42 & 43.

Memoirs of the Geological Survey.

EXPLANATORY MEMOIR

TO ACCOMPANY

SHEETS 42 AND 43 OF THE MAPS

OF THE

GEOLOGICAL SURVEY OF IRELAND,

COMPRISING PORTIONS OF THE

COUNTIES OF SLIGO AND LEITRIM.

BY

ARTHUR B. WYNNE, F.G.S.

WITH

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

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

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

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

Condensed memoirs on particular districts will also eventually appear.

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

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PREFACE.

THE District described in this Memoir was geologically surveyed over its southern and western portions by Mr. Hardman, during the years 1878–80, and over the tract lying to the north of the Glenade valley by Mr. Wilkinson, and to a smaller extent by Mr. Symes. In consequence of the departure of Mr. Hardman, on special colonial duty, for Western Australia in the beginning of 1883, and his detention there up to this time, I requested Mr. Wynne to undertake the preparation of an explanatory Memoir of the whole District, Mr. Wilkinson having supplied him with materials for the description of the north-eastern portion. Mr. Wynne, from previous acquaintance with the country around Sligo, was well fitted to undertake the task, which he has well performed; and this original knowledge was refreshed by a special visit last year, with the advantage of having the completed maps of the Survey in his hands. The District consists of that section of the Carboniferous hill-country of Sligo bordering the Atlantic and Donegal bay, and is remarkable for the boldness of its physical features, its high table-lands, its broad and deep valleys, and the grandeur of the terraced escarpments by which those valleys are bounded. It is a district, in fact, where the effects of meteoric abrasion and of river action amongst horizontal strata of different characters and powers of resistance may be studied with advantage by the student of nature.

EDWARD HULL,
Director.

GEOLOGICAL SURVEY OFFICE,
Dublin, 29th July, 1885.

P.S.—I may add that, while the Memoir was passing through the press, Mr. Hardman returned to this country, and had an opportunity of perusing its pages and of adding some additional particulars.

EXPLANATORY MEMOIR

TO ACCOMPANY

SHEETS 42 AND 43 OF THE MAPS

OF THE

GEOLOGICAL SURVEY OF IRELAND.

General Description.

The western portion of the ground represented in these maps belongs to the County of Sligo, and is bounded by the Atlantic Ocean; the eastern and larger part belongs to the County of Leitrim, and the whole area lies between longitudes 8° 7′ and 8° 42′ W., and latitudes 54° 7′ 30″, and 54° 28′ N.

There are no important towns within these limits, the largest being the prettily situated one of Manorhamilton, close to the woods and village of Lurganboy in the S.E. corner of the district. The village of Kinlough at the western extremity of Lough Melvin lies near the northern boundary of the district, and not far outside of this are the sea-bathing resorts of Bundoran and Mullaghmore. Grange and Carney are two small hamlets near the coast further west, and the town of Sligo lies but a short way beyond the southern limits of the district.

Form of the Ground.

The district generally may be regarded as mountainous: the Benbulben* range (fig. 1), its valleys, slopes, ramifications, and environs occupying all the central space. The central masses are bordered to the west and north by more open country, part of which forms the low promontory between the bays of Sligo and Donegal. The Ox range also enters this region from the south-west; and, as it dies out in the neighbourhood of Manorhamilton, becomes but a subordinate feature amongst the more massive and generally tabular elevations of the Rossclogher and Carbury baronies; which, fringed by mural precipices, form the conspicuous and characteristic features of this part of the country. These boldly-scarped table-lands, rising to an average height of more than 1,500 feet above the sea, and of 1,400 above the neighbouring low lands, have summit elevations in the Dartrey Mountains, over Lough Melvin, of more than 1,300 and 1,400 feet, whilst almost in the centre of the district the lofty undulating moorlands of the Benbulben plateau, with heights of over 1,600 and 1,700 feet, culminate at Truskmore in an altitude of 2,113 feet. This central mass of mountainous ground is deeply and

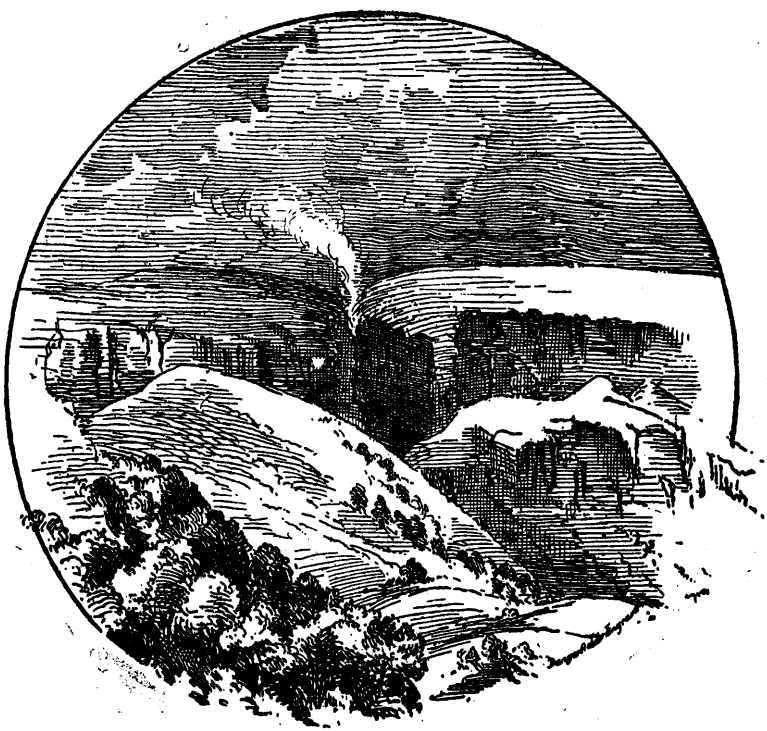
* Hill of the Hawk. Fig. 1.

entirely intersected by the two great passes of Glenade and Glencar, each with its lake of the same name, enclosed and overhung by lofty grey and weatherbeaten precipices, which, under the influence of the mists so prevalent in this moist region, assume an appearance of gloomy grandeur, enhancing the picturesque aspect they usually wear.

The entrance to Glenade, south of Kinloch is about 2½ miles wide, and its sides are bordered by an almost continuous belt of vertical cliffs, the waste from which dresses itself in the form of a steep, grass-grown, talus, sloping with what amounts in the aggregate to a concave curvature melting into the bottom of the valley—see fig 4. It presents a fine example of aqueous erosion, aided, it is more than probable, by the ice of formerly existing glaciers.

Of the two named, Glenade is, perhaps, the larger, bolder, and finer glen; but the lake in Glencar is the largest, and the mountain slopes around it are wooded to the base of the crags above (fig. 3). There is a pretty waterfall in the woods north of the lake, and one of the mountain streams from the Benbulben moors falling over the edge of the precipice into Glencar is often caught by the south wind and entirely blown back as a spray and mist forming the "Waterflight" which, when the stream is full, can be seen from a considerable distance rising like smoke against the sky (see fig. 2).

Fig. 2.



The Waterflights, Glencar.

Besides the two lakes just mentioned, nearly the whole of Lough Melvin* is within the district, lying at the north-eastern foot of the Dartrey Mountains. Studded with wooded islets it forms a narrow sheet about a mile in width and over six in length, stretching westward almost to the village of Kinlough, and is not without a certain amount of scenic interest, presenting the usual contrast to be found where a fine sheet of water lies in the immediate vicinity of mountains, however bare.

Of these three lakes that of Glenade lies much higher than the others, being 216 feet above the sea. Glencar lake is 97 feet and Lough Melvin only 90 feet above the same level.

The lowland belt stretches through the district as an undulating or boggy tract between the central mountains and the sea, most usually presenting a low line of cliffs and islets, or a sandy foreshore, to the full force of the Atlantic breakers.

What are commonly known in the locality as the Keelogyboy† and Castlegal Mountains rising south of Glencar and extending to the southern edge of the district, are simply a portion of the more central mountain mass, somewhat detached by the excavation of Glencar valley, and blending with the mountains around Lough Gill.‡

The drainage system of this district is altogether local, and principally or ultimately westerly; the only considerable exception being the S.E. corner, where the stream from Glenade, called the Bónet River, takes a south-easterly course on its way to Lough Gill and the sea.

That part of the Atlantic off the coast has not any great depth in the vicinity of the land, nor does it seem to present any such abrupt irregularities in the form of its bed as diversify the shape of the ground under description.

Such depths as eight, fifteen, and twenty-five fathoms are marked on the Admiralty chart, within distances from the coastline which taken inland would show differences in elevation equal in amount to considerably more than 200 fathoms.

Drumcliff Bay is only one or two fathoms deep, and even out in the widest part of Donegal Bay, midway between the Teelin and Ardboline headlands, the depth given (of thirty-one fathoms) is less than the height above sea-level of the broadest part of the Ardboline or Lissadill promontory, at the foot of Benbulben.

Four miles from the northern shore of this promontory land re-appears in the small flat island of Inishmurray and adjacent rocks.

Although the ground over so large a portion of this district rises to high levels, the elevations are not of that class known amongst Physical Geographers as "true mountains," or ridges of special elevation, this term being probably not even strictly applicable to the small part of Benbo Mountain, near Manor-

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* Famous for its fishing. † Pronounced Kullogubwee.

‡ Described in the Memoir accompanying Sheet 55.

It is difficult—or impossible—to define where the terms "mountain" or "hill" give place to each other. Those elevations of Sligo are exactly similar to the Derbyshire and Yorkshire hills, to which the term "mountain" is never applied.—E. H.

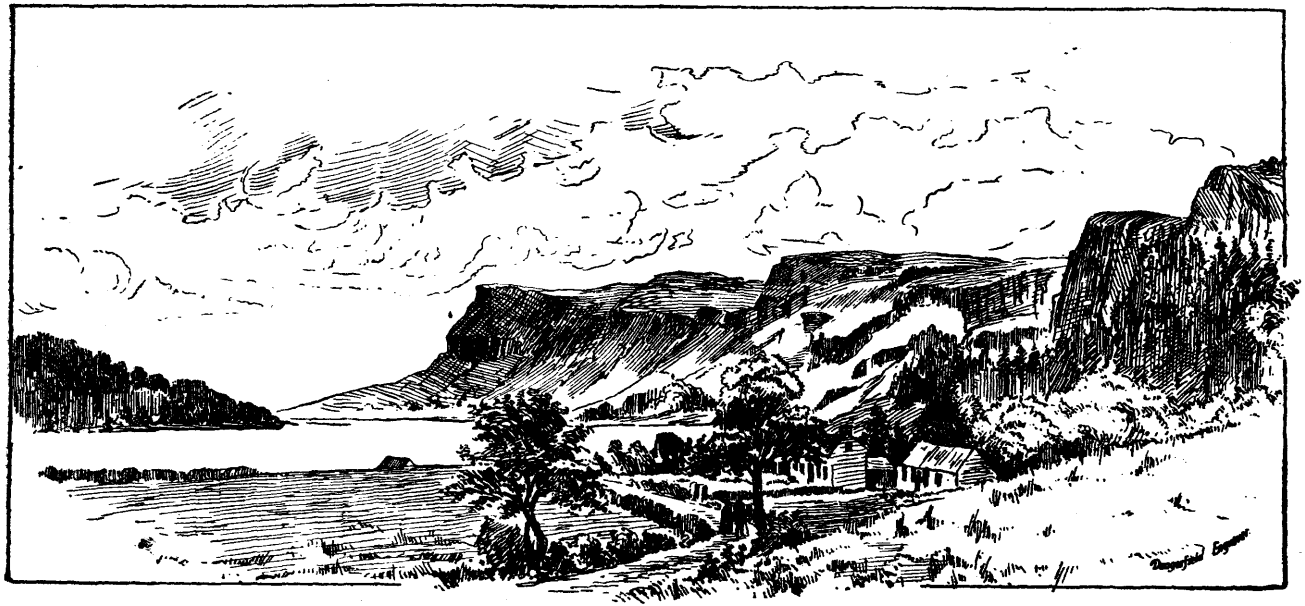

Fig. 3. Glencar and Lake.

hamilton, which occurs as the last conspicuous member of the Ox range. The features of this region, taken as a whole, are emphatically due to erosion or denudation, as contrasted with any particular local or special elevatory action, and they present most typical examples of the class to which they belong. It is of course to be understood that all ground sculptured into mountains of this order has been previously elevated, this elevation being the initial agency which set that of erosion in operation. Every successive bed of the great series of rocks of which the ground is composed having been formed upon an old sea-bottom, the present situation of these beds in the mountain sides, or on their tops, proves the fact of elevation, while nothing could show more plainly than the way in which these horizontal layers have been excavated into glens, or left standing as mountain masses, the vastness of the long continued agency of erosion, which has impressed its characteristic results so strongly on the physical features of the country.

The forms of these features are also so closely connected with the structural relations of the rock groups, that both enter together under consideration and cannot well be separated in seeking to understand the geology of the district.

The local rock-series may be thus classified in a geological arrangement mainly corresponding with their natural order of age and superposition.

Rock Formations and Divisions.

Aqueous Rocks.

Recent or Post-Pliocene.

Name.		Colour on Map.
Blown Sand,		*Pale burnt Sienna, dotted.*
Alluvium, Bog, and other Superficial covering,		*Raw Umber.*
Raised-beaches,		*Burnt Sienna.*
Glacial Drift,		*Engraved dots.*

Carboniferous.

Yoredale Sandstone,	d^8	*Yellow with red dots.*
Upper Limestone,	$d^{2'''}$	*Dark Prussian blue.*
Middle Limestone or 'Calp,'	$d^{2''}$	*Indigo.*
Magnesian Limestone,	M $d^{2'}$	*Green.*

Metamorphic.

Gneiss, &c.,	ν	*Pink.*
Serpentine,	Σ	*Pink lined with green.*

Igneous.

Basalt, Dolerite,	B	*Burnt Carmine.*

This classification, though it differs little from that of Sir Richard Griffith, the only authority of note prior to the examination made by the Geological Survey, is based upon the general results of widely spread detailed observations extending far beyond the limits of this district; indeed, the geological notices left by early or independent observers regarding the district are almost entirely limited to those papers to be mentioned incidentally hereafter.

In describing the occurrence of the various groups in the foregoing list it will be well to consider them in their natural or chronological order of succession, the oldest first, referring to connected masses when convenient, and grouping the purely igneous rocks by themselves.

Metamorphic Rocks.

The oldest of the groups in our list includes the gneiss and quartzites occupying a limited space near Manorhamilton, and a still smaller inlier on the little promontory between the bays of Sligo and Drumcliff.* The rocks are best exposed in the first of these, rising from the comparatively low ground which lies on each side of the river Bonet, to form the flanks of Benbo Mountain.† A good view of this mountain is obtainable from Saddle Hill, three miles N.E. of Manorhamilton. Looking across from this point over the low undulating ground it may be observed that though no marked inequality or landscape feature defines the contact of the crystalline rocks of Benbo with the adjacent limestones on the south side of the exposure, this contact becomes strongly pronounced in the higher ground on the northern flanks of the mountain, where the rounded outlines of the crystalline mass change abruptly into the sharply scarped forms characteristic of the limestone area.

These crystalline rocks appear frequently along the mountain slopes, on stony undulations of the low ground, on the wooded hills near Lurganboy, and about Manorhamilton. Coarse gneiss of various textures, with large crystals of white and reddish felspar, and black mica, in a silicious base, is the predominant variety; but fine-grained dark hornblendic gneiss occurs, and quartzite is also to be met with in frequent association with silicious grits and schists. Some of these gritty gneissose beds, on the road N.E. of Skreeny house, but in the townland of Curraghfore, were observed by Mr. Hardman to contain small veins of carbonate of copper and iron pyrites.

The foliation of these gneissose rocks is usually very distinct, and their bedding is also often clearly seen, the strike being most generally like that of the whole crystalline mass itself, northerly to north-easterly, and the various inclinations of the beds in different directions, at high angles, show these to be as much compressed and contorted as is elsewhere the case in the neigh-

* In the absence of my colleague, Mr. E. T. Hardman, from this country, and while engaged in describing ground examined by him, it may be well that I should anticipate his correction of a passage which he would, I am sure, take the first opportunity himself of setting right. It occurs in his paper to the Royal Dublin Society, June, 1882 (see Proc. R. D. S., Vol. III.), where he refers to the Metamorphic rocks of the Rosses point, Sligo, as a "triangular boss which has not yet been noted on any map or in any other publication." These rocks and their exposure, clearly shown in Griffith's Geological Map of Ireland of 1836–55, are amongst my earliest geological or other recollections, and Mr. Hardman himself, in a very useful list which he had compiled for the Geological Survey of Ireland, ten years or so previously, of published papers upon the Geology of the North of Ireland, &c., gives references to at least two in which the Metamorphic Rocks of the Rosses are noticed. One of these is by the Venerable Archdeacon Verschoyle (Proc. Geol. Soc., Lon., Vol. I.), the other by myself (Jour. Geol. Soc., Dub., Vol. X., p. 1), hence the passage above quoted must have been a mere oversight.—A. B. W.

I am obliged to Mr. Wynne for pointing out and correcting this oversight. I may mention, however, that on the copy of Griffiths' map which I happened to consult, this small patch of rock was not colored. Hence the error.—E T. H.

† The summit of this is just outside the limits of the ground represented on map 43.

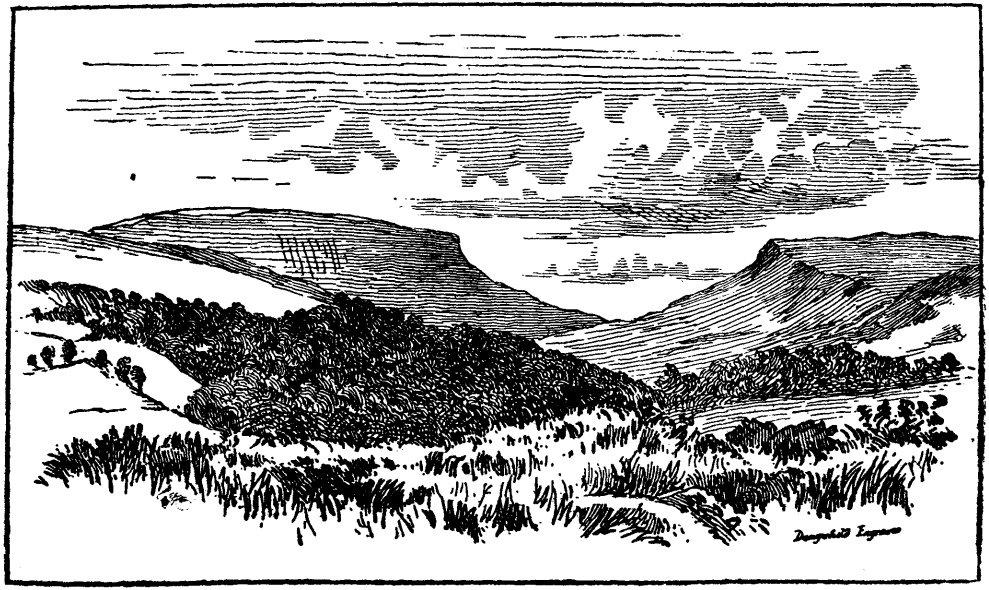

Fig. 4. Distant view of Glenade, showing its sectional form.

bouring extensions of this crystalline area.* Weather-stained and lichen-covered, the warm gray, orange and purplish tints of the rocks distinguish them at a glance from those of the surrounding country, and afford a pleasing contrast of colour with the grass and rougher herbage of the craggy ground from which they protrude.

The smaller exposure of these old rocks occurs on the low undulating headland of "the Rosses," between Sligo and Drumcliff bays, and stretches eastward from Bomore old racecourse for nearly three miles. The beds, as usual, present a considerable variety in their detailed composition, including gneissose and mica schists, quartzite, quartzose schists, fine-grained and coarser gneiss, with pink and whitish felspar, and both black and white mica, as well as here and there magnetic iron oxide, with some specular iron, garnets and tourmaline, as accessories; they are chiefly exposed at each end of the patch marked upon the map, and from the observed inclinations of dip it is plain they undulate over one or more axes having in a general way somewhat of an easterly and westerly bearing.

Although the area occupied by the two exposures of these crystalline rocks indicated upon the map is not large, their presence is physically important, displaying as it does part of the material forming the ancient surface of the ground prior to Carboniferous times. The age of these older rocks is not shown definitely in our area, but they are assumed, from wider study than is here possible, to be of great geological antiquity, representing some portion of an Archæan era.†

As the continuation of these crystalline rocks extends over a large neighbouring area in the same relative position with regard to the overlying Carboniferous limestones, it is a fair supposition that they likewise extend beneath the great limestone and sandstone formations of this district, forming the general floor of the country occupied by the Carboniferous formation.

Serpentine.

The serpentine (hydrous silicate of magnesia) mentioned in our list occurs in close association with the metamorphic rocks as large dyke-like masses, seen in the valley of a small stream at the northern foot of Benbo Mountain, close to some old mines on the Lurganboy estate. There is much evidence of disturbance and dislocation at the locality, and the general run of the serpentine follows a north-easterly direction. It is traversed by numerous parallel planes of division, which dip at 80° to the N. of W. and S. of E., and appear to have been considered by Mr. Hardman to represent those of stratification. It is also much jointed, fine-grained, or compact, of a dark green colour, and,

* See description of this in Explanatory Memoir accompanying Sheet 55, by Mr. Kilroe.

† See Professor Hull's paper on the Laurentian Rocks of Ireland, Sc. Proc. Roy. Dub. Soc., vol. 1, 1882, p. 252.

according to Mr. Hardman's notes, is not perceptibly magnetic, but contains some mica and chlorite. As serpentine rock usually takes a good polish, it is possible that more solid portions from the interior of the mass would afford a handsome dark green marble.

Serpentines of very similar character to this are associated in greater quantity with the same crystalline rocks of the district immediately to the south, and are noticed in the Explanatory Memoir to accompany Sheet 55, by Mr. J. R. Kilroe. That of Manorhamilton, as well as those just mentioned, are described in Mr. Hardman's paper already referred to, with a note on their microscopic characters by Professor Hull. The former author suggests the possibility that all these serpentines may have been produced by metamorphism of magnesian limestones.

To this particular kind of rock different modes of origin have been attributed. The limited exposures of it in the metamorphic area of this district, near Shanvaus Bridge, assume collectively a dyke-like aspect, and penetrating the adjacent beds, in north-easterly parallelism with more than one of the local dislocations, indicate an originally intrusive rock, however much it may have undergone metamorphism, and notwithstanding the planes of pseudo-stratification which have been observed.

Mr. Kilroe (*loc. cit.*) from his personal observation and consideration arrives at the same conclusion as this with regard to the Slishwood serpentine near Lough Gill, to the southward. According to an observation of my own, made many years ago, the serpentine of Manorhamilton was at one spot crowded with garnets. I do not find that this has been noticed since. (See *Geol. Soc. Dub.*, pl. Vol. X., pt. i.)

Note by Mr. Hardman while passing through the press:—

While admitting the possibility of serpentine being a transition product in many cases from some igneous rocks—as indeed is generally allowed to be the case—I can see as yet no reason to adopt that view exclusively with regard to the Sligo serpentines. That serpentines may be the resultant of the alteration of magnesian limestone is certain. Indeed, I have a specimen in my possession, collected many years ago from the Silurian Rocks near Tramore, County Waterford, showing the transition. No one will deny the possibility of bands of limestone occurring amongst the old sedimentary rocks, and like them, being altered since deposition. The presence of minerals, which are perhaps most often noted in igneous rocks, cannot always be taken to indicate the igneous origin of every rock in which they occur. For instance, garnets, to which Mr. Wynne refers, are frequently found in schists and altered slates, the sedimentary origin of which no person can doubt.

E. T. H.

From inspection of these old crystalline areas on the map, it will be seen that much less than half of their boundaries would show their original contact with the succeeding formations, and even where this contact presumably exists, exposures of the actual junction are very rare, the older and newer rocks meeting in most cases along concealed lines of fault and displacement, some of which, however, are either believed or proved to extend for considerable distances away from the places of contact into the surrounding and overlying beds.

Notwithstanding the prevalence of these dislocations, there is sufficient evidence in the general relations of the two formations to indicate a total discordance, and consequently the lapse of a long interval between the periods at which the old crystalline and the newer Carboniferous rocks were formed. None of the rocks deposited during this great interval are here exposed,* their very absence going far to prove the complete and decided character of the break in the geological series, as represented in this district.

Taking this gap in the succession, and this unconformity of the rocks as an advantageous starting point in considering the preponderating mass of newer palæozoic deposits forming the rest of the country under description, it will appear that there is a unity both of character and structure, marked by great simplicity in the general stratigraphic aspect of the mass, combined with a grandeur in the retrospective physical changes, of which we have the geological record before us.

It has been shown that there was an old floor or surface in this region, formed, so far as is known, of crystalline rocks, worn into ridges and hollows like those of a land surface; but as the Carboniferous deposits resting immediately upon this floor are marine, the old land indicated must have subsided beneath the sea, in which were laid down all the Carboniferous deposits of the neighbouring country, overlapping and burying the irregularities, even to the extent of levelling over the nearer parts of the Archæan ridge.

The frequently earthy or sandy character of these Carboniferous beds (locally the lowest portion of the group) would suggest that the sea was a shallow one, receiving continually quantities of mud and sand from the adjacent land. Continued subsidence seems then to have brought the area beneath greater depths, removing the shore-line to a distance: for the muddy and sandy beds of the Limestone Series are succeeded by a mass of clear blue Upper Limestone of pelagic aspect. After a long interval a rather sudden change is again marked by the rapid upward passage from these pure limestones to the sandstones and grits of the next group, the Yoredale beds of our list, thus indicating an action of elevation which caused the sea to become shallow and land to re-appear, from whence came the sandy material of the highest Carboniferous subdivision in the district. At this (Yore-

* Representatives are, however, to be found at some distance away from this region.

dale) period the elevation just spoken of had not had the effect of altering the sub-aqueous conditions which prevailed over the whole of this area; and to what extent the sea had continued depositing an increasing thickness of Carboniferous (Coal-Measure) rocks there is no evidence to show. There is ample proof, however, that the whole region was subsequently raised out of the water and subjected to the enormous and prolonged operation of those agents of erosion which came into action immediately upon the earliest appearance of a land surface. With the newer Carboniferous strata this surface has long since disappeared; but it may be presumed that the outlines upon which the agencies thenceforward continued to act were originated at an early stage, and that the impulse has mainly followed the same directions ever since, always wearing away the ramparts, and deepening and enlarging the natural fosses of the ground. Modifications would, of course, occur from accidental causes, such as the erosion being purely meteoric, aided by gravitation, and distributed over the land surface; or mostly marine, and thus largely restricted to the coast-line of the sea, which would itself afford protection to the part submerged.

There is nothing to show that the rugged features of this district are either directly or indirectly due to huge coincident fractures in this part of the earth's crust, along which the erosion might possibly have acted more effectively. Fractures and dislocations are numerous enough, as shown upon the maps, but they cross and intersect both the features and each other, rather than coincide to any extent with the great natural excavations, except in the minor instances of recent landslips which have taken place upon slopes already formed.

Fig. 5.

Cliffs over Crumpaun, Northern entrance to Glenade.

In further observing the relations between the geological groups and the form of the ground, the most striking connexion is found to exist between the one and the other. The beds of which the

various Carboniferous groups are composed all lie nearly horizontally, and the mountain tops are nearly flat (see frontispiece); again, the bold bluffs which border these are always formed of the hard splintery, cherty, and jointed Upper Limestone, and from their faces great masses vertically separated from the rest by atmospheric action, are slowly but continually in process of being detached and carried away (see fig. 5). This characteristic feature in the retreat of such limestone cliffs, wasting slowly backwards, but still presenting a bold precipitous face and massive front, is as strongly marked here as is usual elsewhere, and the total height of the precipices often closely corresponds with the thickness of the Upper Limestone group.

Below this cliff-line the profile of the surface changes at once with the nature of the rocks, and the earthy and darker limestone bands and shales no longer stand in vertical walls but slope steeply outwards towards the lower grounds, the slope becoming less and passing gently into the undulations of the lowland belt or larger valleys.

Above the Upper Limestone cliffs, and rising from the plateau, a much smaller and less pronounced feature coincides with the area of the Yoredale beds. It shows itself best in the capping forming Truskmore summit, but around the larger outlier between Glenade and Lough Melvin there is frequently no escarpment at all present.

Hence it follows that the peculiar manner in which the Upper Limestone has yielded to the erosive agencies has originated the strongest features of the ground; and in a nearly similar degree all the principal modifications of form will be found to show a direct connexion with the nature of the rocks or their position, or with both. The analogy may be even continued further than regards the sculpture of the masses, for the debris resulting from their enormous erosion has itself under atmospheric agencies assumed both characteristic forms and methodical distribution, in the long arched outlines of the mounds of glacial drift spread over the low country or occupying positions in the larger valleys.

The forms assumed by the crystalline rocks under the same process of erosion present a contrast with those of the superior formation as great as exists between their mineral composition; and their disturbed and contorted stratification compared with the general horizontality of the latter.

There is not a sufficient extent of these Archæan rocks within our area to show their most characteristic forms in mass, but still enough to exemplify the fact that, old and hard as they are, they have yielded locally to the denuding agencies, though strong enough to have assumed the form of a miniature mountain range close at hand. Just around the town of Manorhamilton, where the mass may have been somewhat weakened by the prevalence of faults, these old crystalline rocks have suffered so largely from abrasion that instead of forming conspicuous hills of the usual character, they occupy low open undulating ground sometimes less than 200 feet above the sea. This low ground being part of the basin of Lough Gill, the retaining rock barrier of which is but twenty feet or so above low-water level, it is evident that the

agencies of erosion had room here to act most powerfully in lowering the surface of the ground and in transporting its reduced material, soluble or sedimentary, into the Atlantic ocean.

It may assist in conveying an idea of the general denudation over this country if, as comparatively minor results, the quantity of rocks removed from the once-continuous mass to form Glenade and Glencar, be roughly estimated. For the former the material carried off, counting only from the upper edge of the precipices downward, if inverted, would form a ridge six miles long, about a mile and a half in average width, and 800 to 900 feet in height. Glencar being longer and in parts wider, the mass removed to form it would have a length of over nine miles, a width of two miles at each end and one in the centre, and a vertical height varying from about 400 feet towards the head of the glen to 1,100 feet at its mouth. Still the gaps which these materials once occupied are but a small part of the excavation which has left the mass of the elevations themselves standing out from the lower tracts in conspicuous relief.

Aqueous Rocks.

Lower Limestone.

Owing to the irregularity and uneven form of the surface upon which the lowest Carboniferous rocks here were deposited, partial or entire concealment by transgressive overlap of the upper beds would be likely to occur. This, or even the surface spoken of being at the time dry land, will account for the feeble display of the Lower Limestone in this area, together with the entire absence of a basal Carboniferous Sandstone group. The only beds that have been referred to the Lower Limestone horizon, are the magnesian limestones forming parts of a broken and sometimes discontinuous band of about 100 feet in thickness, always in contact with the crystalline rocks, and are shown upon the map by the green tint.

These magnesian limestones may lie in their normal position at the Rosses point, being partly overlapped, while in the larger exposures near Manorhamilton the latter arrangement is obscured by the numerous dislocations. The rock is usually brown and gray crystalline dolomite, sometimes fossiliferous, and sometimes less magnesian in composition and less brown in colour at a distance from the junction.

This would seem to be the proper place to notice some conglomeratic sandstone beds recorded by myself (in my paper to the Geological Society, Ireland, previously referred to, p. 38,) as occurring near Lurganboy, close to the gneissose and micaceous beds of the Archæan range. When in the country last summer I again noticed blocks of the conglomerate, &c., in the walls near the old mines, but could not remember exactly where I had made the observation recorded so many years ago in my paper, nor could I find their locality marked upon the field maps. Similar rocks to these have been found at other places on the flanks of the same crystalline axis (see Memoir, sh. 55). They represent shore deposits at the local base of the Carboniferous rocks.

Calp or Middle Limestone.

The next member of the Carboniferous Limestone of this country is very largely developed in the western, north-western, and northern parts of the district, but has more scattered representatives to the S.E. It embraces the mass of earthy limestones, shales, and sandstones lying immediately beneath the horizon of the Upper Limestone.*

The rocks present a very considerable difference of composition. In the south-western part of the district dark-coloured and black limestones and shales prevail, with few exceptions; as, for instance, in the neighbourhood of Castlegal Mountain and upper part of the Rathbraghan river, where light-coloured sandstones occur amongst the limestones. Sandstones occur again on the Glencar side of the same mountains, near the old church, in the same apparent relation to the great zone of limestones which occupies the lower grounds and mountain slopes all round the foot of Benbulben from Glencar to Milk Haven and Ballaghnatrellick.† To the N.E. of these places the continuation of the low drift-covered ground is formed everywhere of nearly horizontal layers of sandstone and shale, which entering the lower part of Gleniff, are checked by a fault crossing the northern entrance to Glenade, and still extending through the low ground, occupy both sides of the northerly part of Lough Melvin. Besides these limestones and sandstones, the subdivision includes masses of shale most typically seen on the slopes of the Dartrey Mountains, south of Kinlough, whence the shale beds sweep round to the south, penetrating Glenade as far as the lake. The inter-relations of the three varieties of the beds composing this group can seldom be traced far, on account of the quantity of drift overspreading the low lands, and often rising upon the mountain slopes. The extent of this concealment of the rocks may be gathered from the fact that in the low ground between Drumcliff and Donegal Bays, from Milk Haven and Grange to the Drumcliff river, but two small exposures of the rocks (limestones and sandstones) near

* The point whether there are not also present in the Sligo and Leitrim Limestones some more extensive representatives of the Lower Limestone of the rest of Ireland, has a certain amount of interest. Lower Limestone rocks occur not far to the north, but in the absence of the officer who examined the ground, the results, as he has mapped them, can only be given here.

In the opinion of the Palæontologist of the Irish Survey, who, several years ago examined a set of fossils collected by myself in this country, forms characteristic of the Lower Limestone of Ireland occur, both in the upper and in the lower parts of the Benbulben series, at several different localities. See (appendix to paper quoted, Jour. Geol. Soc., Dub., vol. x., pt. 1, p. 40). Also Palæontological Notes, &c., herewith, p. 32.

For my own part I could find nothing in the general aspect of the rocks or their relations to show that the more westerly beds of this district might not include representatives of both the Lower Limestone and the Calp (or middle group of Ireland). In many cases the lithological character of the beds would answer for either group, and unless the most recent examinations of the fossils should show good palæontological reasons for a different conclusion, I should prefer to accept Mr. Hardman's classification, with the reservation that some of the Lower Limestones may also possibly be present.—A.B.W.

I quite agree with Mr. Wynne as to the possibility of some of the so-called Calp beds belonging to the lower division; particularly those along the western coast. But at the time I examined the country there was no evidence sufficient to warrant the insertion of a divisional line. Various traverses, from the boundaries of the Calp with the upper Limestone, in the hills, to the sea-shore, failed to reveal any material lithological differences in the rocks. E. T. H.

† Called Ballintrellick.

Grange, a couple in the western slopes of Benbulben, and one at the village of Carney, have afforded opportunity for observations to record upon the field maps of this ground.

In the promontory of "The Rosses" between Drumcliff and Sligo Bays dark-coloured cherty and shaly limestone is seen in several places surrounding and dipping away from the inlier of the Archæan schistose and gneissose rocks previously mentioned. At the western end, and along the southern side of this exposure, the highly-magnesian limestones have been taken to represent the Lower Limestone group; but along its northern side there is much evidence of disturbance at the junction with the older rocks, and the contact is believed to be a line of fault. Dark limestones, thin-bedded and fossiliferous, re-appear at Tully hill, not far from the Chapel; but from this, for more than two miles to the eastward, there is nothing seen but drift deposits.

In this direction the section afforded by the Rathbraghan stream shows dark thin-bedded cherty limestones, apparently coming out from beneath the Castlegal sandstones previously noticed; and the arrangement of the rocks generally, seems to indicate the existence of a fault between these beds and the Upper Limestones of Castlegal Mountain.

Throughout the lower parts of Glencar, the dark limestones and black shales (and occasionally sandstones) of the Calp group, appear at intervals, the shaly limestones being often conspicuous beneath the cliffs.

Passing to the westward, but little rock is seen until the seashore is reached beyond and about Lissadill, Raughley, and Doonera points, where the same kinds of dark limestone reappear.

Just north of the demesne of Lissadill, some gray, solid, and rubbly limestone and thick shales, have an unusually high dip to the westward at 45°, 55°, and 60°, and the cliffs of this Ardbowline headland generally afford instructive sections in the Calp beds of the country. Thin and regularly-bedded blue, gray, and dark gray limestones, undulating or dipping mostly in a southerly direction, but without any particular quantity of shales, prevail in all these cliffs. The beds are in places unusually fossiliferous, as at the "Serpent Rock," where the remarkable masses of large curving cylindrical corals matted together, or weathering out, have given the place its somewhat fanciful name. Within a mile eastward of this spot the beds are cut through by a four-foot dyke of basalt, and further on, along the shores of Agharrow and Streedagh, the limestones become in places cherty or flaggy and of bright colour, the beds undulating over north-westerly axes, with predominant low dips to the south-west and west.

The rocks on the shore here, west of Streedagh House, present a singular display of naturally-prepared specimens of fossil corals, the matrix surrounding which has been dissolved and removed, leaving numbers of large specimens of *Zaphrentis cylindrica*, 18 inches to 2 feet in length and from 2 to 3 inches in diameter, projecting from the slightly-inclined surfaces of the beds. These are themselves often largely formed of such cluster corals as the genus *Lithostrotion*. There are also some large-sized brachiopods of the genera *Producta* and *Spirifer;* but the corals,

separate or in masses, greatly predominate, and their exposure in such quantity forms the striking feature of the place.

It has been said that the country between Benbulben and the sea in the direction of Grange, affords but little evidence as to structure, in consequence of the prevalence of drift and bog. This is to be regretted; for the concealment here prevents the exact relations being seen between the fossiliferous limestones of which we have been hitherto treating, and the great expanse of thick and thin bedded reddish, yellow, brown, and white sandstones, grits, and micaceous flags,—alternating sometimes with shales and rarely with limestone layers,—which spread their nearly-horizontal beds over the whole of the more northern part of the district, between the foot of the mountain and the sea, and reappear in the island of Inishmurray and the promontory of Mullaghmore. Some of these sandstones, bending into the lower part of Gleniff, would seem to overlie, and to alternate with, dark limestones, at Ballaghnatrellick Bridge; but the further arrangement is immediately concealed by drift and bog—though there is some reason to suppose the mass of the Calp sandstones mainly underlies the limestones seen from this place to the westward, as it plainly does those to the east.

In the furthest recesses of Gleniff, and along its western side, the dark Calp limestones are frequently seen coming out from beneath the paler "Upper" Limestones of the cliffs, and contrasting strongly with them both in colour and in the greater distinctness of stratification shown by the lower beds. This is very evident in the singular sharp crag of Benwiskin, overlooking the western entrance of the Glen (see fig. 7). The mountain slopes forming the eastern side of the valley present, chiefly, continuous sheets of bog, covered with coarse grass, from which, along the hill-top, the craggy edge of the upper limestone protrudes.

From the notes of Mr. Wilkinson it appears that:—

"The low-lying land on the north of Lough Melvin, partly that on the south shores and extending to the sea, is occupied by quartzose sandstones of the Calp (or middle group) differing very slightly in appearance from the Yoredale sandstones. These beds are faulted, so as to enter the northern mouth of Glenade, but are almost immediately checked and cut off by another fault crossing the Glen. Where well exposed the beds appear to be slightly more argillaceous than the Yoredale sandstones, and to yield more readily to the action of the atmosphere. They alternate occasionally with a few shale beds and have generally low southerly dips of from 3° to 5° except where disturbance consequent on dislocation has taken place."

Succeeding these sandstones the Middle or Calp Limestones occupy the lower slopes of the mountains, and are seen repeatedly in the rivulets and watercourses or "Alts," leading the mountain drainage to Lough Melvin. Amongst the upper portions of these limestones dark shales appear, locally largely developed, as above Mount Prospect, where their presence and their great difference of texture from the superincumbent Upper Limestone, has resulted in landslips, causing a recurrence of jagged broken cliffs and undercliffs, the shales assuming pyramidal forms,*

* Locally named "The Sphinxes," according to Mr. Wilkinson.

often too steep and friable for vegetation to exist upon them (see fig. 6). The general southerly dip at this part of Lough Melvin, leads the sandstone to pass under the level of the shore, away beneath the mountains, and brings in the Calp Limestone and Shale series on their N.W. slope from this point till they pass out of the district to the east, with the same general arrangement; though faulted portions, having slipped out of position, interfere with the regularity of the boundaries.

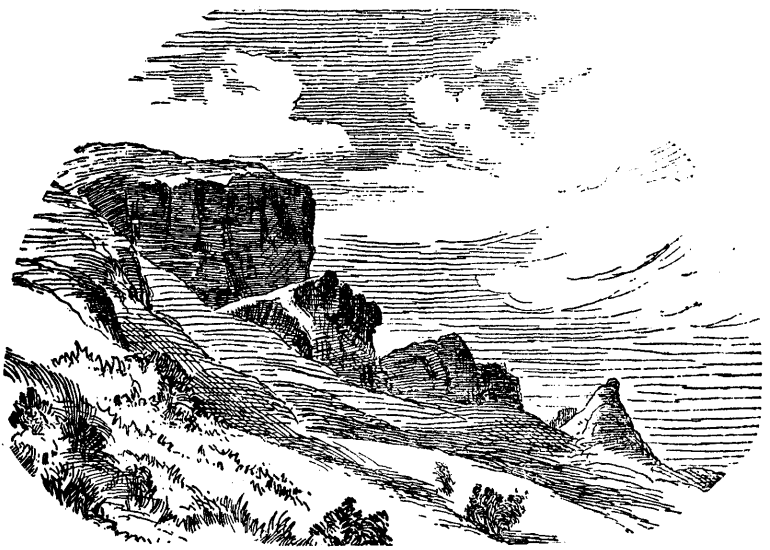

Fig. 6. Landslip above Mount Prospect.

These Calp Limestones re-appear in several smaller exposures, on both sides of the old crystalline axis, and at its termination near Manorhamilton: in every case more or less associated with disturbance from faults. According to Mr. Wilkinson's notes the rocks "are the same dark-blue argillaceous beds as characterize the greater mass."

As to the thickness of this subdivision: the Calp Sandstones of the northern part of the district may be roughly estimated to have a thickness of from 500 to 800 feet, and that of the overlying Calp Limestones, including the shales, may be from 700 to 1,000 feet.

Upper Limestone.

This member of the series contrasts with that just described, in the absence of beds of shale and sandstone, and consists of a solid mass of grey coralline and crinoidal limestone, in some places largely replaced by bands and irregular masses of chert.

The most remarkable physical fact about the Upper Limestone is that it always forms the plateaux of this region, a feature that would come prominently out upon the map from the geological colouring alone, but for the darkness of the hill shading, and the representation of the mantle of mountain peat, which occupies the plateaux and frequently also the slopes of the mountains.

From the S.E. corner of the area included in sheet 43, this massive sheet of pale gray rock spreads over all the lofty ground towards the N.W., W., and N., exhibiting in its fine natural sections a thickness of 700 to 800 feet. Its cliffs and scarps around, the Cope's or Castlegal mountains south of Glencar Lake, are very fine, showing both its massive and jointed character, by which the bedding lines are entirely or almost entirely obliterated. This arises from the cross joints in these horizontally-stratified rocks, affording the easiest access to the penetration of the wasting atmospheric agencies. The cliffs at the western point of this mountain exhibit, further, extreme results of this action along master lines of division, enlarging fissures and separating huge masses of the cliffs. The same bold features are displayed in greater or less degree all along the northern side of Glencar (see fig. 3), where they are accompanied by slips and local subsidence of detached crags.

Viewed from a distance, a part of these cliffs over the Lake of Glencar presents an appearance of local arched curvature of the strata, which is lost on nearer inspection, and seems to be due to the shape of the ground, and to the perspective of detailed forms taking the light. Throughout the district generally the uniformity of this gray Upper Limestone manifests itself, marked by its regular even bedding (where this is seen) its generally purer nature and paler colour than that of the lower group; growing paler still under exposure; while its compact texture and its tendency to develop joint-planes, unite to produce a splintery condition. Cherty nodules or beds frequently occur, and marine fossil remains, as stools of coral, &c., are not uncommon.

The western bluffs of Benbulben, in their sharply-projecting angular shape, present a fine example of the forms resulting from the subærial erosion of horizontal limestone strata, forms repeated again in Benwiskin Crags (fig. 7), and those overlooking the northern entrance to Glenade (fig. 5). In the interior portions of the glens, we have, on the other hand, nearly as striking instances of recessed excavation.

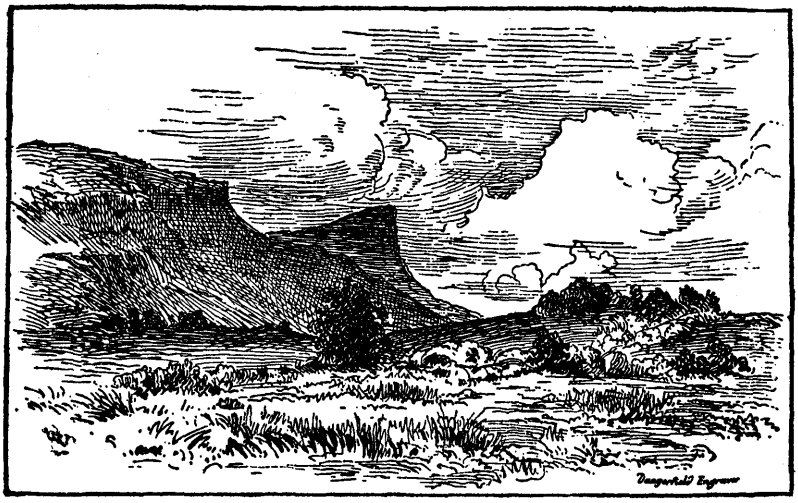

Fig. 7. Benwiskin Crags, north side of Benbulben.

The Poulhein Cliffs at the head of Gleniff are shown, from the heights given on the six-inch Ordnance maps, to have a depth of about 1,000 feet, of which 720 or so is sheer, and chiefly formed of the Upper Limestone, the sloping talus at its foot, formed of the dark Calp beds, being here very steep, and broken up again by small undercliffs. The junction between the two groups in this cliff, particularly at its eastern end, can easily be followed by the eye, and forms a jagged broken line, the angular interspaces of which are filled with crushed or shaly looking rock, presenting an appearance of slipping or disturbance rather than of tranquil succession; and parts of the upper group also show planes, if not actually, yet greatly simulating, those of bedding, obliquely resting on the more horizontal Calp strata. Such appearances as these might result from partial slips or "creeps" of the superincumbent mass; still, however obscure, their existence should be noticed.

Again in Glenade there is a remarkable semicircular coomb-like hollow among the cliffs N.W. of the lake called Crumpaun; a great fragment of one of these is separated from the main mass by the long parallel gap locally known as "The Split." Both the Upper, and Calp Limestone groups, are well exposed in the grand cliffs here, where, to quote from Mr. Wilkinson's notes, "the junction between the two formations is particularly well shown, good sound, rather flaggy beds of cherty limestone resting upon dark shales and bands of argillaceous limestone, belonging to the lower group: a relation which obtains as far as the magnificent escarpment extends, which stretches along this side of the valley to Glenade Lough."

The southern portion of Glenade from the Lough towards Lurganboy is occupied entirely by the Upper Limestone, apparently cut off, and brought into dislocated junction with the lower beds, by a fault crossing the glen obliquely. The Upper Limestone beds seen at slight elevations in this part of the glen are described by Mr. Wilkinson as "blue and gray crystalline and fossiliferous limestone with bands and nodules of chert," and, "the same beds intervene between the Calp group and the Yoredale sandstone on the east side of Glenade."

The general height of the sides of the glen here, being little if anything less than to the north, and the rocks as horizontal in one place as the other to all appearance, it does not necessarily follow that because the Upper Limestone, only, is seen, it must suddenly have increased to double its usual thickness. The probability is that this appearance is due to a general, yet scarcely appreciable, southerly dip of the strata over the whole neighbourhood; and indeed the arrows to mark the dip upon the map would indicate that the beds commence to undulate as they approach the disturbed and faulted neighbourhood of Manorhamilton.

Glenaniff is another deeply excavated valley to the eastward of, and parallel with Glenade, from which it differs, however, in opening only to the south-east. Its excavation to a depth of 500 and 700 feet without having reached the Calp group, shows the thickness of the Upper Limestone here under similar conditions to those prevailing at the southern end of Glenade. Although

the sides of the glen are much covered by detrital accumulations and by bog, the stream channel and tributary rivulets show numerous sections through the rocks, which are always nearly horizontally-bedded and consist of the usual varieties of gray and blue compact or crystalline, and frequently cherty, limestone. The same rocks occupy the whole of the summit of the mountain between this glen and Lough Melvin, and form considerable cliffs near a depression in the ridge called the "Gates of Glenaniff," where the homogeneous nature of the rock and the abundance of vertical joints almost entirely obscure the bedding planes. The base of this Upper Limestone group appears on the Lough Melvin side of the mountains at heights of 700 feet and over, while near the mouth of Glenaniff the same junction occupies positions about half of this height, hence it follows that the whole mass, although apparently horizontal, has in reality a more or less southerly dip, at least partially accounting for the erosion not having reached the next lower group within Glenaniff.

To the southward of this, the ground about Manorhamilton is so much cut up by faults that the distribution of the Upper Limestone, the middle and the lower groups will best be seen by reference to the map.

Yoredale Sandstone.

This is the newest member of the Carboniferous series of the district under description. It occurs in three patches, occupying the most lofty ground, and is always nearly horizontally bedded, except where a few slight and local displacements, caused by small faults, occur. "The beds are hard, whitish and yellow, sandstone and grit, evenly, and sometimes thinly, bedded or flaggy."* Such rocks as these form a sort of triangular pyramidal summit rising out of the plateau of Benbulben at Truskmore, the highest elevation of the area represented in these maps. Another outlying portion caps the ridge immediately to the north; and a still larger isolated area is occupied by the same beds on the highest ground between Glenade and Glenaniff; where, however, its limits are much concealed by the presence of upland peat. The rocks of this Yoredale group have evidently opposed less resistance to atmospheric action than those beneath them. Mr. Wilkinson observes that—"Judging from the amount of debris and displaced blocks, the beds appear to have been subjected to much glacial action; but, owing to subsequent weathering, the traces of this action, in the form of grooving, polishing, or striation of surfaces, are hardly ever seen."

IGNEOUS ROCKS.

There are but few examples of igneous rocks in the district.

Basalt.—One basaltic dyke has been already noticed amongst the limestone cliffs of the Lissadill promontory, and in the townland of Ballyconnell. It consists of "amygdaloidal basalt, is four feet thick, and with a southerly inclination of 50°, cuts through thin, cherty, regularly-bedded limestone."* "In the townland of

* Mr. E. T. Hardman's notes.

Killrask, W. of Brackarymore schoolhouse, a very small portion of a dyke of fine-grained, blue, basalt is seen in a laneway; it is immediately covered by drift."*

Dolerite.—A mass of dark green, coarse-grained, crystalline dolerite occurs in a stream course, cutting through the mountain bog to the south-east of Kinlough, high up among the Dartrey mountains. It is much decomposed, and but a very small area is visible, owing to the thick covering of mountain bog.

These are the only cases in which rocks of the igneous series have been noticed in this district.

Post Pliocene.

Glacial Drift.

This deposit consists of stiff blue clay with pebbles and blocks of rock, often glaciated; and is largely developed in the country under notice all over the lower ground, and sometimes on the mountain tops, up to 1,500 feet elevation. In the northern portions of the district Mr. Wilkinson says :—

"The drift is distributed in irregular hillocks, and on the higher ground is banked against the hills, in some instances to a considerable depth. It consists of boulder-clay in which limestone and sandstone boulders largely predominate, and the latter show very often, clean, well-defined glacial scratches; the matrix is a tough blue or yellow clay, very retentive, and almost impossible to drain."

The extent to which this glacial drift has covered the country to the westward about the foot of Benbulben has been noticed already; it also occurs over parts of the lofty Dartrey mountains. It may be said to appear in force throughout the lower, northern, and western parts of the district, and in the more open parts of Glencar valley, about Tullyhill; the conspicuous mound of Knocklane, and in other places, the characteristic whale-backed mounds of the glacial drift may be recognised.

Recent and Post-Glacial.

Mr. Wilkinson notes that "There are large areas along the banks of the Bunduff river occupied by alluvial flats as well as by peat bogs of great depth. These flats may in time be drained and make fair land, as there is a considerable fall towards the sea; but they will always be subject to flooding by the Bunduff, which, having its source in the adjacent hills, rises and falls very rapidly, and coming strongly down its tortuous course overflows the banks considerably. North of Lough Melvin there are also several tracts of peat bog."

Both the Benbulben and the Dartrey mountains are, in places, more or less heavily covered with post glacial accumulations of peat, which recur, and are worked for fuel, on the top of Benbo mountain, as well as on the group of elevations south of Glencar.

Raised Beaches.—Portions of the coast of Drumcliff Bay, not far from Carney, are marked on the map as raised beaches, these containing oysters, clams, periwinkles, &c., and are now four to six or seven feet above highwater mark.†

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* Mr. Wilkinson's notes. † Mr. Hardman's observation.

Blown Sand occurs largely at intervals on the coastline of this district, particularly at Mullaghmore, Doonera, and Bomore.

Quite within the memory of the writer the Doonera or Knocklane sand dunes in the townlands of Ballineden and Ballintemple used to travel before the prevailing winds as others do, and had so completely buried and drifted over the formerly existing hamlet and old church in the last-named townland, that when the flagstones used as chimney-lids had been removed it was necessary to be careful where one stepped.

Since then the proprietors* by extensively planting creeping *Bent-grass* have prevented the sand from travelling and thus converted the shifting sandhills into coarse pasture land.

Caves.

As is usual in limestone districts generally, and particularly in those where the ground is broken, caves are frequently present.

There is one large cavern in the north side of the upper part of Glencar, which is called Templepatrick, and is reputed to have stone seats round its inside, and to have been used as a place of worship.

Dermod and Graunia's Bed in the lofty cliff on the left side of Gleniff, is another large cave well known in this country, which was explored by Mr. Hardman, and also by the Reverend Mr. French, of Drumcliff; there is another in the face of Benbulben Bluff, one in the Lissadill promontory, as well as others of less note.

These caves were, some of them, certainly formerly inhabited. Mr. French found a bronze wedge or hatchet in that called Dermod and Graunia's Bed; and Mr. Hardman found some bones of recent animals.

It may be mentioned here that certain mound-like banks or islets in the lake of Glencar, have been declared to be artificial *cranoges*, or lake dwellings.†

Mines.

In the neighbourhood of Lurganboy and Manorhamilton mines have long been known to exist, and one of these is marked on the Ordnance map as a gold mine. Operations have been carried on at these mines, but it is now many years since they were abandoned by the last company who worked them.

From statements of old men‡ who had worked in these mines, it has been gathered that one of the most productive was the lead and silver mine on Frazer's farm in Twigspark, now filled up. There are other mines in the townlands of Shanvaus and Pollboy, the latter being those most recently open.

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* The late Sir R. Gore Booth, Bart., and late J. Gethin, Esq.

† For much information about the archæology of the Co. Sligo, see Colonel Wood-Martin's recent works, "History of Sligo." Hodges & Figgis, Dublin, 1882.

‡ Pat Maguire and others.

There are, it appears, two lodes here, both having a north-easterly direction, parallel with some of the numerous local dislocations, with which generally there is little doubt the fissures occupied by the lodes are in connexion.

The most northerly of these "is in magnesian limestone, the vein stuff apparently occupying a fault, and being full of copper pyrites and carbonate of copper, also galena"* (proto-sulphide of lead). The lode to the south of this one is on the northern bank of the stream, which exposes the serpentine previously mentioned; it is described* as "a lode of copper ore about six feet wide, with specks of copper pyrites and galena." From inspection of the old spoil banks at the mouth of an adit opening towards the river, it appears that this lode is also in the magnesian limestone; but it must be close to, if not exactly at, the boundary, for a reef of quartzite occurs between it and the river.

These mines are stated to have been opened and worked for about four years previous to 1846, at which time the company which owned them failed. Long before that time however, there had been mining works here, the waste heaps of which were worked over again by the later operators. It does not appear that the works could have been at all extensive, for it is reported the ore was sent in such small quantities as 15 cwt. at a time, by cart to Sligo for shipment to Swansea, where the copper fetched £12 per ton, and the argentiferous galena £17 per ton. Both of these minerals were being worked at the same time.

The entrances to these mines are now so completely closed and overgrown by brambles, &c., that nothing can be seen, and the waste or debris has been so often searched that scarcely a specimen can now be found which is worth removing.

The Twigspark locality affords even less information, but pieces of the vein stuff lying about here are noted by Mr. Hardman as containing "copper, zinc, lead, and apparently native silver in small specks," and "a good deal of zinc blende."

Smaller indications of copper ore occur north of Skreeny House, near Manorhamilton, in the metamorphic schists, as indicated on the map.

Galena is stated to occur at the Rosses Point, and lead, copper and baryta, at King's Mount, part of Benbulben, in a list of mineral localities, by the late Sir R. Griffith. Here there is, apparently, a long lode of sulphate of baryta,—slightly impregnated at one place, with carbonate of copper, copper pyrites and galena—extending in a north-north-westerly direction from the cliffs over Glencar lake to the head of Gleniff. The lode is from 5 to 6 feet wide, and slopes (or hades) to the westward, the containing upper limestone in its vicinity being sometimes magnesian.

Rather extensive works were carried on upon this lode about the years 1878-79, by Mr. Barton, who, I understand, has since died abroad; but although the mineral is abundant, and he had

* Mr. E. T. Hardman's notes.

the energy to erect a wire tramway (the remains of which are still there) to convey it from the top of the grand cliff here, to the road in the valley of Gleniff—his enterprise proved unsuccessful. If the barytes here should ever be worth working, its conditions of position seem to be very favourable, the lode being at the top of a mountain only a few miles from the sea, in two directions, and not far from a certain amount of water-power.

Faulting.

The dislocation of the rocks throughout this district present such various directions that they can scarcely be reduced to any systematic arrangement. Part of one very important fracture which extends for considerably more than twenty-five miles from Ballysodare, in Sheet 55, towards Garrison in Sheet 44, crosses the corner of this district, at the north-west side of the Manorhamilton Crystalline rocks.

Many of these faults disturb the regularity of the geological boundaries. For instance, one running northwards from the village of Lurganboy to Lough Agaw, on the mountain between Glenade and Glenaniff, brings the Yoredale sandstones down far below their ordinary place on the mountain top, and it will be seen from the map that fault boundaries to the various groups are of common occurrence. Hence the tranquility with which the accumulation of the great horizontal Carboniferous groups took place has been succeeded by disturbances, the traces of which are never far to seek in this region.

Landslips.

A special feature of the country is the local and minor dislocation produced by percolating rainwater opening the natural joint or master-joint planes of the limestone rocks, and as these extending diminish the cohesion of the mass, portions less supported than the rest give way and subside to lower levels, thus causing the landslips seen at several points around the belt of cliffs which borders the Upper Limestone. The interruption of the percolating water by the less pervious shales or clays of the "Calp" group, together with the height at which the junction is situated, is the principal reason why the landslips are almost entirely confined to the Upper Limestone outcrop.

(A. B. W.)

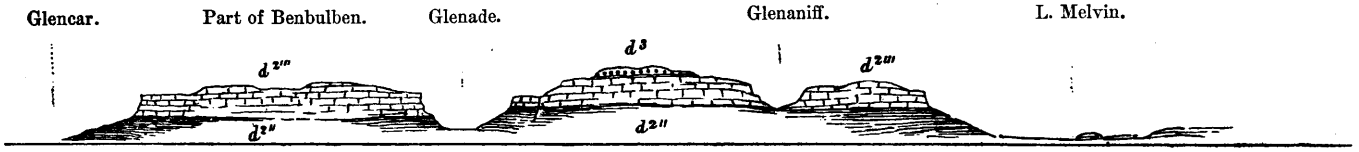
Glacial Striæ observed in this District.

Townland.	Direction.	Remarks.
*Lareen, . .	E. and W., .	Flow towards East.
†Manorhamilton,	S. 10 E. .	Schistose rocks (*roches moutonnées*).
Rosses, N. of Old Seal Bank, . . .	E and W., .	Flow to W. Limestone.
Rosses, Doonmeelin L.,	N. 40 W., .	Gneiss and schists.

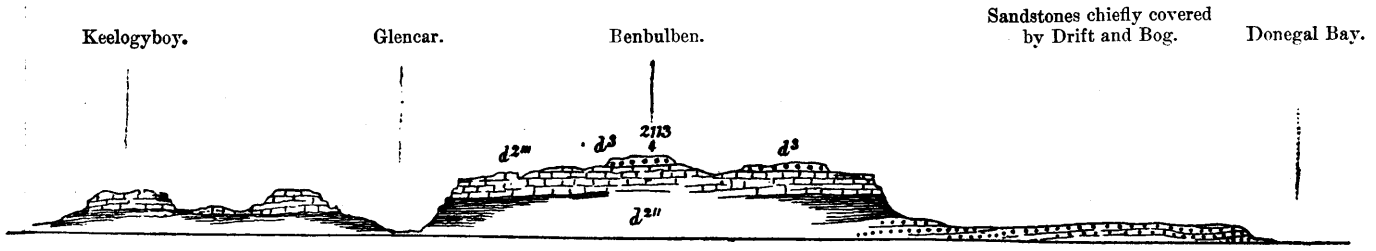
E. T. H.

* Mr. Wilkinson. † Mr. Hardman.

FIG. 8.—HORIZONTAL SECTIONS TO ILLUSTRATE THE PHYSICAL FEATURES AND GEOLOGICAL STRUCTURE OF THE DISTRICT COMPRISED IN SHEETS, 42 AND 43.



Sketch Section across Glenade and Glenaniff.



Sketch Section across Benbulben.

Palæontological Notes to Sheet 42 (Eastern Portion) and Sheet 43.

Localities from which Fossils were collected.

No. of Locality.	6-inch Map.	County and Townland.	Situation, Geological Formation, and Sheet of 1-inch Map.
			Sheet 42.
		County of Sligo.	Carboniferous Limestone and Shale.
1	4/	Ballyconnell, . .	Rocks on shore at Knocklane Point, "Serpent Rock," about two and a half miles north-west of Grange, dark gray limestone.
2	8/3	Rosses Upper, .	Rocks on shore at Deadman's Point, Sligo Bay, one mile south of Rosses Point, gray earthy, and calcareous limestone.
		County of Leitrim.	Sheet 43.
3	2/2	Boyannagh, . .	Quarry in field, two miles east of Mullinaleck Bridge, three miles south of Ballyshannon, dark gray shale.
4	6/2	Corglass, . .	On mountain half a mile north-east of Glencar Lough, about eight miles north-west of Manorhamilton, gray compact limestone.
5	6/4	Knocknaclassagh, .	In stream close to school-house, half a mile south-east of Glencar Lough; dark gray earthy limestone and shale.
6	7/3	Shanvaus, . .	At Shanvaus Bridge, on left side of road from Manorhamilton to Glencar Lough, light gray, limestone.
7	7/3	Tullynasharragh, .	On same road, left side, one mile west of preceding locality, dark gray limestone.
8	12/1	Moneenshennagh, .	Quarry in field near Millview, on left side of road to Leminea, one and a half miles east of Manorhamilton, coarse gray limestone.
		County of Sligo.	
9	2/1	Kilkilloge, . .	Rocks on shore at Pollachurry, half a mile north-east of Roskeeragh Point, gray arenaceous limestone and micaceous shale.
10	3/1 & 2	Castlegal, . .	Rocks on shore a little east of Sherrydoo, five miles south-west of Bundoran, dark gray arenaceous limestone and micaceous shales.
11	3/1 & 2	Grellagh, . .	Rocks on shore at Pullinghole, Lackalahy, about half a mile of preceding locality.
12	8/3	Rosses Upper, .	Quarry in field near Curraghmore, north of Rosses, dark gray limestone.
13	9/1 & 2	Gortnagrell; . .	On boundary between Sligo and Leitrim, a little south of Glencar Lough, dark gray shales.
14	9/1 & 2	Tormore, . .	North side of Glencar Lough, dark gray limestone.
15	9/3	Edenbaun, . .	About two miles south of Glencar Lough, dark gray 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 × placed before some of them is intended to denote their comparative abundance.

CARBONIFEROUS LIMESTONE, SHALE, AND SANDSTONE.

Plantæ.

	Localities.
"Large Plant Stems,"	11.
Plant fragments,	9.

Actinozoa.

Alveolites depressa,	13.
Amplexus?	6.
Chætetes tumidus,	× × × 5, 13.
Cyathophyllum ceratites,	1, 9.
„ or Zaphrentis,	2, 5, 14.
„ giganteum, (Zaphrentis cylindrica)	× × × × 1,
Lithodendron affinis,	1, 15.
„ junceum,	1, 2, 14.
Lithostrotion Portlockii,	1.

Echinodermata.

Actinocrinus lævis,	5, 7, 13.
„ triacontadactylus,	8.
„ sp. indet.,	2.
Archæocidaris glabrispina,	6.
Crinoidal remains,	2, 4, 5, × × × 6, 7, × × × 8, 12, 13, 14, 15.
Granatocrinus (Pentremites) Derbiensis,	8.
Platycrinus lævis,	5, 8.
Poteriocrinus crassus,	5, 6, 10.

Polyzoa.

Ceriopora rhombifera,	13.
Fenestella antiqua,	3, 6, 7, 9, 13, 15.
„ tenuifila,	3, 13.
„ varicosa,	5.
Glauconome bipinnata,	5.

Brachiopoda.

Athyris ambigua,	6, 15.
„ planosulcata,	4, 5.
Chonetes Hardrensis,	5, 9, 13, 15.
„ papilionacea,	2, 5.
Orthis Michelini,	2, 5, 15.
„ resupinata,	× × × 3, 5.
Productus aculeatus,	6.
„ fimbriatus,	2, 15
„ giganteus,	1, 2, 3, 10, 12.
„ margaritaceus,	5.
„ punctatus,	4, 5.
„ scabriculus,	× × × 5.
„ semireticulatus,	2, 3, 5, 9, 15.
Rhynchonella pleurodon,	5, 12, 13.
Spirifera laminosa,	3, 13.
„ pinguis,	9.
„ striata,	2, 5, 13, 15.
Spiriferina cristata,	13.
Streptorhynchus crenistria,	3, 5, 9, 10, 13.
Terebratula hastata.	4, 6,

LAMELLIBRANCHIATA.

	Localities.
Aviculopecten granosus,	10.
„ Sowerbii	3.
Pullastra bistriata,	3.

CEPHALOPODA.

Cyrtoceras Gesneri,	15.

TRILOBITA.

Phillipsia pustulata,	5, 15.

REMARKS ON THE FOSSILS.

The fossils observed at localities, Nos. 1, 2, 3, 5, 7, 9, 10, 13, occurring in dark shales and dark gray limestones, contain species eminently characteristic of Lower Limestone Shale; whilst those at localities 8 and 15, most probably belong to an Upper division of the Carboniferous Limestone.

With respect to locality 11, my only authority for the fossils said to occur there, is that on the 6-inch map of that place, "large plant stems" is written; this I only saw since my return from visiting the district.

WILLIAM HELLIER BAILY.

August 4th, 1885.

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