Memoirs of the Geological Survey.

EXPLANATIONS

TO ACCOMPANY

SHEET 134 OF THE MAP

OF THE

GEOLOGICAL SURVEY OF IRELAND,

ILLUSTRATING PARTS OF THE

COUNTIES OF CLARE, TIPPERARY, AND LIMERICK.

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EXPLANATIONS

TO

ACCOMPANY SHEET 134 OF THE MAPS

OF THE

GEOLOGICAL SURVEY OF IRELAND.

General Description.

The ground included within this sheet embraces parts of three counties—Clare, Tipperary, and the northern end of Limerick. The River Shannon and lower part of Lough Derg forms the natural boundary between the counties of Tipperary and Limerick on the east, and that of Clare on the west.

The principal towns are Nenagh, in Tipperary, and Killaloe, in Clare, with the villages of Tomgraney, O'Brien's-bridge, and Annacarriga, in Clare, and Silvermines, Portroe, and Birdhill, in Tipperary.

1. *Form of the Ground.*

A mountainous tract of country extends from the N.W. to the S.E. of the district, crossed by two large valleys, the one running N. and S., and embracing the southern termination of Lough Derg, and the portion of the River Shannon which forms its outlet; while the other —that of the little Kilmastulla River—stretches from the plain of Nenagh to the Shannon, near O'Brien's-bridge.

The mountains divided from each other by these valleys have different names: those in the S.E. of the district belong to the Slieve Kimalta, or Keeper Hill group; those lying between the two valleys are called the Arra mountains; while those on the west of the Shannon are a part of the Slieve Bernagh range.*

The highest elevation within the district is the summit of Keeper Hill, which is 2,278 feet above the level of the sea. There are several hills in its neighbourhood of over thirteen and fourteen hundred feet, the heights declining westward to three and four hundred feet. The ridge to the northward of the Keeper Hill, having the local name of Silvermines Mountain, has a summit of 1,587 feet, and several similar heights will be found to the eastward of it.

The Arra cluster of mountains, which lies entirely within this district, is composed of a number of ridges, all branching from a central and principal elevation of 1,517 feet, called Tountinna (near *The Graves of the Leinster Men*), many of their rounded summits varying from eight up to more than twelve hundred feet in height.

The Slieve Bernagh mountains, separated by the valley of the Shannon from the Arra group, enter the district from the west; and the parts of them within it have a general east and west direction,

* The names of the two latter groups are taken from Sir Richard Griffith's Geological Map.

with an elevation towards the south, near Ballymolony Wood, of 1,181 feet, and further northwards two called Glenagalliagh,* one of which is 1,458 and the other 1,746 feet high. Another elevation, to the west of these, is Cragnamurragh, 1,729 feet; while to the east a spur runs out towards the Shannon, with a summit height of 1,268 feet. To the north of these elevations, and in continuation with the high ground upon which they occur, a curving ridge bends to the north-east by Croaghnagower, Knocknagower, and Caher Mountain, to Farran Point, surrounding the steep-sided valley of Annacarriga upon all sides, except that opening on Lough Derg.

The low ground occupying the north-eastern side of the district consists of a part of the cultivated plain of Upper and Lower Ormond, some of the undulations of which rise at Daag's Hill to an elevation exceeding 470 feet, at Gibbet Hill to one of 350, and in the N.E. corner of the district to elevations of over 300 feet. This plain is gradually contracted into a valley, where it runs between the Arra mountains and the Keeper group, and is thus connected with the part of the plain of Limerick which just enters the S.W. corner of the district. The height of none of the hills in this southern part of the area included in the map exceeds 300 feet above the sea.

The lowest point in the district is the point at which the Shannon leaves it S. of O'Brien's-bridge, at a height of ninety feet above the sea.

The whole of this district is drained by tributaries to the River Shannon or Lough Derg. The principal of these tributaries are the Nenagh and Mulkear rivers, both of which rise among the Keeper group of hills outside the limits of the district. The former drains the E. and N.E. parts of the district, while the latter comes into it as a mere brook from the S., and after curving round the northern base of Keeper Mountain in its course through Glencolloo, leaves the district again at the same side, its circuitous direction eventually leading it into the Shannon at Annacotty, in Sheet 144.

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

Aqueous Rocks.

	Name.	Colour on Map.
	Alluvium, Bog, &c.,	*Pale sepia.*
	Drift,	*Engraved dots.*
Carboniferous.	d². Lower Limestone,	*Prussian blue (light).*
	d¹. Lower Limestone Shale,	*Prussian blue and Indian ink.*
Old Red Sandstone.	c. Old Red Sandstone,	*Indian red (dark).*
	Lower Silurian, b,	*Purple.*

b. *Lower Silurian.*—This formation in the Slieve Bernagh and Arra mountains consists of alternations of green, gray, olive and blue grits, hard conglomerates, shales, and slates, with some yellow and greenish clay rocks, and peculiar soft conglomerates. Black shales are also found in the northern part of the district, and the freshly opened

* Pronounced as Glounagalogh. It is, however, most usually called Crag.—G. H. K.

surfaces of some of these are often crowded with impressions of graptolites, chiefly Diplograpsus. Tracks of marine creatures (? crustacea) have also been observed in a few places. The conglomerates are locally abundant, occurring in massive beds, the principal pebbles in them being formed of white quartz, ranging from the size of an egg to that of small shot, the latter being most common. Besides these there are fragments of grit and slate, which are sometimes angular, while those formed of quartz are always rounded and worn; the base of the conglomerate is usually calcareous, and often contains fragments of fossils.

In the Arra mountains, and in the southern part of the Slieve Bernagh group, the above-mentioned rocks are cleaved; but in the northern part of the last named mountains cleavage is of rarer occurrence, and is often entirely absent.

The Lower Silurian of the Keeper group is usually composed of green, gray, olive, and blue, fine-grained grits, shales, sandstones, and slates, with some bands of fine gravelly conglomerate, and a few beds of dark-coloured shale. Many of the sandstones or coarser grits are somewhat calcareous, and easily acted upon by the weather; and when this is the case, they are frequently found to contain casts of crinoids and of parts of shells. In some few of the flaggy beds distinct impressions of orthoceratites and graptolites have been found, and in one place a calcareous nodule, in blue flaggy grit, was observed to be composed of a mass of the coral *Favosites Gothlandica.*

c. *The Old Red Sandstone*, as seen within the space included in the map, is supposed to belong to the upper subdivision of this formation only; but as there is no very distinct boundary line between that and the beds immediately underneath it, it is quite possible that some of its lower beds may be on the same horizon as some of the upper beds of the lower part elsewhere. The rocks consist principally of yellow, white, and red sandstones, with some conglomerates. Red, purple, yellow, and greenish clay rocks and shales are locally abundant, and greenish gray and purplish micaceous partings are sometimes found between the beds of sandstone, especially in the upper portion of the formation, where they have been observed to contain the remains of plants.*

The clay rocks and shales are most largely developed in some places in the lower, and in others in the upper part of the formation, as seen in this district; and they, as well as the conglomerates, are of local occurrence, not being continuous for long distances laterally, and lying on several different geological horizons.

The thickness of these rocks at the S.W. of the district is about 1,000 feet; along the base of the Arra mountains about 750; near the Keeper Hill their thickness does not apparently exceed 450 feet; while to the N.W., near Tomgraney, they are 1,300 feet thick.

The Carboniferous Group is represented only by its two lowest subdivisions in the area now under consideration, there being no evidence to show that either the middle or upper portions of the limestone are present.

* These fossils were not observed actually within this district, although immediately outside of it, to the S.W. of Tomgraney, where they were found abundantly in a section exposed by the Anamullaghaun River.—*See Map and Explanation of Sheet* 133.

d¹. *The Lower Limestone Shale* consists of apparent* passage beds from the Old Red sandstone upwards into the limestone. Close to the sandstone it contains gray, yellow, and blue gritstones, some of which are flaggy, interstratified with gray and blue shales, and shale partings. Higher up are alternations of black and blue shales and grits, with a few beds of shaly limestone. These are succeeded by black and blue shales, and earthy limestones, with some thin bands of grit, and over all are dark earthy and shaly limestones.

In the S.W. portion of the district, however, a somewhat different succession occurs, for there the upper beds of the sandstone become calcareous, and finally pass upwards into flaggy limestone, without any considerable apparent development of shale.

The first bed of compact limestone that is met with in the ascending order has been taken as the basal boundary of the Lower Limestone.

The thickness of this group, as seen at the N.W. side of the district, is about 300 or 350 feet, and its representatives are only seen in two or three isolated localities in the eastern portion of it.

Almost all the beds of this group are fossiliferous.

d². *The Lower Limestone* of the S.W. portion of the area contained within this map is often interstratified with shale beds. It is of a dark blue or sometimes nearly black colour, granular, fœtid, inclined to separate into flakes under the action of the atmosphere, and frequently has veins of indurated clay, of a black, red, or gray colour, running in all directions through the mass of the limestone. There are partings between the beds consisting of yellowish and red plastic clays, or black, blue, or gray shale, some of these being nearly a foot in thickness. Overlying these lower beds are gray and blue limestones, in which the bedding is rarely perceptible, the rock being much crossed and cut up by joints and a sort of cleavage.

The lowest beds of this formation in the eastern portion of the district, consist usually of dark-coloured limestones. In the vicinity of Silvermines, the lowest seen are frequently magnesian, and sometimes seem to be impregnated with barytes and pyrites; or, more rarely, to be partly formed of materials derived from the wearing down of mineral veins. Many of them are nearly black and frequently crinoidal, but some compact gray beds are also to be met with. Over these are pale gray limestones appearing in considerable abundance, which are in places pinkish, and in one locality variegated red (marble) beds occur; but owing to the partial exposure of all of these limestone rocks, their relations to each other in point of superposition are rendered obscure.

The Drift of the eastern part of this district is, as usual, capriciously distributed. It is composed of limestone gravel and clay; and although frequently found in the low grounds, some of the elevations there are not covered by it, while limestone gravel, clay, and boulders, are found in many of the mountain glens. The largest development of the drift occurs in the form of eskers at the N.E. corner of the district, and in widely-spread mound-like masses along the course of the Kilmastulla River, near Shallee House, on the ground to the south-eastward and S. of Killaloe, and S. and S.W. of O'Brien's-bridge.

* These cannot be true passage beds, since the "Carboniferous slate," which has a thickness in parts of the county Cork of not less than 5,000 feet, is altogether wanting here; and there must be, therefore, a great gap in the series, instead of a regular passage.—J. B. J.

Numerous fragments and rounded boulders of syenitic granite, similar to that of Galway, are scattered over the country, but are not always associated with large deposits of the drift. In many places amongst the Keeper mountains considerable depositions of local detritus occur, in which, after close search, small fragments of white chert containing the casts of pieces of encrinite stems have been found, showing that they are derived from the limestone, and that the apparently *local* deposits contain transported fragments, and may therefore be merely a local variety of the general drift of the country.*

Alluvial Flats.—The principal of these are the Pollagh, the *callows* of the Shannon, and those along the Nenagh River. They consist of fine clay and sand, brought down to lower levels than they occupied before, by the action of rain, and probably deposited in accumulations of still water. Peat mosses or bogs containing roots and fallen stems of trees, in several cases overlie the alluvium of these flats; and sections of some of these which are exposed along the shores of the Shannon and Lough Derg bear witness to the fact that the basins in which they were formed must have been older or have existed at different levels or under somewhat different circumstances from those occupied at present by the collected drainage of the country. In some instances white shell marl, full of the shells of dead lymnea, &c., overlies the alluvium, or is interposed between it and the overlying peat, or is interstratified with the lowest portion of the latter.

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3. *Relations between the External Form of the Ground and its Internal Structure.*

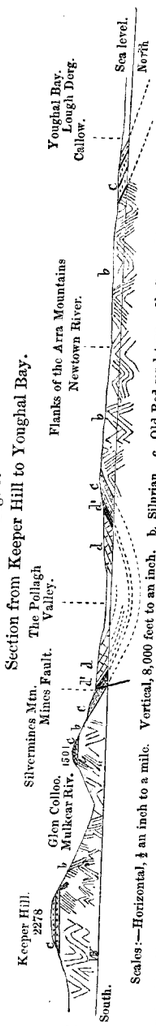
The relations between the form of the ground and the rocks of which it is composed are these:—All the mountainous and most of the other high ground is formed of the Silurian and Old Red sandstone rocks, while the low country to the S.W. and N.E., as well as a small part of the extreme N.W. corner of the district, is underlaid by the Carboniferous Limestone, which also occupies much of the valley between the Keeper Hill and Arra mountains. The transition from the high to the low ground takes place by slopes of varying inclination, which although in reality not so steep as they at first sight appear, change with quite sufficient rapidity, from a gradual fall into the low undulations of the plains, to mark at once the geological dissimilarity of the ground. A further relation of form is observed in the fact that these gradual exterior slopes of the high ground are composed of the Old Red sandstone rocks which always occur, as an irregular surface band, between the Silurian and Carboniferous limestone formations, except where the geological succession is interrupted by *faults*. Accumulations of the drift at the bases of the mountains sometimes

* Although these deposits are situated at the extreme limits of the "transported" drift, and, being mainly composed of local angular materials, appear to be chiefly due to the disintegrating action of atmospheric agencies, they seem, notwithstanding this, to be connected with the true "drift" deposits by these small transported fragments from the limestone. A gradual diminution of such limestone fragments is sometimes to be observed as one passes from the well-marked limestone drift into these local superficial deposits. Other travelled fragments, too, such as pieces of syenite, occur occasionally in the latter, and their materials have frequently the appearance of being shifted down the slopes on which they lie, as if they had been re-arranged by subærial agencies.—A. B. W.

prevent these sandstone rocks from being seen where there is every reason to believe that they are present.

Fig. 1.

Section from Keeper Hill to Youghal Bay.



The irregularities in the width of the surface exposure of the Old Red sandstone, and its occasional occurrence in outlying patches, are owing to its unconformability to the Silurian rocks on which it lies, and to the inequalities of their general surface when it was deposited, as well as to the way in which the subsequent denudation has acted upon it. This denudation has not only removed the limestone in many places entirely from off the sandstone, but also removed and carried away the sandstone itself for large spaces, leaving outliers of it, however, here and there resting upon the Lower Silurian rocks which have been thus exposed.

The whole country generally owes its present configuration, both in plan and elevation, to the force of elevation and the erosive action of this denuding agency. This agency has not only worn away the large masses of unconformable and superincumbent strata from the hill country, but also has cut out the steep valleys occupied by Lough Derg and those through which the rivers Shannon and Mulkear flow, the latter remarkable natural excavation having the name of Glencolloo. Another and older action of denudation is proved to have existed by an examination of the relations between the Lower Silurian and Old Red sandstone, for the beds of the former are found to terminate abruptly upwards, abutting against the under surfaces of the base of the Old Red sandstone, thereby showing that after having been tilted into various positions by forces of elevation, they were denuded and worn down so as to form the nearly horizontal or slightly undulating surface upon which the first beds of the unconformable sandstones were deposited, and this deposition was probably succeeded by that of several thousands of feet of other sandstones, shales, and limestones.

Faults.—A long line of fracture extends from near O'Brien's-bridge, by Birdhill and Shallee, to beyond Silvermines, bringing very different rocks into juxtaposition at the surface, and thus effecting a junction in some places between the Carboniferous Limestone and Silurian, in others between this and the Old Red sandstone, and also between different beds of the latter formation. The throw of the dislocation by which this has been caused varies from a slight shift to one of over a thousand feet, being always a downthrow to the N.*

G. H. K. and A. B. W.

* See Fig. 2. and also the engraved Longitudinal Sections, Sheet 9, New Series.

Detailed Descriptions.

[This district was surveyed by Messrs. G. H. Kinahan and A. B. Wynne, who have jointly drawn up the following detailed description of it.—J. B. J.]

The following order will be observed in these descriptions:—The country east of the Shannon will be taken first, commencing with the country east of the Keeper Hill; then taking the Keeper Hill and the ground W. of it; the Bird Hill and Kilmastullagh districts; the Silvermines and the ground N. of it, and the Nenagh district; then the Arra Mountains; and lastly the Slieve Bernagh, and country west of the Shannon.

The South-east corner of the Map.—The rocks are well seen here, both in projecting crags on the hill-side, and in almost every stream-course, especially in the channels of the Mulkear and the head-waters of the Nenagh River. The part of the latter which crosses the S.E. corner of the district exhibits an almost continuous section in the Silurian rocks, which have there a general northerly dip, at angles varying from 10° to 60°. They consist of gray grits, slates, and flaggy shales, or fine sandstones, among which some darker and more bluish-gray beds than are usual in these rocks, were observed at Poulanass Waterfall and the Raven Rock. In the latter locality some of the thin flaggy shales bear impressions of a kind of orthoceratite.

The ground to the S. and south-eastward of this, consists of high boggy moorlands, upon which the rocks are only occasionally seen. Close to the elevation marked 1,094 feet, beside the Anglesey road, some graptolites were found in dark bluish-gray flagstones. Southward and eastward of the boggy pool called Lough Duff, bluish-gray slaty grits were observed; and the same kind of rocks, with some shale beds, appear at intervals along the Anglesey road, where their dips will be found marked on the map.

On each side of this road, between the heights marked 1,259 and 1,543, many beds of gray grit and shale, sometimes cleaved (the cleavage striking 20° N. of E., and dipping N.N.W. at 55°), and sometimes thin bedded or flaggy, project from the hill sides; their general dip is to the west, but at the east side of the road a sudden change in their inclination towards the N.E. would seem to indicate the existence of a fault.*

About half a mile S.W. of the elevation marked 1,259, some bluish-gray horizontal flags occur in a quarry, and here was found the only well preserved coral (Favosites Gothlandica, already alluded to) which has yet been discovered in the Silurian rocks of the whole Keeper group of mountains. The Silurian ground, N.E. of this place, is formed of long undulations, sloping to the N., and as it is in many places covered by drift, the rocks do not so frequently appear, except on the hills, and in the valley of the upper part of the Nenagh River. Some dips, however, were obtained in gray grits and shales along the Anglesey road, near the heights marked 680 and 987, and also not far from the supposed place of the Old Red sandstone at Monaquil, and near that part of it seen at Traverston. A junction between the Silurian and Old Red rocks appears in the river close to Happy Grove Mills. The Silurian is composed of gray flaggy sandstones, grits, thin slaty beds, and some red slates with a vertical cleavage, running E. 20° N. They dip S. at angles of 65° and 70°, while the Old Red sandstone, like that at Traverston, consists of red shales and flagstones, and red and white sandstones, which seem to be at first horizontal, but then take northerly dips of 35°, 40°, and 20°.†

* Small fragments of white chert occur in the local debris near this place.

† The junction at this place may possibly be affected by a continuation of the faults to the W., for the sandstone appears to abut against the Silurian; but as this might result from deposition, in the absence of better evidence to prove it, the existence of a fault here is not absolutely asserted. Some fucoid-like markings were observed in the red sandstone here.—A. B. W.

The Silurian rocks appear again near the villages of Mucklin and Curryquin, chiefly in the stream courses; and also upon Knockbrack, and in the glen to the west of it, and along the boundary of the Old Red sandstone to the N. of it. They are of the usual kinds of gray shales, with some beds of hard pale gray sandstone, becoming in places a very coarse granular grit. This latter variety occurs near a group of houses between Mucklin and Knockbrack, where an * is engraved upon the map, and when carefully examined was found to contain impressions of small crinoid joints and fragments of small corals.†

Southward of this is a low rounded elevation, called Knockaphortaderg, and in the stream courses near it, and at a place still farther south, called the Prisoons, the Silurian rocks may be seen, consisting, as usual, of pale gray and bluish grits, slates, and slaty shales, the inclinations of which are various, both in direction and amount.

Glencolloo.—Glencolloo is the valley in which the Mulkear River flows between Slievekimalta and the Silvermines Mountain. The elevations upon both sides of it are mainly composed of Silurian rocks, but are capped by portions of the Old Red sandstone, which, in all probability, was once continuous across the place now occupied by the glen. The rocks are exposed in nearly all the numerous streams which flow down the sides of the valley, but are seldom seen either in the lower parts of it or in the Mulkear River. Although much of the Silurian rocks are thus exposed and proved by their various inclinations to be much contorted, they do not exhibit any great variety, but consist of the same kinds of blue and gray clay rocks, shales, flags, and gritstones, which are seen elsewhere in this neighbourhood. In one instance only, where the dip of 80° to the S. is marked upon the map between the letters U and L in the name KILLOSCULLY, was there any thing like a fossil observed, some obscure and small casts of the fragments of crinoids and ribbed shells being found here in a bed of gray weathered gritstone.

Keeper Hill.—The Keeper Hill, or Slievekimalta, rises on the S. side of Glencolloo, to the height of 2,278 feet above the sea. It is a massive, somewhat rounded, and nearly flat topped mountain, with steeply-inclined and grass-covered sides, sloping on the E. into an undulating, boggy, and heathery moorland; on the S. to the Doonane River (a tributary to the Mulkear), and on the W. dividing into two spurs which run on each side of Ballyhourigan Wood. The tabular capping of Old Red sandstone, which forms the summit of the mountain, slopes at low angles to the W. and S.W., and being coated with peat, and thickly covered by heather, the rock is only to be seen at the edges of the outlier, where the mountain streams commence in rocky coombs, such as Coumaniller and Coumnoght, with vertical precipices round their heads, formed by the escarpment of the Old Red sandstone. These coombs afford conspicuous instances of the unconformability between this sandstone and the Silurian rocks, which frequently appear just below it, and are in actual junction with the sandstone in Coumaniller, and in another nameless coomb or ravine to the S.

Similar exposures of these rocks, nearly in juxtaposition, occur also near the top of a stream at a little distance to the S.S.E. of the last named ravine, and in the deep open hollow called Coumnoght, as well as at the heads of two small streams which spring near each other from the N. brow of the mountain. These junctions, and some small projections of the edges of the beds composing it, afford good evidence upon which to draw the boundary of the outlier, except at the S.E. side, where the mountain is covered with bog and heather.‡

† Very similar in its general appearance and in its fossils to the quarry on Army hill S. of Moneygall, in which small fragments of corals were also found. See Sheet 135, and Explanations.

‡ The base of the sandstone does not rest at equal heights all round the outlier as has been already stated, for the junctions at its N.E. side occur at an elevation of about 1,900 feet, while those on the S.W. are at heights of between 1,500 and 1,700 feet, the beds in both places lying apparently horizontally. As the angle of inclination between these points is only about 4° or 5° at most, it may be that of the undulations of the surface on which the Old Red was originally deposited.—A. B. W.

The thickness of the Keeper Hill Old Red sandstone, as exposed in Coumnoght, seems to be nearly 300 feet, about 100 feet of it being exposed in Coumaniller.

In all the courses of the streamlets which radiate from the outlier, as well as in the coombs, the gray shales, slates, flags, and grits of the Silurian, may be observed dipping in many and various directions, at numerous different angles. At the N. side of the mountain they contain ores which will be alluded to further on.

By the occurrence of some Old Red conglomerate, formed in a great measure of Silurian fragments, upon the spur on which the height 1,299 is marked, the existence of another smaller outlying patch of these sandstone rocks is proved, the edges of some Silurian slates being seen between the two.

The gray grits and slaty beds of the Silurian may be found in many places upon this extension of the Keeper Mountain, and in the old road to the place called Gold Mines, some of the shales very much resembling those found in the Coal Measures. South of this spur there is a deep glen, on the southern slope of which lies Ballyhourigan Wood. The Silurian rocks may frequently be observed in the stream at the bottom of it, having apparently a general dip to the S.* Another long spur extends to the westward from Keeper Mountain, to the southward of this glen; it is covered with deep upland bog, so that the rocks are greatly concealed, but nevertheless, it is believed to be capped by the Old Red sandstone running up from the west. The conglomeritic grits of the Old Red are indeed seen in two or three places at the S. side of the ridge, with a low dip to the W. or W. by N., and the *debris* of these rocks occurs upon the height marked 1,474. In Ballyhourigan Wood, too, the Silurian rocks are in some places of the red or purple colour, which they so frequently assume near their junction with the Old Red sandstone in the neighbouring hills.

The Silurian rocks are also exposed in the upper part of the Doonane River, where they dip to the N.N.W. at angles varying from 35° to 70°, and are also seen in other places in the glen; but as they are quite the same as those varieties already mentioned, and lie in the same generally contorted state, they do not require a more detailed notice. Old Red sandstone conglomerate, is seen nearly in junction with the Silurian, in a small stream flowing into this river from the S., and marked opposite to where the latter part of the word Doonane is engraved; the probability therefore is, that although not seen in the river, it crosses it lower down in its course as shown upon the map.

In the Mulkear River, at and above the demesne of Kimalta House, the Silurian gray grits, and gritty shales, with some red portions, dip E.S.E. at from 20° to 50°. About a mile below this the river enters the Old Red sandstone, which appears upon both sides of it on the high ground, at some distance from the river.

A. B. W.

Country between the foot of the Keeper Mountain and the Shannon, near O'Brien's-bridge.—The Old Red conglomerates are seen at the lower end of Ballyhourigan Wood, close to some Silurian slates, N.N.E. of Curraghduff, and on the opposite side of the river, S.W. of Kimalta House; but these rocks do

* A copper mine was begun to be worked near where the road crosses the river in this glen, about the year 1858, and "tin, lead, and copper," are mentioned in a MS. relating to it, in the hands of the agent for the proprietor. (*Information kindly supplied to me by Mr. Toler Garvey*).—A. B. W.

not appear in the Mulkear River within the limits of the area represented on this map, except at one place just above where the Doonane River joins the main stream. The ground to the westward of this, although sometimes over 400 feet in elevation, is so completely covered by limestone drift that neither the Old Red sandstone nor the overlying Carboniferous limestone beds can be seen except in the neighbourhood of Cragg House, S. of Birdhill; and the boundaries of these rocks, as represented upon the map in this neighbourhood, are chiefly drawn from inferences derived from the facts to be observed there. There is, however, sufficient evidence whereby to draw the boundary which limits the northern extension of the Old Red sandstone of this part of the district. Red and variegated Silurian grits and shales occur near the cross road which leads down to Kimalta church, from the main Nenagh and Newport line of road, and S.W. of this place, in the road last-mentioned, red sandstones of the Old Red dip southward at 10°. At the distance of nearly a mile due W. of where these are seen more red sandstones, with a similar dip occur, and a mile still further to the W. they appear again in another road.

To the S. and W. of the village of Swinehill, the Silurian rocks are frequently seen, consisting of red and gray grit and shale, which are either vertical, contorted, or dip at high angles to the S.E. or N.N.W.

A stain of copper was observed in some gray shales near a bend in the road, half a mile W. by N. of the R. C. Chapel, near Swinehill, and at the same place fragments of fossils were found in a coarse grit rock. Gray grits and shales also appear to the northward of this, near where the height 303 is marked on the map.

As the Silurian rocks have so frequently a peculiar reddish tinge close to the Old Red sandstone, the occurrence of numerous red shales in this locality would seem to indicate that the latter had been little more than removed from off them, and would probably be found not far away, and this probability is strengthened by the fact, that an outlier of the Old Red sandstone does occur in their immediate neighbourhood upon the height marked 486; and that the continuation of the Old Red sandstone which we have just now alluded to as coming from the east, after curving to the northward, passes close by them on the south. The outlying beds consist of fine purple conglomerates and red sandstones, which dip to the S. at 10°, and are surrounded on all sides except the N. by exposures of red and gray Silurian grits and shales, which are either vertical, or dip to the N. or N.W., at angles of 80° and 85°; thus adding another instance to prove the unconformability between these two rocks. To the S. of this outlier, the continuation of the Old Red sandstone appears dipping to the S. at from 5° to 10° (not far from the Silurian rocks), but here it is no longer always red, for yellow grits frequently appear, and, indeed, predominate in the numerous exposures of these rocks upon the ground south of the outlier, where a broken section of them, having a thickness of about 500 feet, dips at angles of 5° and 10° underneath the limestones of Cragg. These latter rocks are frequently exposed to the N. and N.W., as well as at and to the south-eastward of Cragg House, having everywhere low dips to the S. and S. by E., seldom at so high an angle as one of 10°. Just south of where the letter M in the name KILCOMENTY is engraved upon the map, there is only a space of about 200 yards between the lowest exposure of the shaly limestone and the uppermost one of the yellow (Old Red) sandstone, grits and micaceous shales, both having the same inclination to the S.

All the limestone rocks in this neighbourhood are of very much the same aspect, being of a dark blue colour, evenly, and distinctly bedded, owing to the occurrence of thin partings of black shale alternating with the beds of limestone, and sometimes, as on the hill N. by W. of Cragg House, containing layers of ochreous clay. Veins of red clay also very frequently cross these limestones in an irregular manner.

The country to the S. of this locality, along the edge of the district, is extensively covered with limestone drift, often piled into great mounds and esker ridges.

Where the road from Birdhill to Limerick, after passing through a small alluvial flat crosses the boundary of the Old Red sandstone and limestone formations, close to where the L in the name KILCOMENTY is engraved upon the map, these different rocks may be seen *in situ*, very near to each other; and in sinking for a gullet under the railway, a little to the W. of this place, dark blue shaly limestone was found resting upon yellow sandstone, both having a southerly dip of about 5°. The dark blue limestones in the townland of Thornhill have dips to the S.E. at 10°, along the road, and at the N.W. boundary of the townland shaly limestones dip S. at 5°, lying underneath eight feet of bog, while the same dip is to be observed in yellow flags and grits, and red shales of the Old Red sandstone, between the bog and the small alluvial flat before-mentioned, at a distance of about 100 yards N.N.E. of the shaly limestones.

The Neighbourhood of Birdhill.—To the S. of Birdhill a tongue of Old Red sandstone, principally composed of red sandstones, extends from the main mass towards the north, capping the low hill marked 406 feet. The Silurian slaty rocks which appear in its vicinity, have the same red colour observed in the neighbourhood of the outlier to the E.N.E., and a red shale, sometimes so hard and silicified as to resemble jasper, occurs in one place close to the sandstone near where the dip of 5° to the S. is marked. This red tinge does not, however, affect all the Silurian rocks between these two places, for midway between them strong gray grits and fissile shales are found; and at one place, near where the dip of 70° to the N.W. is marked, the grits have been extensively quarried for use as road metal. At this place, also, a horizontal fault or shift of the beds was observed, and some of the joint planes were found to have a film or coating of copper pyrites. In the neighbourhood of Birdhill House, and also close to some buildings westward of the Roman Catholic Chapel, the indurated red Silurian shales and grits are to be seen, and close to them by the roadside at the Police Barrack, the lower beds of the Old Red, consisting of red sandstone full of little balls and layers of red limestone, dip to the S. at 15°.

Red and yellow flaggy grits, sandstones, and conglomerates belonging to the Old Red sandstone, frequently appear, undulating over the ground lying between this place and Parteen Villa, and also about the height marked 206 feet; and 300 yards S.S.E. of this elevation, where a dip of 5° to the S. is marked, some lead is reported to have been found, about the years 1845 or 1846, in a quarry of yellow grit. The Old Red sandstone extends from this place to the westward by Montpelier and O'Brien's-bridge, but is almost entirely concealed by the great mounds of drift before spoken of. These mounds are surrounded by deep bogs.

A. B. W., from Notes by G. H. K.

The Kilmastulla Valley.—The Silurian rocks just spoken of, form a well-marked ridge of high ground, running from Birdhill House to the E.N.E. past Swinehill, and just S. of Ballycahane and Shallee House (lower). This ridge slopes abruptly to the N. into the low valley of Kilmastulla, which is full of immense mounds of drift. No rock *in situ* is to be seen in this valley, except in the low ground a little N. of Birdhill, where beds of Carboniferous limestone show themselves at two places. One of these is near a farmstead, a quarter of a mile N.W. of Coolly's Bridge, and the other in some fields, a quarter of a mile E.N.E. of Cool Bridge. These lime-

stones are dark and shaly, apparently some of the lowest beds of the formation, and they undulate at very low angles.

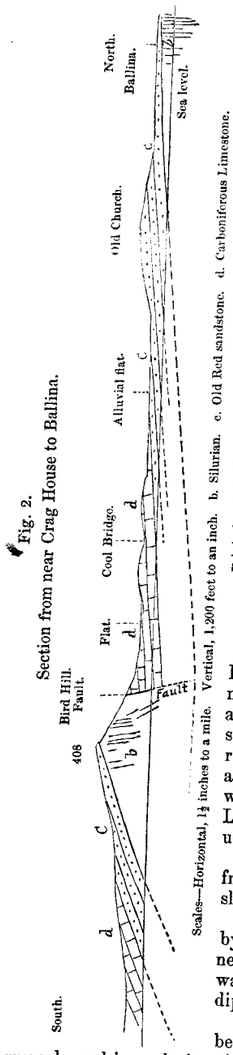


Fig. 2.
Section from near Crag House to Ballina.

The Old Red sandstone rises from underneath these beds to the north, into the flanks of the Arra Mountains. Some beds, apparently the uppermost of the Old Red, appear in the stream that runs down by Derduoil.

There is, however, no appearance of the Old Red sandstone rising from underneath the limestone on the south along the northern foot of the Bird-hill ridge, although it clearly does not end in that direction, as is shown by its appearance along the southern slope of that ridge. It seems, therefore, most likely that the Carboniferous limestone extends under the drift of the Kilmastulla valley, to the front of the Birdhill ridge, and is there made to abut against the Silurian rocks, in consequence of a great fault or dislocation which runs along that foot, as shown in the diagrammatic section, Fig. 2. Indications of such a dislocation are apparent to the E.N.E. at Silvermines, and to the W.S.W., near O'Brien's-bridge, as will appear presently.

The Shallee and Silvermines District.—A little east of Shallee House (lower), the ground rises considerably, forming the hill called Lackagh, the summit of which is 1,520 feet high. The consequence of this rise of ground, or diminution in the amount of denudation, is, that the Old Red sandstone appears on the slope and summit of the hill on the S. side of the fault just mentioned.

J. B. J.

Good evidence (from the statement of Captain King) seems to exist underground close to his house, near Shallee cross-roads, to prove the occurrence of a fault there between the sandstone and the limestone in nearly the same general direction as the rest of the line of fracture is supposed to take; and at this place a north and south cross-fault, coinciding with one of the lodes there, seems to drop the black Lower Limestone shales against the ends of the underlying gray sandstones.

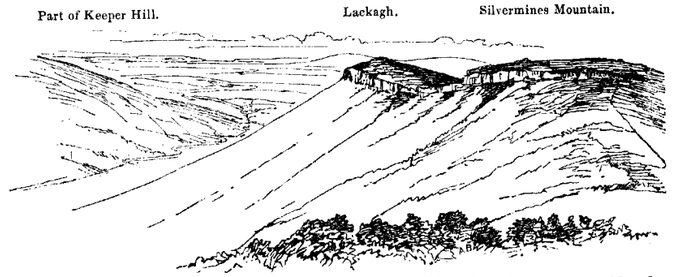
To the eastward of this an irregular line of fractures has been traced, extending along the N. slope of the mountain to beyond Silvermines.

The highest part of the Lackagh ridge is capped by a covering of Old Red sandstone, which lies nearly horizontally upon its top, but curves downwards with the slope of the hill to the N., so as to dip, in some places, N. at 25°.

This patch of sandstone is of peculiar shape, being deeply cut into at the sides upon the high ground; and in such situations, generally, having a bluff or cliff-like outcrop, but where this is presented towards higher ground it is frequently concealed

by the surface debris.* These sandstones and conglomerates may be seen in many places, and it is remarkable, that although apparently a continuation of those forming the Keeper outlier, as will be observed by inspecting the section, Fig. 1, they are of a different colour and in places have a peculiar aspect. The beds upon the Keeper Mountain are nearly all red, but here they are seldom or never of that colour, being generally whitish gray or of a pale yellowish brown. The whitish conglomerates may be seen projecting from the surface of the ground in the form of a little cliff along the top of the ridge overlooking Glencolloo, where they form the marked feature in the hill shown in Fig. 3, and they may be traced round the basal edge of the patch of sandstone, and also form two small outliers near it on the E.S.E. Further down upon the slope hard white quartzose conglomeritic sandstones are found in numerous places, and in the neighbourhood of Shallee these become of a pale bluish gray or lead colour, containing minute pieces of pyrites and galena in the vicinity of the mineral veins of that place.† The numerous arrows upon the map will point out both the frequent appearance of these rocks here and the direction of their inclinations.

Fig. 3.



Outline of the West termination of the outcrop of Old Red sandstone on S. side of Silvermines Mountain looking west by south.

At the W. side of the patch the sandstones contain several veins of baryta, and all along the line of fracture forming its northern boundary the bedding is frequently indistinct, although at a little distance from the fault it is evident enough. Some black shales at the mouth of one of the shafts at Shallee, and stated to have been raised from below it, were found to contain a few casts of crinoidal fragments and some obscure plant-like impressions; but from what place exactly these were taken could not be ascertained. It is, however, possible that they came from a *black bar* or mass of shales said to lie to the N. of the sandstones of this place. At Gorteenadiha or Gortnadine Mine the fracture

* It will be observed that two large indentations at opposite sides of the sandstone approach each other in the general direction of a horizontal contour line of the hill-side in that place. thus showing, that if the land had remained longer at the elevation which it had reached when these indentations or sinuosities were formed. the sandstone on the top of the ridge would have remained as another outlier of the same character as that upon the top of Keeper Hill.—A. B. W.

† The sandstones here frequently, or indeed generally, have this peculiar leaden colour, in some parts more so than in others, and small particles of galena and iron pyrites may sometimes be distinguished by the aid of a lens. If they are the result of the deposition of very minute particles worn from older lead veins, they are for the most part too small for their mechanical origin to be determined by inspection. The possibility of lead having by some means penetrated the body of these sandstones since their deposition, is a question for mineralogists, and many places near this locality might be found worthy of their attention.

containing the lode seems to have but a slight throw to the north, for the sandstone occurs upon both sides of it, containing, however, it is said, beds of shale on the north which are absent on the south side of the fissure. Near the place where the first part of the name Garryard is engraved, the Old Red sandstone and Lower Limestone shale are seen in junction in a stream, and both contain a certain quantity of pyrites or mundic. They are supposed to be separated by the continuation of the fault, the shales dipping to the north at 35°, but the bedding of the sandstone is very obscure. Where the sandstone terminates near this to the eastward, it contains iron pyrites in two places, the largest deposition of the two occurring at its junction with the limestone and Silurian rocks, all three of which may be seen within the distance of about 250 yards in a nearly straight line, and none of them presenting their ordinary appearance. The limestones appear to be mineralized by the addition of foreign substances; they contain a quantity of baryta in some places, while in others they are cherty and shaly; and magnesian limestone or dolomite may be frequently found here, about Garryard and towards Gortnadine. The sandstones are conglomeritic, and have dark coloured shaly veins; but their bedding is obscure, and they contain a quantity of iron pyrites, without any appearance of its being confined to a lode. The Silurian rocks are of a deep red colour, apparently containing red hæmatite. One fault certainly exists here, between the sandstone and the limestone, but there may be more; there is not, however, sufficient evidence upon which to introduce others.

The Silurian rocks of which this Silvermines ridge is mainly composed may be seen in many places, both in the streams which flow down its N. face and in those running S. into Glencolloo. They appear also in the two streams to the E. and W. of where the last letter of the word ARRA is engraved upon the map, as well as upon the higher part of the ground forming the western termination of the ridge between the capping of sandstone and the neighbourhoods of Killoscully and Ballycahane. They will be found to have everywhere the usual shaly, and slaty, and gritty character, the colours being of the same blue, gray, and olive tints; except at or near the junctions with the Old Red sandstones, where they are frequently but not always changed to a deep red. One instance of this red colour has been just now alluded to, and others will be found at the junction near the top of the stream which passes by the word *Mine-works*, near the two small outliers to the E.S.E., and along the out-crop of the sandstone overlooking Glencolloo.

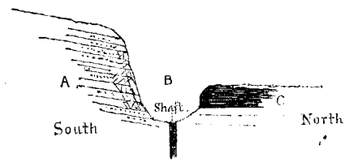
Red Silurian shales and grits are also frequently seen in the country N. and N.W. of Killoscully; but gray grits and shales are also to be found along the road which passes upon the map between the two central letters of the name ARRA. The most northerly place at which these rocks were observed in this neighbourhood is at Shallee House (Lower), where some bluish-gray gritty shales appear in a rivulet.

To the northward of this the country is occupied by the lower part of the Pollagh flats and by cultivated fields, under which there is an undulating expanse of drift composed of sand and gravel, of which a vertical section of twenty feet is exposed in some ravines near Shallee House. This drift does not extend over much of the sloping ground formed by the Silvermines mountain-ridge in this neighbourhood, although it is found upon both sides of it at its termination near Killoscully, and limestone boulders have been observed upon its northern slopes at a height of about 600 feet. Between Shallee House and the old "*Mine works*" to the S., a stream from the mountain, finding the drift thinner there than usual, has cut it through near the road, so as to expose the sandstone and limestone rocks near each other, both dipping in nearly the same direction, although probably separated by a fault. Higher up, on the Silurian ground, this stream cuts through a thick deposit chiefly composed of Silurian fragments and clay. The drift upon both sides of the Pollagh is widely but unequally spread, being accumulated in the greatest quantity

where the valley becomes narrow, but gradually allowing the rocks to be seen here and there as the valley opens.

In the neighbourhood of Shallee cross-roads blue, gray, and dolomitic limestone appears in a few places, the dolomitic portion being nearest to the sandstone, and the dip, where it can be seen, inclining to the N. at low angles.

Fig. 4.



Diagrammatic N. and S. Section of the Open cast at Gortenadine.

A. Sandstone. B. Place from which the lode has been removed. C. Black shale.

At Gortenadine Mines a large open excavation exposes upon one side some soft, black, thinly-laminated shales lying nearly horizontal, or with a slight inclination to the N., in such a position as to abut, if produced, against the strong gray sandstones, containing thin layers of blackish shale, which form the other or south side of the excavation. A hollow in the ground exists to the northward near this place, and in it, at the mouths of several old shafts, the *spoil banks* are composed of the same shale, in a fragmentary condition. It can be traced in this way extending to the E.S.E., between the sandstone and the dark shaly, cherty, and magnesian limestones so frequently to be seen in this locality, with a general dip to the N.

At Ballynoe, near Garryard, some dolomitic limestone, dipping apparently to the N.W. at 40°, is brought against the splintery shales of the Silurian by a fault, and both are exposed in a large irregular pit or opening from which lead and copper ores are being raised (1859–60). At a distance of about eighty yards to the eastward of this opening some nearly vertical black fossiliferous shales, of the Carboniferous series, inclining slightly to the N., are by means of the fault brought into juxtaposition with the gray grits and shales of the Silurian which dip N. at 60°. Over these fossiliferous shales there is a quantity of black dolomite which dips N.W. at 40°, striking directly at the Silurian and Old Red sandstone ground. Apparently overlying these beds of dolomite or magnesian limestone, and seen in the two streams close to this place, there occurs a curious gray rock sometimes speckled with red spots and containing pyrites, orpiment, &c.,* but consisting most largely of sulphate of baryta. It is rendered very heavy in consequence of this; and although more solid-looking, its general aspect, and way of resisting the action of the water in the streams, is not unlike that of a limestone at a little distance. Further down the streams, more limestone, massive, cherty, dolomitic, flaggy, and siliceous, exhibits some dips to the northwards at 30° and 40°, near Dunalley Castle; but below this the streams join together, cutting through a quantity of clayey limestone drift, which is quite white and sandy in places. The thickness of this drift exposed is not less than fifty feet, and it may be found again forming the sides of the ravine containing the stream to the west of Garryard.

Returning to Ballynoe, the beds forming the termination at that side of the Shallee sandstone will be found to strike directly at those of the limestone, thereby proving the existence of a fault which has not the same direction as

* See Paper by M. Alphonse Gages, *Journal of the Geological Society*, Dublin, vol. viii. page 243.

that just now alluded to, but may still form part of the same chain of dislocations. Close to the place where the fossiliferous limestone shales and those of the Silurian are in junction, the fault there seems to pass to the S. of a curve in the limestone and sandstone rocks, by which a small portion of the latter, consisting of white and yellowish sandstones and conglomerates, are brought to the surface, appearing near this junction and in the fields to the E.N.E.

Another slight hollow in the ground here following the curve of the sandstone beds, and containing some old shafts with black shale debris in the *spoil banks* at their mouths, has been taken as evidence of the occurrence of the same thin band of Lower Limestone shale which occurs at Gortnadine. Immediately to the E. of this exposure of the sandstones, black shales and magnesian limestones dipping to the N.N.W. at 65°, are again brought into junction with the Silurian rocks by a continuation of the last-mentioned fault, which passes thence to the eastward.*

In the neighbourhood of Silvermines village a quantity of thick, pale-gray, crinoidal, and sometimes magnesian limestone dips to the N. at 35°, and under these are black and dark-gray shaly limestones, containing some iron pyrites, overlying dark calcareous shales with thin beds of limestone, as seen at Silvermines Cottage; and near the Roman Catholic Chapel some strong dark limestones underlie these, and underneath them there occurs what appears from the investigations made underground to be an interstratified mass of dark-gray dolomite, containing a bed of gossan, calamine, &c., from twenty feet to nearly eighty feet thick. These beds, with nearly the same inclination, run southwards against the hill until they are met at its foot by a continuation of the fracture alluded to as running in this direction from Ballynoe, and which here seems to divide so as to include a mass of sandstone belonging to the Old Red formation. The northern branch of this fracture contains the great sulphur lode (which will be noticed further on) and the limestones with the interstratified gossan, dolomite, &c., abut against the nearly vertical lode contained in the fault; while in an easterly direction they are apparently cut off by a cross (N. and S.) fault nearly coinciding with the direction of the stream which passes by Silvermines Cottage, and are thus brought into junction, to the eastward, with certain soft, greenish-yellow, brecciated, shaly rocks, supposed to belong to the Old Red sandstone. The eastern continuation of the fault, which is occupied by the sulphur lode, turns to the southward at a point due S. of Silvermines, and then bends again to the E., apparently rejoining the S. branch of the fracture.

Where the stream from the glen to the S. crosses the run of this lode near its supposed junction with the S. branch, some soft greenish yellow shales adjoining the lode occur, and at the distance of a few feet to the S. the Silurian slates are seen. The same kind of shales are to be found in another stream immediately to the E., grown over with brambles and much concealed, but having an apparent though very slight dip to the N.N.W. They are traversed by cleavage planes crossing the stream, and are thought, from their similarity in texture and colour to some of the shales in the upper portion of the Old Red sandstone, to belong to that formation. Similar shales are occasionally seen for a space of about twenty yards in another small stream course, much overgrown by brambles, lying to the eastward of this place. To the west of that again, where the Silvermines Stream broke into the mining excavation below, they are stated to have been exposed for a depth of eighteen feet, with the gossan bed in junction, and the line of separation, already stated to be apparently a fault, haded to the W. at an angle of about 60°.†

The lower part of the ground about here does not expose any other sections. The continuation of the sandstone band, which is exposed in several

* Galena and iron pyrites occur at this junction of the rocks.

† This place is now filled up.—Dec., 1860.

places in Lord Dunally's Deer Park, is apparently abruptly broken off westwards by an oblique fault, which, being prolonged to the W.N.W., with a downthrow to the N., has probably allowed the limestone to sink below the level of the triangular piece of sandstone included between this and the N. and S. cross-fault, and the eastward continuation of the main fracture.

A number of faults seem to come together at this locality, and the want of better evidence than the place affords, renders their arrangement excessively obscure.

The gray grits and flaggy shales and slates of the Silurian occur in many places in the glens S. of Silvermines, and a slate quarry has been opened at one place not far from the mines and close to a waterfall upon the stream which passes by the village. At this slate quarry the beds are nearly vertical, and consist of thin flaggy shales, upon the surfaces of which the casts of long tapering orthoceratites were observed. The cleavage appears to coincide with the beds, and large flaggy slates are easily obtained.

Similar gray shaly and slaty beds may be seen in several other localities in the neighbourhood, in the stream-courses, or on the hill slopes, and frequently close to the boundary of the Old Red sandstone to the east.

A narrow band of these white sandstones and conglomerates, with some red beds below, runs along the foot of the hills from Silvermines to the eastward, by Happygrove and Traverston, at which place they are best seen appearing as fine red sandstones, gravelly conglomerate, and red shales, dipping N. and N.W. at from 3° to 10°.

At one place, where the dip of 15° to the N.W. is marked upon the map, on the hill between Silvermines and Knockbrack, the white sandstone shows the peculiar rusty concentric weather stains upon the joint faces which are often observed in the upper beds of this formation.

The country North of the Silvermines Mountains.—Gray and pale gray limestones appear in some places not far away from the northern foot of the Silvermines Hills. A quantity of pale gray limestone is seen near Boherboy (whence Lord Dunally has obtained several heads of crinoids, univalves, and other shells), and dips which occur in gray limestone, sometimes variegated or magnesian, will be found engraved upon the map, to the E.N.E. of Kilboy and S. of the name BALLYNACLOGH.

The country is covered by a considerable quantity of drift, in the valley between the mountains and the high ground called Daag's Hill; and the drift, although absent upon the steep slopes to the S. of Silvermines, extends far into the valleys in the neighbourhood of Curryquin, and covers the country to the eastwards, except upon the higher parts of the ground.

The limestones which occupy positions nearest to the Old Red sandstone in this north-eastern portion of the district, although sometimes pale and splintery, are generally dark coloured and crinoidal, in some places having a lenticular structure, caused by alternations of cherty layers, with others of a more calcareous and earthy nature; but no distinct line of demarcation between them and the other limestones of the district presents itself.

Near Ballynaclogh some beautifully variegated red, gray, green, and dun-coloured marble or siliceous limestone is seen in the Nenagh River, close to Ballynaclogh House, and on its south bank, where it dips to the N. at about 5°; and it appears again upon the hill, 400 yards to the northward, in the demesne of Debsborough.

From the converging dips of the beds in these two places the marble appears to crop on the sides of a synclinal curve or basin in the ordinary limestone; the thickness of these marble beds being, perhaps, not more than twelve or fifteen feet. As it is, however, only seen in these two places, the lateral extent of the basin cannot be estimated.*

* Some of this marble appears to great advantage when used for ornamental purposes, as seen in Debsborough House.

Upon the high ground two miles and a-half to the westward of this, called Daag's Hill, the drift being thin, and sometimes entirely absent, the limestone appears in a great number of places, upon the upper part of the hilly ground and to the northward of an alluvial flat, between it and Silvermines. Pale pearly gray compact and crinoidal limestone, which is often magnesian and frequently full of fenestellæ, is found extending as far northwards as the upper part of the Pollagh* alluvial flat; but in the neighbourhood of Tulla House, as well as near Kilmore Glebe, dark and bluish gray limestones occur.

On the western side of the Pollagh some dark, finely laminated, and thin-bedded Lower Limestone shales are exposed in a small stream about a mile to the N.E. of Newline Bridge, on the Birdhill and Nenagh road, and in the low ground at a somewhat less distance to the E.N.E. of these shales one old quarry in black crinoidal limestone occurs, but the somewhat undulating ground to the N.E. is covered with drift, limestone gravel, &c.

In the country about Ballintogher House, gray and pale gray limestone occurs in several scattered quarries, and some black limestone appears on the Limerick road, near an alluvial or peaty and marshy flat, at a place about two miles from Nenagh.

The Neighbourhood of Nenagh.—Bluish and pale gray limestone comes to the surface near the highest part of Gibbet Hill, and dark gray compact and shaly limestone occurs near the wood south of the name KNOCKAUNKENNEDY. The country about this hill does not expose much rock in quarries, &c., and must therefore have a considerable covering of drift, which appears more frequently in the shape of clay, enclosing boulders or pieces of limestone, than in the form of gravel. Some gravel hills, however, lie on the N. side of the Ballintotty River, and in the river itself, near Ballintotty Old Castle, are seen some nearly horizontal beds of dark gray and black limestone. The Ollotrim River to the N. of this exposes gray compact limestone in its bed, just where it enters the district, near Rathurles, and also near Islandbaun. South of the letter I, in the parish name LISBUNNY, and near a little patch of wood, which will be found engraved upon the map there, a large quarry has been opened in nearly horizontal black compact and earthy limestone.

Bluish and dark gray limestone, dipping to the E. at 40° and 60°, has been quarried near the Court House and in other places to the S., on the outskirts of the town of Nenagh.

Pale gray limestone occurs at the White Walls road, near Nenagh, on the way to Hogan's Pass, and massive gray and variegated limestone appears further on, on this road, and near that leading to Richmond, between the latter place and Solsborough. Closer to Hogan's Pass some nearly horizontal dark gray and black limestone occurs in the townland of Belleen, Lower, and in the stream close to the village.

In the country on the south-west side of the Nenagh River, near Moyroe House, Richmond, Rockford House, and Monsea Glebe, projections of, and quarries in, pale gray, compact, subcrystalline, and fossiliferous limestone may be met with occasionally.

Near the Old Castle and Flour Mills, not far from where the Nenagh River leaves the district, dark and pale gray compact limestone appears, and at a little distance to the S.W., upon the hill where the old and new Roman Catholic Chapels are situated, some pale and dark gray deeply weathered crinoidal limestone comes to the surface, dipping at low angles in various directions. To the W.S.W. of this, some dark gray crinoidal limestone, regularly bedded, and nearly horizontal, crops from the hill; it is somewhat

* This fen, partly bog and partly alluvial or marshy ground, is flooded every winter. It occupies a depression along which the River Shannon would naturally have flowed round the Arra Mountains if it had not been for the deep valley across them, near Killaloe.—A. B. W.

similar to the limestone seen in the stream near Hogan's Pass, where it appears to lie equally flat.

Near Rathnaleen Cottage, on the road from Nenagh to Rathurles House, gray and lavender-coloured gray compact limestone is seen, and it also occurs beside a short cross-road to the westward of this.

Upon the road from Nenagh to Rapla, near Rathnaleen Castle, a hill has been cut away to a slight depth, and some hard, pale and variegated gray, scaly and sparkling limestone exposed, which is in places magnesian, and contains veins of white crystalline carbonate of lime. In this neighbourhood, too, south of where the name South-hill House is engraved, and on some high ground near the cross-roads there, hard and pale gray compact limestone, lying apparently horizontal, comes to the surface, and more pale gray limestone is seen near Rapla House and Demesne, and beside the road S. of Ballinwear. In the vicinity of the latter place, near a new road, some quarries have been opened in a solid bluish-gray compact or finely crystalline, granular, and sometimes oolitic limestone, which is extensively used for cut stone work, &c.*

Near the Roman Catholic Chapel to the E. of Rapla, pale gray limestone occurs in two places, but its stratification is obscure. A. B. W.

The Arra Mountains—The Old Red sandstone.—In most of the streams that drain the south slopes of the Arra Mountains partial sections of the Old Red sandstones are exposed, but none of them require particular notice. The basal bed in this part of the Old Red is always a red rock, usually a soft friable sandstone, but in a few places a hard breccia. The strip of this kind of rock that runs up the mountain, three miles N.E. of Killaloe, by Black Lough to Coumbeg Lough is very thin, being only the basal beds, except between the two loughs, where it must be over forty feet thick, as there, above the red beds, are thick yellow grits and flagstone; but as the mountain is covered over with a coating of peat, no exact measurement could be made.

At Ballina, near Killaloe, in the railway cutting, there is a good section of the lowest beds of the Old Red sandstone; and a small outlying patch of Old Red was observed a little on the N.W. of Ballina. At and to the north of the bridge at Killaloe, soft red sandstone, belonging to the Old Red sandstone, rests on the edges of vertical Silurian grits and slates; in the stream three furlongs due east of Ballina, a similar rock rests on vertical red Silurian grit. On the hill to the eastward, immediately south of where the second E in TEMPLEACHALLY is engraved on the map, in the cutting for the road, the basal bed of the Old Red is a conglomerate, which at the outcrop is a loose gravel, made up of rounded pebbles of Silurian rocks, and lying on the edges of purple Silurian slate. Farther E.N.E., between the A and C in Templeachally, there is an outlying patch of Old Red so small that it cannot be represented on the map, where a similar junction is also to be seen.† There were also junctions observed near the N. extremity of Black Lough, and in the "togher" leading to Black Lough.

A few miles further east, near Burges' old bridge, the two formations are also nearly in juxtaposition. Two and a-half miles N.E. of Burges' old bridge,

* These are called the Loughourna quarries.

† Immediately S. of where the first A in Templeachally is printed, there is a boulder of Silurian conglomerate, and though not very large, being not more than two or three tons, it makes a marked feature in the landscape, standing perched on the ridge formed by the outcrop of the Old Red sandstone. This stone is called "Cloughaun" (pronounced Cluffhorn), or the "giant's stone;" and the legend about it is that "a giant hurled it from Crag (called on the map Glennagalliagh), at an enemy who was standing on Keeper (twelve miles distance), but it was too heavy, and fell where it now remains, having buried more than half of itself in the ground."

yellow grits and good flagstones have been quarried, which dip S.E. at 10°. A mile on the N. of the last-named place there are also Old Red rocks exposed, which lie in the trough of a synclinal curve, that suddenly deflects the boundary to the W. for about half a mile, white, yellow, and red sandstones, flags and shales, were observed, that dip N. at 5°, and S. at 7°. To the N. of Kilcoleman House there are also yellow sandstones. A section of similar rocks is exposed in the Newtown river, a mile and a-half N.W. of Kilcoleman House, where "there is exposed a thickness of at least 200 feet."

Yellow and red sandstones are also seen along the road from Newtown to Portroe in another synclinal curve. On the west of Youghal House, and from that towards the west, a strip of Old Red sandstone forms a fringe along the shore of Lough Derg.*

The basal bed is exposed in places, and where observed was always a red soft sandstone or breccia, over which are red sandstones, and on them a quartzose conglomerate, from ten to twenty feet thick, and often highly calcareous. It contains rounded pebbles of white quartz, and angular pebbles of jasper and Silurian grits and shales, the first-named being the most abundant. G. H. K.

Arra Mountains—Silurian Rocks.—The Silurian rocks of the Arra Mountains, on the side next to Nenagh, consist principally of gray and olive grits and shaly slates, the beds having everywhere a marked slaty character, and traversed by numerous joints. Near the village of Youghal they may be seen on the high ground to the west, and in the Youghal River at a little distance above Ballycarridge Bridge. In the former place, half a mile W. of Youghal House, the Silurian and Old Red sandstone rocks are seen almost in junction, and, as usual in such cases, the Silurian has a peculiar red tinge.

On the high ground near Monroe, in the roads and about the eminence called Knockacrohy, cleaved gray grits and gritty slates may be seen in many places, with various inclinations at different angles, and the bedding very frequently concealed by the cleavage. Eastward of this, in the Newtown river, half a mile S. of Newtown Bridge, gray grits and flaggy shales dip N. at angles varying from 50° and 55° to 60° and 70°; and further south, near Knockshan Rath, the river has cut a channel for itself through hard gray cleaved grits and gritty slates, in which two sets of planes cross each other nearly at right angles, one set dipping E. at 15°, and the others apparently nearly vertical, or having a slight tendency to incline northwards, but which is bedding, and which is cleavage, it is difficult to determine, the probability, however, being that the bedding planes are those which incline eastwards. Half a mile further up the course of the same stream thin gray grits dip to the N. at angles of from 60° to nearly vertical, and are crossed obliquely by cleavage, striking 20° S. of E. Still further S., above a ford where the river makes a double bend from the W., first S. and then to the N., it has cut through thick gray broken grits and gray slates, the average dip of which is apparently S. at low angles, varying from 30° to nearly horizontal, and the cleavage here has the same strike as that last noted. Eastward of this locality, and S.W. of Kilcolman House and Demesne, a hollow, very nearly coinciding with the course of a small rivulet, had been excavated in the gray slaty grits of the Silurian formation prior to the deposition of the Old Red sandstone which now occupies it; and round the edges of the sandstone trough the two kinds of rock frequently occur near each other, the Silurian consisting of gray and bluish cleaved grits, which are found (where the cleavage permits the bedding to be seen) to incline so variously that they must be considerably contorted; these contortions, however, do not affect the direction of the cleavage, which seems everywhere to dip towards the S. at about 40°.

* A small strip along this coast is in the map, Sheet 125

The most elevated parts of Burgesbeg at Knockanabohilly, and to the S.W. of that elevation, as well as the part of Youghalarra adjoining, contain a good deal of rock near the surface of the ground, particularly in the neighbourhood of the small streams which flow from this place northward into the Newtown River, and southward into the Pollagh. They consist of the same kinds of gray grits and gray slaty shales, and their inclinations are as numerous and various as those in other parts of the Arra Mountains. A. B. W.

To the westward of Youghal Bay, there are green grits, conglomerates, and a few slates, belonging to the Silurian formation, which dip S.S.W. and S.W. at angles varying from 70° to 88°. At and on the N.E. of Portroe the beds either dip northward or are vertical. About two miles S.W. of Portroe is situate the *Laghtea slate quarry*, in which there seems to be a bed of good slate, but when visited (October, 1860), it was abandoned, and the quarry was full of water and rubbish. In some small trials a little further S.W., the strike of the cleavage was found to run E. 10° N., with a dip of 70° to the southward.

The principal quarries in this district are those of Corbally, which are situated about five miles on the N.E. of Killaloe, and nearly two miles due south of the village of Portroe, of which a more particular account is given below.

In the country that lies to the south of those slate quarries, sections are seen of the Silurian rocks undulating in sharp curves, the axes of which generally bear E. and W., similar to those on the south slopes of Slieve Bernagh. To the south of Coumbeg there was a trial for slate, but it was found to be of a bad quality. On Tountinna, the rocks, which are principally grits and conglomerate, are exposed in small crags and bosses, especially on its western slopes. To the N. of Tountinna, near the *Graves of the Leinster Men*, are two small slate quarries; in that to the south the beds dip N. at 70°, while in the other they dip S. at 45°. Through them runs a fault that bears N.E. and S.W. The cleavage here is nearly vertical, and strikes E. 15° S. Further E., at *The Gap*, is a vein of good slate, where there is a vertical E. and W. cleavage. Nearly a mile S.W. of *The Gap* there are massive green grits and conglomerates, interstratified with beds of slate that have been worked to a small extent. W. of this, and due south of Derry Castle, there is a large quarry, which at present is only worked a little; in the slates here the cleavage runs E. 10° S., and dips N. at 80°; in some of the beds it seems to be curved. A mile south of Derry Castle there is another slate quarry, where the cleavage strikes E. 15° S., and dips southward at 75°; fossil tracks were remarked in this place on the face of some of the beds. Another quarry is situated half a mile N.W. of Ballina, in which the bed of slate is covered by a massive green grit, that is at least twenty feet thick. For this reason these works were abandoned, as the beds dip at about 45° to the N.E., and the mass of grits had to be first removed before the slate was taken out.

Corbally Slate Quarries.—At this place there is an amazing vertical thickness of slate; over 350 feet is exposed in the principal quarry, in which there are only a few thin grits, and Mr. Headech, the lessee of the royalties hereabouts, has proved a much greater thickness.*

When visited (in the winter of 1860), only one quarry was being worked, (the one immediately north of where the S in slate is engraved on the one-inch map, as it was found to be more profitable than any of the others.

This quarry is divided into three parts by two parallel faults, locally called

* To Mr. Headech, and his manager, Mr. D. Mannix, I am indebted for the data of these workings, as they courteously, during my visits to the quarries, accompanied me and afforded every information.—G. H. K.

Red ends,* that bear N. 25° E., and have downthrows to the N.W. These faults are part of one large step-fault, as two other parallel *red ends* or faults are found, one a little to the E. in an old working, and the other at the S.W. extremity of the quarry, in works lately opened, both of which are downthrows to the N.W. No *red ends* were remarked in the old works farther west, and I was informed by Mr. Mannix that they do not occur in them.

In the present working the slate is of two kinds, cleaved shale and cleaved clay-rock.† When a cleaved shale, the slates are *ribboned*, and when a cleaved clay-rock, the *veins* are generally of a considerable thickness, averaging from fifteen to twenty-five feet; the latter are the most profitable, as they split easily, and in them *soles* are often found, while in the cleaved shales they are of rare occurrence.

The *soles* ~~are greatly prized by~~ the quarry-men, as, without them, there is a considerable loss of the unwrought slate in getting out the blocks, which sometimes are nearly immovable.

The strike of the beds is from E. 10° N. to E. 20° N., the dip being northward, generally at 45°, although in a few places it rises suddenly to 50° or 55°; and at the S.W. extremity of the present quarry, in the new working, there is a flattening (which may be the north side of an anticlinal curve), that makes the beds nearly horizontal, but with a slight dip towards the west. The beds have a greater inclination in the quarries that lie further east, as there the dip is N., at angles varying from 60° to 80°.

The strike of the cleavage planes is east and west, or nearly so; in the best slates being generally vertical, and in the *rock* (gritty slate or grits), inclining S. at from 60° to 75°. The *poles* or oblique joints, usually run every way across the quarry with various dips; but in some places there are systems of parallel *poles* that bear N. and S., and dip E. at 45°; these are well developed at the S.W. extremity of the present working, (*Oct.* 1861). The *bellies* generally come out from the *ends* or *poles*, and usually destroy the mass of slate contained between them and the other joints; that mass being gritty (locally called a *rock*), and cut up by oblique *concealed joints*, although sometimes, when the mass contained between the *belly* and the other joint is very large, good slate will be *got* in the centre of it. *Ends* are found parallel to the *red ends*, but they are only local, never going any considerable distance.‡

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* A great many local terms are used in these quarries, such as the following:—
Bellies.—Curved joints.
Cleave.—The cleavage.
Concealed joints.—Lines in which the slates are inclined to break.
Ends.—Vertical joints that are parallel to the *Red ends*.
Jump.—The throw of a fault.
Poles.—Oblique joints.
Red ends.—Faults that bear N. 25° E.
Ribbon.—The lines of lamination.
Rock.—Gritty slate or slaty grits.
Rough slant.—The face of a bed on which there is a structure that may be ripple marks elongated by cleavage.
Slant.—The face of a bed.
Soles.—Horizontal joints, or joints at an angle below 20°.
Vein.—A bed.
The *Red ends* are nearly vertical, although one at the top of the quarry (or near the original surface of the ground) *hades* or *underlies* a little to the N.W., and at the bottom a little towards the S.E.; they are called red ends as they are stained with peroxide of iron, and often contain bunches and strings of galena and iron pyrites.

† What are here called shales, are argillaceous muds that were deposited in layers or laminæ, while a clay-rock was deposited in a mass without any lamination.

‡ Mr. Headech kindly furnished me with the following sizes and prices of the slates made:—

		£	s.	d.	
1*st Queens*,	27 to 42 inches long by various widths,	2	10	0	per ton.
2*nd* ,,	,, ,,	1	17	6	,,
Princesses,	24 inches long by 14 wide,	10	10	0	per thousand.
1*st Duchesses*,	24 ,, 12 ,,	9	10	0	,,
2*nd* ,,	22 ,, 11 ,,	7	0	0	,,
1*st Countesses*,	20 ,, 10 ,,	6	0	0	,,
2*nd* ,,	18 ,, 9 ,,	4	0	0	,,
Ladies,	16 ,, 8 ,,	3	0	0	,,
Doubles,	13 ,, 6½ ,,	1	10	0	,,
Mosses,	From 19 to 24 inches long by various widths,	6	0	0	,,
Quarters,	,, 15 ,, 18 ,, ,,	2	15	0	,,
Half-quarters,	,, 12 ,, 15 ,, ,,	1	5	0	,,
Commons,	,, 10 ,, 12 ,, ,,	0	8	0	,,

G. H. K.

Country West of the Shannon, beginning with the Neighbourhood of Tomgraney.—Dark blue argillaceous limestones, fetid when struck with the hammer, show themselves near Tomgraney. The beds have shale or clay partings between them. They dip N. and N.N.W. at angles varying from 5° to 15°, and belong to the lower part of the *Lower Limestone*. Towards the east they disappear under the *alluvial flat*, consisting of sandy marl, clay, and peat, that lies along the Scariff River and Scariff Bay.

Immediately under these limestones, extending from the west margin of the district to the alluvial flat just mentioned, are black and blue shales with beds of shaly limestone. They are well exposed immediately S. of Tomgraney, where they dip N.W. at 20°. These rocks are the upper part of the *Lower Limestone shale*.

Under the Lower Limestone shale is the *Old Red sandstone*, which is here well exposed, and consists of yellow and red sandstone grits and flags, with a few red and greenish shales, and one large bed of quartzose conglomerate. Immediately south of Tomgraney they dip N.N.W. at angles varying from 15° to 35°. Further east, in the vicinity of Raheen, they incline nearly north, at about 20°. At Raheen Bridge there are red flags that dip N. at 5°, and further S.W., along the same stream, are yellow and red grits and sandstones, that dip N.N.W. at about 25°.

About half a mile on the east of Raheen Bridge there is a massive quartzose conglomerate from ten to twenty feet thick, under and over which are red sandstones. This conglomerate can be traced towards the E., and in about another half mile it will be found lying on nearly horizontal red and gray Silurian shales, so that in this half mile the previously-mentioned beds that intervened between the conglomerate and the Silurian must have thinned out. From this to where the Old Red sandstone goes under Scariff Bay, about a mile further east, the conglomerate seems to be the lowest bed of the Old Red formation. It has a very calcareous base immediately N. of where the *ng* in *Bunglasha* is engraved on the one-inch map. From Raheen towards the W., these rocks all dip nearly N., generally at an angle of about 30°, although in a few places it is as high as 45°. Some of these rocks are marked with ice scratches, that have a bearing of N. 40° W.

The Old Red sandstone just described rests unconformably on the *Lower Silurian* rocks that occupy most of the rest of the space on the W. of Lough Derg, and north of Killaloe. It will be seen from the dip arrows on the map, that they incline irregularly in different directions, being twisted and folded in both sharp and gentle curves. Near the shore of Lough Derg, and on the south of Bunglasha, the rocks, which are principally fine conglomerates and massive green grits, form a synclinal curve, dipping S. at 30°, and nearly north at 60°. To the W. of this, and on the east slope of Cahir Mountain, similar rocks dip W. at from 50° to 70°, while immediately S.W. of the same hill they dip S.E. at about 45°, and farther S.W., in the vicinity of where the trigonometrical point 952 is engraved on the map, they dip N.W. at 60°. A little

more than a mile N.W. of this, at Knocknagower, there are green grits which form the peak of that hill, and are nearly perpendicular, as they dip S.E. at 75°. On the western slope of the hill they dip N.W. at 50°, while in the stream which divides the parishes of Tomgraney and Ogonnelloe, they are vertical, but have a similar strike to the rocks on the west slope of Knocknagower. Immediately south of where this stream joins the boundary between the Old Red and Silurian rocks, there is a large development of black shale, associated with which are beds of iron ore, which will be afterwards mentioned.

A mile south of Knocknagower there is an outlying patch of Old Red sandstone. The Silurian rocks on the north of this are nearly horizontal, but on the E. they dip W. and W.N.W. at about 60°. The Old Red consists of a coarse quartzose conglomerate, and about twelve or fifteen feet of yellow and red sandstone, which intervenes between the conglomerate and the Silurian rocks. The Old Red rocks are nearly horizontal, but have a slight dip to the N. To the S.W. of this outlier is the Cornagnoe Valley, in which grits, shales, and conglomerates of Silurian age are visible, and on the south of the valley are more Old Red rocks, which are part of the belt of that formation surrounding the Silurian country, but here extending toward the E. in a promontory over two miles long.*

Glennagalliagh, or Crag, and the Hills W. of Killaloe.—Craglea is the hill which rises from the shore of Lough Derg, a little N. of Killaloe; it is formed of conglomerates and green grits, with a few beds of slates, some of which have been worked. An imperfect cleavage also runs through the grits, but seldom or never affects the conglomerates.

This conglomerate seems to begin about four miles on the west of Broadford, in Sheet 133, where a few beds are found. From that they can be traced along the N. of Broadford to Cragnamurragh, on the W. margin of our present district, where they are well developed, forming the bold peak to that hill. From Cragnamurragh there seems to run two bands of conglomerate—one northward, round the valley of Annacarriga, forming Knocknagower, Caher Mountain, &c.; and from that across the Shannon into Castle Lough Demesne, from whence they extend until they are lost under the Old Red sandstone on the south of Youghal Bay. The other band runs E. from Cragnamurragh to Craglea, where the conglomerates are largely developed, and from thence through the hill immediately north of Tountinna to the Old Red sandstone. Although the conglomerates are best developed in the lines now mentioned, they are not confined to them, since other beds may be seen in the included space.

In the neighbourhood of Cragnamurragh, especially in the valley called Coumnagan, on the N.E. of that hill the conglomerates are soft and friable, and interstratified with clay rocks; similar beds will be found farther E. at the hamlet in Cornagnoe Valley. At Craglea the cleavage planes in the slates are vertical, and strike W. 25° N., while farther W., to the east of Glennagalliagh, they have a different strike, being nearly always E. and W.

The southern slopes of that part of Slieve Bernagh that we are now describing are covered with local drift and peat, but numerous sections are seen in the streams. The rocks, as will be seen by the arrows on the map, undulate in sharp, anticlinal, and synclinal curves, the axes of which usually run E. and W.

The Old Red sandstone S.W. of Killaloe.—Near the bottom of the south slopes of these hills the Old Red sandstone comes in. The boundary between the two formations can be easily traced, good junctions being seen in some of the mountain streams, except in the vicinity of Killaloe, where there is deep drift. The Old Red is different from that just described on the north of the hills, as there are no conglomerates found here, but thick beds of red and yellow clay rocks and shales, about thirty feet above the Silurian. The basal bed is usually a soft friable red sandstone that sometimes changes into a breccia, in which case it is often a hard rock. Partial sections of the Old Red are exposed in the streams called the Black, Ardcloony, and Ballyteige Rivers, but none of them are worthy of special notice.

The Ground near O'Brien's-bridge.—Immediately N. of Knockadrehid, which lies half a mile on the N.E. of the village of O'Brien's-bridge, there is a small patch of Lower limestone which is highly siliceous.*

Immediately to the S. of this limestone, in the cutting of the road, gray Silurian slates may be seen, and Silurian debris in the fields on each side of it. There must, therefore, be a fault running between these two rocks of sufficient magnitude to conceal the whole of the Old Red sandstone. It is almost directly in the line of the fault running from Silvermines to Birdhill. If this fault is followed towards the west, its throw is found to decrease considerably, as immediately N. of O'Brien's-bridge, it only brings down the higher beds of the Old Red sandstone against the lower; but farther west, at the margin of the district, it again increases in magnitude, as there the Old Red rocks on the north of the fault are lower than the Silurian on the south.

Six furlongs to the N.W. of O'Brien's-bridge are quarries in yellow and red grits and sandstones, from which good building stones can be raised.

At the west margin of the district, on the south of the fault, there are *Silurian* rocks, as just now mentioned, which are the eastern extremity of the mass of Silurians that form part of the Cratloe Mountains. Over these, lying unconformably, is the *Old Red sandstone*, which is only seen near the junction of the two rocks as the tract of ground that lies on the south of the fault, and to the W. of the Shannon, is covered with deep drift, principally composed of fine sand and gravel.

To the southward of Aughboy, the subjacent rock is supposed to be *limestone*, but it nowhere appears at the surface of the ground. G. H. K.

5. *The Drift.*—All the limestone districts are largely covered by irregular beds and accumulations of sand and gravel, the pebbles of which are chiefly limestone. Beds of yellowish clay are sometimes associated with these deposits. The distribution of these superficial materials is capricious, some parts being deeply covered with them, while in other parts they are absent. Where the surface of the limestone rises higher than usual, it is generally more or less completely uncovered. This limestone gravel runs, in some places, to a greater height on the flanks of the Old Red sandstone and Silurian hills than any part of that on the plain, and scattered blocks and fragments of it, are sometimes found at very considerable altitudes, and some miles from the limestone country. Mr. Wynne says of the glens on the western side of the Keeper district:—

"*Limestone Drift*, composed of gravel and pebbles, occurs both in the glen of the Doonane River and in Glencolloo; in the former it is in places heaped up into mounds, the largest and most remarkable of which occurs close to

* It is possible that the outlier just mentioned may be connected with this promontory by two narrow strips which at present are covered with Old Red debris. If so, there is a small island of Silurian rocks enclosed between two narrow necks of Old Red, neither of which could be more than thirty or forty feet wide, and as this ground is lower than that occupied by the Silurian, the Old Red must have been deposited round a peak of Silurian grit. This may have been the case, but I thought it advisable not to join the Old Red in one, as in neither of these narrow belts are there any rocks *in situ*.—G. H. K.

* The silica in this limestone makes it worthless for lime burning. It is quite different from the usual beds of the Lower limestone, like those N. and S. of Birdhill and at Tomgraney, but partakes very much of the nature of some of the beds at Ballynoe.—*See Mr. Wynne's description, p.* 19.

Doonane. It was not observed to be prominent in Ballyhourigan Glen, but great masses of it appear in the neighbourhood of Killoscully Village, and further up, in Glencolloo, small boulders of limestone washed out of it by the freshets, are in dry weather collected from the bed of the Mulkear River in considerable numbers to be burned for lime. Large accumulations of detrital matter, chiefly composed of a yellow and rusty-looking sandy clay are deposited upon the smooth sloping sides of the hills to the eastward of the Keeper Mountain, and these deposits, even at the height of about 1,100 feet, have been found to contain some small fragments of white weathered chert, in which minute casts of crinoid joints were perceived."

Of the drift near Nenagh he remarks :—

"In this neighbourhood the drift may be frequently seen becoming thin upon some of the hills. It is sometimes gravelly, but seems more generally to consist of the clayey coherent variety; and in some places at the N.E. corner of the district, the gravel assumes an esker-like form.

"The drift over this country is unequally spread. N.E. of Nenagh, upon the other side of the river, and upon both sides of it at Wellington House, and below Nenagh Bridge, the drift is composed of clay and limestone fragments, with some pieces of sandstone, syenite, and other rocks, and has apparently a very considerable thickness. Large syenite blocks,* and other boulders, are scattered over a good deal of drift-covered country, lying to the N. of Rockford and Ballyanny.

"The alluvial flats occupied by fine loamy or muddy deposits are frequently marshy or peaty, and these, together with the marshes, callows, and mosses, or bogs, will be found coloured of a pale orange upon the map. The bogs almost always contain fallen trees; and in one place near the eastern limits of the district, between Ballynaclogh Glebe House and Monaquill, parts of the skeleton of an Irish elk (*Megaceros Hibernicus*) were found in a small piece of marshy ground."†

Mr. Kinahan, when speaking of the country N. of Killaloe, says :—

"Between Cornagnoe Valley and Lough Derg is the semicircular valley of Annacarriga, in which there is deep drift that in places extends for a considerable distance up the slopes of the surrounding hills. It is principally made up of Silurian debris, although in some places limestone and Old Red fragments abound, while syenitic granite blocks are also met with, some of which are of considerable size. Several large blocks were broken up to build part of the demesne wall of Tinarana, and a block five feet long was remarked at the village of Annacarriga. Generally occupying the hollows in the drift, there are small lakes or bogs, in some of which the skulls of the Irish elk *Megaceros Hibernicus*, were found."‡

He observes of the drift on the opposite shore :—

"In the Castlelough Demesne there is deep drift in places full of fragments of limestone, and in the small bay immediately north of the house there are numerous large angular blocks of limestone, all of which are perforated with holes."

The bogs and alluvial flats of the district are not very numerous. The most important are those that environ the eastern foot of the Arra Mountains, from Youghal Bay down to O'Brien's-bridge. They spread near the latter

* These large blocks are composed of a syenitic granite, with large crystals of pink feldspar. They are evidently derived from the granite on the N. side of Galway Bay.—J. B. J.

† These were found by Mr. H. Head, who has built a residence not far from this place. Information supplied by Mr. W. Bayly.—A. B. W.

‡ I was informed by the Rev. Charles Mayne, rector of Kilmastulla, that in a small bog in the vicinity of Tinarana House, heads of the Megaceros were found by Mr. Purdon, of Tinarana, and along with them large quantities of what seemed to be hazel nuts.—G. H. K.

place on each side of the Shannon, and are connected with those which run so widely over the district in Sheet 144.

Mr. Kinahan remarks of the neighbourhood of O'Brien's-bridge :—

"Mr. Crowley, of Whitehill Cottage, found in the bog immediately S.W. of his house, a cow's skull in *undisturbed bog*. It had five feet of turf between it and the marl, and fifteen feet over it. He also found in the bog on the W. of his cottage, in *undisturbed bog*, a roll of butter, eighteen inches long and five wide, at a depth of ten feet, and having ten feet between it and the marl. When found it was quite like butter, and when seen by us it was dry and light, but if applied to a flame it burned with a bright light, and had the smell of rancid butter or oil. Through the mass were brown rootlets of plants, which gave it the appearance of the white peat of Valencia Island."

The connexion between great eskers or mounds of drift and large bogs is a frequent one in the centre of Ireland, though not invariable.

The accumulation of these mounds and ridges in the mouths of valleys, especially in those that form low and rather wide passes between detached groups of hills, is very remarkable. They seem to have been accumulated in the slack water caused by the meeting of opposing tides or currents, when the land stood at a lower level, and these passes formed "straits" between islands.

The mounds in the valley of Kilmastulla, which commence insensibly on the slopes of the hills on each side, but end in steep slopes towards the valley of 100 feet or so in height, are good examples of their mode of occurrence, and cannot fail to strike the eye of a traveller from the peculiarity of their forms.

Other excellent instances occur in neighbouring districts, as near Broadford on the west side of Slieve Bernagh, in Sheet 133, and near Roscrea, in Sheet 126, descriptions of which will appear in further Explanations.

The blocks of Galway granite, many of them as much as two feet in diameter, which are scattered here and there over the plains, and sometimes on the flanks of the hills, prove the currents of the glacial sea to have had a southerly set, and like the seas of Labrador and Newfoundland, at the present day, to have sometimes drifted down block-loaded icebergs from north to south. These currents would, near the shores of the islands, of course, have their directions locally modified, and eddies caused in them, owing to differences in the outlines of the coast or in the form of the sea bottom.

J. B. J.

6. *Mines.*

The principal mines occurring within the limits of the district included in Sheet 134, are those of the Silvermines locality. Besides these there are some other detached mining localities among the Slievekimalta or Keeper Mountains, and mines have also been worked at the N. and N.W. sides of the Arra Mountains; and in the north-western corner of the district, upon the slopes of the spur from the Slieve Bernagh Mountains, which adjoins the low ground in that neighbourhood.

The Silvermines District.—The Silvermines mining district* extends along the northern slope of the ridge which rises between Glencolloo and the plains of Ormond. It is about five miles long from E. to W.

The excavations have been made at different heights above the level of the sea, the most important of those in the eastern part of the district

* See a short notice of this district in the "Journal of the Geological Society of Dublin," vol. viii., part 3, page 244, where other notices of the same are referred to. [Since that paper was read some additional facts have come to light, altering slightly the interpretation of the geological features of the district.]—A. B. W.

having an average height of about 550 feet, declining, however, to the westward, to an average height at the base of the ridge of about 270 feet; but in this vicinity, and S.S.W. of Shallee cross-roads, there are some workings at an elevation of 900 feet; and higher still, near the very crest of the ridge, due S. of the cross-roads and overlooking Glencolloo, mining operations have recently been commenced at a height of 1,300 feet.*

The mineral deposits occur in fissures and faults, which lie either wholly in the Old Red sandstone or between the Old Red sandstone and the Carboniferous limestone, or between that and the Silurian rocks, according as these different rocks are brought into juxtaposition by the dislocations. Those veins contained by the Old Red sandstone consist, without exception, so far as is at present known, of argentiferous galena in a gangue of sulphate of baryta; but such as are situated at the junction of two different kinds of rock are composed of argentiferous lead ore, copper ore, iron pyrites (or sulphur ore), and blende, unequally and indiscriminately mixed and contained in a gangue which does not consist so largely of sulphate of baryta, but is more frequently composed of a siliceous breccia, enclosing fragments of fine sandstone, and full of veins of compact white quartz.

For the sake of convenience, it will be perhaps well to consider each group of workings separately, giving to them the names by which the miners know them, and wherever possible tracing the connexion which may exist between them. These groups or subdivisions of the district will then be as follows:—"*Shallee Western Stopes*," "*Lackagh Stopes*," "*Shallee East Stopes*," with some small intermediate works; "*Gorteenadiha*," or as it is more generally called "*Gortnadine Mine*," "*Knickeen*," "*Ballynoe Mine*," "*Ballygowan*" or "*Knockeenroe Mines*," including the Sulphur and Calamine Mine near Silvermines Village, and some other outlying localities.

Shallee West.—These "*stopes*," † fourteen in number, are situated in the townland of Shallee (White), at a considerable elevation on the mountain side, and their "*burrows*" may be seen from many places in the plain beneath. They are long narrow excavations, running straight up the hill, some of them over eighty yards in length, and having an average depth of about five fathoms, with a width of from three to six feet. They lie nearly parallel to each other at distances from ten to twenty yards apart, and have all been made at "*daylight*" (or the surface of the ground), following the course of several small lodes or veins of galena, which had an average width of eight inches.

The direction of these veins is at right angles to the general contour of the hill, their strike being usually 30° W. of N. and E. of S., or varying a few degrees more toward the N. Some of them, however, and those among the lowest on the hill side turned to the W., having a direction frequently similar to that of veins of barytes in their neighbourhood, of from 20° to 30° N. of W. and S. of E. From the inclinations of the sides of a few of these lower excavations, it is inferred that the veins which partly occupied them must have "*haded*" or underlain, in some towards the north and east, and in others towards the west, at angles which appear to have been as high as 50° or 60°, but more frequently the sides of the "*stopes*" or cuttings are vertical.

The run of the "*stopes*" in some places ends abruptly or changes, or is slightly shifted to one side, but continues then in the usual direction as if the veins had been "*checked*" by small faults.

* When visited in the years 1859 and '60, these mines were worked by the General Mining Company for Ireland, and many of the facts which are here recorded were communicated in the most obliging manner by that Company's local agent and able manager, Captain Thomas King, who called attention to many things which must otherwise have escaped notice.—A. B. W.

† See Glossary at end.

Although most of the vein stuff has been removed, that of some small ones can still be observed closely united to the containing rock, through which occasionally some lead seems to be disseminated in the vicinity of the veins, and it is stated that their walls here were not well defined.*

The matrix or *gangue* of the ore, as usual in the sandstone, is heavy spar (sulphate of baryta), of a whitish gray or brownish tinge, generally opaque or semi-transparent; and the galena associated with it is argentiferous, containing from fifty to fifty-five ounces of silver to the ton of lead, of which latter the ore contains sixty-six per cent., the remainder being chiefly sulphate of baryta.†

The Lackagh Stopes are those situated at the northern extremity of the townland of that name, S.S.E. of the locality last alluded to, and near the crest of the ridge, where some nearly vertical veins of heavy spar traversing thick beds of sandstone—similar to those containing the veins just now described—in directions varying from 15° N. of W. and S. of E. to 25° W. of N. and E. of S., were found to have associated with them a considerable quantity of argentiferous galena, which was obtained by quarrying in the sandstone and driving a short level northwards along one of the veins. The metalliferous part of the deposit seemed to be here irregularly distributed through the matrix, but in some places small *ribs* of galena were observed in the centre of the veins of baryta, and small crystals of pyrites were found scattered through the ore which affords seventy per cent. of metal, and is assumed‡ to contain fifty ounces of silver to the ton of lead.§

Between Shallee East and Shallee West, where an intended new line of road crosses the boundary between the two townlands, some other veins of baryta were exposed in making a cutting for this road, and were found to contain galena also. Four excavations have been made along them similar in character to those described when writing about Shallee West, except that one nearly parallel to the boundary, and about fifty yards to the east of it, instead of having been worked at *daylight* throughout its course, runs for a distance of about twenty-five fathoms at its southern end under ground, ascending the hill in a direction nearly parallel to its surface, and coinciding with the dip of the beds of the containing sandstone, which is here at an angle of about 15° to the N., one of the beds forming its floor for some distance. None of these excavations were deep, and the ore taken from them was similar to that of Shallee West.

Another vein of spar (sulphate of baryta), containing lead ore, occurs crossing the unfinished road eastward of these, and a little more than half way between them and the workings known by the name of Shallee East. It is quite similar in character to those last mentioned.

Shallee Eastern Stopes.—The veins at the S. side of this group of *stopes* were discovered also by means of the cuttings for the new line of road which was intended to facilitate the ascent of Shallee Hill, and nearly coincided with Cromwell's old Road.

The whole group of workings which are situated near Shallee cross-roads are the most extensive and important excavations in the western part of the district. Not less than forty small veins of argentiferous galena, associated with a trace of copper and some iron pyrites, existed here, and some which do not exceed a few inches in width are still being actively worked. The excavations partake most strongly of the characters of those already described, but

* The peculiar colour of the containing rock here, and the circumstance of its having small disseminated particles of galena in it, has been already noticed, page 17. As it would be impossible to mark all these and the other stopes on the one-inch map, owing to its small scale, their general position only is indicated by the gold lines near to and north of the word ARRA.

† The market value of this ore in 1858, was about £18 4*s.* per ton.

‡ By Captain King. § Value about £18 to £20 per ton (Captain King).

are in some respects dissimilar. Seventeen open *stopes* may be counted above ground, never more than about fifteen yards asunder, having a general direction from 10° to 20° N. of W., and being, like the others, worked upon veins which were vertical or nearly so; while under ground the intervening walls of sandstone rock have been in many places removed, leaving large cavern-like spaces covered in by the horizontal or slightly inclined beds of the sandstone, which is so strong and tough as to support itself for considerable distances without props, even though consisting of many superincumbent beds. From these excavations the lead ore is brought up to the surface by shafts, the deepest of which was sunk forty fathoms.

Where breaks occur in the rock-walls of some of the *stopes* near Captain King's house, at Shallee East, small veins branched off and connected the adjoining lodes. And this circumstance, on a much reduced scale, is sometimes observed in the working of the veins where the faces of joints in the rock cross their direction, and are found to be coated with a film of galena.

The veins are not quite straight, but maintain a general parallelism, which in some places is even more regular than it was here.

The gangue of the veins at this place is chiefly quartz and sulphate of baryta, but the latter is much more scarce than in the localities to the westward; while in some places there is, properly speaking, no gangue at all. The ore contains 72 per cent. of lead, which affords from 45 to 50 oz. of silver to the ton.*

All these veins† occupy separations in the rock; but one of them seems to have occupied a N. and S. fault which brings a quantity of black shales lying to the W. against the sandstone, for an adit running from it to the S.W. obliquely across the lines of bedding and direction of the veins passed for some distance through nothing but these dark shales.‡

A few yards to the N. of this somewhat isolated group of workings, running nearly E.N.E. and W.S.W., and underlying at a steep angle to the north, two small lodes,§ one consisting of iron pyrites and the other of galena, were cut by a driving to the S., made from the bottom of a shaft which was sunk to the depth of fifteen fathoms, at the corner of Captain King's garden.

The containing rock in all this East Shallee neighbourhood is the same as that of the localities hitherto described, namely, pale and bluish-gray very quartzose sandstone underlying some beds of black shale. The limestone is found underground, within a distance of a few feet to the northward of the last-mentioned lodes, appearing, from description, to abut against the sandstone, and it is associated with black shaly beds containing fossils.

Gortnadine Mine, perhaps the most important and certainly the largest single excavation in the district, is situated beside the stream which flows down Gowlaun Glen, passing underneath the Barony Bridge, about a quarter of a mile to the E. of the group of workings last alluded to. There is here a great ill-defined brecciated *ramp* or lode, which is uneven in its course, but has a

* Value of this ore about £19 10*s.* 10*d.* per ton (Captain King).

† As all these nearly parallel veins contain the same metalliferous deposits, and not in the form of brecciated lodes, while those to the east, with a different general direction, have a mixed and brecciated character, there is a strong probability that they were formed at different times.

‡ The occurrence of close parallel systems of mineral veins being somewhat peculiar, it may be mentioned that a similar arrangement of nearly vertical, parallel, north and south veins, some of the same small thickness as those found here, and also containing argentiferous galena, will be found recorded in the *Quarterly Journal of the Geological Society* (of London), vol. xvi., part 4, No. 64, page 424, in a Paper upon the Breadalbane Mines, by C. H. Gustav Thost, Esq.; but those veins are stated to occur in a horizontal calcareous stratum overlying mica schist.

§ Which may possibly be in continuation with that at Gortenadine, as although they do not quite coincide in direction or contents, they hade in the same way, and at an equally high angle.

general bearing of 15° S. of E. Its width varies greatly, being in some places as much as forty feet, and in others much less; but twenty-four feet is about its average breadth. The lode is chiefly remarkable for its size and its mixed and indefinite character. It has been traced for a distance of at least half a mile,* and wherever proved was found to contain both lead and copper, with a small quantity of iron pyrites. The lead occurs chiefly as argentiferous galena (sulphide of lead containing silver), and the copper is almost entirely yellow pyrites (sulphide of copper and iron). Some cat-tooth ore (*acicular* crystals of white carbonate of lead),† is also occasionally found in cavities within the *gangue* or other ore.

The *gangue* of this lode possesses everywhere a marked similarity of appearance, and is found to consist of a hard quartzose *breccia*, containing sulphate of baryta and patches of gray sandstone of different kinds; but it must here be stated that the limits of the lode, in a north and south direction, are frequently not at all well defined, and what was shown as its north wall in some places under ground was found to consist of the same kind of sandstone as that to the south. This might result either from irregularity in the course of the fracture; from its containing a mass of sandstone; from the existence of more fractures than one; or complications of one fracture; or from abrupt undulations occurring in the beds along the N. side of the fault, which is clearly proved, in more places than one, to coincide with the run of the *ramp* or *lode*. The south wall of this lode is more regular than that to the north, and from its inclination the underlie of the lode is assumed to be toward the N. at an angle of 80°.‡

A small excavation which was driven through sandstones, more or less impregnated with mineral or metalliferous substances into the lode 200 yards W. of the floors and water-wheel, exposes something like a junction between the lode and its north wall; but this is remarkably obscure, although the bedding of the sandstone may be plainly seen, and a feature in the ground N. of this parallel to the run of the lode, suggests the idea that the sandstone seen here may be in the fault itself, and not on its northern side.

Between this place and the engine-house the lode was worked by means of a large *open cast*, showing that it must have had a considerable width, and that a line of fault coincided with it at this place, for different beds are seen at opposite sides of the opening. From the *open cast* drivings were made to the east, west, and south, and shafts were sunk beneath it; but the chief mining operations have long since been transferred to the part of the lode immediately eastward, where the excavations now known as the Gortnadine Mines are situated.

The width of the lode here varied from thirty to forty feet, and its contents have been removed in many parts of the mine for vertical spaces of forty and fifty feet. A long gallery or level, at the depth of eighteen fathoms from the surface, runs horizontally along the course of the lode, for a distance of about 500 feet, having a height varying from twenty to fifty feet, and a width chang-

* If this be the same lode which is worked at other places between this locality and Silvermines, as a general similarity of appearance would seem to indicate, it must have a length, although perhaps not a continuous one, of not less than two miles.

† This combination is supposed to result from the decomposition of galena.

‡ When I went over this ground with Mr. Wynne, I had no difficulty in recognising the existence of one great east and west fault, with a downthrow to the north, not differing in character from any other faults. Most large dislocations are complicated; they both undulate in some places and divide into branches, often again uniting, and have more or fewer cross fractures diverging from them at right angles. When a large fault traverses inclined and undulating beds, it of course cuts through, now one and now another part of the beds; and if this occurs near the boundary of one or two formations, these parts will belong sometimes to the one and sometimes to the other. This necessarily produces much complication in the mining details of such a locality.—J. B. J.

ing as the lode did, from thirty-five to twenty feet. Out of the whole of this spacious excavation, the lode which once occupied it has been almost entirely removed, but at the east end of the level it may still be seen; and when visited in 1859, operations were being carried on upon some bunches of ore at the S. side of the excavation. This long gallery is not straight, for it followed the lode which was *warped*, or curved to the N., nearly underneath the whinze-shaft, but from that point gradually recovered its original direction. Near the bottom of the whinze-shaft, too, another gallery leaves the main one bearing towards the N.N.E. It was excavated upon a branch lode, containing a large lenticular deposit of galena (surrounded by black shale), which was eight fathoms long, twenty-four feet wide, and from nine to ten feet or more in height.* Between this lode and the main one, a mass of hard quartzose sandstone intervenes, the bedding of which is very obscure.

These galleries or excavations appear to be nearly vertical, but the lode which occupied the main one had an underlie of 10°, equivalent to a dip of 80° to the N. The hade of the other could not be ascertained.

Several shafts communicate with the long underground excavation, one of which was sunk to a depth of twenty-two and a-half fathoms, being almost the deepest sinking in any of these mines.

The lead ore of this mine contains from sixty-eight to seventy per cent. of metal, including from twenty to twenty-five ounces of silver to the ton of lead.†

Near Gortnadine Mine, in a N.E. direction, are a number of Old Men's Workings, which appear to have been sunk through the dolomite and the Lower Limestone shale beneath it, for fragments of these rocks, as well as some black and white striped sandstone are found in the *burrows* at the mouths of the old shafts. These workings are reported to have been very productive of the cat-tooth lead ore, and lumps of ochreous *gossan*, containing calamine, were found in some of the burrows.

A line of such old shafts, extending in a direction of about 15° S. of E. from Gortnadine Mines, and for a distance of about half a-mile, having at their mouths heaps of weathered black shale, marks the occurrence of this rock, between the limestone to the N. and the brecciated lode of Gortnadine, and suggests the probable continuity of the metalliferous deposit along here.

About 500 yards E. by S. of the mine are some reservoirs, from which water is supplied to the wheels at Gortnadine and Shallee. Along their south side the Gortnadine *ramp* appears above ground, and it has been opened into between this place and the Engine-house chimney, but its width is much less here than at Gortnadine Mine.

It was found necessary to clean out the most easterly of these ponds a short time ago, and in the course of this operation a bed of gossan, containing calamine, was observed showing itself at the surface, for a width of fifteen feet.

Eastward of the ponds and close to the boundary between the townlands of Gortnadine and Garryard, West, is situated what is called the Boundary shaft. It appears to have been sunk upon the extension of the Gortnadine lode, and to a depth of about two fathoms. Drivings were then carried eastward for twelve fathoms, where the lode was sixteen feet wide, and westward for two fathoms, upon a rich vein of galena which, at a depth of eleven fathoms, was cut out by or ended abruptly downwards upon a flat shaly floor. Underneath this, at a depth of eighteen feet below it, the *gangue* again contained some lead, but only for a width of six or eight inches. The lode at this place contains both lead and copper, and inclines to the N. at an angle of 70°. The productive part of it having been removed, the works were relinquished, and are now full of water.

* Captain King.

† Market value, £15 per ton. The copper ore fetches on an average £6 per ton.

Almost continuous with the Gortnadine old workings, and in the same general direction of 15° S. of E., the remains of others may be traced extending into the townland of Garryard, West, and lying to the northward of a rather marked feature of the ground, along which the Gortnadine lode is supposed to run, and where a line of fault coinciding with it is believed to exist. The place of these workings is marked upon the Ordnance Map by the name *Silvermines*, and they are reported by the miners to have been productive lead workings. The debris at the mouths of the old shafts consists principally of dolomite, shale and cherty fragments, and in the ditches near the place shaly and cherty dolomite is seen *in situ*, as well as elsewhere in the neighbourhood—(see *ante*, page 20), from which it is argued that this was the containing rock.

About 430 yards S. of Garryard House, near this locality, there is a slated cottage, at the mouth of a steep ravine, inhabited by Mr. Mullins, clerk, or assistant to the local agent of the mines; and close to the cottage, in the right bank of the stream which runs down the ravine, the cherty dolomite rock seems to be decomposed nearly *in situ*, and the disintegrated rock contains small bands or veins of a black tenaceous clay, which is not unusually heavy, but nevertheless when treated with fluxes, was stated by Captain King to afford fifteen per cent. of lead. Before the blow-pipe it gives off water and sulphurous fumes, and finally fuses into a vitreous globule, tinged with a leaden hue when borax and nitre are used.

Opposite to the cottage an adit, which empties itself into the stream, was driven backwards from this place, first to the south, and then more towards the west, chiefly through soft ground; but in the latter part of its course, about six fathoms into the sandstone, where it unwatered what is now called the Dry shaft, situated S.E. of the Boundary shaft. This adit rises slightly towards the hill, but is fourteen fathoms below the surface at the shaft; and although it appears to have crossed the run of the Gortnadine *ramp*, and that of the lode found at the Boundary shaft, no lode was met with in its course.

Proceeding up the course of the stream, into which this adit discharges itself, until a point is reached, which bears nearly 25° S. of E. from Gortnadine Mine, a faulted junction between the sandstone and some black shaly beds occurs, and a short driving was made into the sandstone, which is here brecciated, and contains a quantity of sulphur ore (pyrites). The shales have an undulating dip to the N. at 35°, and seem to be a good deal mineralized, containing pyrites and weathering red, as if hematitic.

About 100 yards E. of the place where this junction is seen, there is a piece of waste ground dotted with the *burrows* of more old workings, which are called on the Ordnance Map "Old Lead Mines;" white-lead ore is reported to have been raised here at a very remote period. These workings are situated on the north side of the supposed run of the fault figured above, and are probably those alluded to in Dr. Boate's book. Southward of these old workings, and 200 yards distant from them, on the slope of the hill, an excavation has been made, in white and gray flaggy and strong sandstone, streaked with fine layers of pyrites and hematite, upon a brecciated lode which appeared to strike W. 35° N., and contains both galena and pyrites.

Ballynoe.—To the eastward of the localities last described in the townland of Gortshanroe, the ground seems to have been a good deal disturbed, and both the succession and the continuation of the beds has been interrupted by a fault or faults, in direct connexion with which depositions of metal sometimes occur.

The principal of these is called Ballynoe Mine,* and is situated between the

* Near Knockeen or Ballynoe, a mass of gray sulphate of baryta, &c. (see *ante*, p. 19), occurs in the limestone, from which the specimen was taken alluded to in a paper by Monsieur A. Gages, which will be found in the Journal of the Geological Society, Dublin, vol. viii., part 3, page 243.

stream which passes by Dunalley Castle, and that immediately to the west. A large irregular pit has been sunk here to the depth of eighty feet, and excavations have been carried from it fifty feet westward, to remove a great bunch of copper ore out of the containing dolomite rock, which is brought against the Silurian by the fault.*

These are, perhaps, the workings alluded to by Mr. Weaver, in the Geological Society of London's Transactions, first series, vol. v., page 242, where he speaks of "superficial works between Knockeenroe and Gortnadine;" but this supposition must be received with caution, as there are other old works not far away.

Knockeen.—In the stream-course within 200 yards W. of Ballynoe Mine, the sandstone and some black shales are seen almost in junction. The former is brecciated and contains a quantity of iron pyrites, but whether in the form of a lode or not, from the small amount of evidence the place affords, it is difficult to say. Trials have been made upon beds in the limestone containing a quantity of pyrites, along both the streams which flow northwards from Ballynoe, but they were never carried to any great extent and are now abandoned.†

Some shafts have been sunk on the hill-side, too, in the Silurian slates S. of this locality, and it is conjectured that these are upon some of the "three other veins" mentioned by Weaver, in the paper alluded to already, where he says, "they are nearly parallel to each other but of less dimensions than the last (? Ballynoe), being only from two to three feet wide." * * * "These veins also consist of quartz, galena, heavy spar, blende, and pyrites." Wherever any fragments of ore are lying about the mouths of these pits they are found to contain galena, and heavy spar is commonly the matrix, so that it is probable this conjecture is correct.

About 900 yards N.E. of Ballynoe, some old shafts were sunk in a hollow of the ground near a rath, but what was found in them is not known. East by south of this rath, at a distance from it of about 250 yards, a junction between the Silurian and the dolomitic limestone is effected by means of a fault. No particular lode appears, yet indications of lead ore accompanying heavy spar were observed to occur in the dolomite.

Ballygown or Knockeenroe mining locality, lies in the vicinity of a small plantation of fir trees between Silvermines village and the steeper part of the hill to the south; it bears E. by N. from the faulted junction last mentioned. The extent of the operations carried on here in former times, may be estimated from the size of the excavations and the quantity of debris above ground, as well as from the extraordinary number of levels, winzes, and passages which, ramifying in all directions through the *country* under ground, have been discovered and re-opened within an area of several acres in the course of operations now in progress (1859).

Intersecting the fir plantation, and running thence along the southern end of the townland of Cloonanagh towards Gortshanroe, with an average direction 15° N. of E. and S. of W., will be found a great brecciated sulphur lode or *ramp* which appears to be nearly vertical, but is stated to incline at a high angle northwards. One shaft which has been sunk upon it within the wood is now open (1860), and here at the depth of twenty-four feet the lode is said to be thirty feet wide, while fifty feet further down its width increases to forty-eight feet. Its N. and S. walls are very irregular, that on the S. where the lode is said to gain most being composed of sulphur rock (*i.e.*, quartzose sandstone of the Old Red period containing a quantity of pyrites), and that on the N. of dolomite and black *flookan* (soft shale), which also contains veins of sulphur ore. At this place sulphur ore, galena, and blende are raised, but the sulphur or iron pyrites greatly predominates.

* The value of the copper ore of this place is averaged at £9 per ton.
† 1859.

This is the "powerful vein" mentioned by Weaver, in the "Transactions of the Geological Society, London," vol. v., page 242, and described by him as "consisting at the surface principally of quartz and iron pyrites, with some heavy spar, galena, and blende."

Above ground it has been almost entirely removed wherever it was productive, but for a length of sixty fathoms its S. wall is exposed in the plantation, above alluded to, where it is singular to observe how, like the lode at Gortnadine, it seems incorporated and blended with the sandstone; and here, too, lines very much resembling undulating, nearly vertical, bedding, may be distinguished among the numerous other separations arising from joints and artificial fractures.

This similarity to the lodes of other places along the apparent line of E. and W. fracture, is increased by the circumstance that they are everywhere brecciated lodes; and although it might be difficult to conceive of one fracture admitting of such flexures, it is still probable that the same line of fractures does continue right across the whole district under consideration; the places where its continuity seems doubtful, as at Ballynoe, and eastward of this sulphur mine open cast, in the townland of Ballygown, being probably affected by cross fractures shifting the main fault and its contained lode.

Underground beneath the place, immediately at the E. end of the fir wood, the sulphur lode was observed at the extremity of a level leading from the West-whinze or Rock-gate shaft southwards, and at a depth of about twenty-five fathoms from the surface. Its strike was here nearly E. and W., and it presented a smooth slickenside surface, hading N. at an angle of 75°, in junction with beds of dolomitized limestone and black shale, which dip in the same direction at an angle of about 15°.

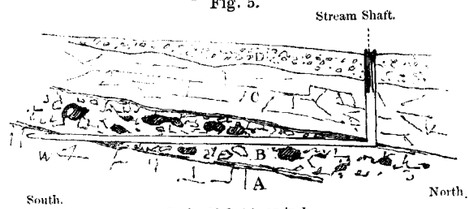
Further to the E. a very similar kind of junction takes place between the sulphur lode and the carboniferous rocks, by means of which and the surface exposures, the sulphur lode has been traced in the curved direction shown in the map.

Where this lode intersects the river the last of these exposures occurs, and it has not been traced or seen further, but probably does extend somewhere to the S. of E. for a fault is believed here to break off the continuity of the Old Red sandstone, as already stated, page 20.

Indications of the existence of a cross fault running N. and S. near this place, hading to the W. at a high angle, and against which the gossan deposit terminates to the E. have been observed, as stated in the detailed descriptions, page 19.

A few yards to the N. of the places last described, and eastward of a remarkable square group of buildings, where the Mining Company have an office, a number of old shafts are situated, sunk for the most part through

Fig. 5.



Scale, 80 feet to an inch.

Diagrammatic Section of Shaft and Level, Stream Shaft, Silvermines.

A. Magnesian Limestone. B. Gossan and Calamine Bed. C. Magnesian Limestone. D. Mining debris, &c.

mining and clayey debris or gossan; but in some instances through beds of very hard crystalline dolomite, containing a great irregular, and apparently more or less interstratified deposit of a very rusty decomposed ochreous gossan (peroxide of iron), which has frequently been found washed into, so as to choke and fill up, many of the *Old Men's Workings*.

This gossan bed is associated with ordinary dark gray fossiliferous magnesian limestone, and it frequently contains great irregular rounded or subangular masses of magnesian limestone, which sometimes appear to lie in planes parallel to the stratification of the adjacent limestone. It is seen in some places underground passing beneath a sloping roof of the magnesian limestone, and in others lying upon a similarly sloping floor, which gives to the whole bed a presumed dip of about 10° to the N. The place occupied by this gossan does not seem to lie anywhere in this immediate locality below the reach of shafts of twenty-five fathoms deep, and it has been seen in one place coming nearly to the surface, but its taking cover to the north would lead it so deeply below this, that a shaft of fifty fathoms would, according to Captain King's calculation, be required to reach it under Silvermines village, supposing it to extend so far. All the ground contained in the angle between the sulphur lode and the supposed N. and S. cross fault, is so penetrated by a labyrinth of winding levels, whinzes, and sometimes spacious excavations, that it may well be compared to a large rabbit burrow; and these excavations display a good deal of the internal structure of the deposit, which shows many irregular and lenticular appearances of stratification.

As well as the numerous included masses of magnesian limestone, which have been noticed, the excavation which is now being made (1860) for a straight under-ground railway from the engine-shaft southward, exhibits alternations of gossan and the containing rock, which (although the stratification is obscure) may be accounted for by the existence of undulations in the bedding, or by irregularities in the boundaries of the deposit.

The thickness of this gossan bed is from four to perhaps thirteen fathoms in different parts of the workings, and taking into consideration the area (some fifteen acres), which it has been proved to occupy, its quantity must be very great. It contains a variety of minerals. Beside the peroxide of iron, of which it so largely consists, it is estimated that fifty per cent. of it is formed of the carbonate and silicates of zinc,* and some specimens of blende have been found. Argentiferous galena also occurs in it in small crystalline lumps, and binoxide of manganese appears in filiform veins and botryoidal incrustations. An impure variety of cat-tooth ore (carbonate of lead), and a fibrous or stalactitic oxide of iron, like decaying wood, are also found; but besides these there are probably numerous other minerals.

The works now carried on here are chiefly for the purpose of procuring the zinc ores from the gossan. They have, doubtless, been considerably extended since the district was examined in 1859.

Many smooth slickensides may be observed running through the deposit, often curved and inclined in different directions, and efflorescences of different minerals appear here and there on the sides of the older passages.

The junctions between this deposit and the sulphur lode, as well as with

* Zinc ore is not mentioned as existing in this locality, in any of the notices which have been met with, prior to that of Professor Apjohn, and its discovery here took place in February, 1858, through the instrumentality of Captain King, who had observed and called attention to the gossan for some four years previously. His idea was that it was "on the back" of a great lode of some kind, but observing in it a whitish. nearly transparent crystalline mineral, with a more compact kind occurring in veins, pipes, and hollow concretions, and sometimes appearing to cement together portions of the gossan, he forwarded specimens to Dublin in the year 1858, which were sent to Doctor Apjohn, Professor of Chemistry, T.C.D., who discovered it to be electric calamine (silicate of zinc), and read a paper on it, which will be found in the "Journal of the Geological Society of Dublin," vol. viii., part 2, page 157.—A. B. W.

the shaly rock seen where the river broke into the mines on the E., have shown it in each case to terminate abruptly, and with little if any apparent connexion with the adjacent mineral deposits, and the only visible geological relation between the sulphur lode, or the fault which it occupies, and this calamine deposit and the Carboniferous limestone is, that the dark shaly calcareous and gossan beds seem to rise a little towards the fault, a fact frequently observed on the downthrow side of such fractures. In some places a quantity of black crushed shale, flookan, or killas is said to intervene on the N. side of the sulphur lode, between it and the calcareous gossan-bearing rocks, but in others they meet closely together, the sulphur lode having at such a junction a smooth slickenside surface, dipping N., or else being nearly vertical.

Notwithstanding these deposits being thus distinct, there may be some connexion between the occurrence of gossan, &c., and the contiguous fractures or their contents. The sulphur ramp, however, presents all the appearance of an original metallic vein, while the other seems to have undergone, and to be still undergoing chemical changes in the arrangement of its parts depending upon the association of the numerous different mineral materials, infiltration, &c., &c.*

In Sir Richard Griffith's List of Mining Localities in Ireland, lead and copper, both argentiferous, are said to exist in the townland of Garryard, East, but all inquiries have failed to ascertain the place of the deposit, and it is not known to Captain King, who looked for, but could find no trace of it.

Other Localities.—The principal mining localities in this part of the district have been described above; but mining operations have been carried on, or metalliferous indications observed in some other places, which will now be pointed out.

A quarter of a mile to the E. of the Calamine mine (directly south of where the *g* in Silvermines Cottage is engraved on the map, and W. by S. of an enclosure which once contained a small wood), two or three pits or shafts were sunk in the townland of Cooleen, and some lead ore was obtained from them which was not, however, in sufficient quantity to be of any commercial value.

Half a mile S.E. of these, along a stream on the outskirts of a large irregularly shaped wood, and in the townland of Lahid, some trials, called Moorhead's pits, were made with a view to finding the continuation of the sulphur lode of Silvermines; but nothing appears to have been found.

A mile further on in the same direction, upon the top of a rising ground overlooking the large wood alluded to above, and close to the boundary between the townlands of Mucklin and Lisnageenly, but in the last-named townland another trial pit was sunk to the depth of three fathoms upon an E. and W. vein of galena, which has not been considered sufficiently profitable to continue working. Further on still, in nearly the same direction, and above the village of Mucklin, another unsuccessful trial seems to have been made.

The next locality in the Silurian rocks, like the three last, but lying at a considerable distance S.W. of the others, is situated on the northern brow of Keeper Mountain, close to its cap of Old Red sandstone, near where two streams rise, which separating from each other, embrace an eminence at the base of the mountain, the elevation of which is marked as 792 feet. Some

* What the object was of the numerous Old Men's Workings which are continually met with in the process of clearing out some of these levels, and carrying new ones through the ground or "country" here, is difficult to guess, for in places, particularly where the carbonate of zinc predominates, the labour of breaking is considerable; the value of the zinc ores was then in all probability unknown, and the quantity of argentiferous galena to be found, if as scarce as it is at present, could hardly have repaid the trouble of making such numerous excavations, although we must bear in mind that some lumps of the latter have been found containing 80 oz. of silver to the ton of galena.
A. B. W.

shaly beds here contain a good deal of iron pyrites, and by the most westerly of the two streams, a working has been recently commenced (1859) upon a vein (or perhaps a bed), containing this substance, which strikes 40° E. of N.

Goldmines.—Another mining locality in Glencolloo is at Goldmines. The workings are now closed, but considerable traces of former excavations remain. Two veins of copper ore are stated to cross each other obliquely here. The nearest approximation to their direction which could be ascertained was, that one of them ran about N. 20° W., and a short driving into the hills which was said to have followed the vein as far as it went ran in a direction of about S. 20° W., underlying to the W. at an angle of about 80°.

Another shaft was observed near, but above where the roadway crosses the stream in Ballyhourigan Glen to the S.W. It is situated close by the bank of the stream, and is stated to have been sunk upon a rich lode of copper ore. This lode may possibly have some connexion with the metalliferous veins at Goldmines, but unfortunately no further evidence concerning it could be obtained.

A table will be found at the end showing the number and value of the ores of the Silvermines district. A. B. W.

Garrykennedy Mine.—Due north of Portroe, at the margin of this district, there is a vein containing lead ore (*galena and white lead ore*), associated with calc spar and quartz. The rocks in the vicinity are coarse grits, or fine conglomerate and shales, the vein thickening in the shales where *bunches* of ore were "got," but being only a few inches wide in the grits or conglomerates. About five or six years ago, when the last trials were made, while driving along the vein towards the east, they came on *Old Men's Workings* that had previously been unknown, in which they discovered lying on a heap of stones, a human skeleton, from whence it has since been known by the name of the "*Dead Man's Drift.*" None of the workings, either by the *Old Men* or the last explorers, were carried deeper than thirteen fathoms.*

This lode is remarkable, as it occupies a reversed fault, which bears nearly E. and W., and hades S. at 60°, having an upthrow to the S. of nearly two feet. This fault is well exposed in a mine hole, immediately N. of where the plantation joins the road; the rocks at this place dip S., those immediately N. of the fault at 25°, and those on the S. at 20°; but the latter, for about two feet in width from the fault, have an inclination towards the downthrow.

Other Localities.—All the Silurian rocks in the vicinity of Garrykennedy Mine have traces of lead ore in small fissures and veins that traverse the rocks in various directions, and numerous pits and open casts have been made, but no other regular lode was discovered.

At Mr. Headech's slate quarries, on the south of Portroe, strings and bunches of lead and sulphur ore (*galena and iron pyrites*) have been found in what are there called the *red ends* (see page 26), but no lode exists.

Two and a half miles S.W. of Portroe, and immediately W. of where the trigonometrical point 1,083 is engraved on the map, there are two small veins that contain lead ore, associated with calc spar and quartz. They were discovered about seven years ago by a Mr. Kent. Four years ago a small shaft was opened, and an adit driven by the Laghtea Slate Company.

About 660 yards N. 18° E. of Derry Castle, copper ore was found, about thirty years ago by Mr. Head, of Derry. When it was examined, none of the lode could be seen; but in a heap of debris at the place, there are large lumps of quartz stained with the peroxide of iron.

According to information received from Mr. Twiss, of Bird Hill, lead ore was found in a quarry of Yellow sandstone on the S. of Parteen Villa, near O'Brien's-bridge (see p. 15).

* The information about this mine was communicated by Mr. John Hely, formerly chief clerk.

On the west of the Shannon, Mr. Paterson informed me that *tumblers* of galena were found in the townland of Bullycuggaran, a mile to the south of the village of Annacarriga; and numerous flying veins of sulphate of baryta, with specks and strings of galena, occur in the rocks that appear in the river half a mile W. of Annacarriga. They were also found in the townlands of Caher, Ballyhurly, and Ballynagleragh, about three miles N.N.E. of the same village. Trials have been made in Caher and Ballyhurly, but in none of these places was a lode found.

Ballymalone and Bealkelly Mines, near Tomgraney.—In the townlands of Ballymalone and Bealkelly (Eyre) there are extensive *Old Men's Workings* for iron ore. The ore, which is the peroxide, is found in black Silurian shales, and seems to occur in beds interstratified with the accompanying rocks; but as the works are now filled with either rubbish or water, their exact relations can not be determined. The workings in Ballymalone are situated ten furlongs S.E. of Tomgraney, and are 450 yards long, being principally large open workings, having an adit to drain them. The ore seems to have been smelted in the townland of Ballyvannan, about a mile and a half on the west of the works, where there are the remains of old furnaces and a large heap of slag. In Bealkelly (Eyre) there is now only an old adit open, but there seems to be also the remains of an open work, that has since been closed. Towards the north of this townland, and 450 yards due E. of Raheen House, there is the remains of another iron furnace, where the ore raised in this townland was most likely smelted. No record can be obtained of any of these works, and no tradition about them could be found with any of the inhabitants of the country; but it is evident that wood was used for smelting purposes, as fragments of it can be found adhering to some pieces of the slag.*

In other places in the Silurian rocks, traces of lead, copper, and iron pyrites were observed, but none of them require special notice.

G. H. K.

*There is a tradition that "red mine" was brought up the Shannon, to mix with the bog iron ore, when the furnaces were at work at Woodford and Whitegate (Sheet 125). Perhaps some or all of that was brought from these mines near Tomgraney.

Table showing the Natures, Values, &c., of the Ores of Silvermines District.

Name of Working.	Position or strike of the rock.	Dip of the rock to	Name of the formations in which the deposits occur.	Average strike of the lodes.	Hade or dip of lodes.
Lacka,* . .	Nearly horizontal,	North, if any,	Old Red sandstone,	Various, but chiefly northwestward,	To E. and W. and nearly vertical,
Shallee, West,* .	Strike about E. 35° N.	N.N.W. at 15°,	Do., .	N.W. to W. 30° N.	To E. W. and northwards at 60° to 80°,
Shallee, East,* .	Curving with the ground, average strike, E. 30° N.	Northwestwards at 25°, increasing to 55°,	Do., .	N. 15° W. .	Nearly vertical,
Gortenadine, .	Undulating, nearly horizontal.	N., N. by W. and N. E., generally northward,	Ditto, and between Old Red and limestone shale,	Undulates 15° S. of E. warped	N. at 60°, 70°, and 75°,
Do., . .	Do.	Do., .	Do., .	Do., .	Do., .
Ballynoe or Gortshaneroe,†	Junction between magn. limestone and Lr. Silurian limestone, strike N.E.	N.W. 40°, .	Between Silurian and limestone, or in the latter,	? Strike; in bunches,	?
Silvermines,‡ .	Bed of gossan in magnesian limestone nearly E. and W.	N. at 10°, .	Carb. limestone,	—	—
Ballygown or Silvermines,	E. 15° N. where bedding can be seen,	Towards N.W. 5°,	Old Red sandstone,	Curves of iron, E. 25° N. to E. and E. 30° S.	N. 75°, . .
Silvermines, .	Gossan in dolomite, ? E. and W.	N. 10°, . .	Carb. limestone,	—	—
Do., . .	Do.,	Do., .	Do., .	Irregular deposit,	Not a lode, N. 10° to 15°,
Do., . .	? Do.,	? Do., .	? Do., .	? No lode now known,	—
Do., . .	—	—	—	—	—

* The places marked * contain many parallel lodes or veins.
† This deposit has not a definite form like a lode.

Kind of Ore.	Kind of Gangue.	Associated Minerals.	Proportion of metal.	Proportion of silver to ton of lead.	Value per ton of ore.	Date at which value was ascertained	Authority.
Argentiferous galena,	Quartz and sulphate of baryta,	Quartz baryta, specks of iron pyrites,	70 per cent.	50 oz. .	£18 to £20,	1859,	Capt. King.
Do., .	Ditto, but chiefly sulpht. baryta	Do., . .	66 per cent.	50 to 55 oz.	£18 4s.	Do.	Do.
Do., .	Quartz and sulphate baryta,	Ditto, carb. lead, and a trace of copper,	72 per cent.	45 to 50 oz.	£19 10s.	Do.	Do
Do., .	Chiefly quartz and sandstone brecciated,	Sulpht. of baryta, and carbonate of lead,	68 per cent.	20 to 25 oz.	£15,	Do.	Do.
Copper, .	Do., .	Do., . .	6 to 7 per cent.	6 oz. .	£6,	Do.	Do.
Copper and argentiferous galena,	—	Iron pyrites, .	9 to 10 per cent.	6 to 8 oz.	£9,	Do.	Do.
Argentiferous galena,	Gossan, .	Oxide of manganese, peroxide of iron, carb. of lead, argentiferous galena, carb. and silicate of zinc, &c.	—	80 oz. .	—	Do.	Do.
Sulphur or iron pyrites,	Brecciated quartz and sandstone,	Iron pyrites, galena and blende,	35 per cent. of sulphur in ore,	—	£1 5s.	Do.	Do.
Calamine, .	Gossan, .	Ditto, and chiefly oxide of iron,	50 per cent.	—	£2 5s. and over,	Do.	Do.
Gossan, .	—	Do., . .	4 stone to ton of ore,	—	—	Do.	Do.
Argentiferous galena,	—	—	—	3 lbs. .	5s. 2d. per oz. £11 on the ground, and £12 in Limerick,	1600	Dr. Boate.
Do., .	—	—	—	—			

† This deposit seems to be a bed or interbedded. In Thom's Almanac for 1855, page 352, the per centage of silver per ton of lead at Shallee, is stated to be 25 oz., and at Gortnadine 300 oz.; at page 428 the lead and copper of the latter place are said to be both argentiferous.

GLOSSARY OF LOCAL AND MINERS' TERMS.

Quarrymen's terms are marked thus †. The rest are miners' terms.

† *Bellies*, curved joints.
Burrows or *spoil banks*, the heaps of debris taken out of a working.
Cat-tooth, crystallized white carbonate of lead.
Checked, applied to a lode when its continuity is broken or interrupted by a fault.
Cut out, applied to a lode when interrupted in its course, or when it ends.
Country, the rock on each side of a lode.
† *Ends*, vertical joints.
† *Flint*, chert.
Flookan, clay or soft crushed shale.
Flookan course, fault or open joint filled with clay.
Flying veins, irregular veins of quartz, &c.
Gangue, the matrix of the metalliferous part of a lode.
Gossan, peroxide of iron (here containing many other substances).
To Hade (*Hading*), applied to a lode, to slope, dip, or underlie.
Horse, a mass of rock protruding into a lode.
Old Men's Workings, used when speaking of unrecorded works.
Open cast, name applied to large open workings at daylight.
Pencil or *Pincil*, soft shale.
† *Poles*, oblique joints.
† *Porphyry*, fine quartzose conglomerate.
Ramp, a large solid massive lode or vein, consisting largely of gangue.
† *Ribbon*, a quarryman's term for the lines of lamination in slates.
Rockwalls, *containing walls*, the rock in the immediate vicinity of a lode, and touching it.
† *Running Limestone*, limestone fragments in the drift.
† *Sandy Limestone*, magnesian limestone or dolomite.
† *Soles*, horizontal, or nearly horizontal joints.
Slickensides, smooth divisional surfaces in the rocks or lodes, often coated with some mineral, and polished as if by friction.
Stopes, name applied to the open parallel and nearly vertical workings at Shallee; also drivings either oblique or perpendicular to a main lode.
Warp, an undulation in a lode.
Whinze, a short underground shaft, affording a communication between two galleries, at different levels, where a part of one is vertically (or nearly so), below the other.