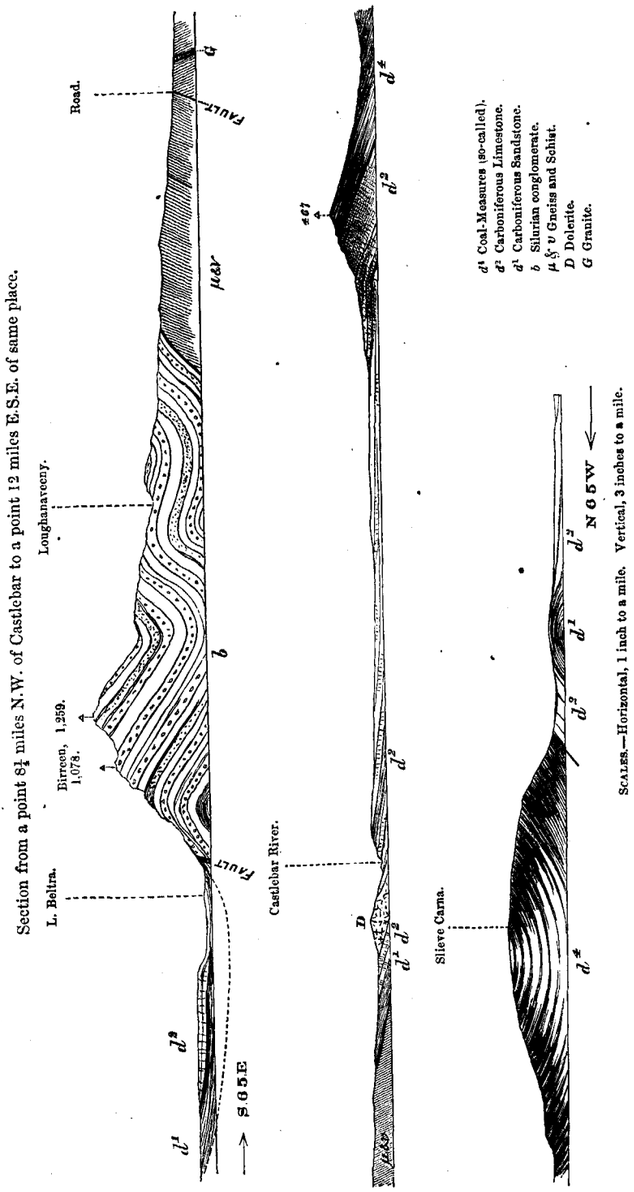

Section from a point 8¼ miles N.W. of Castlebar to a point 12 miles E.S.E. of same place.

SCALES.—Horizontal, 1 inch to a mile. Vertical, 3 inches to a mile.

Memoirs of the Geological Survey.

EXPLANATORY MEMOIR

TO ACCOMPANY

SHEET 75 OF THE MAPS

OF THE

GEOLOGICAL SURVEY OF IRELAND,

ILLUSTRATING A PORTION OF THE

COUNTY OF MAYO.

BY

RICHARD G. SYMES, F.G.S.

WITH

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

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SIR RODERICK IMPEY MURCHISON, BART.,

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

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

IRISH BRANCH.

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

DIRECTOR:

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

DISTRICT SURVEYOR:

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

SENIOR GEOLOGISTS:

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

ASSISTANT GEOLOGISTS:

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

FOSSIL COLLECTORS:

ALEX. M'HENRY; E. LEESON.

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

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

Condensed memoirs on particular districts will also eventually appear.

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

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PREFACE.

WITH the exception of a portion along the southern border, surveyed by Mr. Kinahan, the geological mapping of this sheet was executed by Mr. Symes, under the direction of Professor Jukes, but not published until after his decease. The portions surveyed by the officers of the Survey above named have been described by them respectively in this Memoir.

EDWARD HULL,
Director of the Geological Survey of Ireland.

Geological Survey Office,
16th November, 1871.

EXPLANATORY MEMOIR

TO ACCOMPANY

SHEET 75 OF THE MAPS

OF THE

GEOLOGICAL SURVEY OF IRELAND.

GENERAL DESCRIPTION.

THE area included in this sheet, lying wholly in the central portion of the County of Mayo, contains the town of Castlebar, and the villages of Balla, Ballycarra, or Belcarra, Turlough, Bellavarry, Strade, Ballyhean, and Bohola.

1. *Form of the Ground.*

The long and narrow range of loughs known as the Castlebar lakes, which extends for about six miles westward of Castlebar, and the road which runs N.W. of Castlebar, connecting that town with that of Foxford (in sheet 64), separates the district under consideration into two very dissimilar parts; that occupying the N.W. portion being very wild, rugged, and mountainous, while that to the E., S.E., and S., being comparatively low and undulating, and forming the N.W. limits of the tract known as the great central plain of Ireland. The ground to the N.W. of the Castlebar lakes and Foxford-road rises gradually for about three miles, from 100 feet to about 400 feet; after that the rise is more rapid to within a mile of the eastern shore of Beltra Lough (which is at the extreme N.W. of the sheet), where it attains its maximum of over 1,400 feet, the high ground terminating there in the Croaghmoyle range, of which Croaghmoyle (1,412 feet), Birreen (1,078 feet), and Muckanagh (734 feet), are the principal summits. West of this range there is Beltra Lough (which is only sixty-one feet above the sea), and a small portion of low ground known as the valley of the Newport River, which for the most part lies in sheet 74.

The E., S.E., and S. portion of the district is low and undulating, for the most part covered with a thick mantle of boulder clay Drift, the average height above the sea being about 150 feet, save in the area which lies about seven miles E. of Castlebar, and known as Slieve Carna, formed of Coal-Measures, which rises abruptly from the undulating plain to a height of 885 feet, and which will be more accurately described in the succeeding pages. The low undulating country all around Slieve Carna has its accompanying lakes, bogs, and rivers, which for the most part, have a north and south direction, being rudely parallel to the main drainage of the district.

River Basins.—Three-fourths of the district is drained by the numerous tributaries of the Moy River, the remaining portion

being drained by the tributaries of the Newport River, Carrowbawn or Westport River, and the Aille River.

The River Moy occupies but a very small portion of the N.E. part of the district, and flows from E. to W. in a very winding and zig-zag course, passing out of the district a little W. of Ballylahan Bridge. The chief tributaries of this river are the Spaddagh River; the Gweestion River, with its tributary the Trimogue River, the Strade River, with its tributary the Little River; the Toormore River, with its tributaries the Castlebar and Manulla Rivers; and the Clydagh River.

The Spaddagh River drains but a very small portion of the ground at the extreme N.E. of the district.

The Gweestion River drains all the eastern portion. It rises S. of Slieve Carna, and flows northwards, receiving in its course the drainage of the S.E. and E. flank of the hill, as well as its tributaries the Glore River and Trimogue River, which drain the country to the E. as far as the town of Ballyhaunis.

The Strade River, with its tributaries, drains the W. flank of Slieve Carna.

The Toormore River, with its tributaries the Castlebar and Manulla Rivers, drains the S.W. portion of the district, and only a very small portion of the S. part.

The Clydagh River rises in the hills in the N.W. portion of the district, and flows eastward, joining the Toormore River about two miles N. of the village of Bellavary, where it flows northwards into Lough Cullin, thence into the River Moy, about one mile S. of Foxford (sheet 64).

The Newport River receives its tributaries in this district from the hilly country in the N.W.; they flow into Beltra Lough and then discharge themselves at the S.W. extremity of that sheet of water.

R. G. S.

At the extreme S.W. of the district, a small area is drained by tributaries of the Carrowbawn or Westport River. S. and S.W. of the village called The Triangle the drainage of the country is remarkable, as all the streams in this tract that traverse the sandstone country, become subterranean when they leave the sandstone and enter the limestone; the largest being the Aille River, so-called from the cliffs (*Celtic* Aille), fifty-five feet high, where it disappears in the historical Caves of Aille.

The Aille River rises in Glenmask among the range called the Formnamore Mountain, and after a somewhat winding course of over ten miles, enters this area at 9° 24′ 45″ W. Lon.; subsequently it can be followed northward for a little more than half a mile, when it disappears in the caves. From the Aille caves the course of the subterranean stream can be traced by swallow holes (funnel-shaped hollows), some of considerable size, for nearly two miles towards the E.N.E.; the river again appearing at Pollatoomary in the townland of Bella-Burke, and from thence it flows in a more or less sinuous course towards the S.E., finally leaving the district a mile west of Claureen Bridge; a tributary, however

drains the country in the neighbourhood of Ballyhean. During the summer and ordinary winter floods, the subterranean passage can carry off the water that comes down the upper Aille River, it being impounded to the south of the cliffs and in the deep river course, until the floods gradually subside, but usually two or more times during the year the water overflows and forms a surface steam in the low ground south-west and west of The Triangle, and most of this water appears to leave its own water basin to flow into the catchment basin of the River Moy.

G. H. K.

The watershed between the Moy, the Aille and Carrowbawn enters the district from the S., close to Fortlawn Cottage, runs northwards as far as a little west of Ballycarra, then turns to the S.W., passing N. of Ballyhean and the Triangle, and S.E. of Aille Church, and goes out of the district on the extreme S.W. portion of the sheet. The watershed between the Moy and the rivers which flow westward, joins in with the watershed of the Moy and Aille, at Aille Church. It runs northwards for about six miles, through some low, boggy grounds, then takes a turn to the E. for about three miles, passing along high ground as far as the lake Loughanaveeny, which is on the watershed, and leaves the district on the N. side of the sheet at the trig. point 1196.*

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

	Name.	Colour.
	Aqueous Rocks.	
	Peat Bog Alluvium,	*Pale sepia.*
	Drift (chiefly Limestone Gravel),	*Engraved dots.*
d^5	Coal-Measures (so-called),	*Indian ink.*
d^2	Carboniferous Limestone (not sub-divided in this district,	*Prussian blue.*
	Shaly Beds in the Limestone,	*Prussian blue and Indian ink.*
d^1	Carboniferous Sandstone,	*Prussian blue and Indian ink, with yellow dots.*
b	Upper Silurian (probably Upper Llandovery),	*Purple.*
	Metamorphic Rocks.	
β	Gneiss and Schist,	*Crimson lake.*
Q	Quartzite,	*Chrome yellow.*
λ	Crystalline Limestone,	*Cobalt.*
Σ	Serpentine,	*Carmine, with wavy green lines.*
	Igneous Rocks.	
B	Dolerite or Melaphyre,	*Rose lake.*
D	Diorite (Greenstone),	*Rose lake.*
Δ.	„ when metamorphosed,	*Rose lake.*
F	Felstone (Intrusive),	*Vermillion.*
Gf	Granite (Foliated),	*Carmine.*

* The mearings along the top of the Croaghmoyle range of hills are pointed out not by land-marks but by the watershed.

Aqueous Rocks.

b. Upper Silurian.—These beds are composed almost exclusively of conglomerates, the chief pebbles being white and pink quartzite, fine-grained granite, sandstone, and a few occasional pebbles of limestone, supposed to be metamorphosed. Lofty cliffs (almost perpendicular) of this conglomerate are seen in this district, with rarely a bed of sandstone or shale interstratified among them. They are supposed to be of Upper Llandovery age from their lithological character, as well as their similarity to thick-bedded conglomerates which occur on the western shore of Lough Mask (sheet 85),* in which fossils have been found; but no trace whatever of fossil remains have been found in the Silurian rocks of this district. Their probable thickness may be from 700 to 1,000 feet. They cover a considerable area, are at high angles, but undulate in a very short space, as shown in the section. (See section, Frontispiece).

d[1]. *Carboniferous Sandstone.*—This, in this district, is probably not more than about 150 feet in thickness, and consists of good thick-bedded quartzose conglomerate as a base, with purple sandstone and reddish-brown calcareous grits and sandstones forming the junction with the Carboniferous limestone. The calcareous grits are fossiliferous, the fossils are always formed of carbonate of lime, which weathers rapidly, so that nothing is ever found save the cast.

Total thickness of the Carboniferous Group.

	Feet.
Coal-Measures (so-called),	1,000
Cherty limestone,	200
Ordinary gray limestone,	1,300
Black soft shales,	50
Hard quartzose limestone and conglomerate,	100
Carboniferous sandstones, grits, and conglomerate,	150
	2,800

d[2]. *Carboniferous Limestone.*—This is not here sub-divided into the groups into which the limestones in the east and south of Ireland have been divided, in consequence of the late Mr. Jukes having come to the conclusion that such division was not tenable, as the survey advanced northwards from a line connecting Galway Bay and Drogheda Bay.

The limestone under consideration has very different lithological characters throughout its several horizons. The lowest or basal bed is a very remarkable one, consisting of large and small pebbles and grains of well-rounded and angular quartz—some of the pebbles extremely well-rounded, and as large as a pigeon's egg. Where this occurs, the rock might be termed a conglomerate, inasmuch as the pebbles predominate over the limestone, which is only the cementing ingredient. This peculiar bed is only observed N.W. of Castlebar, for according as we go N.E. along the strike

* Preparing for publication, November, 1871.

of the bed, the pebbles become gradually smaller, and less rounded, till we come as far as the northern limits of the district, where this bed almost assumes an oolitic structure; the fragments, or almost imperceptible pieces of silex, being a nucleus within concentric rings of carbonate of lime. These quartzose beds are probably not more than 100 feet thick. Above them are ordinary gray limestones, with thick beds of black and blue soft shales resting on them. These, I consider, answer to the *calp* of the eastern portion of Ireland.

Above the shales are light gray highly crystalline limestones, varying in hardness, texture, colour, and composition, and are probably from 1,200 to 1,400 feet in thickness.

Resting on the gray limestones is a considerable thickness, probable about 200 feet, of a white and black, generally ribbond chert, very hard, yet brittle, appearing in considerable masses in one place, and in another powdered down to a very fine gravel; this forms the top of the Carboniferous limestone series, and the junction bed between it and the (so-called) Coal-Measures.

All the limestones just described, save the cherty limestones, are very prolific in fossils, especially corals; the fossils towards the base of the limestone are silicated, whereas in the upper beds, near the Coal-Measures they are calcareous. The total thickness from the top of the Carboniferous limestone to its base is probably not more than 1,700 feet, which shows its gradual thinning out towards the N.W., and N. of Ireland.*

d[5]. *Coal-Measures* (so-called).—These beds occur solely in the high ground N. of the village of Balla. They consist of reddish-brown and yellowish-brown quartzose sandstones, interstratified with black shales and a few hard, compact, ferruginous, grits.

The shales are especially rich in fossils, the names of which have been determined by Mr. Baily (See page 14).

Mr. Hull regards these beds as in reality the representatives of the Yoredale series, and Millstone Grit of England; and, therefore, in a position below the true Coal-Measures of that country; and he thinks it is to be regretted that the same term has come to be popularly applied to strata, which are on altogether different geological horizons in England and Ireland. The name Coal-Measures can, therefore, only be considered as provisionally retained.

The probable total thickness of the Coal-Measures is about 1,000 feet in this district.

* To me it appears probable that the lower part of the Carboniferous limestone is wanting in the country hereabouts; the rocks that exist being the representative of the upper or "Burren type" limestone, as also in the country to the southward adjacent to Loughs Mask and Corrib. If this be correct, the sandstones and such like rocks that appear to underlie the limestones, are not the true basal rock group of the Carboniferous period, but rather *shore beds* deposited in the vicinity of land which at that time was gradually sinking and being submerged. Of the true age, however, of the Carboniferous rocks of this part of Ireland we ought to be able to speak more positively when the examination of the rocks in the county to the N.E. is finished. In this opinion, however, Mr. Symes does not concur.

G. H. K.

METAMORPHIC ROCKS.

μ & ν. Gneiss and Schist.—The schistose rocks vary considerably in their degrees of crystallization, texture, composition, and colour; those to the east of the large fault, by which they are traversed to the N. of Castlebar, being more highly crystalline, and uniform in composition, while those to the west of the fault have a great variety of accompanying minerals. The different varieties of schistose rocks that occur are, "*Highly micaceous schist*," and "*Hornblendic schist*," east of the fault, and "*Chloritic schist*," "*Talcose schist*," "*Steatitic schist*," "*Hornblendic schist*," "*Coarsely laminated micaceous schist*," west of the fault.

The lamination and foliation of these rocks coincide towards the west of the district, while towards the east the lamination is somewhat approaching the horizontal, while the foliation is nearly vertical, plainly showing that the rocks to the W. were less highly metamorphosed than those to the east.

Q. *Quartzite.*—The quartzite occupies a very small area. It is very thick-bedded, pale blueish-white in colour, very hard, brittle, and finely crystalline.

λ. *Limestone.*—Very little superficial evidence of the limestones is apparent, consequently no reliable information can be given of them; and were it not that they occur among the metamorphic rocks, I would place them down as belonging to a more recent formation.*

Σ. *Serpentine.*—There are two small localities in which serpentine was observed. In one it was in the form of a schist, passing into a steatitic schist, and then into a talcose schist; while in the other locality its composition and texture was very different, being intensely hard, having a preponderance of silica, and very rudely bedded.

Mr. Kinahan thus describes a rock in the country examined by him:—"Apparently allied to the serpentine, and evidently being a pseudomorph of some variety of hornblende-rock (Metamorphic Whinstone), is a rock that may be described here. It has a green, greenish or purplish matrix, with red or reddish spots—is unctuous to the touch—compact and tough, but at the same time with a more or less incipient foliation. The red spots evidently are some variety of garnet, while the magma seems to be allied to, or smaragite—the rock probably being a variety of eklogyte."

IGNEOUS ROCKS.

B. *Dolerites or Melaphyres.*—These are irruptive, bursting out in five different localities in long narrow bosses near the base of

* My reason for supposing that these limestones are not metamorphosed is that they are highly crystalline, and totally devoid of mica. They appear to me to have been formed from the original superincumbent rocks, supposed to be the Carboniferous limestone; the disintegration of the limestone passing along its own crevices, down to the subjacent strata, and then trickling into the apertures crystallized out in a stalactitic form. In the district N. of this under consideration, there is no doubt that such is the case, as the limestones there lie right across strike, bedding, &c., and there can be no other way for accounting for their formation.

the Carboniferous rocks, as at Derrycoosh, Castlebar, Turlogh Corn Mill, Kilbree, and on the north side of the Moy, E. of Ballylahan; the direction of the dykes being N.E. and S.W. approximately parallel to the stratification of the beds through which they intrude. They are composed of minutely crystalline augite and felspar, of a blackish-green colour. The rocks are slightly columnar, and weather rapidly to a brown powder, acting as a highly fertilizing soil over the limestone in contact.

D. *Diorite (Greenstone).*—There is only one locality in this district in which diorite was observed, viz., at High Bridge, about 3 miles N.N.E. of Castlebar. There, a considerable area is occupied by this rock or huge boss, the centre of which is highly porphyritic, while towards its extremities it is finely crystalline and contains iron pyrites. It is intensely hard and tough, yet easily affected by weather, as some siliceous veins stand very prominently out from the weathered portion.

F. *Felstone.*—Very little evidence of this rock was observed, inasmuch as where it occurs, it assumes the form of a small boss about 300 or 400 yards long, and about 200 yards across, among the Silurian conglomerates, in the W. of the district. It is a grayish-white, hard splintery rock, always decomposed near the surface. It has burst up through the conglomerate, altering the beds as regards their position, as well as indurating them.

Gf. *Granite foliated.*—This rock which occupies a portion of the northern edge of the sheet has been evidently foliated at the same time as the sedimentary rocks in conjunction with it; the foliation of both being N. 50 E. or thereabouts. It generally consists of two felspars (probably orthoclase and oligoclase), two micas (lepidomelane and margarodite), and quartz.

3. *Relations between the Form of the Ground and its Internal Structure, and General Account of the latter.*

The first thing that is apt to strike the observer's eye on looking at the Geological map of this district is the very well-defined boundary between the Carboniferous sandstone and limestone, and between the Carboniferous sandstone and the metamorphosed rocks beneath. This boundary is marked by a line running in an almost N.E. and S.W. direction throughout the district, and is continuous in the same direction throughout the districts to the N. and N.E.

A boundary so regular as this, must have been determined by some cause; and the cause in this case is due to the internal motive power which displaced the rocks to the N. of this boundary, accompanied and followed by denudation.

This, and similar parallel axes of elevation and depression of so constant a direction, and so clearly shown in the promontaries, headlands, mountain ridges, as well as in most of the igneous rocks throughout this part of Ireland will never be clearly defined until the whole of Ireland is surveyed, and then accurate lines can be drawn representing the numerous parallel upheavals which must have occurred throughout this island.

3. Palæontological Remarks.

Localities from which Fossils were collected.

No. of Locality.	Quarter Sheet of 6-inch Map.	Townland.	Situation, Geological formation, and Sheet of 1-inch Map.
		County of Mayo.	
1	68/2	Muckanagh, . .	South of Beltra Lough, six miles north-west of Castlebar; Lower Carboniferous gray micaceous sandstone.
2	68/2	——	A little north of preceding locality; Carboniferous limestone.
3	78/2	Rathbaun, . .	Half a mile north of Castlebar; Carboniferous limestone.
4	78/2	New Antrim, . .	Quarter of a mile north of preceding locality; Carboniferous sandstone.
5	78/2	——	Half a mile north-west of Castlebar; Carboniferous sandstone.
6	78/3	Annagh, . .	Half a mile north of Cloonkean, four miles south-west of Castlebar; Lower Carboniferous limestone.
7	78/4	Gortnasmuttaun, .	Half a mile south-east of Kilboyne House, three miles south of Castlebar; Carboniferous limestone.
8	79/1	Boundary of Cappavicar, North and South.	Quarter of a mile north-east of Ballinvoash Lough, four miles east of Castlebar; Carboniferous limestone.
9	79/3	Ballykill, Lower, .	One mile south-east of Hawthorn Lodge, three miles south-east of Castlebar; Carboniferous limestone.
10	79/2	Moyhenna Close, .	In River Manulla, at Gneeve, five miles east of Castlebar; Carboniferous limestone.
11	79/4	Ballinhoe, . .	One mile east of Manulla; Coal-measures, brown shales.
12	79/4	Boundary of Carrowkeel and Prison, North.	One mile south-east of Manulla; Coal-measures, black and brown shales.
13	80/1	Altbaun, . . .	Two miles south of Bohola; Coal-measures, black shales.
14	80/1	Cuillalea, . .	In stream a little north-west of Bushfield, four miles north-east of Balla; Coal-measures, black shales.
15	80/3	——	Three and a half miles north-east of Balla Coal-measures, black shales.
16	80/3	Craggagh, . .	Two miles north-east of Balla; Coal-measures, black shales.
17	80/3	Largan, . . .	Half a mile east of preceding locality; Coal-measures, brown shales.
18	89/2	Buncarn, East, .	A little north of Buncarn Lough, three and a half miles south south-east of Castlebar; Carboniferous limestone.
19	89/2	Derrew, . . .	A little south of Ballyhean, five miles south of Castlebar; Carboniferous limestone.
20	90/1	Roslahan, Upper, .	Half a mile north-east of Ballycarra, five miles south-east of Castlebar; Lower Carboniferous limestone.
21	90/2	Ballymacloughlin, .	A little west of Rockstown, half a mile north-east of Balla; Carboniferous limestone.

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

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

LOWER CARBONIFEROUS SANDSTONE.

Plantæ.

	Localities.
Stems and fragments of Plants, some coarsely ribbed, and three quarters of an inch diameter, others narrow and finely striated, in gray micaceous sandstone,	× × × 1.

CARBONIFEROUS LIMESTONE AND SANDSTONE.

Actinozoa: *Corals.*

Alveolites depressa,	19.
Chætetes tumidus,	5, 6, 8, 10.
Cyathophyllum ceratites,	8, 9.
,, turbinatum,	? 8, 18.
,, or Zaphrentis, species undetermined,	6, 8, 9, 19, 20.
*Lithodendron affinis,	× × 2, 7, 8, 9, 10, 18, 19, × × 20, 21.
,, irregulare,	9.
,, junceum,	9.
Lithostrotion Portlocki,	7, 8, × 9, 18.
,, striatum,	7, 9, × 19.
Lonsdalia floriformis,	19.
†Michelinea favosa,	× × 6, 20.
,, ,, var. megastoma,	6.
‡Syringopora geniculata,	6, 7, 9, 20.
,, ramulosa,	2, × 6, × 7, 8, × 19, 20, 21.
,, reticulata,	6, 7, 18.
Zaphrentis cylindrica,	× × 6, 7, 8, × 19, × × 20.
,, Enniskilleni,	20.
,, Phillipsi,	6

Mollusca: *Polyzoa.*

Fenestella membranacea,	10, 20.
§ ,, ,, ? var. Hemitrypa Hibernica,	20.

Brachiopoda.

Athyris ambigua,	4.
,, planosulcata,	× 6, × × 9, 19, 20.
,, Royssii,	10, × × 18.
Chonetes Hardrensis,	6.
Orthis Michelini,	? × 5, × × 6, 20.
,, resupinata,	3.

* As there is some difficulty in defining the genera Lithodendron and Lithostrotion, I would propose to include under that of Lithostrotion, only those corals which are astreiform, having the corallites closely united, or compressed together, as for example, *L. striatum* (basaltiformis), the species originally described under that generic name by Lhwyd; whilst Lithodendron should include those species which are fasciculate and branching, such as *L. junceum*, *affinis*, &c., and species occasionally coalescent, or united by longitudinal sutures, as in *L. Phillipsi*.

† Probable synonyms, *M. antiqua* (Dictuophyllia), M'Coy, Synopsis Carb. Foss.; *M. grandis* and *M. glomerata*, M'Coy, Brit. Pal. Foss.; *M. megastoma* and *M. tenuisepta*, Phillips' Geol. of Yorkshire.

‡ The species of *Syringopora* included in this list are most probably all varieties of one, viz., *S. ramulosa* or *S. reticulata*, Goldfuss. *Aulopora campanula* and *A. gigas*, M'Coy, are, I think, young forms of Syringopora.

§ The fossil described by Professor M'Coy as *Hemitrypa Hibernica* (Carb. Foss., Irel., p. 205), I believe to be nothing more than a peculiar condition of the common *Fenestella membranacea*, their identity appearing to me to be clearly exhibited by specimens in the Survey collection. In his description, Professor M'Coy remarks that "the internal network bears much resemblance to *F. membranacea*, but from the difficulty of procuring well-preserved specimens of this latter, it is difficult to determine the question satisfactorily."

	Localities.
Conchifera.	
Aviculopecten hemisphæricus,	4.
Pullastra scalaris,	? 8.
Pleurorhynchus aliformis,	6.
Small bivalve shells ? Edmondia and Sanguinolites,	3, 5.
Gasteropoda.	
Euomphalus catillus,	? 5, 10.
„ Dionysii,	8, 9.
Loxonema impendens,	19.
„ rugifera,	8.
Natica tabulata,	8.
Turritella triserialis,	8.
Small univalve shells, Natica and Pleurotomaria, species undetermined,	8.
Heteropoda.	
Bellerophon apertus,	2, 8, 10.
„ species undetermined,	9.
Cephalopoda.	
Nautilus (Discites) sulcatus,	19.
ECHINODERMATA.	
Actinocrinus or Cyathocrinus variabilis (joints),	4, × 5.
Crinoid stems and joints,	8, 10.
ANNELIDA.	
Spirorbis caperatus,	6.
„ (Serpula) spinosa, *De Koninck*,	6.
Crustacea.	
Bairdia curta,	7.
Leperditia Okeni,	7, ? 10, 19.
Phillipsia pustulata,	6, 19.
Pisces.	
Helodus lævissimus,	6.
(*Coal-Measures*, so called.)	
MOLLUSCA: *Conchifera.*	
Aviculopecten (Lima) alternata, M'Coy,	14, 16, 17
„ papyraceus,	13, 14.
„ variabilis,	× × 14.
Posidonomya Becheri,	× × × 14, × × × 15.
„ membranacea ? var. of Becheri,	× × 11, 12, × × × 13, × × 14, 15, × × × × 16, 17.
„ vetusta,	× 12, 17.
Cephalopoda.	
Goniatites sphæricus,	× 12, × × 13, 14, 17.
„ „ var. crenistria,	× 11, 12, – + 14, 15.
„ serpentinus ?	14, 15.
Orthoceras Steinhauerii,	13, 14, 15.
„ inæquiseptum ?	12, 14, 15, 17.

The fossil plants in the collection from this district are precisely similar in appearance, and the character of the deposit in which they occur also corresponds with those collected by the Geological Survey at various places in the south of Ireland, particularly in the counties of Kerry, Cork, Wexford, Kilkenny, and Tipperary, all of which are described as Upper Old Red Sandstone. These plant remains are from one locality only (No 1,) south of Beltra Lough, at the north-west corner of the map; in some cases they permeate the strata in considerable abundance, and although not in a sufficient state of preservation to determine genera or species, correspond sufficiently in character with those before mentioned from so-called Upper Old Red Sandstone strata as to correlate these widely distant localities.*

* I think the evidence is scarcely sufficient to warrant such a conclusion. From the position of these beds immediately underlying the Carboniferous limestone, I concur in the opinion of Mr. Symes, who surveyed the district, that the beds are of Carboniferous age.
E. H.

The fossils collected from strata, also coloured on the map as Lower Carboniferous sandstone, were all obtained at localities a little north of Castlebar (Nos. 4 and 5), they are of a very different character to that of the plant beds, as is also the rock in which they occur. These fossils consist of casts of marine shells and crinoidal impressions, and although few in species are characteristic of the Lower Carboniferous limestone.

Amongst the fossils collected from the Carboniferous limestone, corals preponderate, many of them being beautifully exhibited in relief, consequent upon atmospheric weathering. At some of the localities, particularly Nos. 6 and 20, species occur which are also characteristic of the Lower Carboniferous limestone.

The so-called Coal-measure fossils from localities at the eastern portion of the map, consist of Aviculoid Mollusca and the Cephalopod genera, Goniatites, and Orthoceras; amongst them the characteristic species of the lower coal-shales, as in the counties of Dublin, Meath, Clare, &c., are very prevalent, such as *Posidonomya Becheri* and *P. membranacea; Goniatites sphæricus*, as at Loughshinny, co. Dublin; with *Orthoceras Steinhauerii*, and *O. inæquiseptum*. Mr. Hull considers these beds to be representatives of the Yoredale and Millstone grit series of England.

WILLIAM HELLIER BAILY.

June 23rd, 1871.

DETAILED DESCRIPTIONS.

Position and Lie of the Rocks.

For the purpose of better description, this district may be arranged under four divisions:—

First—That of Castlebar, including the mountainous tract to the N.W.
Second—That of Ballyhean.
Third—That of Balla, including Slieve Carna hill.
Fourth—That of Bohola.

Country around Castlebar.—About one mile and a half N.W. of Castlebar occurs the boundary between the Carboniferous rocks and the older and metamorphosed rocks, and this boundary running in a N.E. and S.W. direction marks as it were the division between the productive and the unproductive soils. Between the town and the boundary there occur black shaly and impure limestones; hard black and green, slightly columnar dolerite; thick well-bedded bluish limestones, containing rounded and angular pebbles of quartz; brown calcareous sandstones; and well-bedded quartzose conglomerate.

The town of Castlebar stands on dark gray thick evenly bedded limestone, which dips at a very slight angle to the S.E. The principal exposures occur in the Green, Castle-street, and Spencer-street. Underneath this well-bedded gray limestone is the black shaly flaggy impure limestone, along the beds of which the river running through Castlebar has cut its course.

In the Castlebar river the best exposures occur a little N. of Millbrook, which is about a mile N.N.E. of Castlebar; also at Ballynew cornmill, where the beds are fossiliferous, and dip E.S.E. at about 5°, and between the bleach mill and the village of Turlough, which is about three and a half miles N.E. of Castlebar, where the black flags dip S.E. at 5°. Some of these flags contain large cubes of iron pyrites.

Beneath this impure flaggy limestone is the peculiar quartziferous limestone; but immediately to the N. of Castlebar, and stretching in a

N.E. direction for about four and a half miles, is a narrow boss of igneous rock, which has been erupted between the soft black shaly limestone and the hard quartziferous limestone. This igneous rock, called dolerite, from its composition of augite and felspar is with difficulty to be met with in its normal condition, inasmuch as atmospheric action disintegrates it rapidly, and the weathered portion crumbles readily into a coarse brown sand. The true condition of this rock is slightly columnar, and of a sap green colour ;* the crystallization being very minute.

Beneath the igneous rock there is the quartziferous limestone, which varies from a grit to a conglomerate; the grit being composed of angular pieces of quartz cemented by carbonate of lime, while in the conglomerate the pebbles are rounded, and some were as large as a pigeon's egg. None of these pebbles can be identified with any of the older rocks in this district. The quantity of lime also varies very much in this limestone; in some cases it is suitable for burning purposes, whereas in other cases it requires the acid to give proof of the existence of any carbonate. The best exposures are seen in large crags between Sion Hill and Rathbaun Lough, which is about one mile N. of Castlebar, there the beds dip S.E. at 5°, and consist of well-bedded pale-gray thick limestone, spreading into short irregular flags full of small round pieces of quartz.

This bed then is constant throughout this district, forming the base of the Carboniferous limestone. Immediately underneath this quartziferous limestone there are yellowish-brown slightly calcareous sandstones, dipping in the same way and at the same angles as the limestones above them : there is no considerable thickness of them, and they are very soft, easily affected by atmospheric action. Wherever this sandstone occurs in this district there are numerous lakes, showing how the denuding agents, which passed over this district, eat their way into the softer rocks and leaving behind holes and loughs monuments of their errosive force. The lakes occurring along the course of this sandstone, commencing from the north, are Loughs Cat, Mullan's, Bob Gay, Mulroy's, Richard's, Roe, Black, Chancery, Akeel, Cappagh, Tucker's, New Antrim, Rathbaun, Black, Mallard, Dambaduff, Drumminaha, Woodville, Drumneen, besides numerous very small ones.†

Beneath the calcareous sandstones are thick, well-bedded brownish yellow quartzose conglomerates, which are seen to rest unconformably on the micaceous schists, one mile and a quarter N. of Castlebar, on either side of the road leading to the Windy Gap.

The limestones to the W.S.W. of Castlebar are identical in lithological character with those already described N.W. of the town; the position of the various beds corresponding as well. In the hamlet of Snugborough, which is about one mile W. of Castlebar, there are limestone crags which abound in quartz. On the road side on the S. shore of Lough Mallard, about two miles W. of Castlebar, there are five quarries opened; in these are sandy limestone full of plates and chips of silex. Close to Raheen's House, and in the arterial cut S. of the house, are blue limestones which dip S. at 3°. One-third of a mile W. of Raheen's House a new drain exposes dark gray limestone dipping S.; while two hundred yards N. of this there are sandy limestones dipping

* All along this boss and on either side of it there is an extremely rich soil, evidently due to the disintegration of the igneous rock.

† The town of Castlebar being situated near the extreme limits of the great plain of Carboniferous rocks, at the base of which is the water-bearing strata of sandstone and conglomerate, with the dip of the strata from the boundary in the direction of the town, admits the possibility of obtaining water from wells of sufficient depth.

At the present time there is but one well, viz, at the new gaol; it is about 134 feet deep, and has been bored through the quartziferous limestone down to the soft calcareous sandstones, from which a good supply is obtained.

Independent of this well there have been in use several large catchment basins which have been worked out of the solid rock, and which receive the drainage of the superficial rocks as well as of the drift in the immediate neighbourhood. In the infantry barracks are three of these reservoirs, in the old gaol one, and in the cavalry barracks one, which latter was thoroughly exhausted daily during the summer of 1868.

The Royal Engineer department in October of that year consulted the late Mr. Jukes on the subject, and he ordered me to visit the spot and give my report on same, which accordingly I did, recommending that a hole 20 feet further be bored and that then the good water-bearing strata would be reached.

In the month of September of the present year, since the above was written, I visited this catchment basin which now may be termed a well, and learned from Mr. Glanville, the contractor, that the rock had been bored the required depth, that a constant supply had been obtained, and was never near being dry, even when the cavalry were quartered there during the dry summer of 1870. I also found that the rate of boring was by no means uniform: in some cases the jumper went down two or three inches at a time, showing the passage through the soft calcareous sandstones; in other cases the resistance was as great as when they commenced to bore.

S.S.E. at 5°. On the shores of the Castlebar Lough (more especially on the northern shore) are blue limestone blocks; all these blocks are curiously water-worn, very similar to *Pholas* borings. There is no quarry of these limestones here, but the rock must be close to the surface. Only one exposure is met with along the N. and W. shores, and that occurs adjoining the herd's house at Annagh promontary, and consists of the black flaggy and shaly limestone similar to that N. of Castlebar, along which the Castlebar river has cut its course.

Similar beds are met with at the road side, where the drainage cut, which flows into Islandeady Lough, crosses the main road a quarter of a mile E. of Greenhills, the beds of which dip S.S.E. at 3°.

On the N. shore of Islandeady Lough there is a good section seen in the drainage cut connecting Dambaduff Lough and Islandeady Lough, of arenaceous limestone, resting on limestone containing rounded and angular pieces of quartz, some as large as a pigeon's egg; the dip here varies from 3° to 10° S.S.E.

One-third of a mile S.W. of the last exposure, there is a quarry of gray limestone in the field opposite the police barrack, but it is nearly all filled in. On the W. side of Islandeady Lough there is a cut connecting that lough with the chain of loughs known as Drumneen Loughs, and in that cut to the W. of the Roman Catholic Chapel, there is a good thickness seen of thin-bedded pale-gray slightly oolitic limestone, which dips S.E. at 5°.

On either side of the hamlet of Drumneen, which is about six miles S.W. of Castlebar, there are large drainage cuts. In the cut a quarter of a mile N.E. of the hamlet, is an outcrop of hard compact dark gray crystalline limestone, dipping S.E. at 3°; and in the cut a quarter of a mile S.W. of the hamlet are highly quartzose limestones, dipping at the same angle in the same direction. One mile and a half S. of Drumneen, the railway from Castlebar to Westport exposes black limestones with shale partings, dipping at angles varying from 5° to 20° S.S.E., while a little further on, the railway exposes similar limestones, dipping N. and N.W., at angles as high as 35°. These beds are then the highest beds of the limestone that are to be seen in this district, and form, just in this locality, the topmost beds of a synclinal axis, which is parallel to the strike of the limestone about the neighbourhood. A mile further towards Westport, along the railway, can be seen similar black shaly limestones, but they are displaced apparently by the boss of dolerite that is supposed to exist in this neighbourhood. This dolerite, of which the only evidence

exists in the large massive blocks, (centred in a confined area) consists of a bright micro-crystalline aggregate of augite and felspar. It is assumed that it is contemporaneous with the other dolerites that range in a N.E. and S.W. direction; but the most of these dolerites are somewhat different with regard to their crystallization and their weathering. This dolerite does not weather or decompose; the fracture made at the surface of a block exposes the normal condition of the rock, similar to that in the centre of the mass; whereas at Castlebar all the dolerite decomposes very rapidly, and it is with extreme difficulty that the true nature of the mass can be determined.* The limestones to the S.E. of this portion of the railway form crags, they are light gray in colour, and dip northwards at angles varying from 5° to 10°.

To the S.W. of Castlebar the limestone is seen to crop out in several places, as, for example, in the grounds at the back of the gaol and the lunatic asylum, where it is resting horizontal, and in the arterial cut connecting Saleen Lough with the Castlebar Loughs, in which the beds are for the most part horizontal; but one dip was noted of 2° to the S.S.E. Immediately to the S.W. of the cut, and close to the margin of the lake, there is a quarry of evenly bedded black limestone, the beds of which dip S.E. at 5°.

The townland of Knockaphunta, which is about a mile S.W. of Castlebar, is for the most part devoid of Drift in its N.E. corner, crags of blue limestone appearing over the most part of it. The same may be applied to the townland of Ballymacrah, which is about two miles S.W. of Castlebar. The ground between the Westport road and the lake being, as it were, a sheet of dark gray limestone lying horizontal.

To the S.E. of Castlebar very numerous crags of limestone occur. At either side of the railway station there is dark and light-gray much jointed limestone, dipping S.E. at 5°.

Three hundred yards S.W. of the railway station there are crags of the same limestone cropping out on the shore of Saleen Lough.

Three-quarters of a mile E. of the railway station the cutting exposes dark gray shaly limestone, with black shale partings dipping S.E. at 15°.

South of this cutting and extending along the W. boundary of Hawthorn Lodge are crags of dark gray limestone resting horizontal.

Where the railway cuts through the Castlebar race course, three miles E. of the town, are similar limestones, which have a very slight dip to the S.E.

A mile S. of the race course there is a large tract of ground devoid of drift, and where the crags for the most part are lying horizontal. Any dip noted was to the S.E., and none higher than 5°. In these crags were found great stools of *Zaphrentis cylindrica* standing out unweathered, as they are composed of silex.

To the E. of Castlebar numerous small quarries are opened, especially on the road side, between that town and the village of Balla. These quarries are chiefly used for road metalling purposes.

* This rock is locally termed the Kilbree dolerite, inasmuch as it occurs to the W. of that hamlet. It has been considered by the Midland and Great Western Railway Company a very serviceable and lasting stone, consequently they get it broken there into small pieces suitable for road metalling, which is used at the Broadstone station and North-wall. The following information was obtained from Mr. Price, the Company's engineer:—"I have used it for many years to metal roads subject to the heaviest traffic, and I never saw anything equal to it: it is very tough, but when broken forms nice cubes, which makes a regular pavement; I use some limestone with the latter, forming a paste, to keep the metalling in place. Its specific gravity is 2·96, while that of Welsh and Wicklow greenstone is 2·75. The cost of breaking is 2*s.* 9*d.* per ton, carriage to Dublin 2*s.* 6*d.* per ton, but the public would be charged 8*s.* per ton."

At Breaghwy Lodge, which is about two and a half miles E. of Castlebar, there are two quarries, one to the N.E. of the house where the beds dip E.S.E. at 3°, and the other to the S.E. of the house where the beds are horizontal. A mile to the E. of Breaghwy Lodge there is a large area of limestone exposed, but the bedding was not discernible owing to frequent jointing, and the mass of loose flaggy pieces that covered the true rock.

To the N.E. of Castlebar the chief exposures occur in the townland of Moneenbradagh, which is almost entirely one mass of crags of dark gray, thick, evenly bedded limestone, highly crystalline and crinoidal. No dip was noted to exceed 8°, and that was to the S.E.

On either side of Windsor House, which is about two and a half miles N.E. of Castlebar, are crags of similar limestone, with a slight dip of from 2° to 5° to the S.E. Beneath these crags are the black shaly limestones through which the Castlebar river cuts its course, and of which plenty of evidence is obtained at Ballynew, and from that on to Turlough, which is three miles N.E. of Castlebar.

On the road to Gneeve (which is about five miles E.N.E. of Castlebar), and at the bridge adjoining Beckett's mill to the W. of Gneeve, are gray well-bedded compact fossiliferous limestones; in either case the dip does not exceed 5°.

A mile and a quarter N. of Beckett's mill, the Manulla river passes over light gray well-bedded limestone, which dips S.E. at 3°.

West of this, the ground is strewn with very angular blocks, but no actual section of the rock *in situ* was observed.

Half a mile N.E. of Turlough there is a quarry underneath Viewmount House in which the black flaggy limestone (the same as that in the river at Turlough mill) was observed, the beds of which are horizontal.

Of the quartziferous limestone N.E. of Castlebar, the chief exposures occur to the S. of Tucker's Lough, where the beds dip S.E.: at Ballinvilla two quarries on either side of the townland, where they dip, E.S.E. at 2°; and on the road side between the village of Turlough and the hamlet of Ross, about 200 yards S. of the Clydagh river, where the beds dip S. at 2°.

Of the Carboniferous grits N.E. of Castlebar, the chief sections occur on the road side N. of Tucker's Lough and Cappagh Lough. They consist of fine grained reddish and yellowish brown sandstone, and underneath them conglomerates containing jasper, vein quartz, and quartzite pebbles. The dip of these rocks does not exceed 7° or 10°, and is from the S.E. to the S.S.E.

In the river S. of the hamlet of Cloonkesh, which is three and a half miles N.E. of Castlebar, there is an outcrop of coarse-grained yellow sandstone, which has a slight dip of about 3° to the S.E. In the same river, and about three-quarters of a mile E. of Cloonkesh, there is another exposure of coarse-grained yellow flaggy sandstone, which dips in the same direction as the last. The only other section in this subdistrict N.E. of Castlebar is in the Clydagh river, four and a quarter miles N.E. of Castlebar, where the road from Turlough to Ross crosses it, consisting of yellowish brown quartzose sandstones, which dip as high as 20° to the S.E.

Having now described the Carboniferous group in the immediate neighbourhood of Castlebar, I will pass over the older rocks to the Carboniferous rocks which have been deposited in the Newport valley, and describe those situated about Beltra Lough, which is in the immediate N.W. corner of the sheet.

Before their immediate description, it will be necessary to mention

that prior to the deposition of the Carboniferous group in this district, the older rocks were very much disturbed. The cliffs of Silurian rocks form for the most part the southern boundary of the valley lying in the line of the large fault which runs in a N.E. and S.W. direction, having Lough Conn (sheet 64) and Newport Pratt (sheet 74) for its N.E. and S.W. *termini* respectively. Now in this valley, the horizon of which is much below that of any other part of the whole district, a small portion of the Carboniferous rocks have been preserved through the agency of the fault already referred to, by which they have been relatively lowered on the N.W. side, and thus protected to a certain extent from denudation* (*see* Frontispiece). But three outcrops of the Carboniferous limestone, and one of the Carboniferous grits were observed, owing to the thickness of the drift; but immediately outside the district there is plenty of evidence of the existence of these rocks. The three quarries of limestone are situated to the W. of the lough, one to the S.W. of Muckanagh Lodge, another a hundred yards N.W. of the trig. point 171, and the other on the shore of the lough, at the very top of the sheet. No dip was observed in any of the quarries, as but the surface beds were raised, and they for the most part consist generally of dark gray and black fetid limestone very fossiliferous.

The beds of grit were observed in a small brook one-third of a mile due S. of Muckanagh Lodge, and they appeared to dip in a N.W. direction at 10°. Traces of plants were found here.

Silurian Rocks.—As has already been mentioned, these rocks have been classed amongst those of Silurian age, from their lithological comparison to those of true Upper Llandovery age, situated on the W. shores of Lough Mask, near Kilbride (sheet 85), in which fossils of that age were found.

The rocks of this class in this district are for the most part composed of very thick-bedded conglomerates, containing pebbles about the size of a man's fist, of vein quartz, quartzite, (pink and white) granite, sandstone, limestone, &c., &c. In all cases the quartzite pebbles predominate over the others.

The true thickness of these beds cannot be determined here, owing to the very frequent undulations of the beds, but certainly there are not more than 2,000 or 3,000 feet of strata. These rocks are best seen in the range of hills known as Croaghmoyle range, as well as that of the Burren. In both of these ranges there are inaccessible perpendicular cliffs, composed almost entirely of coarse conglomerate; and with very rare exceptions there are thin bands of variegated sandstones and shales generally mottled.

In the Croaghmoyle range, the axis of which runs N.E. and S.W., tier over tier of these well-bedded, as well as thick-bedded conglomerates can be seen; the dip of the beds being rather high, owing to the fault which ranges along their base. On the N.W. side of the fault the beds dip N.W. at angles varying from 30° up to 50° in a N.W. direction, while to the S.E. of the fault, the beds dip in that direction, at angles as high as 25°. A tolerably good section of these beds can be seen in the gap at S.E. of Beltra Lough, through which the road passes from Castlebar to Belmullet; the highest dip is 20° to the S.E. Immediately at the foot of the Croaghmoyle range, on its eastern side, the beds dip at low angles in the contrary direction, that is, to the N.W., and continue undulating as far as Loughanaveeny (which is on the water-

* The existence of this fault was determined by Mr. Hull on his first visit to the district, 1869.

shed of the district, and from which two rivers flow, one the tributary which feeds Beltra Lough and finally the Newport river, the other a tributary of the Clydagh river, and finally the Moy), where the beds assume a steady dip in a S.E. direction, and range at angles as high as 60°. E. of Loughanaveeny, which is four and a half miles N.W. of Castlebar, the basal beds are met with, which here consist of sandstones mixed up with conglomerates, and in the Clydagh river, a mile N.E. of Loughanaveeny,* similar beds are met with, all dipping away from the lower rocks at low angles.

In Bureen mountain which is about a mile and a half N.E. of the Croaghmoyle hills, similar conglomerates are to be found, which dip S.S.E. at 15°. On the N.W. side of this hill there are cliffs 700 or 800 feet high, and apparently there are very few beds of sandstone interstratified with the conglomerates. At the base of this cliff some greenish sandstones easily weathering were observed, owing to the calcareous matter in them weathering out, these sandstones are useless, as they fall away to the touch. These sandstones generally rested on argillaceous shales, which were extremely thin.

On the low grounds to the S. of these mountain ranges, the conglomerates crop up in many places. On the road side from Castlebar to Newport, and adjoining the hamlet of Derrycoosh the beds dip away from the lower rocks. in a N.W. direction at angles as high as 35°. A mile to the N.W. of Derrycoosh, a brook over which the road from Castlebar to Beltra Lough passes, exposes a good section, consisting of coarse conglomerate consisting of blocks as large as a man's head, resting on brown ferruginous sandstone, which rest on red micaceous sandstones much jointed, conglomerate with angular blocks, mottled green shales, and brown sandstones.

At Ass Bridge, four miles N.W. of Derrycoosh, the conglomerates are for the most part horizontal, but in the brook leading to it, and about half a mile E. of the bridge the beds dip N.W. as high as 45°, while two hundred yards farther E. they dip S.E. as high as 50°.

About a mile and a quarter to the S.E. of the Ass Bridge there is an escarpment of conglomerate ranging in an E. and W. direction for about a mile. Over the whole of this the beds dip every way except to the N.E. at every angle up to 40°. It is on the E. side of this escarpment that the small boss of felstone is met with. It is evidently newer than the conglomerates, inasmuch as it has indurated the beds in conjunction for some distance, and must have disturbed them very much. But a very trifling exposure of the felstone can be seen, and where observed, consists of a splintery grayish white rock, which decomposes near the surface.

To the S. of the boss of felstone there are several out-crops of the Silurian rocks to the W. of the chain of the Drumneen Loughs. They are, for the most part, those which are supposed to be close to the base of that series, and chiefly consist of conglomerates interstratified with purple sandstones and breccias.

One of these beds occurring a little N. of the trig. point 176 W. of Drumneen Lough, has granite blocks the size of a man's fist occasionally occurring in it, and a dip of 15° to the S.W.

Immediately to the S.W. of the last exposure there is a boss of fine conglomerate, which has been rounded by ice; this being the only example of ice action on these rocks in this district, probably due to the rapid weathering out of the pebbles in the conglomerate, thereby rendering the mass easily destructible, and obliterating all traces of ice-action.

* In the Clydagh river the red sandstone, as used for the lining of Tuam Protestant Cathedral, is obtained, but in no great quantities.

Having now disposed of this mass of conglomerate, it will be necessary to point out where the nearest approaches to a junction with the metamorphic rocks occur.

On either side of Lough Sallagher, which is two and a quarter miles N. of the hamlet of Derrycoosh, the actual junction is not seen, but there does not exist more than a couple of hundred yards between the two different classes of rocks, and the base of the conglomerate here is composed of a red micaceous clay-slate, which one might at first sight be tempted to class among the metamorphosed rocks.

Good sections of these micaceous clay-slates can be seen in the brooks, the one a third of a mile E. of the lough, and the other in the Brockagh river, one mile W. of the lough.

Similar red micaceous slates are observed in the brook one mile N.N.E. of Derrycoosh, where the knuckle in the boundary line is marked.

I believe these micaceous clay-slates are a constant base to these conglomerates, not only in this district, but in districts to the S., where the relative comparisons between the conglomerates have been drawn.

Metamorphic Rocks.—These, as has already been mentioned at page 12, vary very much in so large an area. The great fault which traverses these metamorphic rocks in the meridian of Castlebar, and going out of the district on its northern limits, separates the metamorphosed rocks into two varieties, the one E. of the fault being very highly metamorphosed, and composed almost entirely of a highly micacized schistose rock, in which various minerals, such as tourmaline, rutile, &c., have crystallized out, while those W. of the fault boundary are but slightly metamorphosed; in some cases blackish shales are not discernible from unmetamorphosed rocks, save that they are slightly mineralized.

The rocks W. of the fault boundary, consisting of schists, gneiss, quartzite, serpentine, limestone, &c., will be first described, and then the rocks E. of the fault.

In the district about three and a half miles N.W. of Castlebar the foliation follows the bedding, which here undulates very much at high and low angles, chiefly in an E. and W. direction.

Of the topmost beds, which here are massive, bluish, white, quartzites, very little can be said, except that they are for the most part horizontal; where there is a dip, it is at the limits of the boundary between the quartzite and schist, and is always inwards, never exceeding 5°.

Underneath the massive quartzite there are chloritic and hornblendic schists, interstratified with thin bands of quartzites; these beds dip towards the basin of quartzite at angles varying to 35°.

To the S. of Lough Boy, W. of these schists, and underneath them, there is a peculiar class of rock, of which very little could be determined on with regard to its mineral composition.

The late Mr. Jukes made the following note with regard to it:—"Greenish-gray, fine-grained, hard, heavy rock, in some places schistose, and breaking into powder. I could imagine it to be an altered ash; one crag was brecciated, of same material; what to call it I do not know."

This rock (whatever it may be) has a strike of N. 30° E., and a dip of 50° to the S.E. The strike will just coincide with another peculiar class of rock, which I consider to be a metamorphosed igneous rock, and which occurs just outside this district to the N., and which will be described in a future explanatory memoir to accompany sheet 64.

West of this peculiar rock, and E. of Cashel Lough, there are chloritic and hornblendic schists, felspathic quartzite and gneiss, with crumpled foliation; the foliation changes to N. 5° W., and finally to N. 30° W., with perhaps a dip of about 30° as an average.

South-west of Cashel Lough there is but one boss of the metamorphosed rocks, and that occurs E. of a small tarn, where beds of rotten green and red siliceous serpentine rest on mica schist; here the beds dip W.N.W. at 45°.

Among this boss of schist are veins of carbonate of lime, in which were traces of iron and copper.

The metamorphic rocks in the neighbourhood of Lough Rusheen, which is two and a half miles N.N.W. of Castlebar, are very similar to those already described, having their foliation and bedding to agree, and that not constant for any lengthened area, but undulating in almost every direction at various angles. The composition of these beds are also very similar to those already described, only somewhat more diversified, as there are to be found associated with them, talcose schists, dolomitic schists, and mineralized argillaceous shales.

Along the fault boundary the bedding of these schists dips from it, showing that those metamorphosed rocks to the W. of that boundary have been lowered, while these to the E. have been raised, and the beds in conjunction drawn in the several directions at right angles to that boundary.

Along this boundary on its E. side, and about two miles N. of Castlebar, are to be found some serpentinous rocks, chiefly the bright green serpentine, with numerous veins of crysatile. The bedding of these rocks is not clearly discernible.

North of the exposure of serpentine, and in the Clydagh river, the schistose rocks are interstratified with bands of quartzite, through which numerous veins of quartz are to be seen; the rock here dips N. at angles varying from 15° to 40°. N. of the river numerous outcrops occur, but they appear to be very much displaced owing to their contiguity to the fault.

Among these metamorphic rocks are two exposures of a limestone, which has been called metamorphic limestone, the real origin of which I have already expressed an opinion on (*see note*, p. 12).

One of these occurs on the road side, on the old road leading from Castlebar to Lough Beltra, about three miles N.W. of the town, and the other occurs in a tributary of the Clydagh river, about five miles N. 10° E. of Castlebar.

In the first of these sections the external rock is gray and blue in colour, but, when fractured, shows a beautiful white highly crystalline appearance. It is devoid of foliation, and appears to occur exactly in the boundary between the Silurian and Metamorphic rocks; this is also applicable to the second opening. Its structure is very like a highly crystalline stalactite, and when burned proves a very "fat" lime.

In the second exposure the crystallization is not so large, and its bedding seems to be at right angles to the schists, which are close.

In no case was a junction of these rocks observed.

To the S.W. of Castlebar the metamorphic rocks crop out close to Drumneen Lough, but only one quarry is seen, consisting of crumpled quartzose gneiss.

On the E. of the fault boundary, to the N. of Castlebar, the schistose rocks, as has already been said, are much more altered than those to the W. of the boundary, and their foliation appears to be more constant, being for the most part in a N. 40° E. to N. 70° E. direction. At the junction of these rocks with the newer sedimentary rocks, they present well-rounded outlines, deeply furrowed by ice, but northwards they have more or less a plane surface.

Throughout the mass the granite veins are perceptible, in some cases

crossing the bedding and foliation, while in other cases, which are more frequent, the veins traverse the line of foliation.

The surface of these metamorphic rocks is for the most part denuded of vegetation, a scanty growth of heather being found in the lower grounds between the several exposures. The foliation on surface of these rocks is also well defined, owing to the micaceous matter weathering out, while the siliceous particles stand out unweathered. Great veins of pure white quartz traverse the fissures in these rocks generally along the foliation, but in some cases across. The bedding does not coincide with the foliation of any of the rocks E. of the fault boundary.

The only description applicable to these rocks is, that they are highly micaceous schists, with crystals of rutile and tourmaline frequent, and an occasional band of chloritic schist and quartzite.

The most continuous masses of these highly metamorphic rocks occur to the N. of the road leading from Castlebar to Ballina, and about three miles to the N.N.E. of the former town, and consist of rounded bosses of schist, which for the most part are highly micaceous, although some bands of cloritic and hornblendic schist and gneiss are to be found among them. These rocks, of which the bedding is undeterminable, have a vertical foliation which ranges from N. 50° E. to N. 70° E. To the N. of these rocks, and in the neighbourhood of Naspleenagh Lough, the schists are traversed by veins of granite, which are not traceable for any continuous distance. In the Clydagh river (where it flows in the direction of the foliation of the schists) there are alternate strata of flaggy quartzite, mica slate, and vein granite, in a N. 60° E. direction, with a dip of foliation of 60° to the N.W.

Further north, and to the N. of Lough Anaffrin, are thinly laminated flaggy quartzites, with vein granite following the foliation.

The schistose rocks in the neighbourhood of, and to the S.W. of, Levallinree Lough, which is about six miles N.N.E. of Castlebar, are approximately the same as those already described to the N. of Castlebar. The exposures are more frequent, and are generally separated from one another by strips of bogs which lie in a N.N.E. direction. The foliation of these rocks is generally in a W.S.W. and E.N.E. direction, with a dip of about 60° to the N.W. About a mile to the S. of the lough, the schists are penetrated by a boss of coarse granite, which runs in a N. and S. direction. This granite is very coarse, and has black mica in large quantities, also traces of asbestos.

Igneous (or Metamorphic) Rocks.—The main mass of the granite of this district lies in that portion about 4 or 6 miles N. of Castlebar. It is porphyritic, having large crystals of flesh-coloured orthoclase in profusion, and black and white mica generally in small crystals.

This rock, although called granite, is not a true granite, inasmuch as it is foliated, being foliated at the same time as the sedimentary rocks in conjunction were metamorphosed; consequently the foliation of both is the same, generally in a N. 40° E. to N. 60° E. direction. Some might call it a gneiss, as it has a gneissose structure, while others would consider it as a granite formed *in situ*, due to metamorphic action, but I think the proper term in this case is a "foliated granite."

Wherever this rock is seen it presents the rounded or mammilated outline so common to the rocks of the granite class, and which is generally due to weathering.

In this case the rounded forms are for the most part due to the great levelling agent ice, but its paths are not visible, save by the valleys between exposures, as a rock so highly crystalline is soon affected by atmospheric action on its surface, and the marks or striæ are soon obliterated.

On either side of the road from Castlebar to Ballina the granite outcrops in very many places, and the tract in this district, where the granite occurs, is almost sterile; bog, heather, and a scanty herbage, the only growth, save along the little brooks, where the alluvial deposit, composed of the *debris* of other rocks, affords some depth of soil for spade or plough.

The foliation of the granite is vertical, and does not change throughout the tract. A little W. of the Roman Catholic Chapel at Ross the surface of the granite slopes down to the fault at an angle of 25°.

The only other rock in this portion of the district to be described is the diorite, which makes its appearance 3 miles N.E. of Castlebar, and to the E. and W. of High Bridge.

It is a highly crystalline rock, composed of dark green flaky hornblende and white felspar, no other ingredient, save a few crystals of iron pyrites. This rock appears to be newer than the granite or sedimentary rocks in conjunction, inasmuch as it is not foliated. In some parts it might be termed a highly crystalline hornblendic diorite from the absence of the felspar, but on the whole there is a fair mixture of both.

On the W. of Ballyhean, the road leading from that village to The Triangle, exposes very numerous quarries. On either side of this road the crags are to be seen of ordinary dark gray limestone, the beds of which undulate at low angles E. and. W.

In one of these exposures, that to the S. of the trig. point △ 260, beds of oolitic limestone were observed to dip S.E. at 3°.

The Ballyhean Division.—To the N. of Ballyhean there are no exposures, as the country thereabouts is covered with a thick mantle of drift and bog, but on the N.E. side from Kinturk Castle, as far as Kilboyne House, there is one vast sheet of light gray highly crystalline and much weathered limestone, which presents a steep escarpment on its S.E. side, but its surface has but a very slight inclination, and that in the direction of Kilboyne House.

On the N.E. and S.E. sides of Bemcam Lough, which is about one mile and a half N.E. of Ballyhean, similar crags of similar limestone were observed to dip N. at from 3° to 5°.

A mile to the E. of Ballyhean is a rude escarpment of fine-grained well bedded black limestone, in beds of twelve inches thick, and which dip E. at 7°. This peculiar limestone is not very thick, and is exactly similar to that already recorded in the Turlough and Castlebar river, as well as in the railway cutting on the Westport line. Above and below the black limestones are crags of dark gray limestone, which dip E. at about 5°.

Of the older rocks and the Carboniferous sandstone in the S.W. of the area, Mr. Kinahan writes:—

"S.W. of Cooley Lough, the small sheet of water south of Ballyhean, is an outlying exposure of metamorphic rocks forming the small hill called Tonaderrew, and these rocks are supposed to have been originally of Lower or Cambro-Silurian age. On this hill rocks are only exposed to the east and south; but from these it would appear probable that the north part is a massive rock of igneous origin, now not only changed by metamorphic action but also probably by pseudomorphism. It has already been described at page 12. To the south, near the margin of the bog, a somewhat similar rock was noted, it is, however, apparently more fissile; but is very imperfectly exposed, and its relations to the associated schist are consequently obscure. The other rocks seen in this hill are mica and steatitic schists, the latter graduating into talcschist.

"To the E. of the hill, in places on the metamorphic rocks, was observed a thin skin of breccia, the shore bed in this locality of the Carboniferous limestone, while to the south is a small exposure of red Carboniferous sandstone.

"Further east and south the Drift is made up largely of angular blocks of sandstone, and the underlying rock is conjectured to be Carboniferous sandstone; however, only in one place, a mill-race, where on the map the fault crosses the Aille River, does the rock appear to be *in situ*. In the nearly N. and S. flat south of Cooley lake, and also extending north to and beyond Ballyhean, there is evidently a line of fault; while to the north-west the metamorphic rocks are probable bounded by one, a downthrow to the N.W. This seems probable, as farther N. and N.W. the limestones have a slight S.E. dip, while those contiguous to the supposed line of fault dip N.W. at higher angles (30 to 55); furthermore, a mile to the S.W., the rocks south of the Aille river are much displaced, as will be mentioned hereafter. Nevertheless, it is not impossible that the limestones may overlap on to the metamorphic rocks, as is not uncommon in this part of Ireland, due, it is quite evident, to the Carboniferous sea hereabouts containing numerous islands, promontories, &c., of older rocks. Farther westward, S.W. of the village called The Triangle, at the south margin of the area contained in this sheet of the map, is a small tract of lower Silurian age, the N.E. extremity of the tract that extends south-westward to the mouth of the Killary harbour. These rocks consist of pebbly sandstones, grits, and slates. They are at high angles (65 to 80), generally having a south dip, and may, perhaps, be slightly altered, as immediately south of this district there are typical schists associated with indurated grits, the foliation apparently following the ancient cleavage lines; in the slates dipping S.E. at 70° but in the arenaceous rocks not being higher than 45°.

"Fringing the Cambro-Silurian rocks just described is a narrow tract of Carboniferous sandstone. In this the rock is only exposed in a few places, but its limits are defined by the streams becoming subterranean when they leave it and enter the limestone country. Flaggy sandstone was noted at the junction of the carboniferous sandstones and the Lower Silurian rocks at the road adjoining the Aille River, while north of this place in the Aille River are red sandstones supposed to be *in situ*, and pebbly sandstones occur in a low crag a little west of Lough Kip."

Balla District, including Slieve Carna Hill.—This subdivision, occupying the S.E. portion of the district, is composed entirely of rocks of the Carboniferous group, which include the so-called Coal-Measures, limestones and sandstone.

The Slieve Carna Coal-measure hill stands out prominently at a height of about 600 feet above the surrounding plain, and is entirely composed of rocks of the Coal-Measure group, which include sandstones, grits, and a predominance of black shales, having at its base limestones of different lithological character. On the western face of this hill there is a tolerable thickness of coarse yellowish brown quartzose sandstones, interstratified with the black shales, while the black shales rest on probably about two hundred feet thick of ribboned variegated cherty limestones; whereas on the eastern face the sandstones almost die out to beds of a few inches thick, and there is no sign whatever of cherty limestone as being the bed on which the shales rest; so that in the short space of four and a half miles, which may be taken as a fair average of the

breadth of this basin, the sandstones and cherty limestones have died out, and shales and compact limestone have replaced them.

Commencing on the western side of the hill the best exposures occur on the escarpment overhanging, and to the N.E. and S.E. of Carrowmore Lough, which is about two and a half miles N.W. of Balla.

On the N.E. shore of the lough is a rounded hill, which is about 200 feet above the lough, and which is composed entirely of black and white ribboned chert, which does not decompose, but breaks up into angular fragments. The dip of these cherty beds on the eastern side is from 5° to 15° in a S.E. direction, while on the western side of the hill the chert dips N.W. at about 20°.

In the parish boundary to the N. of the chert hill there are two small outliers of the Coal-Measure shales, which form two small basins of themselves, with their beds dipping inwards at all angles up to 80°, and which are separated from one another by some stratified chert debris. Immediately N. of these basins are some white mottled cherts, which dip S.S.W. at 20°, and N. of them, at the village of Drumganagh, are massive gray limestones, which dip E., S.E., and S.S.E., at angles varying from 3° to 15°.

Immediately to the E. of the chert hill, black shales are to be seen which dip S.E. from 20° to 25°. To the S. of these shales, and above them, are thick massive brownish yellow quartzose sandstones, the strike of which is about N. 10° E., and the dip from 25° to 40° in an E.S.E. direction. These sandstones are well seen all about the trig. point 648, and in the causeway which runs S. of that as far as the hamlet of Carrowkeel.

To the S.W. of Slieve Carna the shales and chert apparently disappear, as the sandstones were very frequent, dipping N.E. and E. with good gray limestones very close to them, dipping in the same direction at low angles. Immediately S.W. of this the railway exposes well bedded gray crystalline limestone, dipping N.E., N., and N.W., at about 5°.

On the S. of the hill, and in a brook about a mile N. of Balla, there is gray limestone with chert, which dips N. at 35°, while to the S. of the corn mill, which is by the same brook, the beds dip S. at low angles.

To the N.E. of this, and to the S.E. of Lough Naminnoo, there are outcrops of yellowish brown quartzose sandstones, dipping N.W. at 20°, while further E. they dip as high as 35° in the same direction. S. of these exposures, and in the neighbourhood of Rockstown, are beds of thin flaggy slightly oolitic and magnesian limestone, which dip S. at 3°. These have above and below them beds of dark gray limestone dipping at the same angle in the same direction.

In the barony boundary, two miles N.E. of Balla, and in the brook S. of the trig. point 650, are to be seen good sections of black shales, tinged with iron, interstratified with thin beds of yellowish red flaggy sandstone, which dip N. at angles varying from 5° to 15°.

The black shales in these brooks are highly fossiliferous, and predominate over the sandstones. S. of the section in the barony boundary there is a good exposure of gray crystalline limestone, the beds of which dip N. at 65°. In the roadway S. of this there are gray limestones which dip N. at 25°, and W. at 50°, showing that about here there are some great upheavals in a short distance.

All along the S.E. and E. slopes of the hill there are numerous brooks and rills which have eaten into the hill, thereby exposing almost perpendicular sections of the subjacent rocks. All the sections are very similar. To record one will be sufficient.

The brook to the W. of Ballinamore House, which is about four miles N.E. of Balla, exposes for the first three hundred feet in ascending

order nothing but black shales, with one thin band of sandstone. Above that are thin flaggy sandstones, occasionally interstratified with the black shales and a peculiar hard thin grit, which does not weather much, and which breaks up into lozenge-shaped pieces.

All the black shales are highly fossiliferous, the most frequent fossils being *Posidonomya Becheri*, and *Orthoceras*.

To the S.E. of the last section, and on the E. side of the road to Ballinamore, there is an exposure of black shales, resting on stratified angular black and white chert. The dip is to the N.W., as high as 70°. This is the only case in which chert is seen on the S.E. or E. of the hill.

One thousand yards to the S.E. of this there is an exposure of Carboniferous grit, composed of yellow quartzose sandstone, with gray limestone resting on it at an angle of 15°. If then the average of the two limestones be taken, viz., between that of 70° in the chert limestone at the road side, and of 15° for the limestone resting on the sandstone, we get 42° 50, and that for 3,000 feet, the distance between the two (or top and bottom), it gives a total thickness of something over 2,000 feet, which would be a little above that as estimated for the thickness between the top and bottom of the limestone to the N.W. of the Slieve Carna hill. This gets rid of the necessity of using a fault here to bring in the sandstones, as without the reliable evidence that is obtained from the section to the N.W. it would be hard to suppose that the sandstones could be brought up so close to the Coal-measures in such a short area as 1,000 yards.

In the Pollagh river, to the N. of Ballinamore House, there is an exposure of limestone, with the beds dipping N. at 22°, while to the S. of the house the roadway E. of the river exposes the yellow sandstones dipping in the same direction.

On the N.E. flank of the hill, as well as on the N., the streams cut deep into the surface, thereby in many places exposing the subjacent strata, which consists entirely of black shales, devoid of sandstones and grits. For the most part the shales are lying horizontal, or having a slight dip inwards. In some places large landslips of the shale have occurred, and where such happen there are great contortions in the beds moved.

In the centre of this tract there are but few exposures, as there is a thick coating of Drift and bog over the most part of it, yet the numerous brooks which traverse it expose beds of black shale, with now and then a band of sandstone.

Of the limestones of this portion of the district but little need be said, as there is a remarkable similarity among them, save in the cherty, oolitic, and flaggy limestones, as already described, occurring in the immediate neighbourhood of the base of the Slieve Carna hill.

To the S. and S.E. of Balla, and in that part known as the Plains of Mayo, only a few exposures occur, and these are the representatives of the black shaly limestone, already described as occurring in the Castlebar and Turlough rivers.

The best sections are at cross roads, two and a half miles S. of Balla, and on the road side about half a mile N. of Brees, which is three miles S.E. of Balla. In all the quarries the beds were horizontal, or nearly so.

To the E. of Balla no limestone quarries worth noting occurred, as thick Drift and bog predominate.

To the S.W. of Balla several exposures were noted. In the Meander river, which is otherwise Manulla river, and to the N.W. and S. of Ballinafad House, which is two and a half miles S.W. of Balla, there

are black shaly limestones, which have a slight dip of about 3° to the W.; and in same river, where the roadway N. of Ballinafad crosses, there are dull gray limestones which have a quaquaversal dip of about 5°. S.W. of this, and about half a mile to the N. and S.W. of Doonamona Castle, there are crags of dull blue limestone, which dip N.W. at 3°.

In the neighbourhood of Belcarra, which is three and a half miles W. of Balla, there are numerous exposures (more especially in the Manulla river) of dark gray well bedded limestones, which, to the N. of the village, dip N.W. at 7° to 10°, while at the village they are either horizontal or have a slight dip S.E. In the neighbourhood of New Dublin, which is about three-quarters of a mile N.W. of Belcarra, there are large crags of similar limestone, which have a slight dip to the N.

To the S.W. of Belcarra there is the hamlet of Cloonconragh, which consists of a single street, built on a crag which is horizontal.

At Elmhall House, which is about three-quarters of a mile N. of Belcarra, there are fossiliferous gray limestones with black shales. At Manulla village, which is three miles N.W. of Balla, there are well bedded splintery light gray limestones, which dip S.E. at 15°.

The Bohola District.—This subdivision of the map occupies that portion to the N. of the Slieve Carna hill, and to the N.E. of the sheet, and is for the most part composed of strata of the Carboniferous age, covered with a tolerably good thickness of Drift, bog, and alluvium.

As the rocks are on the same strike as those of Castlebar, they are almost similar, save that there is no representative of the black shaly beds which are found about Turlough, and which probably about this portion are concealed by either drift or bog.

Five and a quarter miles W.N.W. of Bohola, and to the W. of Lough Holan, are to be found the highly quartzose limestones (or basal bed of the Carboniferous limestone in this district) dipping S.E., at between 5° and 10°. Resting on these are black fetid limestones. North of this, and in the river about half a mile N. of the village of Strade, are similar quartzose limestones, which dip E. at about 5°. These two exposures of quartzose limestone, mark as it were the boundary between the limestone and the grit, as it is quite unusual for an exposure of the grits to occur, owing, as has already been said, to their being erroded away on account of their softness, and their place being filled with either a tarn or some bog.

Of the ordinary gray limestone good exposures occur in the village of Bellavary (which lies about five miles W. of Bohola), and on the roadside a little E. of the same. In both cases the dips were about 10°, and were to the E.S.E.

A mile E. of Bellavary, the Strade river exposes beds of gray fetid limestone, which dip E.S.E. at 5°. A quarter of a mile S.E. of this river exposure, and in the same river in the neighbourhood of Spring Hill, are several quarries of gray limestone, cavernous, and slightly rolling at low angles.

A mile to the S. of Bohola, nearly all the small streams which flow down the N. side of the Slieve Carna hill, expose in their beds limestones which roll at low angles, and which are chiefly gray crystalline and sometimes cherty.

About three and a half miles S.W. of Bohola, and in the bed of the stream on either side of the road which communicates the Bohola road with that of Balla, are light gray massive cherty limestones, which, W. of the road, dip at 25° to the S.W., while E. of the road they dip at about 20° to the S.E. Half a mile N.E. of these last mentioned sections, and in the bed of the small stream, there are thin bedded gray limestones, which dip at angles varying from 15° to 60°.

To the N. of Bohola but few exposures of the limestone occur, owing to the considerable thickness of Drift.

At Ballylahan Castle, which lies about four and a quarter miles N.W. of Bohola, there are quarries of black crystalline limestone, the beds of which dip S. at angles as high as 30°.

E. of Ballylahan, and in the bed of the River Moy, both at Castle Island, and about two hundred yards S. of same, are black evenly bedded limestones, lying horizontally.

In the Gweestion River (which is a tributary of the Moy), adjoining Newcastle House, which lies about two miles N.E. of Bohola, are light gray crystalline limestones, which dip S. at 3°.

A mile to the N.E. of Newcastle House is the round tower of Meelick, which is built of blocks of conglomerate of apparently Carboniferous age. This tower stands on dark gray fine-grained crystalline limestone, which has a slight dip of about 3° to the S.

To the S.E. of Bohola there are no exposures worth recording.

Of the Carboniferous grits and sandstones of this subdivision of the district very little reliable information could be obtained. The only exposure on which reliance could be placed occurs in the bed of the River Moy, immediately to the N. of the exposure of dolerite, and on the northern limits of the sheet. It consists of very thin bedded coarse flaggy sandstone, dipping to the E.S.E., at angles varying from 5° to 10°.

Sandstones and conglomerates supposed to be *in situ*, occur between Mullan's Lough and Bob Gay's Lough, about five and three-quarter miles N.W. of Bohola, and which have an uncertain dip to the S.E.

The boss of dolerite which occurs N. of the River Moy, about three and a half miles N. of Bohola, extends in an E. and W. direction for about one mile and a half, while its greatest breadth does not exceed a quarter of a mile.

The normal condition of this rock could not be ascertained, as it was impossible to get an unweathered surface. The rock as met with is a disintegrated mass, composed of highly crystalline augite, and a white felspar, the latter predominating.

GLACIAL STRIÆ OBSERVED IN THIS DISTRICT.

County and Quarter Sheet.		Townland and Situation.	Direction.	Remarks.
Mayo,	78/3	Kilfea, in drain between Dambaduff Lough and Islandeady Lough.	N. 45 E.	Flat surface.
,,	79/3	Pollanaskan, E. of Racecourse, in railway cutting, under drift hill.	N. 10 E.	Flat surface.
,,	69/4	New Antrim, on Metamorphic Rocks.	N. 15 E.	Roches moutonnès—striæ very numerous.
,,	69/4	New Antrim, Cross-roads N.E. of Tucker's Lough, on yellow Sandstone.	N. 15 E.	Flat surface.
,,	77/4	Ballynacarriga, E. of bye-road, .	N. 35 W.	Roches moutonnès.
,,	89/4	Tonaderren, on Metamorphic Rocks,	N. 7 W.	
,,	88/4	Toberrooaun, on Metamorphic Rocks.	N. 45 W.	Roches montonnès.
,,	90/3	Cloghaunageeragh, in brook N.E. of Doonamona Castle.	N. and S.	

DRIFT DEPOSITS, BOGS, &c.

Three-fourths of this district has a thick mantle of drift over it, the remaining portion being high ground, and altogether devoid of it. The deposits may be classed under three heads:—

First—The Boulder Clay.
Second—The Esker, or Water-worn Gravel.
Third—Erratic Blocks.

I. *The Boulder Clay.*—Over the most of the district this drift is to be found, varying in thickness, but not much in its composition, which generally depends upon the subjacent rock. As limestone is the predominant rock, and as over the area where the underlying rock is limestone, thick masses of this boulder clay occur, so the limestone boulders are the most numerous, while the thickness varies from a few feet up to one hundred. Where found (of such a thickness as approximating to a hundred feet) it is generally in the form of a saddle-backed hill, or drumlin, having its longer axis (which is often half a mile in length) parallel to the original glaciation of the district. These drumlins are often separated from one another by as much as a mile, and are very frequent throughout the central as well as eastern and southern parts of the district. The space between any two is generally occupied by thin boulder clay, bog, or crag, and the drainage of the district runs parallel to the hill. As many as between three and four hundred of these distinct hills were counted in the district: their summits are generally convex, verging into the slope of the sides at an angle of about 20°. Sections, showing their composition, can be seen in the railway. Generally we find well-striated, rounded blocks of limestone in a matrix of stiff, coarse, angular material, composed of limestone through which mud is to be found. At Manulla Junction the railway exposes a good section of the angular *dêbris*, with a fair per-centage of well-rounded boulders, which are there generally about half a hundred weight, and which stand out on the weathered slopes. Where any section of these hills was observed over the Carboniferous grit, the boulders were found to be chiefly sandstone, and were not rounded, as the flaggy sandstone does not readily assume a rounded form.

II. *Eskers.*—But very little evidence was obtained of the existence of Eskers. The only section seen occurs in the railway, two miles N. of Bellavary, in the townland of Cloonconlan, where strata of sand and gravel, with an occasional layer of well water-worn pebbles, have been exposed. In the outline of the hill where these have been cut through, there is no trace or form which is so peculiar to the Esker hills in other parts of Ireland, but is similar to the drumlins, which are composed of *boulder clay*. This mound of gravel, however, appears to have been a portion of the long, low, continuous Esker ridge traversing the Moy valley, and which has its origin in the present district, of which the hill in Cloonconlan, and the three hills W. of that, are the roots.

III. *Erratic Blocks.*—On the top of the south-western drumlins there are massive angular blocks of quartzose sandstones, and conglomerates, which are of Lower Carboniferous and Silurian ages. On the northern limits of the sheet there are massive blocks of schists and gneiss (some of them a hundred tons) found resting on the Boulder clay, as well as smaller blocks on the drumlins. Over the granite district these immense blocks, often some distance from one another, are to be found with only

a few feet of bearing, resting on a plane surface of the rock. Some of these can be made to oscillate upon ordinary pressure.

Bogs.—Two classes of bogs occur, namely—the low ground bog and the mountain bog. With regard to the latter but little can be said, inasmuch as although their area is very large, the depth rarely exceeds five or six feet. These bogs grow on the slopes of hills, often of an inclination of 15°. The low ground bogs are very numerous, and none of them of any area in comparison to similar bogs in the districts E. and S.E. of this. They often are long, say two miles, with a breadth of only about a quarter of a mile, and rudely follow the drainage as well as the direction of the drumlins. Some of these bogs have a great depth. Prior to the railway being made from Manulla to Foxford these bogs were all sounded, and although of so great a depth, proved no impediment to a fine line of rails being laid over them. In a bog at Tawnaghbeg, eight miles N. of Manulla, no bottom was found at thirty feet. The bog S. of Cloonconlan ballast hill had bottom at thirty-two feet. There is a bog W. of Manulla Junction in which bottom could not be found with the rod at twenty feet.*

Most of the bogs rest on marl; as, for example, along the Manulla river the section shows bog over three feet of marl, and below that boulder clay, showing that the course of the Manulla river at this place was formerly the bed of a lake. Between the bog and marl are great stools of pine and hazel, with occasionally oak. Hazel nuts are frequent, and the shell sound, but the kernel is always absent.

Crannogues.—A fine crannogue existed in the Castlebar Lough, W. of the town, but all has been spoliated. The drainage works lowered the lake some ten or twelve feet, thereby making what was once an island (Boyd's Island) part of the mainland. Horns of the *Megaceros Hibernicus* and of the red deer were, I believe, found there. Some of the latter I myself have seen, as also a canoe taken out of the lake in proximity to the island. It had been hollowed out of the trunk of a tree, and now lies in the yard of the Castlebar gaol.

Of mines there is no trace whatever throughout the whole district; and although there is what is called the Coal-Measures in Slieve Carna hill, to the N.E. of Balla, not a trace of any coal-seam could anywhere be detected.

* This information was kindly given to me by J. W. Kelly, esq., Contractor of the Railway.

INDEX.

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