II.—*The Geognosy and Mineralogy of Scotland.*

By Professor Heddle.

COUNTY OF CAITHNESS.

"A monotony of external configuration affords" says Geikie, "a good indication of the sameness of the geology"; and a country which is devoid of scenic interest, however well it may in a few cases fill the pockets of the metallurgist, will assuredly never satisfy the cravings of the scientific mineralogist.

A land of diverse formations, gashed by rivers, gouged by glaciers, cleft by faults, and hitched about by slips,—with its mountains never of the same mind as regards the fashion of their contours, tossed hither and thither as if they had been kicking about in chaos,—in such a land, he who would learn from the pages of nature may rest assured that he has much to read.

Caithness stands apart from all the counties of Scotland,—pre-eminent in monotony, pre-eminent in ugliness, pre-eminent in dearth of minerals.

A land of flatness,—flags, and fossil-fishes,—the glories of colour and lustre and form are unknown to it: metamorphism, and pseudomorphism and isomorphism, and homœomorphism are words not to be found in its dictionary: it can hardly add one tittle to the records of the past, has no tale to tell of how the old things became new. On its dismal dyke-lined roads the most stalwart walker would grow weary, the hill-man find his occupation gone, for there is little here to climb.

There are some three fairly well shaped hills it is true, but these have huddled themselves in a far off corner in repugnance. Some fairly good cliffs there are, but these, in the singularly rectilinear coasts, impress one with the feeling that they have turned their faces from the land in shame.

An Old Red Sandstone country, which has concentrated all the flatter features of Orkney, with none of its interest, and but few of its minerals.

A patch of quartzite in the south—and nobody seems to understand how it got there, or what it belongs to; and a portion of an igneous rock of the adjoining county, which had thrust itself into the land, but stopped short chilled by the dismal swamp which lay before it.

Its two chief headlands have been mantled, and rendered somewhat more respectable by the upper sandstones of Hoy; but about the best that can be said of the county as a whole is, that its geology is *flags*, and its history is *fishes*.

Minerals.

The record is very brief.

In his paper on the Mineralogy of Sutherland, Cunningham writes,—"The solitary instance to which I allude is the discovery of *fluor spar* in the Ord of Caithness, a mountain forming the northern extremity of a granitic band, which stretches along a considerable portion of the east coast of the county. The point where this mineral was detected is in some precipitous cliffs overhanging the burn of Ousdale (Ausdale), and near a rocky ledge, over which the stream falls, at a short distance from its confluence with the sea.

The fluor occurs in the granite in two distinct modes, viz., as imbedded concretions, and as mere threads. The former I have never found larger than a small pea; and the latter, though they may have a length of several inches, were in no case perceived to have a greater breadth than a quarter of an inch. Its colour is the imperial purple of Werner's nomenclature, and the usual cuboidal crystalline form is in some instances distinctly developed."

To Dr. Joass, of Golspie, I am indebted for specimens of lamellar *baryte*, from Thrumster, about six miles south of Wick; and to the same gentleman and A. H. Gillieson, Esq., for *limonite*, with imbedded *rock crystal* from the banks of the Isald burn, near Achavarasdale in Reay. The limonite was granular and very siliceous; Dr. Joass failed, after much trouble, in procuring me specimens pure enough for analysis, though he believes that it is sometimes fibrous.

Upon the north shore, near John o'Groats House, *augite* occurs. It was found and sent to me for analysis by Professor Geikie, who on the 2nd November, 1879, wrote as follows:—

"You should receive to-morrow a parcel containing the pieces of the John o'Groat's augite.

I have not time to send you full particulars at present. It occurs in rough, rounded, and broken lumps, imbedded in the coarse agglomerate of a volcanic neck, belonging to the Upper Old Red Sandstone time.

I have had it sliced, and have examined it microscopically. It is not in the least dichroic, and has none of the other features of hornblende.

I have no doubt it is augite. Some of the rough granular pieces suggested, at first, olivine to me. But I found this granular character to be exceptional, and the mineral is fusible, and with hardness equal to 5·5.

It is by far the most interesting volcanic augite I am acquainted with."

On the 4th December, he writes:—

"The specimen I send you is one of a number of pieces of what seems to me to be a form of augite, which I have found in the most northerly volcanic rock on the Mainland of Scotland.

This occurs on the shore, half a mile to the east of John o'Groat's House.

While the whole of that part of Caithness lies upon the so-called "Caithness flagstones" of the Old Red Sandstone, the coast at the locality in question affords an admirable section of the red sandstones, with blue and grey flags and shales (sometimes with well preserved ichthyolites), which form the highest visible portion of the Caithness flagstones.

No igneous rocks of any kind are interbedded among these strata or in any other part of Caithness.

It was therefore with the utmost surprise that, when examining the coast line in the year 1874, in company with my colleague in the Geological Survey, Mr. B. N. Peach, I came upon a well marked volcanic "neck" or pipe, which had been drilled through the John o'Groat's sandstones.

I have no doubt that this neck marks the chimney of one of the Upper Old Red Sandstone Volcanoes.

I again visited Caithness last summer, accompanied by another survey colleague, Mr. John Horne, and made further notes about this interesting locality.

The neck is irregularly oval in shape; the diameter, on this edge truncated by the sandy beach, being about 300 feet. The sandstone round it is somewhat hardened and jointed, as may usually be observed in similar cases. The whole space of the neck is filled up with a coarse tumultuous agglomerate of a dirty green colour, which makes it stand out in strong contrast to the surrounding red sandstones. The paste of this rock is a granular tuff, formed evidently of comminuted diabase.

The blocks imbedded in it are angular, subangular, and rounded, of all sizes up to masses of a yard or more in diameter. I observed among them pieces of diabase (these form the great majority), no sandstone, grey flagstone, gneiss, and abundant fragments of the augite which I send you.

Some of the diabase blocks were of great size, but, as veins of a similar rock traverse the neck, it was not always possible to tell which were parts of veins, and which were really detached blocks. The augite fragments are all rounded, as if they had undergone considerable trituration before they came to rest. Here and there they show a rough cleavage-face, which may have been produced by their striking against another ejected block. They vary in size from mere seed-like grains, up to blocks at least eight or nine inches in diameter.

No sign of fusion, or even of good baking, was to be seen in the bits of imbedded sandstone in the agglomerate.

I should add that I did not observe any minerals associated with the augite, except such as had resulted from the alteration of the tuff.

There cannot be the least doubt that the fragments of augite are true ejected blocks, and did not originate in the matrix where we found them.

They are by no means the only examples to be met with among the Scottish tuffs, though they are very much larger than any I have before observed. Next to these in size, were some which I found in a neck on the shore to the south of Fairlie in Ayrshire, belonging to the Lower Carboniferous volcanoes."

Upon examination, I found these specimens to be of a dark bottle-green colour, and a high vitreous lustre; their specific gravity was 3·36.

They yielded,

Silica	46·076
Alumina	11·391
Ferrous Oxide	7·921
Manganous Oxide	·461
Lime	16·067
Magnesia	15·653
Potash	·818
Soda	1·058
Water	·38
	99·825

These are masses therefore of an *augitic-glass*, somewhat similar to, but neither so much vitrified or flawed as specimens which I had myself previously discovered and analysed from Elie in Fifeshire, and the Giant's Causeway in Ireland.

It will be observed that Geikie remarks on the granular pieces suggesting olivine to him: which mineral the Elie specimens were considered by the writer to be, until their analysis established the occurrence of augite in this peculiar allomorphic condition.

The resemblance to olivine is, in the John o'Groat specimens, by no means—even in the most granular portions—so striking as in those already mentioned; while some portions of the specimens show the cleavages and fractures of unchanged augite.

This fact of the specimens presenting a changed and an unchanged portion,—having been caught or arrested in the middle of the process of change,—renders them certainly far more interesting, from the amount of information they convey, than those in which the glassy condition is perfect.

"Rough, rounded, and broken lumps," —the words well describe them as hand specimens. We will consider these features in a different order, that we may see what they teach.

"Broken";—"rough" because broken; and "rounded,"—that is partially rounded, or they would not still be rough,—rounded on account of some attriting action which operated after they had been broken.

Evidence of their having been broken,—i.e. that they are the fragments of a larger mass. Mere roughness could not prove this: the steam holes of igneous rocks though usually more or less spherical, and presenting rounded or curved outlines, are not invariably so; so that a mineral which ultimately plugged these, through endosmose, would, in the taking a cast of a rough cavity, assume a rough outline; while again, if the augite, after thorough fusion, was, on the abstraction of the heat, to assume the solid state, while the rock matrix was still in a plastic condition, it might form a confusedly crystalline mass with rough surfaces. That the roughness of outline is not here to be so explained, but is really due to irregularity of fracture, is shown *first* by large and fairly brilliant cleavages of the augite abutting against what have been the sides of the masses, as shown by a thin investing layer of calcite, and skin of chlorophæite(?)—and abutting at such an angle to these sides as could be formed neither by a crystalline arrangement which radiated from the sides of a cavity, nor by one radiating from the centre of the mass. The above cleavages, *secondly*, are of such size as show that they must have originally belonged to masses of much greater dimensions than those in which they are now found.

And, *thirdly*, the rough fractured sides occasionally exhibit, as also do internal fractures, portions of crystals of a size much too great to have been formed during the solidification of masses so small as these.

As regards the rounding, it amounts in general to little more than the abrasion of the protruding cleavage-angles, not to the giving a rounded outline to the general mass. The surfaces are now covered with a thin coating of calcite: the nature of the abrasions cannot be seen; it certainly has not been of the continuous nature of wave battering, or river grinding, or sand blowing.

As regards internal structure, there is here the same confused and hackly fissuring which I described in the Elie mineral, the fissures being, however, narrower, and the whole mass more coherent; these fissures are, for the most part, filled with saponite (?) the probable result of incipient change, and rarely with calcite.

The recent fractures are, like those of the Elie specimens, conchoidal; though here and there true cleavages in broad sheets cross the conchoidal fractures, and even lie in directions non-accordant with the cleavages of the less altered portions of the mass; these latter having been, in fact, posterior in formation to the vitrifaction. The conchoidal fractures exhibit a perfect bottle-glass appearance, very similar to that of augite melted in a crucible. Close inspection with a lens, however, shows on the crystalline surfaces a cupped appearance, quite similar, though not so minute as that which, in decomposed glass, was shown by Sir David Brewster to be the cause of the iridescent colouring. Closer inspection still demonstrates that these cup-shaped hollows had been the receptacles of little spheroids of felspar, which may be seen arranged in layers in portions of the mass of the stone. I call the spheroids *felspar* merely from the lustre of their cleavages, and from the presence of alkalies, as shown by a partial analysis.

Two questions at once connect themselves with these "rough, rounded, and broken lumps," which helped to choke up a former volcanic orifice.

The first—*whence came they, or what were they broken from?*

The second—*do they, in themselves, give us any information as to the amount of heat to which they had been subjected in the process of their vitrification?*

These two question may resolve themselves into the more general one—*is there any likelihood that we may be able*, by their recognition as components of a well known stratum, or by the amount of alteration which has been effected upon them by heat—*in any measure to arrive at an estimate of the depth at which the volcanic turmoil originated.*

Such a question is too wide a one to be entered upon in its entirety here; but although a consideration of it, in the two directions indicated above, may lead us but a small extent to any definite answer, yet to that small extent it unquestionably must lead us.

All *fragments* must have been brought by an outflow from beneath the parent rock from which the fragments were torn; the amount of change is the register of *the highest degree of the heat* which was the active agent of the change.

Asking ourselves in this instance, whence came these lumps of augite, we are able to reply unhesitatingly from no part of the Old Red: no formation, not even the chalk could have less claim *in itself* to an augitic mineral.

Inferior to the Old Red we have in this part of Scotland, gneissic and flaggy schists, thrown into wavy folds where they cross the breadth of Sutherland; these, where they underlie the sandstones here, are probably similarly crumpled, and have no great downward trend. Beneath these fractured and folded rocks again, we come upon the gently inclined beds of a highly silicious conglomerate; which beds vary among themselves not at all in the nature of their constituents, but only in the amount of attrition to which their component pebbles have been subjected; they are altogether destitute throughout of vein, or seam, or cavity, within which a crystalline or cleavable mineral had space or time to arrange its atoms.

Going lower still, we may walk for miles across the upturned edges of a rock, the beds of which strike vertically downwards with such an unvarying determination of purpose, that we are impressed with the whimsical fancy that if we ever again meet with them it must be when they come out at the other side.

After many traverses of the formations mentioned, my experience does not enable me to indicate any one spot or bed which could afford an augite the representative of this.

The Shinness limestone locality shows, throughout its great abundance of the mineral, no trace of such a variety.

I know of but one isolated occurrence of augite in the midst of the vast abundance of hornblende in the lower gneiss.

The well known conversion of hornblende into augite by heat may possibly account for its occurrence; but in this case a *double action* is required,—the first, that by means of which the transmutation was affected, resulting in the production of the broadly cleavable masess. The second, that which produced the final vitrification of these masses. Of any such double action we have here evidence only of the feebler,—the vitrifying.

The second part of our query, namely, the topmost limit of the heat to which the augitic lumps had been subjected, is more easily answered, seeing that a near approximation may be arrived at by direct experiment.

Many years ago I had an opportunity of determining the temperature to which fragments of different members of the lower Coal Measures had been subjected, when caught up among the ashes which form the small volcanic cones and necks around the shores of Fife.

In the shore sections of the wave-worn bosses of tufa which stud the coast near Kinkell, much fragmentary matter of various descriptions is to be seen promiscuously imbedded, and characteristically and instructively altered. The bituminous shales have lost all their illuminants; and, of organic matter, retain only the blackening stain of sparsely distributed carbonaceous particles.

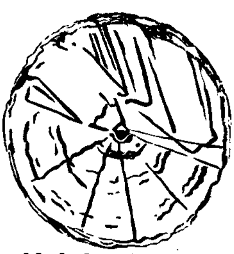
The encrinal limestone has become granular and crystalline.

The included freestone masses present themselves as a quartzite, with firmly agglutinated grains, splintery fracture, elastic resilience, and sonorous ring. Shivery masses of carbonaceous or "black chalk" clay show every stage of a passage into Lydian stone; while volcanic bombs of the latter, perfect in the transmutation, lie impacted in the encircling volcanic mud, with surfaces which exhibit rounding and abrasion.

We have here abundance of material to work upon, in estimating the quantum of the energy expended in the production of these changes.

Close observation of the altered calcareous fragments shows most clearly that the period of time, during which they had been subjected to the heat, had been of but short continuance; for while it will be found that the smaller of these fragments are, to their very centres, converted into a crystalline mass, reflecting light from innumerable facettes; the larger exhibit the change only to a certain depth; the interior presenting itself as an impalpable calcareous basis, studded occasionally with joints of the encrinal stems.

More than once I have found a larger than ordinary joint, in part converted into cleavable calcite, which flashed back reflected light, while the greater part showed the structure of the fossil in no degree effaced.



In the estimation of the temperature to which these erupted fragments had been heated, I operated upon the ordinary bitumenous shales of the district, on the imbedded shaley coke which is found in the tuff, and on the bombs of Lydian stone imbedded therein.

First, as regards the shales, that from the Kenly burn, the nearest point where it crops out, yielded—

S.G.	Water	Gas	Carbon	Ash.
1·79	4·54	25·29	9.27	60·09

That from Kinkell imbedded in the tufa—

S.G.	Water	Gas	Carbon	Ash.
2·57	2·64	6·	·44	90·92

The gas from the latter is non-combustible, or almost so. The shale from the tuff is grey-black,—very dark when the small amount of carbon is considered.

From the Kinkell shale, therefore, the greatest amount of the gas and water has been distilled off, and the greatest amount of the carbon burnt away.

It was next ascertained that the shales of the district parted with their gas below a red heat, for antimony did not melt when inclosed along with them in the retort in which the distillation was conducted.

In working downward as regards temperature, in order to ascertain the lowest point at which the change could be effected, the following process was adopted.

A flat block of iron, of some pounds in weight, had a dome-shaped cavity turned out of one of its surfaces. On the surface of a large quantity of lead which had been melted and cooled in an iron pot, a number of fragments of the bitumenous shales were placed, and covered with the iron block, so as to be inclosed in and under the dome. The lead was melted in a dark room in a Bunsen furnace, which fitted closely round the sides of the pot, so that only the faintest glimmer of light escaped from between the surfaces of contact.

Upon the melting of the lead, the floating iron sank slightly into it, effectually inclosing the shale fragments. Very shortly after the lead had liquified, the iron was heard bumping against the sides of the pot; the sound of bursting bubbles was likewise audible; and wreaths of a flickering lambent vapour, which reflected apparently more light than that which escaped from the crevice in the furnace, were seen to ascend for a height of a foot or more, from around the sides of the floating iron. The form of the iron was clearly delineated in black shadow in the midst of these luminous fumes, while the surface of the lead emitted no light whatever. Whether these gaseous exhalations be phosphorescent or not, the experiment was not arranged to determine, they so appeared. This result sufficed to show that the organic matter could be and was driven out of the shale at a heat below redness.

Finally a quantity of the shale was next enclosed in a capacious iron retort, along with a large quantity of mercury, the retort placed in a furnace, and the orifice of its tube conducted beneath jars filled with water, and standing in the pneumatic trough.

There distilled over—*first*, water; *second*, carbonic acid, mixed with white vapours of a hydrocarbon; *third*, a combustible faintly illuminating gas; *fourth*, mercury along with vapours of paraffin, a highly illuminating gas, and a quantity of one of the paraffin oils; *fifth*, mercury abundantly, much heavy oil, and little feebly illuminating gas; finally after everything but mercury had ceased to distill, the retort was opened, when there was found much mercury remaining, with the fragments of shale, these upon examination were found to be unaltered in shape and bulk, they had darkened in colour, and were somewhat greasy in appearance.

On being analysed they yielded almost no volatile ingredients, and about 5 per cent. carbon, which is less than when decomposed by a red heat.

These shales, therefore, are decomposed partially at a temperature somewhat below that at which mercury boils; and totally, as regards illuminants, at that temperature.

Upon the examination of the Lydian stone bombs, it was found that they contained 6·9 per cent. of water, of which 1·01 was hygroscopic; now this quantity of water is about the normal for that mineral;—the heat therefore had not reached the point at which Lydian stone is dehydrated.

In operating to discover the temperature at which Lydian stone is dehydrated, it was found to lose, when continuously heated just below visible redness 1·963 p.c.; at a feeble red heat a total of 4·272 p.c.; at a full red a total of 4,503; and when heated to whiteness in the furnace 5·886 p.c. At the full red heat the powdered mineral slightly agglutinated, while at the white heat it fused to a blebby scoriaceous slag of a fawn colour—very similar in appearance to some vesicular lavas.

The data presented to us by the first experiments were that the shales had lost all their combustible ingredients, while the Lydian stone had not been deprived of any of its water. We have ascertained that the shales are totally decomposed at the temperature of boiling mercury, while the Lydian stone is partially decomposed at a heat below redness. We are therefore in a position to say that the temperature at which the ashes were finally ejected from the volcanic vents which ruptured the lower coal strata, probably lay between 660° and 900° Fah.

Let us now see what data we have to work upon, in attempting to estimate the temperatures at which ashes, cinders, mud and fragments of penetrated rocks, were ejected in Old Red Sandstone days.

As regards the augitic masses described, we have two circumstances to found upon; the first, that the included felspar—clearly one or other of the soda felspars—probably labradorite, had been so perfectly liquified that it had assumed spherical forms, a fact which also necessitates a *viscous* condition at least in those portions of the augite which included the felspathic spheres. The second, that we have, in the old cleavages and unaltered portions of the augitic masses, evidence either that the heat had not been high enough to vitrify them throughout, or that the period of time during which they had been subjected to that heat had not been sufficiently extended to enable them to be uniformly altered.

In other words, the heat had been such as thoroughly to liquify the felspar, but not such as thoroughly to liquify *masses* of the augite.

What heat then had sufficed?

The process employed in the determination of the water in labradorites had shown that mineral and the plagioclastic felspars generally to be liquified at the temperature of a full, but hardly a bright yellow heat.

The point of liquifaction of the augites varies largely, from readily fusible varieties to the almost infusible diallage.

Direct experiments on the mineral in question were therefore necessary.

Preliminary trials with the blowpipe showed that ordinary sized chips of the mineral were only rounded on the edges, or fused with difficulty, in the best flame that could be obtained; but when subjected to Fletcher's blowpipe, in which the air and gas are both passed through red hot tubes before combustion, a perfect glass, of a colour somewhat paler than the mineral, was readily obtained.

A quantity in chips and powder was heated at gradually increasing temperatures in a platinum crucible; it was found that the highest heat of a fine Bunsen burner had no effect in causing agglutination, even when the crucible was enclosed in a jacket. The crucible and its contents were now subjected to gradually increased temperatures in Griffin's blast furnace; at a bright yellow heat there was no change, and only when the crucible was at the point of bright ignition, approaching to a white heat, did the powder coalesce and liquify.

According to Pouillet, this accords with a temperature of 2200° or 2250° Fah.

This tends to the conclusion that the depth at which the volcanic force operated at the epoch of the Upper Old Red Sandstone was much greater than at the time when the lower coal was disrupted.

As I had myself no means of sifting from the many reports in newspapers the true from the false as regards the finding of gold in the streams of Caithness, I applied to Dr. Joass, of Golspie, and found that his experience was confined to an unsuccessful search in the Duke of Portland's land, and in the neighbourhood of the Scarabins, while he indicates reasons for receiving with caution and doubt all reported finds; this he does for reasons which will be considered when the Sutherland gold is spoken of.

I then wrote to Dr. Lauder Lindsay, who has taken an enthusiastic interest in the matter for long. From him I have received the following list of finds *reputed*.

"*Localities in Caithness of Gold finds, real or reputed, according to the newspapers of* 1869-70, *especially the* "*Northern Ensign*" (*Wick*), *in March and April,* 1869.

I. In the bed, over the banks of the Beriedele water, throughout its course, down to the sea beach.

II. In the Ord Burn, "in fair paying quantities."

III. In the Ausdale Burn ditto.

IV. On the Braemore estate (Sir Robert Anstruther's), through which the Beriedele flows.

V. On the Langwell estate, on the flanks of the Scarabin Hills, by Gilchrist, the originator of the Kildonan diggings of 1869.

VI. In the Langwell water.

VII. In the Dunbeath water, and

VIII. In the Burn of Haster.

IX. In the Lathernwheel Burn.

X. Various localities, the parish of Lathern: "existence proven."

XI. In the Thurso River, at various points, such as Weydale, Acharvadale, Halkirk, The Glut.

XII. In streams rising on Braemore.

XIII. In Strathmore, on Sir J. G. T. Sinclair's property

Special references to the *Caithness* gold localities are to be found in the "Northern Ensign" of February 4th, March 4th and 25th, and April 1st, 15th, and 22nd, all 1869.

In November, 1870, Sir J. G. T. Sinclair wrote to the "Northern Ensign," about gold that had been found on his property at Strathmore. Several other newspaper correspondents describe the *Caithness* gold—comparing it with that of Kildonan, but they do not give their names, so that the only "authentics" that can be cited in connection with *Caithness* gold are Gilchrist and Sinclair."

Dr. Lindsay thus reduces the "authentics" to two, and, as it is very improbable that Sir J. G. T. Sinclair personally found or even sought for gold, it is probable that the "find" was of the same character as the other "newspaper" ones. So that the flanks of the Scarabins would seem to stand as the only indubitable Caithness locality.

The finest varieties of Caithness flags from the Castlehill quarries were analysed by Dr. Hoffmann* with the following results,—a so-called "bituminous shale" was also analysed—

	Top Flag	Middle	Bottom	B. Shale
Insoluble Silicates	68·4	69·45	61·39	69·96
Ferric Oxide and Alumina ..	10·21	11·5	4·87	8·15
Carbonate of Lime..	10·93	10 66	21·91	7·72
Organic Matter	3·88	5·79	3·4	10·73
Loss at 100° C.	·42	·4	·2	·53
Salts of Magnesia & Alkalies..	6·16	2·2	8·23	2·91

ADDENDUM.

Fearing that the absolute non-success in the discovery of the minerals which had attended the few traverses which I made in Caithness (and which had deterred me from further search in the county) might have militated against the fairness of my report thereon, I have, since the above was written, drawn upon the knowledge of my friend, Dr. Joass of Golspie, who has interested Dr. Robert Gunn of Culgower, in the matter.

Dr. Robert Gunn applied to his cousin Mr. John Gunn, of Dale, Halkirk, who enthusiastically "made enquiries in every parish in the county;" the notes which follow are extracts from his letters, which convey the results of the whole enquiry.

(1) Gold was found at Dirlot, but in small quantities. A whole day's work of four men produced only a bit about the size of a common pin-head. This was the only specimen of Caithness gold I ever saw. I remember hearing that gold was also found at Achardle, Harpsdale, on the Thurso. A friend in the Murkle Estates' office tells me that he saw some which was found somewhere near the Thurso river, but it was not much.

I am further informed that a gamekeeper at Strathmore, in this parish, found a large quantity of the precious metal at the time when the Sutherland gold fever was at its height, but he would tell no one where the locality where he made his find was situated. He is now dead, and I fear the secret has gone with him.

Iron was got in considerable quantities near Achavarasdale Lodge on on the property of Sir R. C. Sinclair. About 150 tons were shipped; it was wholly hematite and of first quality, and was found partly in vein and partly in *pots*. The vein was not followed to any great depth, and although the working was stopped some time ago, yet it was not because the ore was exhansted, but because the carriage was too much to allow of profit. There was excitement some years ago about iron being discovered

* "Quart. Jour. Geol. Soc.", vol. xv, p. 402.

at Skinnet near Halkirk; and it was said that it was to be worked, but nothing came of it. Indeed, on making inquiries as to it, I can find no one who has *seen* iron-ore from that place, although several persons *say* it has been found there.

Iron-ore in small quantities was also found at Dirlot; as to its form it occurs in lumps of various sizes, but is of no value.

The Rev. Alex. Gunn, F. C. Manse, Walten, writes me:—

"With regard to the minerals of Caithness, I can give you very little assistance. As to metals, the field is a very barren one. I never heard of any gold being found in Caithness. Lead must also be rare, as I think it is generally associated with lime-stone, of which we have few deposits in Caithness. There is a small burn, about a mile or two from here, where I have heard small cubes of galena or lead-ore have been found, but I never had the curiosity to examine the place. The only iron I know of is found in various places, in the shape of irregular lumps, on or very near the surface of the ground, and is, I suppose, a sort of impure oxide in combination with clay. It is sometimes ground and used as paint by joiners, and makes a very good brown paint. Springs are often impregnated with it, and drains choked. There are some spots in this neighbourhood where it is very abundant."

Mr. Gunn also tells me where I can get a copy of Capt. Henderson's History of Caithness—a book I never before heard of. I will try to get the loan of it, as Mr. G. says it contains a good account of the mineral works in the county in past times. If you have not seen tho book I will send you such extracts as may appear useful.

I got a specimen of the Dirlot iron-ore (?) which proves to be nothing more than the impregnated clay spoken of by Mr. Gunn. I can get plenty of the same stuff almost anywhere in this district.

Silver and lead have been found at Skinnet, near Halkirk, both of average quality, and the latter has been also discovered at Borrowstone, near Reay. I am informed that a lot of lead (very near the surface) was lately discovered at Brawl, between Skinnet and Halkirk. I have succeeded in getting a specimen, weighing 3½lbs of this, which I forward Please advise the arrival of it and of the hematite.

"The late Sir John Sinclair, Bart., of Ulbster had, in his day, parties prospecting for coal on and around Spittal Hill in this parish. Although they were unsuccessful yet they found *something* like what they were in search of. As this took place some sixty years ago, I am unable to say what the *something* was."

Mrs. Henderson, of Westerdale, has a limestone quarry on her property which she works; it is, I am informed, of very good quality. Limestone was worked here at Dale, by my grandfather, the late Capt. Gunn, but the strata dipping it became at last too expensive to work."

Of the specimens kindly procured by Mr. Gunn and forwarded to me by Dr. Joass, I have to note that those from Achavarasdale are *limonite*, and not hematite as supposed by Mr. Gunn. One specimen is in well developed botryoidal forms, and has an appearance in colour and streak so intermediate between limonite and hematite that I regret much that its late arrival has prevented me from analysing it. In another massive granular specimen there are cavities lined with downy crystals, possibly of Göthite. A third specimen carries small doubly-terminated crystals of quartz, pleasingly stained and "capped" internally with yellow ochre. Taking the average of the specimens I have seen from the locality they are very far from "first quality."

The *galena* from Brawl is excellent, but its large foliation, and the dull blackness of its powder, indicate an unusually small percentage of silver. It had on it a small quantity of *cerussite*.

The Skinnet and Dirlot iron-ore is evidently *bog-iron-ore*.

Dr. Joass writes me—"I have come upon *a deed* among the Dunrobin papers which speaks of "all mines and minerals whatsoever whether Lead, Tin, Copper or even Coals," but which does not state that any traces of either were apparent. Anyhow nothing came of it."

"*Nothing came of it.*"—words used by Mr. Gunn also; they have to be written of all mineral enterprise in Caithness, whether scientific or sordid.