

# Memoirs of the Geological Survey.

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## EXPLANATORY MEMOIR

TO ACCOMPANY

SHEET 19 OF THE MAPS

OF THE

GEOLOGICAL SURVEY OF IRELAND,

BY

F. W. EGAN, B.A.

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## P R E F A C E.

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WITH the exception of a small portion along the eastern margin, surveyed by Mr. W. A. Traill, the geological survey of this Sheet was executed by Mr. F. W. Egan, the author of the Memoir—between the years 1878-81—and was on several occasions inspected by myself during this time. By far the larger portion consists of sheets of the “Lower Basaltic Series,” but the small outliers of the “Upper Basalt,” with the underlying bands of iron ore at Tully Hill, Pharis, &c., show that the upper sheets of augiticlava have been originally spread over the whole of the region now occupied by the subordinate sheets, stretching at least as far westward as the hills of older metamorphic rocks, which form the western portion of the district. The position of the “Lower Basalt” on the summit of Carntogher Hill, at an elevation of 1,521 feet, and the great dislocation which ranges to the westward of this line of hills, is suggestive of the important terrestrial movements, and the extent of the denudation to which this district has been subjected since the Miocene Period.

EDWARD HULL, *Director.*

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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## SHEET 19 OF THE MAPS

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## GEOLOGICAL SURVEY OF IRELAND.

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### CHAPTER I.

#### PHYSICAL GEOGRAPHY.

THAT part of Sheet 19 which lies west of the river Bann, occupying about three-fifths of the entire area, is situated in the county Londonderry, the remainder being in the county Antrim. In the former division are the towns and villages of Maghera, Kilrea, Tobermore, Swatragh, and Bellaghy; in the latter Portglenone, Ahoghill, Rasharkin, Cullybackey, and Grace Hill.

The general surface of the ground rises gently westward from the river Bann, which flows northward as far as Kilrea at an almost uniform level of about 45 feet above the sea. The ascent becomes more rapid near the western margin, except in the areas adjacent to its two extremities. East of the river a very gradual rise takes place as far as the rocky and boggy ground midway between it and the river Main, where the slope increases, culminating in a height of a little over 600 feet; and then descends eastward to the level of the latter river, which flows at about 240 feet above the sea, but falls 100 feet lower in the last three miles of its course within this sheet.

The most elevated points occur in the hills which form a ridge stretching north and south for nine miles along the western margin. Of these, which are for the most part composed of mica-schist, the highest is Carntogher, 1521 feet above the sea; an eminence easily recognized from the surrounding country by its peculiar shape, and consisting of a cap of basalt overlying the mica-schist and Carboniferous sandstone, with a rounded flank about 40 feet in height on the south and west, at a short distance from the summit. North of Carntogher are—Moneyoran Hill, 1363 feet; Pollangorm Hill, 1259 feet, and others of less altitude; and to the south, Crockoor, 1059 feet.

The higher ground here spoken of is either devoid of Post-Pliocene or Drift deposits, or else but thinly covered by them. With the exception of Carntogher it presents no abrupt features, but in the Drift-denuded and less elevated area extending for about three miles E.S.E. of that hill, the surface is frequently broken by a series of small escarpments in the basalt and dolerite, ranging nearly north and south, and running continuously for

various lengths up to about 800 yards. These are commonly twelve or fifteen feet in height, sometimes more, and form the rugged western sides of narrow rock exposures, the ground on the east falling away at about  $10^{\circ}$  to  $15^{\circ}$ , in a manner approximately coinciding with the dip of the beds, which soon disappear below a thin remnant of Drift sand or clay. Similar features exist in the denuded space at Knockcloghrim, three miles west of Bellaghy; at Moneydig Hill in the north; and in isolated spots throughout the intervening Drift-covered ground.

The formation of these cliffs is due to the weathering away of the basalt from exposure to the atmosphere, in the first instance along the outcrop of some easily decomposed bed. The most striking and regular examples occur in ground which had previously assumed a sidelong form, probably through the action of ice moving nearly in the line of strike; the beds being thus from the commencement uniformly exposed to the process of disintegration.

Overlying the metamorphic schist, skirting its eastern margin for about four miles, and for a short distance in the northern part, the Calcareous Sandstone slopes down and disappears below the basalt, overlaid in part by intervening portions of the Triassic rocks. Below this sandstone, at the southern extremity of the schist area, there are dull red conglomerates and earthy sandstones, which constitute the lowest part of the Carboniferous formation.

Along the river Bann, and for an average width of about four miles to the west, the surface is largely covered by peat bogs and alluvial flats, some of the former being of considerable extent. These are separated by, and studded with, mounds of Drift, a large portion of which consists of stratified sand and gravel; either forming a deep deposit, or else lying thinly on the top of the boulder-clay hills, or in irregular heaps against their flanks. Small esker-like ridges also occur occasionally, traversing the bogs.

The sand and gravel become abundant towards the south-west corner of the district; and again in the north-west, where they are associated with a thick deposit of laminated clays, thin bands and layers of which are also found among them in various places throughout the district. Where the sand and gravel occur in large quantity the surface is characterized by frequent and irregular undulations, which form a contrast with the smoother outline of the boulder-clay. This accumulation of fine materials belongs probably to the marine sand and gravel division, or *Interglacial Beds*, which were deposited in the interval between the periods of the Upper and the Lower Boulder-clays, the former of which may possibly be, in some cases, represented by the straggling blocks that are sometimes found resting on the surface, while the clayey Drift which covers the greater part of this district is the Lower Boulder-clay. No fragments of shells were found in the Drift.

The whole of the drainage of this sheet is conveyed to the Atlantic by the Lower Bann, which joins the sea at about four

miles below Coleraine. The western drainage passes to this principal channel by the Agivey river in the north, and by the Claudy and other smaller rivers in the south; except in the south-west, where it is carried by the Moyola to Lough Neagh. East of the Bann, the drainage of an area ranging in width from two and a-half to four and a-half miles is effected directly by that river, while the remainder flows southward to Lough Neagh by the river Main. The watershed between these two (the Bann and the Main) passes along the bog near Gillistown, northward by Prieststown, where it bends a little eastward, then west and north to Loan Hill, and thence nearly due north to the margin at about Long.  $6^{\circ} 26'$ . The Bann enters the sheet at somewhat less than fifty feet above sea level, and leaves it at about twenty feet lower, the greater part of the fall being at the eel weirs near Kilrea.

## CHAPTER II.

### ROCK FORMATIONS AND DIVISIONS.

#### *Aqueous Rocks.*

Name.		Colour on Map.
Recent,	Bog and Alluvium,	{ <i>Chalons Brown and Gamboe.</i>
Post Pliocene (Drift),	{ Sand and Gravel,	
	{ Lower Boulder Clay,	{ <i>Engraved dots.</i>
Cretaceous,	Upper Chalk, with Flints,	<i>Green.</i>
Triassic,	{ Keuper Marl and Sandstone,	<i>Venetian Red (deep).</i>
	{ Bunter Sandstone,	<i>Do. (light).</i>
	{ Lower Limestone,	<i>Prussian blue.</i>
Carboniferous	{ Calciferous Sandstone,	{ <i>Upper Beds, do., with wash of Indian Ink and Yellow Dots.</i> <i>Lower Beds, do., with darker wash, do.</i>

#### *Metamorphic and Igneous Rocks.*

Mica-schist, with bands of Hornblende-schist (altered Lower Silurian),	{	<i>Pale purple, with a wash of carmine.</i>
Beds of Crystalline Limestone in do.,		
		<i>Prussian blue.</i>
Miocene Basalt and Dolerite,	{	<i>Burnt carmine (deep.)</i>
Upper Division,		
Iron Ore, with Lithomarge, &c.,		<i>Gold dots, with light reddish brown.</i>
Lower Division,		<i>Burnt carmine (light)</i>

### CARBONIFEROUS BEDS.

*Lower Carboniferous (Calciferous) Sandstone.*—The beds of the lower division of the Calciferous Sandstone are exposed to view in several sections along the streams that flow southward to the Moyola river in the country west of Maghera. At the

base, and for some distance from their junction with the mica-schist, they consist of red earthy brecciated conglomerates, very coarse in the lowest part, and containing large angular pieces of mica-schist and quartz, the former reaching a length of two feet; also rounded pebbles of the same rocks, with quartzite and hard grit, and occasionally jasper. Among the conglomerates there are thin beds of red earthy sandstone, sometimes marked with light green striping; and higher in the section this becomes the prevailing character of the rock, as far as the commencement of the harder and lighter coloured sandstones, &c., which compose the upper division. They are for the most part finely micaceous, and often somewhat calcareous.

At 900 yards south of Ranaghan Bridge the conglomerate is brought down by a fault against the mica-schist, the harder beds of the latter forming a ledge across the stream, which gives rise to a miniature waterfall. In following down the ravine, which attains a depth of about fifty feet, the dip appears to point steadily to E. 20°-30° S., increasing in amount from 20° in the lower beds to 45° in the upper. These dips, however, are in a great measure due to oblique bedding, and can not be relied on in estimating the thickness of the deposit.

North-east of Campbell's Bridge the red basal beds come to view along a ravine about thirty feet deep, and consist mainly of red marly sandstones, with coarse conglomerate in the lower part.

Favourable sections for examining the upper beds of this group are found along the streams that traverse the upper part of the district extending from one and a-half to three miles west of Maghera, and northward to Carntogher. They consist of a considerable thickness of variously coloured sandstones and shales, with a few beds of conglomerate and impure limestone, and underlie the limestone that occurs south of Maghera.\* Many points of resemblance exist between these sandstones and those below the limestone at Armagh, while the identity of the limestones is strongly confirmed by the occurrence, at Desertmartin, of the most characteristic fish remains of the Armagh beds. The sandstones, in fact, are part of those earliest deposited Carboniferous beds which, filling a depression in the older rocks to the south and south-west, occupy a similar position here, and widen out from Armagh northward so as to extend beneath a large part of the county Antrim.

The most continuous section, commencing at nearly a mile and a half S.S.E. of Carntogher House, exhibits red and light yellowish brown grits and conglomerates, with thin red and green sandy layers, and friable shales of a purplish colour, the coarser beds containing numerous rounded pebbles and large grains of

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\* That these sandstones underlie the limestone, as was supposed by Portlock (see Report, pp. 486, 579), there seems no reason to doubt. Some uncertainty has existed owing to the lack of evidence caused by the deep superficial deposits that cover the district between Lisnamuck Bridge and White Hill, in which localities the sandstones and limestone respectively come to the surface.



quartz. Below them there is a small portion of the lower conglomerate already described. Some of the sandstones are quarried for flags, and afford slabs of considerable size. At the south-west of Seefin Hill, where the line of section makes a large angle with the direction of the dip, there are faintly and often obliquely laminated sandstones of gray, greenish, and purple colours, with thicker beds of fine white calcareous sandstone, all more or less micaceous, and at most about two feet thick. West of Ballyknock, these are overlaid by about seventy feet of thin-bedded dark shales and shaly limestone, both in some places very delicately laminated; and these again by finely laminated sandstones with shaly layers and occasional beds of impure nodular limestone. The sandstones are in some instances extremely hard, and contain quartz pebbles. A few of the harder shale and limestone beds are traversed in a remarkably regular manner by fine cracks intersecting one another—apparently the result of shrinkage caused by exposure to heat when in a soft condition. The position of this part of the section may be indicated as lying a mile and a quarter due east of Ranaghan Bridge. The dip about here changes from E.S.E. to E.N.E., averaging in amount about  $25^{\circ}$ . In proceeding farther south-east along the stream, the dip is found to change again shortly to E.S.E., and after a little, exhibits several variations southwards. The beds here described are well exposed for a large part of the section along the sides of a steep ravine reaching nearly fifty feet in depth, and are covered by fifteen feet of boulder-clay. They are, to some extent, still better seen along the neighbouring stream that passes by the south of Ranaghan, through a ravine forty feet deep. Where it passes close to the road, the harder sandstones are worked for scythe-stones, grinding-stones, door-steps, &c.

At the junction of the two streams just referred to, and again north of the chapel, the upper beds of the Calcareous Sandstone are further exposed to view, and consist, in ascending order, of thinly laminated brown and red soft micaceous sandstones; the same with layers of red flags; others of light greenish and pinkish colour; coarse white sandstones overlaid by red and green sandy marls; and pale reddish, rather coarse siliceous sandstones. Beds generally similar to these, but containing near their base a wide band of hard quartzose conglomerate, and above it about seventy-five feet thick of deep red soft marly sandstone, occur in the streams at Carntogether House.

From what is seen in the various sections, allowance being made for small faults and reversed dips, there may possibly be a thickness of about 2000 feet in this portion alone (the upper division) of the Calcareous Sandstone; but there are intervals where no rock is exposed, and from the varying nature of the dip south of this, as seen especially along the Moyola, it is not unlikely that the changes of dip to the west are more numerous than what come under observation, and that the estimate of the thickness just stated should be diminished. Besides it is impossible to conjecture what additional thickness may be concealed between these beds and the limestone near Maghera, so that no

reliable calculation as to the total extent of the division is obtainable.

The beds along the Moyola are especially interesting as having yielded many examples of fish and plant remains, the former including scales and teeth of *Holoptychius*, spines and bones of *Gyracanthus*, &c.\* Those first met with near the west of the sheet are blue and gray calcareous shales with occasional beds of hard arenaceous limestone, above which are light-coloured and somewhat variegated sandstones, quarried for tomb-stones, &c. W.N.W. of the corn mill, in the river, there are blue shales and dark shaly limestone, containing fish remains, and traversed by strings of carbonate of lime. The dips change here, in going eastward, from south-easterly to north-westerly directions. Similar changes, with contortions, are observed in the stream at and south of the corn mill, among flaggy beds of red and brown sandstone, underlaid by a reddish conglomerate containing round pebbles, up to six inches diameter, of quartz, quartzite, jasper, and hard bluish grit. There are also some pebbles of hard white and reddish nodular limestone, such as occurs only, and in rare instances, among the shales and sandstones of this upper division; so that these beds, although approaching in character the red conglomerates of the lower division, do not belong to that zone, as was supposed by Portlock, who classed them under the *Old Red Sandstone*.†

In the stream flowing south of Campbell's Bridge to the Moyola, there are dull gray and bluish marly shales and variously coloured sandstones, and thin beds of red earthy limestone. These dip chiefly N.W. at  $10^{\circ}$  to  $30^{\circ}$ , and in one place form a synclinal axis, the dip changing temporarily to S. at  $50^{\circ}$ .

White close-grained calcareous sandstone occurs in the river north-west of Forge Bridge with layers of shaly limestone, some of the former containing thin strings of calcite. The dip here again changes, forming an anticlinal axis a little west of the bridge, and east of it there are further slight variations. About 400 yards east of Forge Bridge a thin seam of coal is said to have been met with in the sandstone, and some indications of this mineral exist at about 700 yards S.S.E. of Campbell's Bridge.‡

South-west of Tamnybrack, the lower Carboniferous beds come to the surface in the stream at the point where the arrow occurs, and consist of light reddish brown and gray sandstones with soft red and green sandy shales, evidently the continuation of the beds that appear in the streams at Carntogher House.

Near Carrowcladagh the sandstones are seen only along the stream south-west of that place, resting on mica-schist, and in the upper beds dipping towards the basalt, where the latter has been thrown down by a large fault.

*Lower Limestone.*—The limestone occurs in the river Moyola at the south of White Hill, two miles south of Maghera, and is laid bare in a quarry in the adjacent hill to the south, where it

\* Portlock's Report, pp. 463-4.

† *Idem*, p. 578.

‡ Similar indications exist in a few other places in the adjacent district to the south (Memoir, Sheet 27.)

retains the south-easterly dips that prevail in the sandstone to the west. It is said to have been also quarried at one time in the south-east part of Big Hill.

It is tolerably certain that the limestone extends under Clover Hill, halfway between White Hill and Maghera. Many angular blocks, supposed to indicate its immediate proximity, have been quarried from the drift south of the old church, for the purpose of burning; while the water from a well in the adjacent lane is highly charged with carbonate of lime, depositing a thick crust on vessels in which it is boiled.

The extension of the limestone eastward appears to be sufficiently established by the record of its having been quarried at the west of the road from Maghera to Knockcloghrim, nearly a mile north-west of the latter place; and of its having also been found *in situ* five feet below the surface in drains near the same locality.

### TRIASSIC BEDS.

*Bunter Sandstone.*—A section in the upper part of this series occurs on the narrow road two-thirds of a mile W.S.W. of Gulladuff, containing beds of rather coarse micaceous sandstone of various shades of red, and in part becoming white. These have an obscure south-easterly dip, which, however, may probably arise from oblique lamination.

Beds of much the same character as the last, in part obliquely laminated, and some containing pebbles of red shale, occur in section seven feet deep in the Brockaghboy River, near the north-west of the sheet. North of that they are lost to view, but it is probable that part of the flat ground is underlaid by Keuper Marl containing gypsum, as fragments of this mineral are stated by Portlock to have been found in Ballintemple Glen, a ravine traversing the basalt between the low ground here referred to and Ballynameen.

*Keuper Marl and Sandstone.*—The Triassic beds occur in several places along the small river which flows by the south of Maghera. In the lower part they are concealed below a deep covering of drift and alluvium. So far as they are seen they consist principally of finely laminated bright red soft sandstone, with some red and green marly beds, and probably represent the lowest portion of the Keuper series. Comparatively hard flags appear in the bed of the river north-east of the chapel, west of Maghera; and beds of a softer nature are exposed in section at a little distance east of the neighbouring bridge. Somewhat higher up a few layers of red and green marl occur; and above these, farther down the stream, the sandstone assumes in part a light salmon-colour. Red marly sandstones occur below the basalt in a stream at the east of Rosemount, and they appear at the surface a little south-east of that point.

### CRETACEOUS BEDS.

*Upper Chalk.*—The Chalk appears only at one place within this sheet, namely, in the bank of the Brockaghboy River, above the

Triassic beds already described. Indurated chalk with flints is exposed below the basalt on the eastern side of the stream for a depth of five feet; and on the opposite side for two feet deep over the New Red Sandstone, covered by boulder-clay.

Masses of chalk with flints, together with angular blocks of extremely hard flinty breccia, occur among the débris heaped up along the southern border of the basalt at Carntogher, and point to the probable extension of the Chalk southward to this point, but there is no evidence that it crops out here.

#### METAMORPHIC SCHIST.

The rocks of this series occur here in various forms. They are for the most part micaceous, and sometimes gneissose; in some instances talcose, in others hornblendic; while in a few localities there are beds in which hornblende is largely developed, and which approach in character some of the more coarsely crystalline rocks of the metamorphic area which lies south of this and north-west of Cookstown. In a large quarry three quarters of a mile west of Tamnybrack, beds of crystalline limestone, such as was formerly known as "primitive limestone," are worked for the production of lime, a good quality of which is yielded by the purer kinds. It is of a bluish gray colour, and occurs in beds which reach about two feet in thickness, together with schistose and more micaceous layers, all weathering nearly white. Some of the latter are calcareous, but are not considered worth burning. The mica in the limestone occurs in minute silvery scales, and there are thin coatings and small crystals of iron pyrites, veins and nests of white calcite, and comparatively little quartz. These beds are again found in the stream forming the parish boundary north of Pollangorm Hill, and others similar in character occur under the Carboniferous grit at the west of Carrowcladagh, where they are also utilised for lime. The mica is in some cases dark in colour, and occasionally forms large well developed black scales.

North-east of the height marked 1,242 there are hard finely-granitoid schists with black mica, grains of quartz, and imperfect crystals of felspar. East of these, and between them and the limestone near Tamnybrack, the rocks throughout the district called "Curragh" present several varieties. North-west of the height 885 feet are two bosses composed of dark coarsely crystalline rock in which hornblende is abundant, and small specks of bronzy mica, the latter being perceptible only where the mass is weathered. A similar rock appears at the road-side north of this, associated with the ordinary schist, into which there appears to be a distinct passage. Here it weathers with a nodular form, and contains broken veins of quartz, and cavities lined with prismatic crystals of the same mineral. Thick beds of mica-schist, having a fine granitoid structure, occur in an adjacent quarry; and interstratified with them are thinner beds, very micaceous, and much decomposed.

Close to the hornblendic rock the schist is in some cases black and highly micacized, resembling the metamorphosed Silurian

rocks in the vicinity of Slieve Croob and other places in the county Down.\*

South of Carntogher the mica-schist comes extensively to view in the Pollan Water and other streams flowing eastward to the Carboniferous area. West of Tullykeeran Bridge it assumes a gneissose form, and contains pink felspar, with little mica, while some beds are of the nature of clay slate, the mica being absent or nearly so.

The rocks along Pollan Water are generally similar, most being quartzose and felspathic; and in several places they are deeply marked with red ferruginous stains. In the stream between Crockoor and Ranaghan some of the more earthy beds contain slender crystals of black tourmaline, and quartz veins are of frequent occurrence.

In a quarry at Ranaghan Bridge, where the beds are broken and somewhat contorted, some contain tourmaline disposed along the planes of lamination. Others have a finely mottled or iron-shot appearance, the quartz occurring in grains and small lenticular masses. Along the stream north-west of the bridge the schists become very gneissose. Springs of ferruginous water issue from the rock, similar traces of iron being met with at the surface south of the bridge.

#### BASALT AND DOLERITE.

*Lower Basalt.*—Towards the west of the district, and in the higher ground east of the river Bann, the basalt often appears at the surface. It may be described generally as a dark bluish gray rock composed essentially of augite, labradorite, titaniferous magnetite, and frequently olivine. It is for the most part finely crystalline, but occasionally rather coarse, and in some instances very compact. The coarser varieties are distinguished by the term "dolerite."

Beds of amygdaloid, or trap containing vesicles filled or lined with zeolites and carbonates, occur at frequent intervals; and, less frequently, those thinner bands of red clay or bole which, in common with them, characterize to a great extent the earlier stage of the Miocene Basalt. These bole beds are in some cases clearly seen to result from the decomposition of the basalt and amygdaloid,† during pauses in the process of eruption or extravasation; and at the same time bear a close resemblance to some of the more compact forms of volcanic ash in adjoining portions of the basaltic area.

One of the best sections exhibiting these varieties occurs along the Agivey river, where it flows through Errigal Glen. South-east of Churchtown there is solid basalt covered by boulder-clay; farther down the stream are beds of fine amygdaloid containing strings of white calc-spar, and a few thin irregular beds of bole. Farther east the stream passes through a very steep ravine, nearly 100 feet deep on the south side, in which the basalt is exposed in

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\* Geol. Survey Memoir, Sheet 48.

† See Geolog. Survey Memoir, Sheets 21 28, 29; p. 22.

various stages of disintegration; some beds becoming reddish coloured, and mottled with dark spots from the decomposition of the substances contained in numerous small vesicles.

The hill south of Gortnamoyagh House is composed of hard solid basalt, sometimes vesicular, exposed in flat ice-worn masses. In the western part, near the Giant's Grave, the vesicles contain zeolites and aragonite.

The high ground east of Dowlin's Bridge is traversed for a distance of 1300 yards from north to south, by a slightly scarped broken ridge of fine Dolerite, having a platy and rudely columnar structure.

West and north-west of Tamnyrankin the basalt occurs partly in irregular rugged knolls, and partly in more evenly-shaped bosses, having a N.N. westerly trend. Five hundred yards west of that place, where it has been quarried from the face of an escarpment twenty-five feet deep, it is underlaid by a bed of red disintegrated trap dipping N.E. at 50°. At a similar distance east of the locality indicated by ice striae, the peculiar stepped form of the surface is well exemplified by two escarpments, in one of which is exposed a section of fifteen feet of hard compact basalt, above five feet of disintegrated rubbly basalt, and at bottom a bed of reddish brown decomposed amygdaloid containing small irregular cavities, some lined with faintly striped pearl-gray chalcedony, others filled with zeolite and calcite.

East of Slaghtneill the road is bounded on the east by a steep face of rock, whence eastward over the hill, and down to within a short distance of the road from Maghera to Swatragh, there occur similar breaks of various dimensions. The area extending eastward from Slaghtneill over Granaghan Hill, and north of the former, affords further good examples of a stepped and terraced outline. These rocks, including the upper part of the ridge which forms the summit of Granaghan Hill, bear clear marks of glacial moulding.

The basalt about here contains scattered grains of olivine, and the vesicles are often filled with globular concretions of carbonate of lime, or radiating groups of fine crystals of the same mineral.

Alternating beds of basalt and amygdaloid, with bole, occur west and south of Killelagh Lough. Seven hundred yards south-west of it, where vesicular basalt rests on amygdaloid, the vesicles in the former are elongated at right angles to the plane of bedding. Five hundred yards further S.S.W., in a similar case, the basalt, for a few inches above the junction with the amygdaloid, is full of flattened vesicles filled with zeolite, and drawn out, as it were, in a nearly vertical direction. The top part of the amygdaloid is reddened by the dissemination of red bole, a condition clearly arising from a change in the original rock, and indicating a process of transformation effected under the atmosphere, and brought to a termination by the outflow of the succeeding bed.

Massive rudely columnar basalt or fine dolerite, presenting in one place a steeply scarped face twenty feet in height, occupies the Drift-denuded space a mile north of Maghera. Here also it

contains distinct grains of olivine, with imperfect crystals of augite. West of Ballymacilcurr the rock is highly ferruginous, sometimes very compact, and weathers to fine spheroids. Vesicular basalt with zeolites in various crystalline forms, and traversed by fissures containing white compact zeolite disposed in thin platy laminæ, occurs in the railway cutting south-east of Maghera, and in a quarry by the old Tobermore road south of the town. Varieties of the basalt, with beds of bole and amygdaloid, are seen in the river east of the road at Upperlands, where the amygdaloid in part contains white zeolite to all appearance amorphous, filling small crowded vesicles and larger irregular cavities.

The basaltic rocks are laid bare at several points along the Derry Central Railway for three miles from where it enters the sheet at the north (a mile and a-half east of Ballynameen). They present a few varieties of dolerite and basalt, often very vesicular, and containing aragonite and other crystalline forms of carbonate of lime. In some parts, as at Edenbane, and west of Drumsaragh, there are also crevices filled with a white chalk-like form of the carbonate.

Alternating beds of amygdaloid and basalt, with irregular bands of bole, are of common occurrence about Knockcloghrim, as has been proved in the sinking of wells. At Cullear, masses of green soapy zeolite four inches long were picked from the rock in a well, below six feet of basalt, overlaid by eleven feet of amygdaloid. The planted hill north of Knockcloghrim is scarped on the east and west sides, the latter presenting two steep faces, one above the other, crowned with solid platy basalt.

The steep sides of the narrow water-course at Moneygran, south-east of Kilrea, contain sections in basalt and amygdaloid covered by boulder-clay. The former is traversed by thin veins of satin-spar (*i.e.* calcite, the term being also applied to the fibrous variety of gypsum).

Basalt and dolerite are largely exposed in the higher ground occupying the central portion of the district east of the river Bann, and, except in the small areas marked as Upper Basalt in the map, seem to belong entirely to the lower division. West and south-west of Pharis the rock forms escarpments skirting the peat-covered ground, and consists mainly of massive sheets of dolerite and basalt, occasionally vesicular. This latter condition becomes more prevalent in the finely crystalline basalt south-west of Ahoghill; and while throughout this whole area amygdaloidal beds may be observed at intervals, the bole and amygdaloid, which are of so frequent occurrence in the lower beds to the west, are here comparatively rare.

At a mile south of Hillhead, west of the road junction, there is, as pointed out in Mr. Traill's notes, a vesicular bed of earthy basalt, from four to five feet thick, resembling the lithomarge of the district, the top surface being very ferruginous. A quarry east of this contains finely crystalline black basalt in vertical rudely hexagonal columns, four to six inches diameter, and exhibiting a certain amount of horizontal platy bedding.

A bed of lignite, to be noticed farther on in the section on

minerals, &c., occurs in the basalt at Pharis, near the north-east of the sheet.

*Pisolitic iron ore, with Bole and Lithomarge.*—The iron ore and underlying bole and lithomarge, which form a band between the Upper and Lower Basalt, exist in the locality last referred to; also in Tully Hill, seven miles to the S.S.W. (marked 668 feet high); and in another hill a short distance due south of the latter. In the place first mentioned the ore is of good quality, and is worked to some extent. At Tully Hill the ferriferous beds are, so far as is at present known, represented by lithomarge and an obscure bed of bole containing a few small grains of hæmatite, the richer ore having probably degenerated, or perhaps quite thinned out, as sometimes happens with the deposit in other localities. West of the rising ground south of Tully Hill, inferior ore has been met with, overlying lithomarge. Here the course of these beds can be traced northward as far as the bog lying to the east of the hill; but their direction southwards is as yet to a great extent uncertain.

*Upper Basalt.*—The beds of this member of the series come to the surface in the hill under which the iron ore extends near Pharis, chiefly along its western side, above the outcrop of that bed. They are massive, in some cases vesicular, and weather sometimes with a spheroidal structure. They are more extensively exposed throughout Tully Hill and the hill to the south, and there consist mainly of hard solid basalt, occasionally divided into rudely columnar masses. No striking difference exists between these beds and those of the lower part of the series in this vicinity; though generally over county Antrim, the upper basalt is more solid than the lower, which is vesicular and amygdaloidal.

*Basalt Dyke.*—A basalt dyke, four feet wide, cuts through thickly bedded basalt, at the road side south of Lisnacannon Hill, as shown by Mr. Traill's notes.

#### POST PLIOCENE. (DRIFT DEPOSITS.)

*Lower Boulder-clay.*—The boulder-clay in this district belongs to the lowest division of the Drift deposits. It is composed of heavy brownish or reddish clay, more or less stoney, containing blocks of the underlying rock, with fragments, generally more worn and rounded, from the neighbouring districts. It sometimes encloses irregular seams of sand or sandy clay. There are not many sections in this deposit, the principal being those that occur along the Derry Central Railway, in which are found many polished and striated boulders embedded in tough clay.

*Interglacial Sand and Gravel.*—In the gravel the proportion of fragments derived from a distance is, with few exceptions, much larger than in the boulder clay, pebbles from various quarters abounding in the former, while the comparatively few contained in the latter belong chiefly to adjacent localities. This seems due to the manner in which the deposition of the sand and gravel was effected, namely, by marine agency, which had liberty



to transport the materials in all directions; while the quality of the boulder clay and its contents, which are generally admitted to be the result of the wearing action of ice, depended on the character of the rocks existing along one direct line of country. In many instances the sand and gravel are obliquely laminated, which proves that the water in which they were deposited was considerably affected by changes in the direction and velocity of its under-currents.

The clays already alluded to as being associated with the sand and gravel in the north-west corner fill a depression traversed by the Agivey River and adjoining streams, along the courses of which they are exposed to view in numerous sections. They appear to occupy a position at the base, and indicate a condition of tranquillity due to some local obstruction of the waters during the earlier part of the interglacial period. Both in the immediate vicinity, and in many other places throughout the district, bands of clay of precisely similar character occur in the sand and gravel. These deposits consist of finely laminated brown or light reddish loam, in general more or less sandy, and containing leafy portions composed of darker very stiff clay. They are covered in various places by alluvial gravel and clay resting on their denuded surfaces. In the stream that joins the river a little west of Errigal Bridge, the beds at the base are darker, and contain small chips of chalk and flint. The clays are in some instances calcareous, a fact which is observed in a higher degree in bands among the gravel to the south, and which suggests the idea that they have been derived in great measure from the wear and tear of the chalk. The dips are nearly horizontal, but slightly undulating. In a section on the Brockaghboy River, south of the road from Carrowcladagh to Ballynameen, the clays are seen resting on the Lower Boulder-clay, and similarly at some distance north of the road.

There are many openings in the stratified sand and gravel throughout the sheet. At the roadside W.N.W. of Magheramore, for example, a section shows eighteen feet deep in fine brown laminated sand containing coarser layers, and becoming gravelly at top, the gravel being composed of basalt, quartzite, mica-schist, hornblende-schist, flint chips, &c. A block of limestone, like that of Desertmartin, fifteen miles to the south, was found among the gravel at the north of Magheramore.

Granite boulders are of rare occurrence, and appear to be confined to the stratified gravel. They were observed a little south of Knockelohrim, and at the north-east of Culnady, near Maghera, where they were dug out from the surface of a boulder-clay hill capped by sand and gravel; also about a mile west of Ballynameen, and in a few other localities.

The town of Kilrea is overlooked on the north-east by high ground composed of compact laminated sand. The well for the pump in the centre of the street is sunk for about sixty feet through gravel with seams of sand, the bottom part becoming clayey, probably the top of the Lower Boulder-clay.

Ironstone nodules are occasionally present in the gravel, and,

less frequently, fragments of silicified wood. Both these, especially the nodules, are comparatively abundant in the same deposits in the county Armagh, south of Lough Neagh. Silicified wood was found in a gravel-pit 300 yards north-west of Black Lough, near Portglenone, and with it pieces of coral from the Carboniferous limestone. Seams of reddish stiff clay, variegated green, occur here; also in some of the many sections in the low irregular ridge that stretches southward from near Kilrea as far as The Meen. East of Thorn Hill there are brown and bluish very stiff laminated clays, and near the river these are overlaid by gravelly clay and peat, and by the alluvial "Bann Clay," to be noticed further on. At Moyknock the road is cut through laminated clay and sand and gravel.

Other localities for the clays are as follows, and in each case they are associated with stratified gravel and sand:—North of Crocknaconsody, near the north of the metamorphic area; in the stream north-west of Ranaghan Bridge, red leafy calcareous clay with layers of brown sand, below clay with boulders; two miles west of Maghera, along the stream separating the parishes of Maghera and Killelagh, light reddish and brown fissile clays with darker and very plastic laminae, the lighter-coloured portions highly calcareous and containing chalk chips, and all overlying amorphous red calcareous clay enclosing larger and more numerous fragments of this and other rocks; in the low ground about Milltown, south-west of Maghera. Along the south bank of the Moyola, 600 yards south-east of Lisnamuck, a section commences, 100 yards long, and about twenty feet deep, showing beds of very finely laminated brownish red clay with whitish leaves, all more or less calcareous, and overlaid by one to three feet of fine gravel with seams of sand. Lastly may be mentioned similar clays in the Moyola River, south-west of White Hill. They here become so hard, on exposure to the air, that they are spoken of as "sand-stones." The more local name is "cracking stones," from the fact that they decrepitate when put in the fire.

In the north of the sheet there are several sections showing the joint occurrence of boulder-clay and stratified sand and gravel, the clay being apparently unstratified. Where the gravel and sand rest on the boulder-clay, as seen in some of the railway cuttings west and south of Kilrea, the bedding is generally obscured about the line of junction, but on the whole they seem, while nearly following the slope of the clay, to have been deposited against its denuded surface. Thus, in a shallow cutting east of Lower Town, near Hervey Hill, a slight hollow in the top of the boulder-clay contains a remnant of the sand and gravel. East of the chapel near Drumagarner, and west of Brizel's Lough, there are cores formed of boulder-clay, overlaid and flanked by sand and gravel. The clay contains numerous water-worn and striated blocks of basalt, with slightly rounded chalk pebbles, &c.

In some cases where the sand and gravel are arranged in narrow ridges or eskers, they have probably been re-assorted in accordance with the direction of certain currents which prevailed

during the close of the interglacial period, and the courses of which are further indicated in a general way at the present day by the principal lines of waterflow. The best examples are seen in the large bogs between Kilrea and Bellaghy. The ridge at Ballymacpeake Lough can be traced almost continuously for a mile and a half, in widths varying from a few yards to eighty yards, and up to twenty feet in height. It is composed of stratified sand, more or less clayey, with gravel and small boulders, these last being chiefly of basalt, and occasionally granite and mica-schist. The gravel includes the same, with flints, quartz, hard sandstones, ironstone, &c.

### RECENT.

*Peat Bogs and Alluvial Flats.*—The large flat area south of Maghera is in great part covered by deep peat, which at one time overspread it more extensively. Below the peat is a whitish sandy clay, generally containing small angular gravel of quartz, mica-schist, and, rarely, other rocks. This deposit, derived apparently from the washing down of the old rocks in the high country to the west, is in its purer and less gravelly portions used somewhat for brick-making, as is also the finer clay nearer to the river Moyola.

A peculiar white alluvial clay (*Bann Clay*) is found along the River Bann, overlying the drift. This also is used for brick-making. The colour, in a fresh state, is dull bluish gray, with more or less of a brownish tinge, but in weathering it becomes perfectly white. It occurs north of Lough Beg above dark gray stiff clay, which is here mixed with it in working for bricks. Between Lough Beg and Portglenone it is four or five feet deep, and is applied to the same purpose. North of Portglenone this deposit nearly disappears, being one foot deep at Annagheraw. South of Portna it lies two feet deep over a layer of peat; it again occurs along the narrow flat north of Kilrea, and can be traced as far north as nearly midway in the adjoining sheet to the north.\* Otherwise the alluvium is in general a fine brown sandy loam, which sometimes forms wide tracts along the courses of the principal streams.

An extensive area of deep peat exists east and south-east of Rasharkin, for the most part uncut except round the margins. In some places, where these bogs have been cut down to the clay, celts, flint arrow-heads, spear-heads, and bronze pins have been found; and rudely worked flint flakes were picked up in a few places lying at the surface of the gravel, viz., at Moneygran, near Kilrea; at Inishrush, west of Portglenone; and at Maghera. Ferruginous springs occur in the eastern part of the area south-east of Lisnacannon Hill, the iron being no doubt derived from some of the beds in the basalt.

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\* This deposit is composed of nearly pure silica, being, as stated in the "Guide to Belfast, &c.," by the Belfast Naturalists' Field Club (p. 73), made up almost entirely of the shells of Diatoms. These are so broken, however, as to be sometimes with difficulty recognisable.

Trunks and roots of fir and other light woods are numerous in some of the bogs, oak being comparatively rare. Bog iron ore occurs in small quantity, in the north-east corner, and south of Black Lough, near Kilrea, &c.

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### CHAPTER III.

#### PRINCIPAL FAULTS.

Of the faults that traverse this district the principal one is that in the north-west, where the basalt is thrown down on the west against the mica-schist and Carboniferous sandstone. It lies between portions of the two rocks exposed in the stream west of Carrowcladagh, but the chief evidence relating to this disturbance occurs in the adjoining sheet. (No. 18.)

On the line of fault passing south of Ranaghan, the red conglomerate of the Lower Calciferous sandstone is seen to be thrown down against the mica-schist in the stream at a point due south of Ranaghan Bridge; and a similar displacement may be observed south of the former locality. In the same line, in a stream midway between Ranaghan and Seefin, the gray shales are brought down on the south against the white sandstone. The dislocation here, however, is slight, and the fracture probably extends but little further east.

The fault 700 yards east of Ranaghan Bridge crosses the stream north of the main road, at a short distance west of the bridge, where occur flaggy sandstones, some horizontal, others dipping towards the mica-schist, the latter being seen at a greater height along the bank.

A small portion of the mica-schist is brought into view south-east of Ranaghan Bridge by the fault that displaces the Calciferous sandstone near Campbell's Bridge; the white beds of the latter appearing on the west side, while on the east the red conglomerate rests on the mica-schist.

The fault between Pharis and Kinboe has a downthrow to the east, the iron ore being found in a well at the latter place, at a depth of about seventy feet below its outcrop at The Glen. The ore disappears abruptly on the east side of the road, as proved by borings; and this circumstance, taken in connexion with the form of the ground, and its soft, spongy nature, serves to establish the position of the fracture.

The slight fault west of Prieststown brings down the ore-bearing beds on the west, its course lying through a small valley that traverses the upper basalt; and it is further indicated to the south by the faulted condition of the rocks at Crosskeys.

#### MINERALS.

*Pisolitic Iron Ore, &c.*—The iron ore in the locality just now mentioned was reached on the west side of the road in a short adit driven along the bed at about 250 yards south of Swanstown (a cluster of houses in the low ground north of the outcrop). The

ore brought to the surface proved poor in quality, the pisolitic grains being few in number, and mostly of small size. This bed, the thickness of which does not appear to have been ascertained, is underlaid by dark gray mottled lithomarge, the latter being again found about 200 yards further south. The ore comes to the surface in the higher ground east of the road, and has been traced eastward towards the bog, below which it disappears.

The bed of lithomarge at Tully Hill, two miles E.S.E. of Portglenone, is recognised by the material dug up along its base at the north-west. Further north are found traces of what probably represents the ore bed, consisting of red bole, having a few pisolitic grains imbedded; and lithomarge occurs on the east of the hill, accompanied by red and yellowish bole, similar to that described in the following locality.

In the north-east of the district the iron ore has been traced along the plantation which skirts the hill west of the road; and where the bed is worked at the southern part of its outcrop the average section, as furnished on the ground, is as follows:—

Red pisolitic ore, consisting of grains of hæmatite cemented by an ochreous paste, . . . . .	18 to 20 inches.
"Pavement," a red and yellowish bole, or aluminous ore of inferior quality, . . . . .	7 to 10 feet.
Reddish and purple lithomarge, often finely mottled white, . . . . .	thickness unknown.

The ore is cut off by the fault along the road, east of which it is covered by a considerable depth of drift and basalt. The bed is said to be two feet six inches in thickness at Kinboe, where it was reached in a deep well. At Cullaleen, where it was worked to a small extent, it appears to have almost died out.

An adit was driven for about sixty fathoms in a north-westerly direction, near the stream under the road north of Cullaleen, through a bed which seems identical with the "pavement" described above, here ten to thirteen feet thick. Any of the richer ore that may have here occurred above it, has no doubt been removed by denudation.

North of Pharis a bed of lignite occurs in the basalt, at some distance below the iron ore, and is said to be associated with a thick deposit of white clay, which in some places it overlies, but which, in others, forms a dyke that has to be passed through in order to reach the lignite. Several pits were sunk for this purpose, and a quantity taken out for burning, but the work was not continued.

#### GLACIATION.

The glaciated condition of the rock-surface is apparent in most places where the Drift has been naturally or artificially removed. The striæ are fine, and not often well preserved, but the flatly rounded forms of the rock surfaces, as seen west of Ballynameen, at Gortnamoyagh House, on Moneydig Hill, near Dowlin's Bridge, Granaghan Hill, &c., and the striæ at the several localities pointed out on the map, afford proof of the extent to which the face of the country was worn down by ice.

With regard to the actual direction of the ice-flow, striæ marked by Mr. Traill south-west of Lisnacannon Hill, east of the Bann, indicate a course from S.S.E. to N.N.W., which corresponds to the observations recorded by himself and others in the districts north of this, and goes to confirm the conclusion arrived at by Professor Hull,\* that "along the tract of country stretching to the eastward of the Lower Bann, the general movement has been a little west of north." As a rule the striæ in this sheet are not sufficiently distinct to furnish decisive proof on this point, but it will be seen that the bearings have all approximately the same north-westerly and south-easterly direction.

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\* "Physical Geology and Geography of Ireland," p. 254.

## INDEX.

- Alluvium, 7, 19.  
 Amygdaloid, 13, 14, 15.  
 Aragonite, 14, 15.  
  
 Ballintemple Glen, 11.  
 "Bann clay," 18, 19.  
 Basalt, Lower, 7, 13.  
     "    Upper, 7, 15.  
     "    dyke, 16.  
 Bole, 13, 14, 15, 16, 21.  
 Boulder clay, 6, 7, 16.  
 Bunter Sandstone, 7, 11.  
  
 Calcareous Sandstone, 6, 7.  
 Carboniferous beds, 7, 11.  
 Carntogher Hill, 5, 8.  
 Chalcedony in basalt, 14.  
 Chalk, Upper, 7, 11.  
 Coal, indications of, 10.  
 Cretaceous beds, 7, 11.  
  
 Dolerite, 7, 13, 15.  
 Drainage, 6.  
 Drift deposits, 6, 7, 16.  
  
 Escarpments in the basalt, 5, 6, 14, 15.  
 Eskers, 18.  
  
 Faults, principal, 20.  
 Ferruginous springs, 13, 19.  
 Fish remains, 8, 10.  
  
 Glaciation, 21.  
 Gypsum, 11.  
  
 Interglacial beds, 6, 7, 16.  
 Ironstone nodules in drift, 17, 19.  
  
 Knockcloghrim, basalt, &c., at, 6, 15.  
 Keuper Marl and Sandstone, 7, 11.  
  
 Lignite, 15, 21.  
 Limestone in metamorphic schist 7, 12.  
     "    Lower, 7, 10.  
 Lithomarge, 7, 16, 21.  
  
 Metamorphic schist, 5, 7, 12.  
 Minerals, 20.  
 Moyola River, fish beds of, 10.  
  
 Oblique bedding in sandstone, 8.  
 Olivine, 13, 14, 15.  
  
 Peat bogs, 6, 7, 19.  
 Physical Geography, 5.  
 Pisolitic iron ore, 7, 16, 21.  
 Pollan Water, section in, 13.  
 Post Pliocene deposits, 16.  
 Principal faults, 20.  
  
 Quarries in sandstone, 9.  
  
 Recent deposits, 7, 19.  
  
 Satin spar, 15.  
 Silicified wood in drift, 18.  
  
 Tourmaline in schist, 13.  
 Triassic rocks, 6, 7.  
  
 Worked flints, &c., 19

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