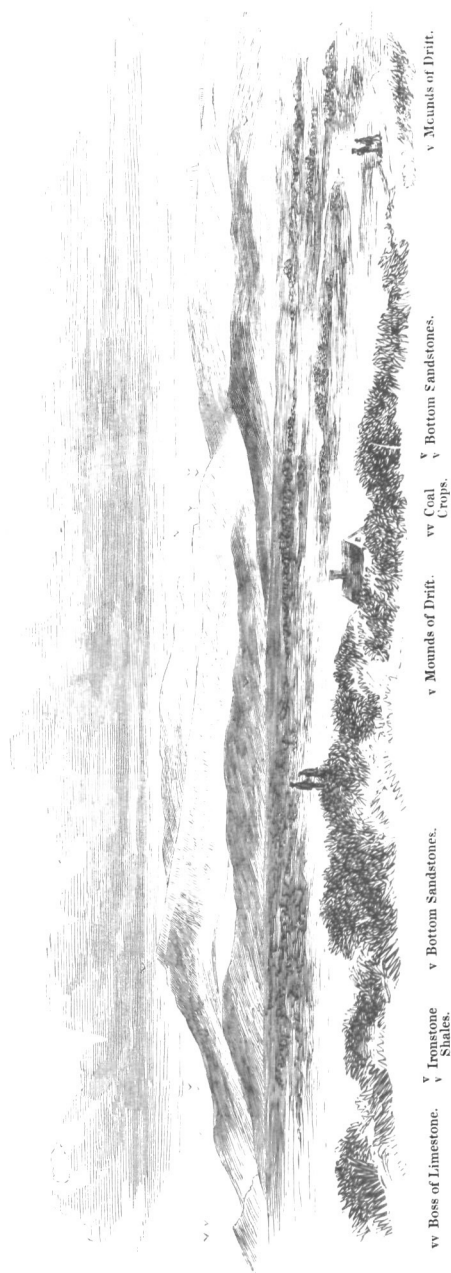


Kilrean Mountain, 1081 feet.

Valley of the Arigna River.

Altagowlan Mountain, 1377 feet.



VIEW OF THE COAL-MEASURE MOUNTAINS, NORTH AND SOUTH OF THE ARIGNA VALLEY, LOOKING N.W.  
From the Limestone on Road near Drumshambo, Co. Leitrim.

# THE GEOLOGIST.

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MARCH 1863.

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ON THE BITUMINOUS COAL OF THE ARIGNA DISTRICT, COUNTIES OF ROSCOMMON AND LEITRIM.

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“WHY is it that there is no bituminous coal of any account in Ireland?” This is a question which I have often been asked by well-informed people, and the answer is comprised in the one descriptive

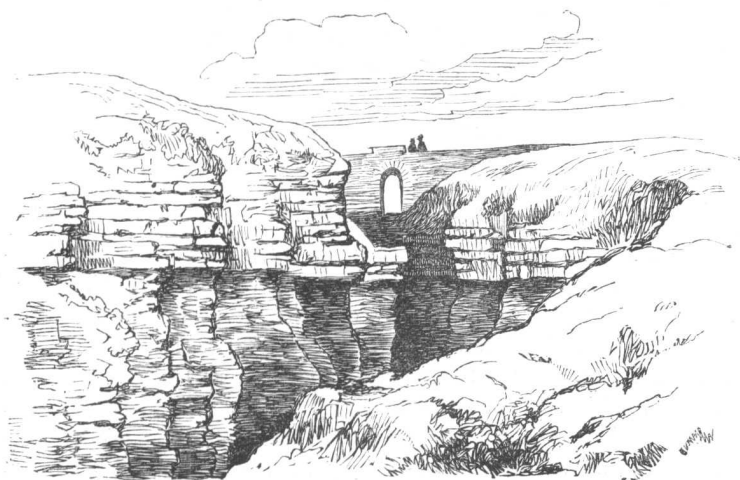


Fig. 1.—Junction of basal sandstones and black ironstone shales, on stream bounding the townlands of Tullymurry and Tullycorka, north-east base of Altagowlan mountain, County Leitrim.

word, "*Denudation.*" In truth, there is no reason why, at one period of our geological history, the great mass of the bituminous coal-bearing strata occurring in England should not have extended over what is now Ireland; but, strange to say, while this store of inestimable wealth was being preserved in England, and covered by the New Red Sandstone and probably Tertiary rocks, the adjoining portion of the earth's crust was being gradually raised from beneath the sea, and wellnigh effectually denuded of its carbonaceous covering. Ireland, therefore, for the most part, presents an older geological surface than England, especially over the areas now occupied by the Devonian and Carboniferous rocks; and I believe that all we have now remaining to us in the upper portion of the latter, is some of the basal beds of the English coal-measures, represented by three thin layers of bituminous coal, capping the mountains at either side of Lough Allen, in the counties of Roscommon and Leitrim, and extending into the Co. Sligo.

The most important coal-beds of the Arigna district, or those which are being worked at present, occur to the west of Lough Allen, and near the summits of the mountains of Kilronan and Altawowan; the former being 1081 feet, and the latter 1377 feet above the sea, having the valley of the Arigna river between them.\* From an examination of these coal-fields, which I made in the month of March, 1862, I am enabled to add some information to that which we already possess regarding them, which, I have no doubt, will be acceptable to those who are interested in the subject of the Irish bituminous coals.

The accompanying view of these mountains, taken from a boss of carboniferous limestone on the roadside near Drumshambo, on the way to the old Arigna iron-works, may convey some idea of the general aspect of the country. (See Plate V.)

The flat middle distance is occupied by the carboniferous limestone, the low ridge beyond, which rests on the S.E. flank of Kilronan Mount, is formed entirely of drift, derived from the disintegration of the local sandstones, dark grey grits, and black shales and ironstones of the coal-measures. The Arigna river passes through the gap in this ridge; to the extreme left of the view a boss of carboniferous limestone makes a feature in the landscape, and the slope of the hill above it, which is deeply intersected by small stream-courses, is composed of the black ironstone shales and dark grey

\* The level of Lough Allen is 160 feet above the sea.

flaggy grits of the basal coal-measures. Above this, and forming the rugged scaur on the brow of the mountain, are the "Bottom Sandstones," or seat-rock of the coals; above them are the two coal-beds; the "crops" of which are defined by the level surface of the underlying sandstones, at either side of the mountain.

The summit is formed of sandstones, with dark grey shales, flaggy grits, and some nodular bands of clay ironstone (see Section).

The mountain to the extreme right is Altagowlan, and the two coal "crops" near its summit are clearly defined on its northern side, by the low precipitous faces of the sandstones with which the coals are associated.

By reference to the accompanying Sections, Nos. 1 and 2, the physical structure of both these mountains will be at once understood.

In order to afford a still clearer notion of the vast amount of denudation to which the whole of this district has been subjected, I give the subjoined diagrammatic section across it, from

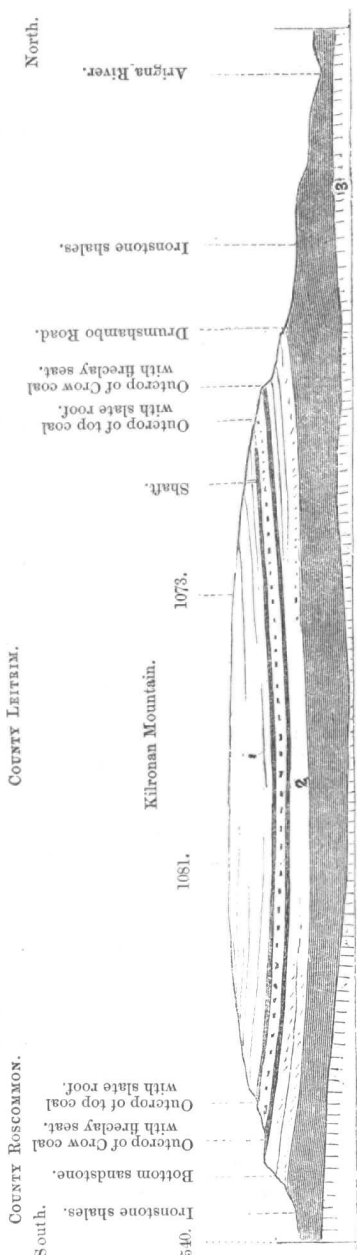


Fig. 2.—Section from S. to N. across the Townland of Rover.  
1. Flaggy sandstone with black shales and ironstone nodules; 2. bottom sandstones; 3. Carboniferous Limestone.

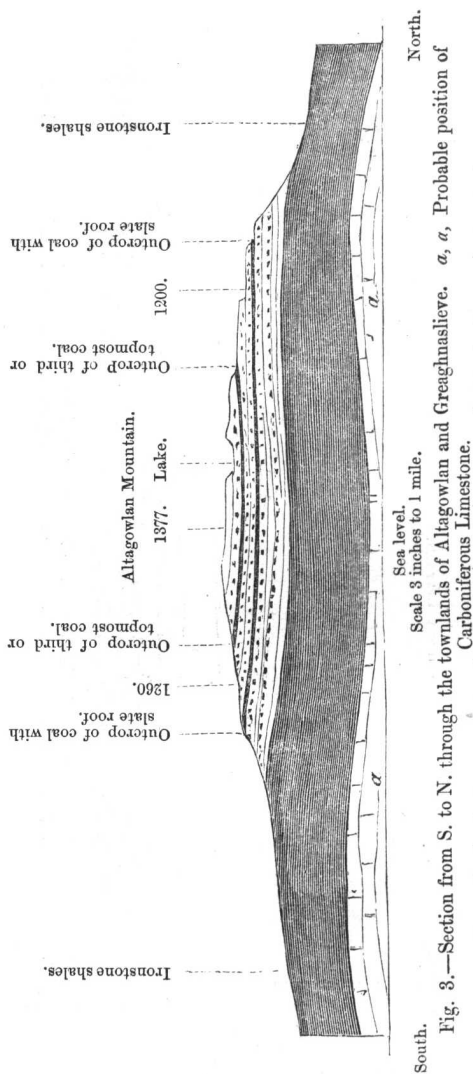


Fig. 3.—Section from S. to N. through the townlands of Altagowlan and Greaghnaslieve. a, a, Probable position of Carboniferous Limestone.

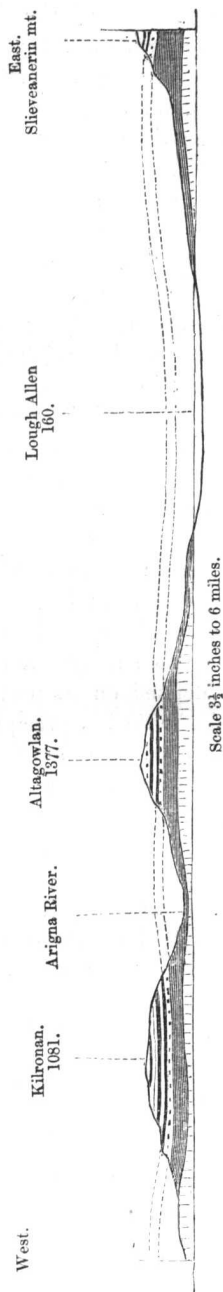


Fig. 4.—Diagrammatic Section across the Coal-measure Mountains between Drumshambo and Drumkerin.



west to east, commencing at the limestone to the west of Kilronan Mount, and ending on the western side of Slieveanerin Mount, which rises to the east of Lough Allen, a distance of twelve miles.

From this it will be very apparent that a little more denudation, and the coal-beds which cap the mountains would have been removed.

In the year 1788, a speculation, under the name of the Arigna Company, was set on foot to smelt the iron ores of the district around Lough Allen, and operations were commenced by erecting extensive smelting furnaces on the south bank of the Arigna river, within a mile and a half of Lough Allen and three and a half miles from Drumshambo. The coals were procured from the pits at Aghabehy and Rover, and a tramway of nearly three miles in length was constructed to facilitate their transit to the works, from the former and more distant colliery.

In the year 1818, Sir R. Griffith compiled a mining and geological report on the Connaught coal-fields, in which a rather too favourable opinion was expressed as to the thickness, extent, and quality of the coals; this he however subsequently modified.

In 1830, Mr. Twiss made a report on the Arigna ironstones, for the directors of the Arigna Company, in which he speaks in the highest terms as to the quality of the ore, the amount of which he regards as inexhaustible. After a trial, extending over a period of about thirty-five years, the Arigna Company failed, and this serious mishap to a most legitimate mining undertaking forms a prominent feature in the history of Irish stock-jobbing speculations.

In 1838, the Railway Commissioners' Report on the Connaught Coal-fields appeared, and it is therein stated that the total area occupied by coal covers 20,000 acres, representing a bulk of 20,000,000 of tons. At present the coals raised from the old pits in the Arigna district are only sufficient to supply the mere local market, and have been estimated by Sir R. Kane, in his 'Industrial Resources of Ireland,' to be about 3000 tons annually. With regard to the Kilronan and Altagowlan coal-fields, so far as I can judge, I see little prospect of their being properly developed, chiefly from the apparent exacting spirit evinced by the owners of the royalties, based upon an exaggerated notion as to the extent and bulk of the coals, and ignorance as to the difficulty of procuring them.

The total extent of the coal-beds in this district and that which lies to the west of it, stretching into the Bralieve range of moun-

tains, is about 5 miles from N.W. to S.E., with an average width of about 1 mile at Kilronan mountain, which forms the eastern termination of that long narrow coal-measure basin. The Altagowlan basin, on the opposite side of the Arigna valley, may be about 3 miles, from N.W. to S.E., with a width of three-quarters of a mile. In these areas there are but three beds of workable coal, the thickest of which is not over 2 feet 6 inches, and one of the beds has its roof and floor of hard sandstone. See "upper coal seam of Creughnaslieve."

The following is Sir R. Griffith's section of the Kilronan Mount coal-measures, taken from his 'Mining Report on the Connaught Coal-fields,' and its general accuracy is undoubted:—

Strata.	Feet.	SURFACE
18	30 to 50	Sandstone flags.
17	30 to 60	Blackish-grey sandstones and gritty slate.
16	100 to 200	Slate clay, in beds of variable thickness and hardness, and containing innumerable beds of clay ironstone.
15	COAL.	Third or upper seam, 8 to 9 inches thick (?).
14	24 to 45	White sandstone.
13	10 to 15	Grey soft slate clay. Coal roof.
12	COAL.	Second coal, 2 ft. 6 in. to 3 ft. 4 in. (Over-estimated.)
11	12 to 15	Sandstone.
10	6 to 15	Black slate clay.
9	4 to 20	Greyish-white sandstone.
8	COAL.	Third or "Crow" coal, intermingled with clay laminae, 1 to 3 feet. (Over-estimated.)
7	1 to 3	Fire clay. Coal seat. (Over-estimated.)
6	1 to 3	Sandstone, with plant impressions. (Often much thicker.)
5	6 to 10	Grey (and very hard) sandstone.
4	9 to 20	Black slate clay (shale).
3	30 to 60	Greyish-white sandstone, known as the first or bottom sandstone.*
2	300 to 600	Black slate clay, with grey flags, and innumerable ironstone nodular layers and beds, varying from half an inch to 2 feet in thickness.†
1		Carboniferous limestone, unknown. Page 20 of Report.

As my examination of these coals was confined to the Arigna district, and had distinct reference to those places where *coal* is now being raised, I shall limit my remarks to the facts which came under my own observation, as by so doing I shall afford some aid to future explorers in this most interesting and important field of research, and I cannot prejudice the question as to the advisability of these beds being worked as a profitable mining speculation.

\* Upwards of 250 feet thick at Altagowlan, and close on 200 feet on the south-east flank of Kilronan.

† Upwards of 800 feet at Altagowlan mountain.

I traced the outcrop of the two coal-beds around the entire northern, eastern, and southern limit of Kilronan Mount; devoting my attention specially to those which appear in the townlands of Aghabehy, Tullytawen, and Rover, and in those of Carrownault, Derreenavoggy, and Cross Hill, on the eastern brow of the mountain. On the other side of the Arigna valley I examined particularly the coal "crops" in the townlands of Greghnaslieve, Tullytawen, and Seltennaveeny, without however having had time to connect them accurately over the intervening spaces. Their position as indicated on the map, and the faults disturbing them, will not, however, be very far from the truth.

The following observations are extracted from my field notes :—

1. *The Aghabehy Coal-field.*—This lies on the northern slope of Kilronan mountain, at an elevation of 510 to 899 feet above the level of Lough Allen, from which it is distant about six miles by the road; there is here but *one* bed of workable coal, called "the top coal," 1 foot 6 inches in thickness, which includes 6 to 8 inches for holing. The roof of this coal is slate, and the floor sandstone. The second, or lower coal, or "crow coal," is separated from the first by 20 to 55 feet of very hard sandstone; it has a thin fire-clay seat with a sandstone or "rock" roof; and is 6 to 8 inches thick, it is full of thin seams of earth, and yields only culm of an inferior quality. The culm derived from the "holings"\* of the top seam is very superior, and cokes well. Blocks of a light, flaky, and glistening coal, measuring 8 to 10½ inches in thickness, are now being delivered at the pit-mouth, at the cost of 5s. 6d. a ton, including the culm; a ready sale is effected for this at 10s. per ton for thick and screened coal, and 8s. per ton for the culm, giving however to every ton of culm 4 cwt. of the thick coal. When struck with the hammer, I remarked that these blocks of coal shivered throughout their bulk, which induced me to suppose that they would not bear any rough treatment in their transit over long distances.

From the northern outcrop of the "top coal" in the N.W. portion of the townland of Aghabehy, and at the stream near the road, a fault has been proved, causing a downthrow to the west of about 100 feet; it strikes from this point South by East to the shafts near the top of the hill, a distance of about 850 yards, or half a mile. From this point I believe it strikes S.S.E. into the adjoining lowland of Tully-

\* The term "holing" is applied to that portion of the bottom of the coal-seam which, in the absence of a Fire clay "seat," is picked away by the miner in order to extract the coal above in blocks. In this instance, the refuse makes excellent culm.

tawen, for the distance of three-quarters of a mile to near the farm-houses of the latter townland, when I think it will be found to strike S.S.E., and with that bearing to leave the district.

It is a somewhat remarkable fact, that on the eastern side of the fault just alluded to, the coals have never been accurately proved or their outcrop defined, with the exception of a small space east of the shafts, at the distance of one-third of a mile above the chisel-pit.

The townland of Tullytawen lies to the south of Aghabehy, on the southern slope of the mountain, and is traversed by the Aghabehy fault, which cuts off the coals by a downthrow to the west. I was informed that the "top coal" here measures 1 foot 6 inches in thickness, with a *fire-clay seat of 3 inches*. The "crow coal" is stated to be here 6 inches thick. Considerable workings have, for many years back, been made in the "top coal" at this locality; but as at Aghabehy no record was kept of the amount of coals extracted, and as the workings were on the pillar-and-stall plan, no sooner was the coal extracted than the roof and floor were allowed to collapse, and thus to obliterate all traces of the works.

The "top coal" has been rather extensively worked, at the townland of Rover, which joins Aghabehy on the east.

In the townlands of Carrownanult, Darreenavoggy, and Cross Hill, the outcrops of the two coals is very well seen. The top seam is, however, by all reliable accounts, lessening in thickness at this portion of the coal-field, and is only 12 inches thick, while the crow coal is only 6 inches; here we find that the basal sandstones are thickening, while the coal is thinning. It is just as probable, however, that in the Western portion of the coal-field of Kilonan or that which extends into the Co. Sligo, the coal may thicken and improve in quality. Around the circuit of the eastern termination of Kilonan Mount, the coal-measures are traversed by at least six faults radiating from the centre of the hill; of these the most considerable occurs in the south-west portion of the townland of Kilonan mountain, but owing to the flatness of the beds, which dip often as low as  $3^{\circ}$ , a slight dislocation in their continuity would throw a coal crop hundreds of yards out of its line of strike. The faults therefore which occur to the east of that at Aghabehy would be of no importance in the event of the coals being worked, as their direction and throws could be most accurately determined and calculated.

2. *The Greaghnaslieve and Altagowlan Coal-fields.*—This area, which appears to afford the most valuable coals in the district, lies

at an elevation of between 710 and 1209 feet above the level of Lough Allen, from which it is distant about three miles; a most excellent road leads from the lake to within 400 yards of the outcrop of the bottom seam of coal. The lower coal has here a slate roof, from which fact, I should suppose that it corresponded to the top coal of Aghabehy, and the upper coal here would therefore agree with the thin seam, numbered 15 in Sir R. Griffith's section, and which is thinly developed in the district to the west of Kilronan mountain. Though this may be probable, I am aware that it is unsafe to attempt to identify coal-seams merely from a correspondence in their "roof" or "seat." At the outcrop of the lower coal, along the northern brow of this mountain, the strata are clearly seen to have a slight dip away from the hill, or to the north-east. This is explained in the Section No. 3, which shows that this portion of the coal-measures forms the northern side of a low anticlinal, the prolongation of which to the north has been cut off by the denudation; by tracing these beds, however, up the mountain, they are found, as a mass, to be bent synclinally and to form a shallow basin. The *rise* therefore of the coal to the hill, on its northern flank, which causes the beds to be self-draining, will, in all probability, be found to cease in the distance of 250 yards.

The lower coal-seam of Greaghnaslieve afforded the following section on the northern face of the mountain:—

Seat rock, sandstone.

Holing 6 to 8 inches in brown sandy clay, and slightly micaceous shale, answering to an impure fire-clay.

Fire-clay coal, or fire-clay, with numerous bituminous layers and strings through it, 8 to 10 inches.

Coal from 1 foot 4 to 1 foot 6.

Roof, black slate clay, 7 to 10 feet.

Rock roof, sandstone.

In my table of thickness, etc., of the coals, I have called this the two-foot coal.

The upper coal seam, or that nearest to the top of the mountain, was not as well exposed as the lower. I traced its outcrop across the townland, but had not an opportunity of examining it closely. I was informed, however, that it is of equal thickness with the lower seam, but it wanted the shale holing, and its roof and floor is sandstone or "rock;" we may therefore value it as an 18-inch coal.

From the inaccessible nature of the ground in the townland of Alta-

gowlan, and its proximity to that of Greaghnaslieve, it is evident that the whole of this coal-bearing area should be worked from the northern side of the mountain. I believe that the quality of the Greaghnaslieve coal is the same as that from the Seltanaveeny Pits.

3. *The Seltanaveeny Coal-field.*—Extensive operations have been carried on here for many years back in the northern part of this townland, adjoining that of Tullynahaw, and shafts to the depth of 120 feet have been sunk in the coal; from the comparatively low position of this ground and the fact that this portion of the coal-field is formed by the stream S.E. end of the Altagowlan basin, and the coal at its outcrop dips to the hill in every direction, great difficulty will ever be experienced in freeing the workings of water. (See map.)

The distance to the lake from those pits is four miles, by the new road to Greaghnaslieve, or two and half by the old and at present broken-up road leading from Tullynahaw colliery.

The subjoined is my estimate of—

THE THICKNESS, AREA, AND WEIGHT OF COALS IN THE FOLLOWING TOWNLANDS, FORMING PORTION OF THE ARIGNA COAL-FIELDS, COUNTY ROSCOMMON.

TOWNLANDS.		ft. in.	Acres.	Tons.
<i>North-west Coal-field.</i>				
Top coal.	Greaghnaslieve, lower seam . . . . .	2 0	100	200,000
	Greaghnaslieve, upper seam . . . . .	1 9	60	95,000
	Altagowlan, lower seam . . . . .	2 0	94	188,000
	Altagowlan, upper seam . . . . .	1 9	42	73,500
			296	556,500
<i>South-west Coal-field.</i>				
Top coal.	Aghabehy, proved area . . . . .	1 6	36	54,000
	Aghabehy, unproved area . . . . .	1 6	133	199,000
	Tullytawen, proved area . . . . .	1 6	18	27,000
	Tullytawen, unproved area . . . . .	1 6	67	100,000
	Rover, partly proved . . . . .	1 6	120	180,000
			468	561,000
<i>South-east Coal-field.</i>				
	Carrownanalt . . . . .	1 0	179	179,000
	Derreenavoggy . . . . .			
	Crosshill . . . . .			
			179	179,000
<i>North-east Coal-field.</i>				
	Saltanaveeny, available . . . . .	2 0	72	144,000
			72	144,000

In the accompanying table certain townlands are given which form only detached portions of the two great coal-fields.

As it may interest some of our readers, I subjoin the analysis of the Arigna coals, and that of the ironstones, as given in that valuable work on the 'Industrial Resources of Ireland,' by Sir Robert Kane (second edition, p. 23):—

"*Aghabehy Coal*.—A rich black coal, easily broken. Specific gravity, 1·274. When heated, it gives off a good deal of inflammable gas, and leaves a light, porous, grey, coherent coke. Analysed in this way, it was found to give, from 100 parts :—

Volatile matter . . . . .	23·10
Pure coke . . . . .	66·15
Ashes . . . . .	10·75
	<hr/>
	100·00

"One part of this coal reduced twenty-six parts of lead to the metallic state ; one hundred parts of it, therefore, represented seventy-seven parts of pure carbon.

"*Celtanaveeny and Meenashama Coal*.—Specific gravity, 1·290.

	Seltanaveeny.	Meenashama.
Volatile matter . . . . .	19·10	18·90
Pure coke . . . . .	65·87	61·46
Ashes . . . . .	15·03	19·64
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	100·00	100·00

"*Rover Coal*.—Specific gravity, 1·287.

Volatile matter . . . . .	17·70
Pure coke . . . . .	74·89
Ashes . . . . .	7·41
	<hr/>
	100·00

"One part of it gave by ignition with litharge 28·4 parts of lead ; hence one hundred parts of the coal corresponded to eighty-four of pure carbon.

"The actual elemental composition of Aghabehy and Rover coals was found to be as follows :—

	Aghabehy.	Rover.
Carbon . . . . .	79·69	81·04
Hydrogen . . . . .	6·24	4·91
Oxygen . . . . .	3·52	6·64
Ashes . . . . .	10·75	7·41
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	100·00	100 00

"*Clay Ironstone Nodules from Arigna.*—Mean of five analyses:—

Protoxide of iron . . . . .	51·36
Lime . . . . .	1·59
Magnesia . . . . .	1·92
Alumina . . . . .	0·98
Insoluble clay . . . . .	12·82
Carbonic acid . . . . .	31·33
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	100·00

And this contains 40 per cent. of metallic iron.

"The loss by calcining, the iron remaining as protoxide, should be in average 31·33 per cent.; and the calcined ore should consist of 100 parts of

Iron . . . . .	58·2
Oxygen . . . . .	16·6
Lime and magnesia . . . . .	5·1
Clay . . . . .	20·1
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	100·00 "

(See Sir R. Kane's 'Industrial Resources of Ireland,' p. 136.)

## CORRESPONDENCE.

### *Crocodilian Remains in the Scottish "Old Red."*

SIR,—Observing that the report of a Scottish crocodile having been found in the Old Red Sandstones of Morayshire has been commented on in your Notes and Queries for February, I think it right to state that no reptilian remains have been recovered from any of the sandstones of that county, of whatever age, with the exception of those of the well-known *Telerpeton*, *Stagonolepis*, and *Hyperodapedon*.

The stone containing the first of these, the *Telerpeton Elginense*, was got from a quarry near the Loch of Spynie, some two to three miles south of Elgin, by the late Mr. Patrick Duff, and is now in my possession. It is described and figured by the late Dr. Mantell (Jan., 1852), in a paper contained in the eighth volume of the 'Geological Journal,' as a small lacertian reptile, about four and a half inches in length.

The *Stagonolepis Robertsoni* has been long known, and was so named by Agassiz, and is by him described, in the 'Poiss. Foss. du Vieux Grès Rouge,' as a ganoid fish. The discovery of many fragments of bones since has enabled Professor Huxley to fix the true nature of these remains. The *Stagonolepis* is described by him, in the fifteenth volume of the 'Geological Journal' (1858), as a reptile having considerable affinities to the crocodile, and as having reached from 16 to 18 feet in length. Many remains of bones and scutes belonging to this creature have been found in a quarry at Lossiemouth, some five miles south of Elgin, and are preserved in different museums, as in that of Elgin, the Museum of the Royal School of Mines in Jermyn Street, etc.

The remains of *Hyperodapedon Gordoni* were got from the same quarry