, resting on the contorted Silurian rocks, fragments of which they contain. These are overlaid by beds of sand with clayey layers, some of the former being quite hardened by the percolation of water charged with iron. The stratification dies away at top into an amorphous gravelly boulder-clay, containing glaciated Silurian blocks.

A few other localities might be noticed, where the stratified sand and gravel rests against hills of Boulder-clay, but the above will suffice. The bedding is often irregular, and some layers obliquely laminated, but there is, notwithstanding, a general arrangement uniformly sloping down towards the lower ground. No traces of shells were discovered in these deposits.

Recent (Bogs and Alluvial Flats).

There is little requiring special notice in connexion with these. The bogs have all been to a great extent cut away, and are in no case of great depth. The largest, lying between Newtown Hamilton and Belleek, covers up low swellings of drift, and fills the spaces between larger mounds. In the country which extends from Carrigatuke to the mining district in the west, many of the bogs are of upland formation, but the most extensive occupy low-lying hollows eroded in the rock, which afforded shallow basins for the stagnation of the drainage and the gradual accumulation of peaty matter.

The alluvial flats, the largest of which are along the courses of the Newry Water and the Cusher and Cullyhanna rivers, consist of brown loamy alluvium, sometimes containing layers of gravel or shingle.

Bog iron-ore was found below a thin covering of alluvium along a small stream one mile and a quarter N.N.E. of Muckno Mill L.; also in large lumps in a mill-race S.E. of Carrickaslane Lough, and in a stream 600 yards south of the same lake. It was also observed along the river south Muckno Mill Lough, and west of the corn mill.

Notes on the Microscopic Structure of the Rocks.

1. *Micaceous Dolerite of Slieve Gullion.*—This is a largely crystalline granular rock, in which the minerals augite, felspar, and bronze-mica are distinctly visible to the naked eye. A sap-green mineral is occasionally present, and the rock is much iron-stained in the interior—due probably to the decomposition of olivine.

With 2-inch objective, the rock is seen to consist of long plates and prisms of plagioclase (Labradorite?), some light-brown pyroxenic mineral (Augite?) without crystalline form, deep brown and greenish mica with scarred structure, numerous rounded grains of olivine, black angular grains of magnetite, and a little of a diffused yellowish-green mineral without structure, we may assume to be epidote, which is of secondary origin; in all some six minerals. Besides these there occurred a solitary example of orthoclase.

With polarized light the thin slice presents a very beautiful appear-

ance, as the felspar, pyroxene, and olivine polarize vividly, and display various tints and colours on rotating the analyzer. The olivine grains are generally decomposed round the margin, which are bounded by a deep fringe of brown; but in the central portions the mineral retains its crystalline state, and polarizes from sap-green to ruby-red, as is characteristic of it. The mica undergoes the following variations in colour on rotating the analyzer:—

Specimens.	Prisms parallel.	Angle 45°.	Angle 90°.
No. 1, . .	Light bronze,	Deep umber,	Reddish bronze.
No. 2, . .	Sap green,	Pale bluish green,	Crimson to yellow.
No. 3, . .	Golden yellow,	Gray,	Blue to purple.

The Rev. Dr. Haughton gives the following chemical analysis of this peculiar rock,* under the name of "Massive Syenitic Trap Rock, west base of Slieve Gullion":—

Micaceous Dolerite of Slieve Gullion.—Chemical Composition.

Silica, ...	53·28	Potash, ...	2·04
Alumina, ...	13·28	Iron protoxide, . .	4·08
Iron peroxide, . . .	10·52	Manganese protoxide, .	0·80
Lime, ...	7·42	Water, ...	1·00
Magnesia, ...	4·45		
Soda, ...	3·03		99·90

Micro-crystalline granular Syenite, southern flank of Slieve Gullion—Consists of felspar, quartz, black mica, and hornblende, with numerous long glistering crystals of disthene, traversing the rock in every direction. The rock is allied to elvanite, the felspar and quartz being abundant, and it belongs to the group of felspathic rocks in which the hornblende seems to be represented by disthene.†

With the 2-inch objective, the rock is seen to consist of quartz, felspar, hornblende, mica, magnetite in large black patches, and disthene in long light-yellow prisms with uneven sides; with a magnifying power of 350 diams. a group of three crystals of olivine, showing the characteristic polarization, was brought clearly into view. The occurrence of this mineral in a rock of the class here described is exceedingly rare, and was a source of much surprise to myself.

The Mineral Disthene (Kyanite).—This mineral occurs in glistering brown and greenish prisms passing through the rock in various directions. When magnified the prisms are either colourless or of a brownish to bluish tinge, with a parallel band along the sides and another in the centre—probably produced by the truncated angles of the prisms. The terminations are blunt or irregular. With the polariscope the following variations of colour were observed in rotating the analyzer—(*a.*) golden yellow to green, (*b.*) paler do., (*c.*) variegated colours, purple, blue, and red mixed. The behaviour of the mineral under the polariscope sufficiently distinguishes it from hornblende.‡

The thin slice of rock on being examined under a magnifying power of 225 diams., showed some curious results. The silica was seen to contain cells with fluid bubbles, and numerous long slender prisms with blunt angular terminations, but bevelled in one direction. These prisms are prolonged into the felspar, and are, sometimes, of great length and perfectly straight. Though generally colourless they are sometimes dis-

* Journ. Roy. Geol. Society of Ireland, vol. iv., part 3, p. 95.

† The mineral was kindly determined for us by Professor O'Reilly of the Royal College of Science, from a specimen procured by Mr. Nolan.

‡ The chemical analysis by Arfvedson gives the following curious result:—Silica, 34·33, Alumina, 64·89. A little iron is probably the colouring matter.

tinctly brownish. I was at first uncertain regarding the nature of these minute prisms, supposing they might be those of apatite, but on Mr. Hardman determining the absence of phosphorus in the rock, I conclude they must be minute prisms of disthene itself, and from their relations to the other minerals, were evidently the first to crystalize.

A description of the microscopic structure of other rocks in this and adjoining districts to the south and east will be found in the Memoir to accompany Sheets 70 and 71.

E. H.

Fossils from Sheet 59.

The fossils found in the Lower Silurian rocks of this district consist solely of graptolites, determined by Mr. W. H. Baily, as follows :—

Didymograptus sextans, from the townlands of Ballenan, in dark gray slates; Ballydoherty, in black indurated slates in the railway cutting E. of Loughgilly; Lisnagree, in dark gray slates in the railway a little N. of Laurel Hill; Kilrea, in slates in railway about 2 miles N. of Goragh station; Pattinlieve (co. Monaghan), in stream, 4 miles N.E. of Castleblayney.

Diplograptus pristis, in the same localities as the above, with the exception of the first.

Graptolithus Hisingeri, from Lisnagree, and *G. Sedgwickii*, from the same locality.

W. H. B.

CHAPTER III.

Mines, Minerals, Principal Faults, &c.

Workings for lead ore were, from time to time, opened in various localities, but the operations have been in all cases discontinued.

The most extensive appear to have been those of the Tassan mine, N.N.W. of Castleblayney, which were carried on chiefly between 1854 and 1861.* There are two principal lodes, nearly parallel, and underlying to the east. The workings on the main, or more easterly lode, are said to have extended under Tassan L., and to have reached the depth of 80 fathoms. Both are also said to be intersected by many minor branches, in most cases making ore at the points of junction.

A lead mine was opened more than thirty years ago in Coolartragh,† N.N.W. of Tassan, and the work carried on for some years. After a cessation it was resumed, and an engine erected, with dressing-floors, &c., the object being to extend operations north and south of the former workings. This was, however, abandoned. The engine shaft is said to have cut the lode at 30 fathoms, and a large and valuable amount of ore is supposed to remain yet unextracted. This lode is considered to be identical with the main Tassan lode. It has an underlie to the east at 2 in 6, and its course appears to have been proved beyond doubt both north and south of the main sinking. The matrix here is chiefly quartz, with some

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* Discovered and worked by Joseph Backhouse, Esq.—Griffiths' *Catalogue of Irish Mines* (1854).

† Argentiferous Lead with zinc, and sulphate of Barytes, worked by W. Conn, Esq. —*Ibid.*

carbonate of lime; and a considerable quantity of blende (sulphuret of zinc) is said to occur along with the lead.

The lode in Lisdrumgormley, passing nearly a quarter of a mile east of the height figured 632, is supposed, on good authority, to be still rich in argentiferous galena, embedded in a matrix of quartz and carbonate of lime. The underlie is 3½ in 6 to the east, and the thickness, so far as it is known, from 2 to 9 feet. This lode, which comes to the surface at the main working, is said to have realized a large profit at depths not exceeding 25 fathoms.

At a point south-west of the last named locality, and in the townland of Lemgare, three shafts were sunk on a nearly vertical lode of lead, supposed to be the same as that at Annaglogh, three-quarters of a mile to the S.S.E. It has not been found north of the former place, being probably intercepted by the basalt dyke which passes there, and which appears to cross the Lisdrumgormley lode without breaking its continuity. The Lemgare lode has been profitably worked at Annaglogh. It hades easterly at 1½ in 6, and is joined from the north by another, also hading easterly at 2 in 6. A shaft at the junction reached rich ore at 17 fathoms. The lode is supposed to be thrown northwards by a cross-course about 4 feet wide which exists as indicated on the map, as all trace of it is lost farther to the east. It is believed to have been proved 160 yards farther north.

The rocks traversed by these lodes are chiefly thick beds of Silurian grit, often abounding in veins of quartz. The gangue is principally quartz, with occasionally carbonate of lime; and the débris at the surface, especially at Annaglogh, contains carbonate of lead. Sulphate of baryta, though abundant in the lodes south of Castleblayney, appears to occur but rarely in this part.

The remains of ancient workings are seen at a point between the Lemgare and Annaglogh shafts. A ruined engine-house marks the site of a lode of galena (lead) said to range north and south, with an easterly hade, in Croaghan, south of Tassan L; and in Clare Oghill, at the edge of the map, nearly due west of Castleblayney, a similar lode was at one time worked. Some of the shafts here remain partly open. A lode of lead is reported to have been discovered in Grig, north-east of the last named townland, and to have been also struck near the railway bridge, south of this.

The localities hitherto mentioned are in the county Monaghan. The following are in Armagh.

The lode at Drummeland,* three and a half miles south-west of Keady, is said to underlie westerly at 45°. A depth of 35 fathoms was reached, the lode having been cut at 20. The operations here ceased in 1842, having been carried on by the Mining Company of Ireland. The gangue is quartz, and it contains a considerable quantity of blende. Other shafts were sunk along its course, and the débris lying at them consists chiefly of black shale and gritty fragments, with traces of blende, mundic

* Worked by the late Lord Farnham many years ago. *Sup. cit.*

(iron pyrites), and galena. The site of an ancient shaft is pointed out at a quarter of a mile eastward, at the south side of the road.

Two lodes of argentiferous galena run nearly north and south along the east side of Carryhugh Glen, W.S.W. of Keady. They are known as the "Blue" and "Red" lodes, from the prevailing colours of the contained matter, that of the eastern lode being dark and earthy, with blue shaly débris, while the other is more gossany or ferruginous. A winze opened on the former exposes it to the surface with an underlie of 70° eastward. The gangue is quartz, with strings of calcite, and it is said to contain mundic in large quantity, with a little blende. The lodes are stated to average about 9 feet each in thickness, and are supposed to unite as shown on the map.

Mining operations for lead ore, now many years abandoned, were carried on at the north-east of Straghan's Lough, near Clay Lake, but no reliable information about the position of lodes, &c., is forthcoming.

A lode of galena was worked some years ago at New Holland, near Keady. It seems to be probably the same that was struck at a point east of the road in Darkley, half a mile north of the Spinning Factory, and worked for a short time.

A shaft was once sunk 10 fathoms at the north-east of Tullynawood Lake, to a lode of lead. It is supposed to have a south-westerly bearing, and to be represented by a fissure at the edge of the lake, containing débris with mundic, and underlying north-westerly at 30°.

A lode of galena is said to have been proved along the stream forming the western boundary of Finiskin, a mile and a quarter north-east of Cullyhanna, and to underlie eastward at a high angle. Particles of copper ore are stated to have been also found.

At a mile north of Belleek, in Carrickgallogly, workings for lead ore were carried on about thirty years ago, and the sites of four shafts may now be seen. The débris, which is derived chiefly from shales, was found to contain fragments of galena, in a matrix of quartz, with a little iron and copper pyrites.

In a glen at the west of Gerald's Pass, north of Goragh Wood, there is a shaft which was sunk many years ago to a lode said to be rich in copper ore.* The depth is given as 106 feet, with a level along the lode for some distance to the north.

Faults.—One is struck with the uniformity that exists between the almost universal N.N. Westerly bearings of the faults in the south-east of the sheet, and the prevailing courses of the basalt dykes in the Silurian area; and it seems probable that these dykes have been intruded during some period of great volcanic activity, along lines of weakness presented by a nearly parallel series of fractures extending over all this portion of the country. On this supposition the majority of the basalt dykes throughout the sheet are of more recent formation than the elvanite, and probably contemporaneous with those that penetrate that rock, and therefore

* Also called Kilmonaghan mine. Catalogue, *Supra cit.*

not improbably of Miocene age, as already suggested with reference to the latter class. (Page 20.)

The fault which passes through Cam Lough, already briefly noticed in connexion with the lake basin, has been accompanied by an upthrow of the granite, elvanite, and dolerite on the west side. The more deep-seated rock has consequently been there exposed by denudation, as seen, for example, in the elvanite, which on the east of the lake is narrowed down to a mere dyke, with a texture more compact than the wider portion. The dolerite has not been laid bare on the east side, but appears from below the granite at the east of Camlough village. The elvanite, also, which ends against the fault south-west of the village, does not reach the surface in the intervening area, but it seems to be represented there, and its proximity indicated, by the extraordinary number of veins proceeding from it through the granite. The amount of the throw is quite uncertain, but it is no doubt considerable.

The course of the fault which crosses the elvanite at the south of Garvagh L. is there marked by a hollow having a steep rugged slope on the west side, where the ground rises upwards of 300 feet towards the level of the hill marked 920 feet. The surface east of the fault is much lower and more gradual in its ascent, and thus is formed one of the irregular breaks that are of such frequent occurrence on a smaller scale in the outline of these hills. The features of this fault can be traced southward into the next sheet.

The fault passing by Davitt's cross-roads shifts the elvanite boundary more than 2,000 feet, and runs along a very conspicuous ravine through the hills. The eastern branch is marked by a steep face along which the elvanite is exposed in regularly jointed but greatly broken masses, the joints being mostly inclined about S. 20° E. at 40° to 65°, one of the few exceptions to the usually high N.N. Westerly inclinations.

Ice-markings.—The effects produced by the passage of the ice-sheet over the country are clearly seen in the more elevated parts in the worn and striated condition of the rocks, and in the ice-moulded contours of some of the hills. The latter may be observed on the Silurian hills in the district south of Belleek, and the general rounding of the surface is more or less perceptible in the highest points, not excepting the top of Slieve Gullion. In a few cases the striæ are very well preserved, as, for example, close to the market-house in Castleblayney, where the rock comes to the surface of the street. Delicate scratchings were observed elsewhere in the town below a little drift.

The tolerably shallow basin of Muckno Lake, probably owes its origin in a great measure to glacial erosion, although it is now surrounded in most parts by a deep deposit of drift or moraine matter. Striæ are found on the small rocky island S.S.E. of Otter Island, the latter being also formed of rock. In the low ground stretching away N.N.W. of Castleblayney, the trend of the drift mounds coincides very uniformly with that of the striæ in this part of the country. These markings are distinctly retained on the island just alluded to, though they are frequently covered by

water; and the same fact is observed at Tullynawood Lake and others.

The glaciation of the surface is well marked up the side of Camlough mountain, east of the lake; also at the north of the latter, where some of the granite bosses are worn into *roches-moutonnées*, and in many of the localities where striæ are indicated on the map.

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FRONTISPIECE.

General View of the Mourne Mountains from the North.

Slieve Muck. Slieve Mweel Beg. S. Mweel More. S. Bernagh. Slieve-na-Glough. Slieve Bingian.

The Mountains of Mourne from vicinity of Hilltown, looking S. and S.E.