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

BY PROFESSOR HEDDLE.

ISLANDS OF UYA, HAAF GRUNAY, FETLAR, AND YELL.

THE ISLAND OF UYA.

THIS lies to the south of Unst; it is interesting as forming the connecting link which unites the rock masses of Fetlar with those of Unst.

Its western extremity is composed of diallagic rocks, containing crystals of that mineral (Hb) very inferior to those of Balta: its middle portion consists of various rocks of the "chloritic series"; towards the east there is seen a bed of graphitic slate (H) quite similar to, and doubtless the continuation of one which appears near Trista Voe in Fetlar. This bed is tilted almost on edge; it cuts through a promontory, appearing again at the northern side of a small bay, whence it strikes in the direction of Unst.

It will aid in clearly defining the position and relations of the strata.

THE ISLAND OF HAAF-GRUNAY.

This consists solely of serpentine.

This rock belongs to a different mass from that which has been described in Unst; being the northerly continuation of the Vord hill in Fetlar.

It is of a nature altogether different from that of Unst; and, as an ornamental stone, has well-marked characters, and some value.

At the north-west end of the island it is obtained of a rich oily green colour, finely diversified with blotches of a paler tint, also with masses of a sulphur-yellow, and branching veins of white.

The highly characteristic yellow serpentine yielded,

Silica	44·003
Ferrous oxide..	6·286
Ferric oxide	·108
Chrome oxide	trace
Magnesia	36 714
Soda	trace
Water	13·2
	100·311 (H)

This ferruginous serpentine is hard and somewhat brittle, unctuous, and very close-grained. It is very slightly translucent.

At the south-east shore a chocolate coloured variety, somewhat similarly veined, and with delicately delineated concentric markings is found. These markings define the progressive stages of the alteration of the rock.

At the north-west point *chromite* has been worked, not very successfully; small masses occur now and again; ordinarily it is sprinkled like grains of gunpowder throughout the yellow serpentine.

Brucite in small quantity was obtained at the time (H); and the rare mineral *pyroaurite* was first found in Britain at the same spot, by the writer.

It here bears the greatest possible resemblance to hydrotalcite, being not of a yellow, but a silvery white colour, and a pearly lustre.

It occurs in thin veins or seams in the yellow serpentine; the structure is obscurely fibrous, or pseudo-fibrous, from slickenside action.

It is with difficulty separated from the serpentine, on account of its small quantity; and it contains a little associated carbonate of magnesia, possibly from incipient decomposition. To appearance it is, however, unaltered.

The two first specimens examined were decomposed by fusion, the third by sulphuric acid. There was got,

	1	2	3
	On 1·3 grm.	On 1·23 grm.	On 1·304 grm.
Silica	6·23	6·341	
Ferrous oxide	·883		insol. 13·303
Ferric oxide	19·119		19·106
Magnesia	37·461	37·479	32·777
Chrome oxide	trace	trace	
Carbonic acid	·888	·75	·888
Water	35·778	35·961	34·049
	100·359		100·123

The last analysis having shown that an insoluble gangue was mixed with the pure mineral, careful search for samples free from this impurity was made, the analysis of these yielded,

Ferric oxide	22·134	22·452	23·625
Magnesia	37·799	37·565	36·85
Carbonic acid	1·024	1·034	
Water	39·266	39·507	40·024
	100·223	100·558	100·499 (H.)

A small amount of magnesian carbonate is still present in the two former of these analyses; they are all, however, purer than the original mineral from Wermland.

To the somewhat meagre description of Igelstrom, I have to add that the powdered mineral is not only infusible, but does not even aglutinate at a white heat; but the powder becomes chocolate brown, and strongly magnetic.

The unheated mineral is readily soluble in both sulphuric and chlorhydric acid, the solution in the latter being of a rich yellow.

This is a highly characteristic mineral; even more so here, than the golden-coloured variety from Wermland: for the absence of colour, and the presence of a pearly lustre in a silicate with 23 p.c. of ferric oxide are marked properties. The production of a magnetic powder as the result of heating will prove a ready aid to its recognition.

The golden colour seen in the foreign specimens being no longer characteristic, I would propose to name it after its discover, *Ingelstromite*. Since the determination of this substance, I have found on breaking up a large mass of the chromite of Hagdale in Unst, what I believe to be the same mineral.

It here occurs in shrinkage cracks or veins, of an earthy form, and a pure white colour,—much like a white saponite. Thrown into chlorhydric acid it is immediately dissolved, striking a bright-yellow colour. The solution contains iron and magnesia.

The 13·303 of what proved insoluble in weak sulphuric acid, was a faintly yellow powder, which yielded,

Silica	6·222		46·755	
Ferrous oxide ..	·883	=	6·644	
Magnesia	4·469		33·601	
Water	1·729		13·	
			100·	(H.)

being very similar to the serpentine previously noticed.

Serpentine in the two forms of *Marmolite* and *Picrolite* also occurs here; the colour is lively green. (H.)

At the south-east corner of the island a quantity of granular *magnetite* was raised, under the supposition that it was chromite.

In a vertical vein about the centre of the east shore *Dolomite* occurs in a form which is very unusual, if not unique. (H.)

It fills the vein chasm with a loosely coherent mass of minute sparkling granules, somewhat resembling marble, but still more gypsum, or a fine-grained loaf sugar.

Its colour is slightly yellowish white; its specific gravity 2·81.

22 grains yielded,

Carbonate of Lime	53·803
,, of Magnesia	44·852
,, of Iron	·768
,, of Manganese	·083
Silica	·874
Alumina	trace
	100·38 (H.)

It is singular that this granular and imperfectly developed variety should be more typical in composition than even the pellucid, lustrous, and well-crystallized specimens of Cross Geo, Unst.

ISLAND OF FETLAR.

Still more than in the case of Unst, is the geographical configuration of this island dependent on its geological structure.

It is bounded on the west and east by two parallel bands of gneiss and mica schist, of from four to six miles in length by one in breadth; a belt of somewhat similar dimensions passes up its centre, on either side of which and between it and the previously mentioned rocks, there lies a trough, consisting of gabbros, clay slates, and serpentines, in repeated succession.

As in Unst, the extremities of these troughs are occupied by more or less extensive arms of the sea.

The bounding gneiss and mica slate rise into ridged eminences of about two hundred feet in height; the central serpentine forms an elongated hill of 500 feet; the troughs are little above sea level.

It was stated of the island of Unst, that its rock masses were the widely spread developments of those of Fetlar: this applies more immediately to its gabbros, serpentines, and schists.

In this island these rocks coalesce like the rayed plates of a fan, or more correctly like those of two fans,—for there exist in the two troughs two independant series of somewhat similar rocks.

The first of these series is identical in almost all respects with those of Unst; the second, lying altogether to the eastward, has little or no serpentine interbedded with the schists.

One half only of Fetlar indeed,—the more westerly, is represented by the rocks of Unst; the great central serpentinous ridge and all east of it has no extension as dry land so far north as Unst; beyond this, that the serpentine of the Vord hill reappears to form the island of Haaf Grunay, to skirt the shore at Muness, and, in all probability to rise as a rocky peak in the insideous and and dreaded Colvidale Baa.

Of the gneiss of Fetlar there is little to say. The general dip, at low angles, is to the west or northwest. The strata are occasionally so deficient in felspar that the rock has much of the character of mica slate.

The mica of the beds of this rock which occur interbedded with gneiss, will, I believe, prove to be margarodite, philite, or some variety distinct from muscovite. The plates of mica are much longer than those of the general mass of ordinary mica slate; their lustre is more pearly; they are frequently associated with garnet, and the quartz is generally platey—massive quartz, which carries the mica between its plates, and not an agglutinated sand.

Towards the promontory of Lambhoga thin beds of limestone, cut by veins of granite, and associated with fine-grained quartzite, are interbedded with the gneiss. An association in which limestone carries no minerals.

The series of schistose rocks which, with interbedded gabbros and serpentines, forms the more westerly of the two troughs of Fetlar is, from the repeated alternation of its various members, of somewhat complicated arrangement.

Hibbert divides it into two, not merely as regards its bounding lines,—which may be admitted, but also as regards the nature of its component rocks.

The gabbros and serpentines which, in nearly equal amount, form the westerly section, he, from the use of the word *unstratified*, might be held as regarding as igneous; and he is perfectly precise on this point when he connects them,—as in fact must be held to be indisputable,—with the same rock masses in Unst. Of these he says that "Euphotide, by being composed of felspar and diallage, can be regarded as nothing more than a variety of greenstone or primitive trap-rock, modified by the presence of magnesian earth." Of the serpentine he says "I am decidedly of opinion that it is to be regarded as unstratified." This western section, thus referred to by Hibbert, consists of a belt of serpentine, with an eastward belt of gabbro. These are first seen a little to the north of the lake of Trista or Vailsie, and they diverge, from increase of width, extending northward so as to form the shore of the west bay of Urie, to reappear of normally increased dimensions, but with perfect identity of lithological features in the south shore of Unst.

Hibbert, however, when he crosses the easterly boundary line of his "unstratified gabbro" to enter upon the consideration of the easterly section, has to admit the existence of a *stratified* gabbro.

He locally and specially does so when he crosses the above line to consider that gabbro "which is associated with mica-slate, talcose slate, and chlorite slate," and which, with repeatedly occurring beds of serpentine, form the floor of the whole easterly trough from Trista Voe to Urie—for he says, "we must now consider euphotide as materially varied in its character, by admitting into it the ingredients of talc and mica; by the diallage showing, in its transition to talc, a more remote resemblance to hornblende, and by the conversion of the euphotide, when associated with mica slate and chlorite slate into a stratified rock."

And he does so generally, and, to use his own expression, in an "explanatory" manner, when he says "It has been observed, that when a rock occurs composed of hornblende and felspar, we give it the name of greenstone. This substance is often unstratified, particularly when it occurs in the form of mountain masses. But the same rock, when it is associated with strata of other kinds, is also liable to occur in a regular state of stratification: it is then designated by the name of greenstone slate, or hornblende slate.

"Precisely the same circumstance apply to the state under which euphotide occurs. Like greenstone, it either traverses strata, under the form of unstratified veins or beds; or on the other hand, its fissility is most easily induced in one direction only, and it is itself disposed into regular strata."

In speaking as to the stratified nature of the gabbro and serpentine of Unst, and indicating that I regarded both as metamorphic rocks, I did so in somewhat of a passing manner; and this on account first of the fact that the relationship of these rocks to indisputable schistose strata can be far more clearly seen in Fetlar; and secondly, because, the evidence on such a point being to a great extent cumulative, I desired to defer the consideration of the question to such time as I had submitted a sufficiency of such evidence.

The very emphatic manner, however, in which Dr. Hibbert has committed himself to the conclusion that both of the above rocks are of an igneous nature, calls for a more than passing notice of their features and surroundings—some criticism of the arguments which he adduces in favour of his conclusion—and an enquiry as to whether some of his own observations do not tend to strengthen an opposite view.

While a consideration of the subject in its full bearings may well be deferred, it is desirable clearly to state the appearances to be seen in a district, than which no one in the British Islands teems with more distinct evidence.

Condensing, not unduly, the argument of Hibbert as regards serpentine, we read, "All the analyses of serpentine prove that. besides containing from 40 to 50 per cent. of magnesia, this rock is distinguished from every other kind of the primitive class in this particular, that it is totally destitute of felspar."

"In many respects serpentine bears some analogy to quartz rock.

"The serpentine of Unst is divided by natural joints with large irregular blocks.

"I have also come to the conclusion that, like mountain masses of granite, stratification is only induced near the junction of the serpentine with regular strata, and that this rock ought to be classed among unstratified masses. I have remarked that the arrangement of particles constituting unstratified masses is indicated by a resemblance to crystalline laminæ, which meet each other under determinate angles, and that such an arrangement is detected by the different directions in which unstratified masses yield to the hammer.

"When I applied to this rock the test of the hammer, in order to prove whether it had one or more directions of fissility, the conclusions to which I arrived was that the apparent seams of stratification were induced by the uniform size of the blocks into which the serpentine was resolved by means of natural joints."

In perusing the above, we come to see how great a bar the hard and fast division of rocks into primary, secondary, &c., must have proved to the older geologists: how absolutely what may be called *intermedicity through metamorphism* must have been excluded from their view.

While it cannot be conceded that any one of Hibbert's four tests can be taken as evidence of serpentine being igneous, it must be at the same time pointed out that he has been singularly infelicitous in this, that his only analogy is drawn between his assumed igneous rock and one now universally regarded as metamorphic.

Nor are his admissions less damaging to his argument. "Stratification is induced," he says, "near the junction of the serpentine with regular strata." The point here is, stratification of the serpentine *as a fact* is admitted,—its having been *induced* in any way is an inference merely.

A more general admission is to be found in this, "the depressions which take place between the hill ridges are not deep valleys, but what some authors would call *furrows*." A more special one in this, "It is true that natural seams appear in the serpentine, and that these give to it much the appearance of stratification: this is very evident at Swinaness."

While as regards its cleavage we have an admission in the following:— "At the junction of the serpentine with talcose slate or chlorite slate, as on the banks of the inlet near Belmont, I perceived in a few places a fissility of the serpentine in one direction only."

So much for the serpentine; now for the diallage rock:—the arguments are much the same. "Euphotide, by being composed of felspar and diallage, can be regarded as nothing more than a variety of primitive trap-rock. On examining the rhomboidal blocks of this rock with the hammer, both at Fetlar and Unst, I found that they were fissile in several directions, and that thus the rock was decidedly unstratified."

As qualifying admissions, we read,—"On the east coast of Unst, however, there are some slight marks of stratification, the rocks yielding with facility to a blow of the hammer in one direction only. There is also a slight mark of stratification on the south of the island of Balta, where I observed thin beds of serpentine interspersed. Like greenstone, it either traverses strata under the form of unstratified veins or beds; or on the other hand, its fissility is most easily induced in one direction only, and it is itself disposed into regular strata."

"At Houbie we find euphotide, but the diallage approaches much less to the character of hornblende than to talc, and the rock may be also found to be distinctly stratified."

As regards the relationships of the one rock to the other, we take the following contrasted sentences:—"The relations of this rock (euphotide) to serpentine, along its westerly bounding lines, are very evident. There is in no instance a gradation of one rock into the other; on the contrary, the line of demarcation is perfectly distinct."

Let the sentence commencing "we must now consider,"—on page 111, be re-read, and then these:—"east of the Euphotide at Urie, we find serpentine, which contains large crystals of diallage; and at the junction of the two rocks, we find Euphotide which contains ingredients of diallage."

"All these strata of micaceous and talcose schists as well as of Euphotide, have their particles disposed in the form of striæ."

Throughout whole pages of his work, indeed, Dr. Hibbert shows the passage of Euphotide into all the several surrounding rocks, excepting only serpentine; so that the change—the only change which has taken place in the Euphotide, when he passes eastward from the fan-shaped belt at Urie to the strata of the trough—is that he passes from a belt of the rock in which he has recognised no tendency to a passage into other rocks, to other belts in which such passages were, even to himself, apparent.

The frequency, and in many cases the almost insensible nature of these transitions among the rocks of the larger valley of Fetlar, though admitted, has certainly not been sufficiently pointed out by Hibbert; while the inference that all are rocks of the same series has quite escaped him.

We find that the sequence of the rocks at the northern and southern extremities of the trough is not the same, and the covered nature of the ground in the centre does not permit of the cause being ascertained.

Starting from the sandy beach of Trista, we find that the thinned out bed of gabbro is succeeded by clay slate, which rapidly assumes an admixture of scales of graphite, forming a rock which will be further alluded to in considering the minerals; eastward it is found that the graphite fades away, the rock successively becoming again an argillaceous, and ultimately an ordinary mica slate. This is succeeded by a bed of diorite of very striking character; this in turn by one of dark green oily serpentine carrying magnetite, after which for nearly a mile there occur strata termed by Hibbert "micaceous, talcose, and chloritic slates,"—serpentine, gabbro, and rocks of an intermediate nature, in repeated succession.

Hibbert says "among the beds of serpentine may often be seen slight and confused marks of stratification. West of Houbie beds of serpentine and strata of chlorite slate often appear to alternate. At Houbie we find Euphotide, but the ingredient of diallage approaches much less to the character of hornblende than to talc, and the rock may also be found to contain mica as well as talc, *and to be distinctly stratified.*"

The nonconformity of the sequence on the Urie side of the island is somewhat strange: it is true that a thorough examination and therefore comparison cannot be made on account of the cliffs of the rock-girt southern shore being singularly inaccessible, from their being capped, to their very edges, with steep rounded grassy slopes; but such an examination as can be made seems to show that the strata strike directly towards the islets of Urie Firth.

East of the gabbro of Urie we do not, as far as I know, find the more schistose strata of clay, graphite, and mica slate, nor the diorite of the south; their place being occupied by a repetition of the serpentine and gabbro of the west; while to the east of these, the alternations are much the same as the south end of the valley, with this difference, that "chloritic" slates, so common in the south, here hardly find a place.

This wonderfully developed alternation of gabbro and serpentine with rocks of indubitable sedimentary origin,—the transitions of all of these rocks into one another, through unnameable intermediates,—the conformable and undisturbed sequence of the whole,—and their identity in strike and dip, can only point to a similarity in the circumstances of their formation;—a close and regular sequence in the periods of time when that formation occurred.

So overwhelmingly convincing indeed are the evidences as to the true nature of the gabbros and serpentine of Shetland, that they necessitated an entire change in the views of Dr. Macculloch as to these rocks. These new views he appended to his work on the *Classification of Rocks.*

As Dr. Macculloch's views are, as is usual with that author, most luminously expressed, and as they were drawn from the very ground at present being considered, this appendix to his now rare work is printed as a note.

To the eastward of the complex system of rocks, now described, there lies the huge pyriform mass of serpentine of the Vord Hill. This is alike devoid of beauty in its contour and in its internal structure. It teaches no lesson to the geologist, it is uninteresting to the mineralogist, since,—with the occasional exception of a sprinkling of grains of chromite,—no mineral is to be seen on its sterile surface.

The low ground which succeeds to the eastward is by no means so pregnant of interest as that to the west: it is occupied almost entirely by repeated alternations of micaceous "talcose" and argillaceous slates: the gradations however which occur among these rocks cannot but satisfy the observer of the great similarity of their nature, and the contemporaneousness of the formation of such rocks in certain circumstances.

From Hestaness to Strandiburgh the schists become chloritic and unusually fissile; serpentine, as might be expected, again appears, showing, according to Hibbert, "marks of stratification much more decisive" than any he saw elsewhere.

Two small indentations of the coast, near the Snap of Fetlar, show that these strata coalesce in their immediate neighbourhood; so that here again we must have a rayed divergence; but the grass-clad valley affords but few bare spots in which to satisfy oneself of the actual course of the divergent belts. They have therefore in the map been delineated as tending in straight course to their northern points of contact.

Dr. Macculloch's views of the Diallage and Serpentine of Shetland.

DIALLAGE ROCK.

"When the preceding pages were written, I had no practical knowledge of the geological connections of diallage rock, and was unable to procure any accurate information respecting it. I was therefore compelled to leave it as a subject for future correction; but it was enumerated at the end of the article on granite, as I had been informed by an observer that it was an unstratified rock, and that it belonged to the primary class. The nature of its composition seemed to claim that as its most probable place.

Having since that period had an opportunity of examining it in Shetland, where it forms an extensive tract, the following description, drawn from its characters in that country, is subjoined.

It ought of course to be introduced into the tabular arrangement among the stratified rocks of the primary class; and as it occurs, indifferently, in company with gneiss, micaceous schist, chlorite schist, and argillaceous schist, while it is at the same time rare, it may conveniently be placed in the table immediately before limestone.

It abounds in the islands of Unst, Balta, and Fetlar; and occurs also, but in very small quantity, at the northern extremity of the Mainland of Shetland. It appears further to exist in a very limited manner in Ayrshire.

In Shetland, the largest mass of this rock, which is that of Unst, succeeds, in some places to gneiss; in others to micaceous schist, chlorite schist, and argillaceous schist; and it is also found, both in this island and in Fetlar, in contact with serpentine.

Although the stratification is often very obscure, it may be determined without much difficulty; partly by the conformable direction of the masses to the prevailing bearing of the accompanying strata, and partly by its alternation with these; while in a few instances it is perfectly distinct; the strata at the same time being prolonged in a parallel direction to the general bearing, and dipping in the same manner as those of the neighbouring rocks.

The strata of diallage rock are intersected in all directions by innumerable joints, from which their frequent obscurity arises. From this cause the protruding surfaces present an aspect resembling that which is exhibited in similar circumstances by granite, an appearance which has probably given rise to the opinion that it was an unstratified substance. This feature is very remarkable in the abrupt cliffs, which are broken in an irregular manner, by fissures so numerous and extensive, as to confound all appearance of stratification.

As this rock alternates, on the large scale with the primary schistose strata before mentioned, so it frequently contains minute beds of micaceous schist, chlorite schist, and talcose schist; more rarely of hornblende and actynolite schists. In the same manner it is found to include small masses of serpentine, as well as to alternate with large bodies of the same rock. It must also be remarked that, in one or two instances, it occurs in very thin beds among the rocks now described, and very widely separated from any other mass of the same substance.

The internal structure, or rather the texture of diallage rock, is sometimes nearly granular crystalline, and it breaks like granite in any direction, although from its toughness, with great difficulty. But it is often fissile, or breaks with more ease in one direction than another. The texture then resembles that of gneiss; this effect being the result of a predominent parallelism in the crystals of the diallage. It is also very frequently intersected by extremely thin veins, or laminæ of talc, chlorite, or mica; these being only discovered by the yielding of the rock in those parts: and hence it is with great difficulty that a true fracture is procured. Lastly, it is often traversed by veins, resembling those which occur in granite and hypersthane rock, in which the constituent minerals are crystallized in larger forms, and in which either the diallage or else the felspar are at times altogether absent, the one or other mineral alone remaining.

This rock passes into talcose and chlorite schists by the intervention of mixtures of talc or chlorite with the felspar; there appearing to be transitions from diallage to both of these minerals. It seems also to pass in a gradual manner into serpentine; or at least the boundaries of the two are not always to be defined. For this reason, a mixture of diallage and serpentine has been included among the varieties in the synopsis: it is often difficult to determine whether this variety, occurring at the common boundary of the diallage rock and serpentine, belongs to the former or the latter.

SERPENTINE.

The examination of a considerable tract of this rock in Shetland, has, like the investigation of the diallage rock of the same country, given rise to an important correction of its history as it was described in the body of the work.

There can be no doubt respecting its stratification in the island of Unst. Although less regularly disposed in Fetlar, it seems there also subject to the same law. It will be necessary therefore to remove it from the division of the unstratified rocks, and to place it with the primary strata, among which it may conveniently follow limestone.

In general, in the tracts above mentioned, the great mass of serpentine seems to hold a parallel course to the stratified rocks which it accompanies, namely,— diallage rock, gneiss, micaceous schist, argillaceous schist, and chlorite schist, than to be itself disposed in strata. Yet in different places the course of the individual strata can be distinctly traced, parallel to the general direction of the whole, and dipping in a similar manner; although the *seams* or divisions between them are not strongly marked. In this respect, however, it is no more obscure than gneiss and mica schist often are; since, in these also, the stratified disposition is, in individual instances, rather inferred from analogy than deducible from observation. It still more strongly resembles limestone in this respect; the primary rocks of this nature being often very obscurely or imperfectly stratified, while occasionally they show no marks of that deposition, but rather seem to form, like serpentine, large imbedded shapeless masses, or huge irregular nodules.

It will not be difficult now to see, that by attending to the analogous disposition of these limestones, all the masses of serpentine yet described will be found to be disposed in similar modes, forming large irregular masses or smaller nodules, or else stratified in a manner more decided and general, or in the shape of small evanescent beds included in other strata.

Serpentine rock is occasionally schistose, splitting as it would appear always in the direction of the stratum."

It is to be borne in mind that the above is the finding of a man than whom no one was less of a Wernerian; of a man whose unrivalled power of description was even surpassed by the acuteness and accuracy of his observation; of a man who as a lithologist was *facile princeps* in his day; and—in our day of polariscopes, microscopes, dichroiscopes, electroscopes, goniometers, delicate balances, and above all, *facilities of comparison*, which rapidity of transit can alone confer,—if we wish to look upon his equal, we simply do not know any direction in which we can turn.

Minerals of the Gneiss.

Garnets occur in ill-defined crystals in the more micaceous beds of this rock.

Kaolin is found at Mouwick in Lambhoga.

It was attempted to be used for pottery, but with no very satisfactory result. Hibbert states that it results from the decomposition of "a whitish rock," and that the kaolin is "glistening yellowish white."

I am indebted to the Rev. David Webster for the supply of this substance, which I have examined and analysed. Mr. Webster tells me that "a vein extends the whole way to Grunie's Geo," a little south of the West Neap. From the strike of the strata about Lambhoga I regard this as doubtful.

"Glistening yellowish white" well describes it appearance, but it is so glistening, and so soapy to the feeling, and altogether so much purer looking than ordinary kaolin, as to give rise to the suspicion that it is a pulverulent talc.

Subjected to elutriation in water it is found to consist of impalpable kaolin, unctuous margarodite, and sharp angled granular quartz. The first of these can be almost absolutely and readily separated from the other two by suspension and decantation; the margarodite can be similarly freed from all quartz; but the latter can hardly be freed from all scales of margarodite. The appearance of the quartz granules is peculiar; they are not fragmentary, but sharp angled particles, which shew the impressions of the crystals of felspar and mica, which had been partly imbedded in them;—they have been saved from all attrition by the delicate packing in which they have so long reposed.

The kaolin yielded on analysis,—

Silica	46·153	
Alumina	38·352	
Ferric oxide	·878	
Manganous oxide	·384	
Lime	·603	
Magnesia	·692	
Water	13·085	
	100·137	(H.)

Of the above water ·995 p.c. is hygroscopic.

The margarodite is in so fine a state of division as to feel soapy as talc between the fingers; friction, however, failing to cause the total disappearance of the minute scales, we are enabled to pronounce this to be not talc.

This margarodite yielded,

Silica	50·768	
Alumina	31·711	
Ferric oxide	1·315	
Manganous oxide	·23	
Lime	·946	
Magnesia	·768	
Potash	5·11	
Soda	·53	
Water	7·969	
	99·347	(H.)

Mr. Collins, in his excellent account of the kaolin of Cornwall,* gives several mechanical analyses of the rough kaolin; summing up by saying that *one* of pure clay in *four* is a rich yield. The Lambhoga contrasts wonderfully favourably with this. Some few pieces have more quartz and sand than the usual. I got for the ordinary about the numbers in 1; for the more quartzy lumps those in 2; No. 3 is Mr. Collins' Treviscoe specimen.

	No. 1.	No. 2.	No. 3.
Coarse sand and mica ..	8·5		67·5
Fine sand and mica.. ..		23·	2·
Fine mica	20·	15·5	3·5
Fine clay..	71·5	61·5	22·

* "The Hensbarrow Granite District," Lake & Lake, Truro, 1878.

The *purified* Lambhoga when heated white hot showed no trace of fusion, and was of a pure white colour; it therefore, in all probability, would be well suited for the manufacture of true porcelain, as it would not prove at all *tender*.

Probably the sample previously operated upon had not been purified in any way.

In quartz on the west shore of Trista Voe large crystals of *schorl* occur (J.) *Bog iron ore* is found in large masses at the Dullans (Webster.)

The "*black magnetic sand*" noted as occurring on the shores of the Loch of Trista, is stated by Fleming—*Ed. Phil. Jour.*, vol. IV, p. 114,— to "occur along with iron-sand imbedded in small grains, in the primitive limestone in the neighbourhood."

It is found both on the north and south shores of the lake,* in a granitic sand in which it occurs to the amount of about one hundredth part of the whole.

This sand presents an appearance under the microscope different from that of any magnetic or "black iron sand" which I have examined. Among the grains there occur a few well-defined, and very slightly abraded octohedral crystals, evidently of the regular system; they are, as is the rest of the sand, jet black and lustrous. The great bulk of the sand is composed of rounded grains which have at first sight a vitrified appearance, but this is due to their surfaces being pitted with a multitude of minute conchoidal fractures, doubtless from repeated collision in the surf of the lake; their fracture therefore is conchoidal, and the lustre is extremely high. Many of the grains still retain adherent transparent quartz, whence I assign their matrix to the gneissic rock.

Excepting the octohedral crystals, the appearance of the grains is uniform, there is no admixture; the proportional quantity of crystals is very small.

The sand had been originally separated from the granitic granules by the magnet, and the process was repeated several times to free it from quartz; it did not appear, however, that there was, as is frequently the case with magnetic sands, a more and a less strongly magnetic portion†.

I have no reason to doubt so excellent an observer as Fleming, and therefore regard the occurrence of this ore in limestone as most interesting.

* From information received from the Rev. David Webster, who writes the author, that it probably was derived from a valley to the north-west called the Dullans, from whence a stream runs into the lake. The high state of the lake prevented the author from obtaining the sand, and he is indebted to Mr. Webster for the supply which he examined and analysed. Mr. Webster also sent it in larger grains from the east shore of Trista Voe.

† Mr. Webster, from observations on the spot, came to the same conclusion.

Specular iron occurs in some of the primitive limestones of Aberdeen, along with sphene.

The powder of this sand was black, with a slight tinge of brown.

Its analysis yielded,

Ferric acid	56·692
Sesquioxide of chromium	17·53
Ferrous oxide..	15·548
Manganous oxide	·6
Lime	1·288
Magnesia	3·9
Silica	5·1
	100·658 (H.)

There was no titanic acid.

The above, however, does not represent the total amount of the ferrous oxide.

It was found that the ordinarily elutriated mineral could not be decomposed by potassium fluoride and chlorhydric acid. It was therefore attacked by calcium fluoride and chlorhydric acid, after having been again elutriated twice,—thrice,—and lastly, that portion only which was held in suspension in water for three days was used.

These three quantities gave respectively 15·026, 15·38, 15·548 per cent. of Ferrous oxide. In every case a quantity of *brown* powder remained undecomposed, the amount in the last case was found to be 37·82 per cent. of what was taken.

As elutriation, and our processes for decomposing minerals for the estimation of the ferrous oxide can go no further, I must for the present rest with the admission that the above probably does not correctly represent the composition of the mineral, so far as the state of the oxidation of the iron is concerned.

From the nearly constant quantity decomposed by the hydrofluoric and hydrochloric acids, it would appear as if two substances were mixed in this sand, but the microscopic appearances in no particular countenance such a view. Dr. Fleming regarded it as "iserine mixed with iron-sand." (? Magnetite.)

Although the above analysis and that of the Unst sand first introduces a magnetic chromium-ore as British, such a compound has been before noticed.

Garrett, in his examination of the American ores, found a magnetic and non-magnetic "chrome sand."

In his formulation of these, he makes the

Non-magnetic ...... $\dot{F}e\ \ddot{C}r_2$ 89·42, $\dot{F}e\ \ddot{F}e_2$ 6·26.

The Magnetic ...... $\dot{F}e\ \ddot{C}r_2$ 61·07, $\dot{F}e\ \ddot{F}e_2$ 38·64.

The imperfect determination of the Fe prevents the Shetland sands being tabulated in the same manner as yet. They are much poorer in chromium.

All these analyses show that although the richest chrome-ores are non-magnetic, valuable magnetic varieties, which may be said to shade off into *chromiferous magnetites*, exist.

"Small crystals of *sphene* occur along with the iron-sand embedded in the limestone." (F.) This limestone I did not see, and Mr. Webster does not mention it.

Minerals of the Schistose Rocks, and the associated Gabbro, Diorite, and Serpentines of the Western Valley.

I have stated above that the covered state of the ground prevents thorough examination of this district, except on its northern and southern shores.

This most westerly rock at its northern extremity is a serpentine very similar to that of Unst, which carries little *chromite*, but much granular *magnetite*, and so in places is strongly magnetic.

Not the most powerful of these is a knoll near Odsta, where the needle points S.W., and, according to BRAND, the magnetic irregularity here, was, about the year 1700, so powerful as to render the compasses of vessels navigating Colgrave Sound almost useless; no Fetlar locality can now claim to be possessed of so high an amount of energy.

Interstitially lodged between this serpentine and the gneiss, there are to be found in the neighbourhood of Odsta, massive granular *chlorite* (Hb.), carrying small octohedrons of *magnetite* of a blue black (Hb.), also *steatite* (Hb.) "a variety of talc which in no respect differs from the common French chalk of commerce."

The "euphotide" near Urie, in the proximity of its junction with the more easterly bed of serpentine, contains imbedded crystals of *diallage* (Hb.) "confusedly intermixed with a minutely granular felspar" (Hb.), *labradorite.* The immediately succeeding serpentine also "contains large crystals of *diallage* which approach to the character of hornblende. (Hb.)*

Mr. Webster has sent me the following :—from Urie, *hornblende ;* from

* Both of these varieties of diallage are eminently worthy of being analysed. The writer was unable to visit this spot, the captain declining to risk the vessel in the westerly bay of Urie.

Urister, light-green *sahlite*, so well-marked—by its double cleavage and greasy lustre,—as to suggest the proximity of limestone; from between Urister and Crossbister, dark-green *hornblende*, imbedded in granular white *labradorite* with *pyrite*. This is probably the northern continuation of a bed to be noticed below.

In examining the rocks of the western trough along their southern cliffy shore, after some thin beds of ordinary clay slate, we, in traversing eastward, came upon a blue black crumpled schistose rock, which was first considered to be graphite, and was afterwards pronounced by Dr. Fleming to hold an intermediate place between black chalk and glossy alum-slate.

This peculiar rock I shall have to note as occurring elsewhere in Scotland, and in every case as holding a similar position, namely low down in the series of the more markedly schistose of the metamorphic rocks. I believe it to have been in every case considered graphite, and in most cases worked as such.

Upon hasty examination it appears like a fine-grained argillaceous mica slate, in which the ingredient of mica has been more or less *replaced* by scales of graphite; though, as a rule, the other ingredient is somewhat too argillaceous, not sufficiently arenaceous for such a view.

The author is not aware that those who entertain the view that this graphitic slate is a mere modification of clay or mica slate have attempted to explain the rationale of so singular an interchange, beyond this, that Cotta, in speaking of mica schist, remarks that, "from its bedding, and the rocks with which it is usually associated, we must conclude that mica schist has chiefly been formed by transmutation from very ancient argillaceous and arenaceous deposits: and that if the original rock contained subordinate strata or layers of coal or the like, these would be changed into graphite."

The rock cannot be said to bear any resemblance to black chalk. With alum-schist it has the following characters in common:—it is highly contorted; it contains, disseminated throughout it, pyrites; and it has a dark colour. But the amount of contortion is in this rock extreme; the quantity of pyrites is small, and is disposed in patches of appreciable size, not in generally diffused particles; and the colour of the rock is not black from the stain of amorphous carbon, but bluish-grey from diffused and occasionally isolated flakes, almost crystals, of graphitoidal carbon.

The amount of contortion or plication of the rock layers is very remarkable. The foldings have taken place in two directions at right angles to each other. In that in which it is most highly developed, it is vertical to what appears to have been the lines of deposit of the rock, and the height of these folds is as great as their amplitude. At right angles to this direction, that is transversely, the stone is fretted at every point with wavelets, no smooth portion being visible; and the cleavage cuts the stone vertically, or at right angles to the directions of both sets of plications. The flakes of graphite are of high lustre, and lie in cavities, or portions of the rock of a structure looser than the ordinary.

Two specimens of this substance were examined. The first was a portion of the ordinary rock, which contains thin bands and nodules of quartz. The second was sent to me by Mr. Webster; it was one of the more highly graphitic portions, being from a vein at the Black Geo,—this was cleaned from visible quartz. Both contained minute quantities of pyrites. As they either fall to pieces, or throw off scales in water, their specific gravity could not be determined.

	No. 1.	No. 2.	
Hygroscopic moisture	·6	1·121	
Water at 212°	4·078	5·075	
Carbon	1·216	8·646	
Ash	94·706	85·158	
	100·6	100·	(H.)

The rock was very slightly soluble in chlorhydric acid; after ignition it was freely soluble, leaving only a quantity of granular sand; the solution yielded silica, alumina, and ferric oxide.

The lixiviated ash gave no alum: a small quantity of sulphurous acid is contained in the 8 per cent. of the carbon of No. 2.

The above results lead to the conclusion that this is a highly metamorphosed alum-schist. The small quantity of carbon, and the interstitial bands of pure quartz, can hardly countenance the view of Cotta that it may have resulted from the metamorphosis, or be in any way attributed to the former presence of "subordinate strata or layers of coal." This peculiar rock may prove one of critical importance in the consideration of the origin of crystalline strata. According to the views of one set of theorists, crystalline stratified rocks "have resulted from an alteration of previously existing minerals of plutonic rocks, often very unlike in composition to the present, by the taking away of certain elements and the addition of certain others." It would be difficult indeed to point to the "previously existing minerals of plutonic rocks" which by such changes, or any change recognised in chemistry, would produce such a compound as the present; but it is not altogether difficult to imagine or point out changes which might convert one of the recognised alum schists into such a compound.

The formation of crystalline schists through chemical and mechanical metamorphism of sedimented rocks, is the opposing theory to the above. The sedimentation of a deposit containing a considerable amount of fucoidal or lacustrine vegetable matter, might quite rationally be supposed to have taken place at a date so much more recent than that of the Eozoon of the Laurentian, and the Scolithus and Eozoon of the limestones of Madoc, Ontario. Such a deposit would primarily form an alum shale, and under the agencies of the same processes of change which produced mica and clay slates, such a shale would be converted into the rock in question. Its occurrence cannot, therefore, but be held powerfully to support the latter of the two theories of the mode of formation of the crystalline schists.

I have already referred to having found this stratum among the cliffs of the eastern part of Uya; Hibbert does not notice its occurrence at the Urie shore, but having indicated to Mr. Webster its probable site, he instituted enquiries and has ascertained that it cuts the north shore at right angles at Rudister, the site of which I have laid down. It probably skirts the west shore of Dai island, and could it be now found on the north shore of Skuda Sound, the connection of the rocks of Fetlar with those of Unst would be complete.*

According to Hibbert, this graphitic slate is succeeded by "a series of strata where talc very frequently takes the place of mica:" he further on says, "these strata of mica slate and talcose schist will be found, for a distance of a mile, to the east;—beds of serpentine and strata of chlorite slate often appear to alternate to the west of Houbie,—while to the east of this, there is a continuation of micaceous and talcose schistus."

There are perhaps few spots in Scotland where we are more entitled to expect the occurrence of talc and chlorite schists, if such rocks are of anything but very exceptional occurrence. It is, however, to be suspected that they are so, and that the words have generally been used in a very loose manner. In collecting evidence on this point, it has here to be stated, that the only rock immediately associated to the east of the graphitic slate which I could find, was a mica slate, passing somewhat into a *margarodite*-slate,—one of the substances which, I believe, has been frequently mistaken for talc slate; and that I shall have to show that the rock to the east of Houbie is a pale hornblendic slate, while one of the strata taken for the chlorite slate, is of a similar nature. While it is very possible that some strata entitled to the two above names may occur, what very evidently does occur is as follows.

*Since the above was written a dark schist, probably the same, has been found at Skuda Sound, by Mr. Horne of the Geological Society.

About a couple of hundred yards directly east of the spot where this graphitic schist is best exposed, a bed of diorite is to be seen protruding through the turf in a gentle ridge. This diorite is of very simple composition, and it is one of the most beautiful rocks in Scotland. Giant crystals of jet black lustrous *hornblende* (H) are set in a paste of white felspar of impalpable structure. When seen in sunshine, with the light flashing from the crystals of hornblende, the contrast is most marked and the effect is quite startling; only the diorite of Glenbucket can be said in any respect to equal it.

When the rock is broken into and the crystals of hornblende, which are several inches in size, extracted, it is seen that their lustre and pitchy blackness of colour is only superficial, and is due to what must be called *incipient weathering* ; but this is a weathering which is not synonymous with decay, rotting, or degredation. Like many other varieties of hornblende, indeed like many other minerals, the beauty is enhanced, the crystals stand forth in clear relief, and the contrast with the matrix is exalted.

The "*fresh*" and perfectly unaltered hornblende is of a dull somewhat muddy green, and a slightly fibrous texture.

This hornblende has a specific gravity of 3·09. Its analysis yielded .

Silica	41·628
Alumina	11·631
Ferric oxide	1·85
Ferrous oxide	8·949
Manganous oxide	·307
Lime	9·247
Magnesia	18·509
Potash	·63
Soda	1·218
Water	5·399
	99·368 (H.)

The matrix in which the above hornblende was imbedded was both hard and tough. When broken into, its perfect whiteness was seen to be merely superficial, it had a cream colour when unaltered. It required a powerful lens to show any structure,—that appeared to be very minutely crystalline, like a very fine granular marble, with the crystalline plates lying in every direction. Its specific gravity is 3·099.

Its analysis yielded—

Silica	46·922
Alumina	30·775
Manganous oxide	trace.
Lime	16·344
Magnesia	·094
Potash	1·498
Soda	3·066
Water	1·583
	100·237 (H.)

This is *anorthite* (H.) Examined with the microscope by polarised light, it was found to be highly characteristic, differing from all other felspars in showing merely a spangled light transmitted through shapeless and mutually interpenetrating plates of small size. It is one of the very few silicates in which I found no trace of iron.

The rock, which it goes along with the hornblende to form, so far as my examination went, contains no trace of any other mineral. Anorthite has already been recognised by Delesse as a constituent of diorite, but a diorite of so simple a composition as this is, in my experience, unique.

The serpentine which succeeds to the diorite is markedly barren, but of peculiar appearance, for it protrudes from the turf in nodulated bosses of a foot or two in height; these, having been used as rubbing stones by the sheep, present finely polished surfaces of a rich oily green, above which there protrudes clusters of rough crystals and hackly masses of *magnetite*. An equally close and singular combination of smoothness and roughness it would not be easy to point to.

A distinct bed of serpentine to the east of Houbie, contains a good deal of *talc* (Hb), and of *asbestos* (Hb), in inferior specimens. In the cliffs of still another bed, just to the west of a small stream which debouches at the head of a bight, *picrolite* in fine plumous arrangements of a delicate sap-green colour, is to be obtained. (H.)

These specimens lie upon the substance which has been called *potstone*. (H.) This here appears to be a massive granular steatite with small imbedded plates of talc; it is not in large quantity or very characteristic.

Jameson states* that the serpentine cliffs "afford beautiful masses of *rock crystal*, also fine specimens of *asbestus* and *amianthus*."

The rock-crystal I did not find—its occurrence in serpentine is extraordinary.

* Mineralogical Travels.

The shore banks at Leegarth contain fair specimens of what may be called *fasciculitic asbestus* of almost a white colour (Webster.) Hereabouts the diallage rock shows the changes which Hibbert thus describes :—" the euphotide is materially varied in its character by admitting into it the ingredient of talc, and the diallage shews a transition to talc." Surely this must be read as an admission either that there is no distinct line of demarcation between the diallage and the serpentine beds, or that serpentine is formed from diallage by admitting into it the "ingredient" of talc.

These banks are partly formed of two strata of which one has been considered talc-slate, while the second has been set down as chloritic slate. The first of these is a simple mineral, occurring as a rock mass in an unrecognised allotropic form ; the second has very much of the same ultimate composition, but with a much modified appearance.

The external characters of both are such as to excuse the error in their nomenclature ; and, although a minute examination gave more than a clue to their nature, they were analysed in the desire to impart some precision to our knowledge of this class of rocks.

The first of these is of a very pale green, almost white colour ; its structure is markedly schistose, breaking with ease in one direction into flat slabs, its cross-fracture showing a laminated structure with fissile rents in the first direction ; it readily cuts with the knife, or is scraped down with the nail ; its powder and its surface are alike remarkably unctuous, quite as much so as any talc, soiling the hands when touched ; it appears to be minutely granular, but with indications of a fibrous structure, especially when bruised. No second ingredient can be detected in its mass.

It was with great ease rubbed down to a fine powder ; its particles seeming to be already in that condition.

Being familiar with the allomorphic variety of hornblende which he described from Doo's Geo., Balta, the author was enabled to recognise this as an extremely soft variety of the same ; had he not seen that mineral, he would have called it a massive talc rock,—talc schist minus the quartz granules. Its specific gravity is 2·995.

It contains

Silica	56·923
Alumina	·22
Ferrous Oxide	4·647
Manganous Oxide	·076
Lime	12·32
Magnesia	22·076
Alkalies	trace.
Water	3·4
	99·662

It is therefore a very pure schistose hornblende.

The second substance is more distinctly a *rock*. It has a leek green colour, the lens detects a trace of fibrous or platey structure, it is studded throughout with minute octohedral crystals of magnetite, and is mottled with minute brown stains. It might be fairly called a chloritic schist. It readily rots, becoming friable, brown, and markedly schistose.

Separated as far as possible from magnetite and the brown portions, it yielded—

Silica	56·1
Alumina	1·07
Ferric Oxide	·403
Ferrous Oxide	5·017
Manganous Oxide	trace
Lime	12·106
Magnesia	22·88
Soda	·314
Water	2·8
	100·69

This is evidently the same substance, existing as an ill-defined actynolite schist.

The silky softness of amianthus is well known, the smoothness of asbestus is utilised in its application as a lubricant, and geologists have now to recognise the fact that certain so-called talc schists and chloritic schists owe their impalpable unotusity to their consisting mainly of the same mineral in a pulverulent form, with a schistose arrangement of its particles.

In the cliffs of a small bight, a couple of hundred yards to the west of Aith, vein specimens are to be got of two colours, light oil and dark blackish green, these most interestingly and admirably shew the transition of a fibrous mineral into *precious serpentine*. (H.) As the fibres of these specimens have neither the silky lustre nor the separate individuality of those of chrysolite, they cannot be regarded as that variety of serpentine, although the pseudo-fibres run transversely to the vein, a marked fracture of chrysolite. They may have been pectolite, which, in an unaltered state, occurs in a somewhat similar association in Glen Urquhart.

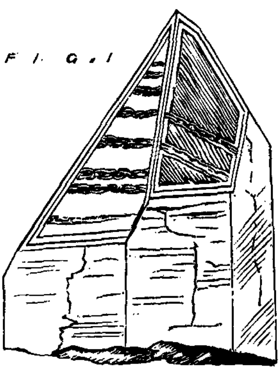
Still nearer to the houses of Aith the cliff face very rarely affords minute cubic (!) crystals of *magnetite* (H), these stud the surface of a bright yellow variety of *precious serpentine*.

This record of the yield of a shore so repeatedly and wondrously diversified by transitions of several of the members of a formation generally rich in minerals, must seem somewhat meagre; could the difficulties special to the examination of cliffs surmounted for the most part by grassy slopes, and in their greasy frontlets affording too precarious a foothold, be in favourable weather overcome by the employment of a boat, the record doubtless would be not inconsiderably enlarged.

The monotonous sameness of the serpentine of the Hill of the Vord, calls for no mention, save that *chromite* is sparingly sprinkled through it, like grains of coarse gunpowder.

Minerals of the Eastern Trough.

FIG. 1



HESTA NESS

The easterly trough of Fetlar, having as its prevailing rocks the less metamorphosed and barren clay slates, with but feeble developments of chloritic slate and serpentine, do not afford many minerals; still my fellow worker, Mr. Dudgeon, had here some measure of success.

Immediately beyond the point of Hestaness, *rock crystal* in well developed crystals of one and a half inches in length, was found in chlorite slate. (D.)* *Pyrite* and *chlorite* were associated with it.

Nearer to the point of Strandisburgh, *chrysotile*,† in small double veins, presents itself in specimens of wondrous beauty and delicacy of appearance. (D.) The double veins, separated by a band an inch thick of loosely granular *magnetite*, are not of the quarter of an inch in width, but they are formed of an aggregate of loosely coherent crystals or fibres, the colour of which is nearly of a golden yellow, while their lustre could not be surpassed.

These fibres run transversely to the veins, and the want of coherence between them, taken in conjunction with the loose granular form of the magnetite (whose grains are still feebly agglutinated by serpentinous matter), leads to the conclusion that they were extruded from the magnetite, by force from within, like wires pushed through the holes of a draw plate.

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* The crystals had a double tier of circumvallations as in the figure 1.

† In enumerating the minerals to be found at Swinaness, in Unst, I omitted chrysotile. It occurs in specimens of a yellow colour, in association with Brucite.

May not these, however, be the true crystals of serpentine,--a substance which Brewster, long ago, found to possess all the optical properties of a crystallised mineral?

There is a peculiarity of these fibres of crystalline serpentine, which I believe to be constant, at least it occurs in all the Scottish specimens; they invariably run traversely to the vein which they fill. Asbestus *almost* invariably does the opposite. I obtained from a quarry near Rothiemay,a vein of amianthus cutting massive serpentine, this vein was two inches in thickness; the fibres of the amianthus lay parallel to the sides of the vein, but this amianthoid vein contained in itself three small veins of chrysotile, the fibres of which lay transversely to the veins.

The chrysotile from Hesta yielded—

Silica	39·732
Alumina	·096
Ferrous oxide	2·923
Magnesia	41·605
Water	15·659
	100·015 (H.)

In Jameson's Mineralogical Travels, p. 215, we read of the mica-slate near Hestaness,—"this micaceous schistus presents a most splendid appearance when the sun shines, his rays being reflected from the micaceous rock as from immense mirrors."

THE ISLAND OF YELL.

This island is composed entirely of gneiss of the common laminated variety, with, in but a few spots, other varieties of the same rock. Towards the south and south-west a hornblendic gneiss conformably overlies the micaceous variety, the dip is here to the north or west of north at an average angle of 35°, and a stratum of about fifty feet in thickness, which is epidotic, intervenes.

The dip of the common gneiss throughout Yell is to the north-west, at somewhat high angles, and the out-crops of the strata thus come to form parallel ridges of hills of extreme monotony; and, from the low elevation and rounded outlines of their summits, they are utterly devoid of interest.

A certain amount of relief is afforded to the geologist by the very remarkable development of granitic and, in the south, syenitic veins which traverse the gneiss in all directions; these are particularly striking at the Noup of Graveland, which is the southern limiting headland of a, for the most part, sea-floored valley, which almost intersects the island.

Hibbert states that at the south-east corner of the island, the admission of hornblende as an ingredient is to be regarded as the cause of "distortions which are there induced in the strata" The hornblendic gneiss of the south-west of the island is, however, subject to no greater distortions than is the adjacent micaceous variety, in fact both are here free from distortions, and while it has to be admitted, that the hornblendic gneiss of Hillswick is most intricately plicated, that is unquestionably to be referred to the numerous intersecting veins of porphyry which there occur.

To the Mineralogist this island is still more uninviting than even to the Geologist. Dr. Hibbert, who characterises it as a "dreary waste," sums up his experience in the words, "the island, which I explored in various directions, will give little interest to the mineralogical traveller, being for the most part covered with an impenetrable moss.

The following is all I have to record. About a mile inland of a point of the shore intermediate between the Voes of Hamna and Burra-firth, the junction of the two gneisses with the interstitially lodged epidotic rock will be met.

The quartz of the lower micaceous gneiss is here plentifully studded with leucitoidal crystals of *garnet*. (D. and H.) These are fine in colour, being of a lively pinkish red; they are, however, much flawed. Their specific gravity is 3·997.

Their analysis afforded—

Silica	37·298
Alumina	21·095
Ferric oxide	7·47
Ferrous oxide	24·023
Manganous oxide	2·141
Lime	4·426
Magnesia	3·53
	99·983

The epidotic rock yields, in the few fissures which are present in its mass, divergent bundles of rayed needle-like crystals, of an inch or two in length, of leek green *epidote*. (D. and H.) These form interesting specimens.

Jameson states that in several places in this island he observed *bitumen* sticking upon stones or floating in small spring wells.

To this I have to add that Hibbert asserts that "at the north-east of the island plates of *mica*, the dimensions of which are several miles, may be found imbedded in granitic veins." Seeing, in the first place, that the plates found by the writer at the above locality had the dimensions only of several *inches*, and in the second, that we nowhere else read of crystals of the above mineral of such a size, we are safe in concluding that the statement was a clerical error, and that the meagre record of the minerals of Yell cannot be relieved by the chronicling of so astounding an illustration of the crystalli-polar force.

At Sandwood also, on the west coast, "lesser plates of mica are found." (Hb.)

The interesting veins of Graveland possibly may yield granitic minerals; a turbulent sea prevented all access to the coast on the several occasions on which the writer attempted to land.

It may not be out of place to warn the mineralogist whose zeal may make him desirous of perforating the "impenetrable moss" which conceals the rocks, that the so doing may not be unattended with danger:—"Brand, the missionary, tells us that one of the ministers of his time, fell into such a loose piece of ground at Yell, that his horse, furniture and all, sank beneath him, and were no more seen, while he himself with great difficulty struggled out and was saved."

ERRATA IN DR. HEDDLE'S PAPER ON UNST (MIN. MAG., No. 8).

Page 10, line 10 from bottom, for county *read* country.
,, 21, line 10 from top and throughout, for Quin *read* cross.
,, 27, line 18 from top, for Cu *read* Ca.
,, 27, line 18 ,, dele C̈.
,, 27, line 22 ,, for 4·13 *read* ·413.
,, 27, line 22 ,, for 3·06 *read* ·306.