VIII.—*On Haughtonite; a new Mica.*

By Professor Heddle.

DR. HAUGHTON, by his numerous analyses of the black mica of the Irish granites, may be said to have established the specific individuality of the *lepidomelane* of Hausmann.

That mineral his analyses showed to differ from Biotite in its great excess of ferric oxide and its comparative deficiency of ferrous oxide and magnesia.

The oxygen-ratios of Irish lepidomelanes as compared with Scotch Biotites are as follows:—

	Lepidomelane.		Biotite.
Silica	20	..	21
Peroxides	15·5	..	8
Protoxides and water ..	7	..	15

there being thus an inversion of the relative proportions of the bases.

Lepidomelane is somewhat heavier and somewhat harder than Biotite;—in other properties the minerals are similar.

I had occasion some years ago to observe that the black-scale mica of the Scotch granites and granitic dykes and rock-belts, contained much the largest proportion of its iron in the *ferrous* condition,—thus differing from lepidomelane; and that they contained very little magnesia, and thus differed from Biotite.

I also found that while in Scotland Biotite was confined to limestone and serpentinous rocks, *this* black-scale mica was never found therein, but was confined to the rock matrices I have above named.

A sufficiency of analyses have shown this Scotch mica to be altogether distinct; and I propose to name it after Dr. Haughton, whose work among the micas and granites in every way entitles him to honourable recognition.

Physically this new mica is somewhat heavier and somewhat harder than lepidomelane, and its characters as a whole give it a position which places lepidomelane as an intermediate between it and Biotite.

In submitting the analyses I have made of this mineral, I arrange them in geologic sequence, commencing with the deeper-seated rocks, and rising in succession to the more recent.

Occurrences in hornblendic (Laurentian) gneiss.

The mineral may occur in the general mass, or in the felspathic bands of this rock, but I have not yet got it in quantity sufficient for analysis. I have though obtained it in the former, in specimens sufficiently characteristic for recognition.

In the granitic veins which cut the rock it occurs in much the finest specimens that I have seen.

In the southern part of Harris a number of huge dykes cut the gneissic beds, generally at right angles.

A great dyke of this description is to be seen on the north-east side of the hill of Roneval; it is glaciated so as to be polished as well as rounded. It is so dense and solid that our heaviest hammers could not find a weak joint to attack; but my friend Mr. Dudgeon and I measured many edges of worn-down crystals of this black mica, which were over a foot in length. We had to content ourselves, however, with merely a quantity of chips sufficient for analysis;—this was, from the same cause, also the case with the magnetite which accompanied it. Only blasting tools could here effect more.

The mineral is here jet-black, transmitting light of a dark brown tint when in very thin plates. It is slightly biaxial, very tough, and so is powdered with great difficulty; the powder is black with a slight shade of green. Its specific gravity is 3·03.

Its analysis yielded—

Silica	37·164
Alumina	15·006
Ferric Oxide	7·689
Ferrous Oxide	17·353
Manganous Oxide	1·044
Lime	1·128
Magnesia	8·88
Potash	8·18
Soda	1·605
Water	2·121
	100·160

About two thirds of the water is lost at 212°, the rest is retained with extreme tenacity.

2. There is an enormous dyke which cuts through the east foot of the hill of Capval, in the south west of the same island. This dyke contains many substances, but this one only in small quantity, and in a mode of arrangement different from that of the Roneval mineral.

At Roneval the crystals were isolated and lay in almost every direction; at Capval they were in divergent groups of elongated crystals. The colour was jet black, they were slightly biaxial. Their specific gravity was 3·071.

They yielded—

Silica	36·806
Alumina..	15·22
Ferric Oxide	7·611
Ferrous Oxide	17·353
Manganous Oxide	·96
Lime	1·54
Magnesia	8·784
Potash	8·31
Soda	1·342
Water	2·47
	100·396

3. Further north on the west coast of the same island, at a point intermediate between Nishibost and Borve, there is a mass of fine-grained granite of such dimensions that I could not ascertain whether or not it was to be regarded as a vein. This granite is itself riddled with exfiltration veins, and in these the mineral is found in crystalline plates of a most brilliant lustre and a colour of pitchy blackness. Occasionally here, however, the edges of the plates are coated with a bright-red rust. They are biaxial to the extent of 2° or 3°, and their specific gravity is 3·05.

They yielded—

Silica	35·154
Alumina	16·704
Ferric Oxide	5·961
Ferrous Oxide	19·063
Manganous Oxide	1·016
Lime	·818
Magnesia	7·461
Potash	9·243
Soda	1·259
Water	3·133
	99·812

4. Still further north on the west coast of the same island, but now in the portion of it called Lewis, the same mineral occurs. The locality from which we took the specimens was the north shore of a small fresh-

water lake called Loch-na-Muilne, which is situated near the north shore of Loch Roag.

The specimens were again in granite veins, but here oligoclase was along with orthoclase an associate. The colour was dark-brown to black.

Analysis gave—

Silica	36·461
Alumina	17·253
Ferric Oxide	4·18
Ferrous Oxide	15·325
Manganous Oxide	·538
Lime	·689
Magnesia	12·23
Potash	9·204
Soda	·657
Water	3·385
	99·922

Of the water ·325 was lost at 212°.

5. Crossing to the mainland of Scotland, we find the same mineral in the same rock, and in the same association.

It may be said to be everywhere seen in the granitic veins, though it does not always occur in quantity sufficient for analysis, or even for the obtaining characteristic specimens.

The western slope of the great hill of Fionaven in Sutherland carries, at a height of 750 feet, a number of large veins. These are for the most part made up of orthoclase and oligoclase. Haughtonite is here very rare, but it is in the most lustrous and jetty-black plates that I have seen. The plates seemed here to be hexagonal.

Their specific gravity is 3·032.

They yielded—

Silica	36·75
Alumina	17·858
Ferric Oxide	2·781
Ferrous Oxide	15·175
Manganous Oxide	·416
Lime	·933
Magnesia	11·166
Potash	9·437
Soda	1·247
Water	4.232
	99·995

Of the above water ·967 was lost at 212°.

6. From a fallen mass of a granitic nature which lay near the south shore of Loch Stack, in the same county, I got larger plates of the mineral. The mass was angular and fresh, and probably had formed part of a vein in the overshadowing precipice of Ben Stack.

The mineral here was of a brown-black colour—not so lustrous as elsewhere. Its powder was somewhat greenish, its specific gravity was 3·05.

Its analysis gave

Silica	35·692
Alumina	20·086
Ferric Oxide	2·233
Ferrous Oxide	14·011
Manganous Oxide	1·
Lime	1·895
Magnesia	14·769
Potash	7·381
Soda	·529
Water	2·465
	100·061

7. A tortuous and nodular vein of red graphic-granite is imbedded in the gneiss on the north side of the little harbour of Rispond, on the west shore of Loch Erribol. Magnetite, oligoclase, and Haughtonite occur in this.

The Haughtonite is here present in small jet-black plates of a high lustre; and in large brownish ones of less lustre.

The black was analysed; its specific is 2·99.

It gave

Silica	36·538
Alumina	22·282
Ferric Oxide	2·433
Ferrous Oxide	16·009
Manganous Oxide	·784
Lime	1·249
Magnesia	10·
Potash	8·264
Soda	·794
Water	1·506
	99·856

From the Felspathic Belts of Micaceous Gneiss.

8. In the rocky face of the rounded hill called Clach-an-Eoin between the mouths of the Navir and the Borgie in Sutherland, the micaceous gneiss contains this mineral in somewhat large plates, though not in large amount. The worn edges of the crystals present themselves, and though the mineral is on its cleavage planes brown, these edges have a blue tint, and bear a singular resemblance to tarnished metallic lead. The associates here are garnet, rutile in crystals, ilmenite and chlorite —all are imbedded in quartz.

The plates of mica are clove-brown in colour, and reddish-brown by transmitted light. They are slightly biaxial.

Their specific gravity is 2·96.

They yielded—

Silica	35·846
Alumina	21·539
Ferric Oxide	4·467
Ferrous Oxide	18·306
Manganous Oxide	·307
Lime	1·249
Magnesia	8·076
Potash	7·759
Soda	·794
Water	1·956
	100·299

From intrusive veins in Micaceous Gneiss.

9. A vein of pale lavendar almost white microcline cuts the gneissic or greywacke schists with a semicircular sweep, immediately to the north of the lighthouse at Kinnaird's Head in Aberdeenshire.

This contains the mineral in very dark crystals, which, when split thin, have a fine rich dark-green colour. A small quantity of radiated Cleavelandite is also imbedded in the microcline.

The Haughtonite here is brittle, and pounds with unusual facility. It is hardly perceptibly biaxial. Its specific gravity is 3·126.

Its analysis gave—

Silica	35·666
Alumina	17·947
Ferric Oxide	7·191
Ferrous Oxide	18·063
Manganous Oxide	2·
Lime	1·4
Magnesia	1·5
Potash	9·273
Soda	3·81
Water	3·2
	100·050

This differs from all the others not only in its colour, but in the small quantity of magnesia which is present.

The locality was discovered by a former pupil, Mr. James Wilson of the Geological Survey.

From Intrusive Veins in Granite.

10. In the granite quarry of Cove, five miles south of Aberdeen, the veins carry the mineral in a peculiar association with Muscovite. Elongated crystals of the Haughtonite lie imbedded in crystals of Muscovite parallel to their larger diagonal.

It requires some force to tear the plates of the one mica separate from the other. This close consorting is singular, as the two are seldom even associated in the same rock or locality.

The colour here is brown. It is uniaxial.

Analysis gave—

Silica	35·469
Alumina	18·798
Ferric Oxide	4·611
Ferrous Oxide	19·188
Manganous Oxide	·643
Lime	·904
Magnesia	7·007
Potash	8·188
Soda	·238
Water	4·97
	100·016

From exfiltration veins in Syenitic Granite.

11. The fine-grained granite which forms the little hill of Cnoc-dubh about a mile east of Lairg in Sutherland, carries in its mass small crystals of sphene and hornblende.

A vein of a foot or two in width traverses it on its north side, and from this quite an assemblage of minerals were got.

Orthoclase, oligoclase, sphene, allanite, and this mineral, in long, narrow, pale-green crystals with a somewhat greasy lustre, and a slight appearance of decomposition all occur here. Those which were deep-seated were of the usual brown colour.

The plates here were so twisted that none sufficiently large for ascertaining either the optical properties or the specific gravity could be found.

The analysis gave—

Silica	35·555
Alumina	16·694
Ferric Oxide	1·883
Ferrous Oxide	18·037
Manganous Oxide	·694
Lime	2·722
Magnesia	8·472
Potash	9·896
Soda	·105
Water	5·714
	99·722

From Diorite.

12. There is a good deal of a dark mica throughout the dioritic rocks of Banffshire in certain localities.

This mica would appear to replace the hornblende, for in some parts of the county, as near Rhynie, the rock contains only labradorite and the mica.

Only at one spot, however, have I succeeded in getting a sufficiently large mass for analysis, so I am unable to say that all the dark mica of this rock is of the same nature; it has in many places, especially in the veins, very much the appearance of Biotite.

The locality where the mass was obtained was the west shore of the bay of the Durn near Portsoy, where by a chance-find, a portion of a vein some pounds in weight was got.

It consisted of a mass of crystals twisted into one another in most confused arrangement; the colour was a somewhat bronzy-brown; the lustre greasy and glimmering, the specific gravity 3·074.

The composition is—

Silica	34·076
Alumina	17·339
Ferric Oxide	3·613
Ferrous Oxide	18·703
Manganous Oxide	·384
Lime	3·23
Magnesia	10·538
Potash	6·78
Soda	1·193
Water	4·052
	99·908

I have also analysed specimens of doubtless the same mineral from near Cape Wrath and from the Clova Hills in Aberdeenshire; but the specimens from the former locality had apparently suffered peroxidation, while those from the latter were possibly contaminated with the gneissic matrix.

Twelve fairly closely accordant analyses from seven diverse geognostic habitats are, however, amply sufficient for estimating the claims of any substance to be considered entitled to specific distinction.

The following table presents the general accordance in composition to the eye.

	Sp. G.	$\ddot{\mathrm{Si}}$.	$\dddot{\mathrm{Al}}_2$.	$\dddot{\mathrm{Fe}}_2$.	$\dot{\mathrm{Fe}}$.	$\dot{\mathrm{Mn}}$.	$\dot{\mathrm{Ca}}$.	$\dot{\mathrm{Mg}}$.	$\dot{\mathrm{K}}_2$.	$\ddot{\mathrm{Na}}_2$.	$\dot{\mathrm{H}}_2$.	Total.
Roneval	3·03	37·16	15·	7·69	17·35	1·04	1·3	8·88	8·18	1·6	2·12	100·17
Capval	3·07	36·81	15·22	7·61	17·35	·96	1·54	8·78	8 31	1·34	2·47	100·40
Nishibost	3·05	35·15	16 7	5·96	19·06	1·02	·82	7·46	9·24	1·26	3·13	99 81
Loch-na Muilne ...		36·46	17·25	4·18	15·33	·54	·69	12·23	9·2	·66	3·39	99·92
Foinaven	3·03	36·75	7·86	2·78	15·18	·42	·93	11·17	9·44	1·25	4·23	99·99
Ben Stack	3·05	35·69	20·09	2·23	14·01	1·	1 89	14·77	7·38	·53	2·47	100·06
Rispond	2·99	36·54	22·28	2·43	16·01	·78	1·25	10·	8·26	·79	1·51	99·86
Clach-an-Eoin ...	2·96	35·85	21·54	4·48	18·31	·31	1·25	8·08	7·76	·79	1·96	100·33
Kinnaird's Head ...	3·13	35·67	17·95	7·19	18·06	2·	1·4	1·5	9·27	3·81	3·2	100·05
Cove...		35·47	18·8	4 61	19·19	·64	·9	7·01	8·19	·24	4·97	100·02
Lairg		35·56	16·69	1·88	18·04	·69	2·72	8·47	9·9	·11	5·71	99·77
Portsoy	3·07	34·08	17·34	3·61	18·70	·38	3·23	10·54	6·78	1·19	4·05	99·9
Average	3·04	35·93	18·06	4·55	18·06	·81	1·49	9·07	8·49	1·12	3·27	

The averages of the twelve, and the oxygen ratios are as follows :—

		Oxygen.		
Silica	35·93	19·16	19·16	19
Alumina ..	18·06	8·41	9·78	10
Ferric Oxide	4·55	1·37		
Ferrous Oxide	18·06	3·8	12·67	12·5
Manganous Oxide	·81	·18		
Lime	1·49	·42		
Magnesia ..	9·07	3·63		
Potash	8·49	1·44		
Soda	1·12	·29		
Water	3·27	2·91		

These ratios are so different from those of lepidomelane and of Biotite, as to leave no room for doubt that the mineral is quite distinct from either.

But the question is,—is it new? It is new as regards its specific individuality being now for the first time indicated, but not new as regards its being now for the first time analysed. From Dana's table of analyses of Biotite I select three, to which I have added two from a more recent source.

	$\ddot{Si}$	$\dddot{Al}_2$	$\dddot{Fe}_2$	$\dot{Fe}$	$\dot{Mn}$.	$\dot{Ca}$	$\dot{Mg}$.	$\dot{K}_2$	$\dot{Na}_2$	$\dot{H}_2$	Total.
16. Brand	37·18	17·53	6·20	15·35	·31	·79	9·05	5·14	2·93	3·62	98·1
17. Do.	37·06	16·78	6·07	15·37	tr.	·57	9·02	5·96	2·86	3·77	97·46
18. Hartzburg ...	36·17	18·09	8·7	13·72	...	·52	11·16	7·59	tr.	2·28	98·23
Schwarzwalder...	33·6	15·	4·99	19·29	...	3·36	11·62	7·53	·51	4·58	100·48
Tydrberger ...	35·5	18·01	9·24	12·11	tr.	3·02	10·86	9·18	1·93		99·85

The averages of these and their ratios are—

		Oxygen.		
Silica	35·9	19·1	19·1	19
Alumina.. ..	17·08	7·96	10·07	10
Ferric Oxide ..	7·04	2·11		
Ferrous Oxide	15·17	3·36	12·34	12 5
Lime	1·65	·47		
Magnesia ..	10·34	4·14		
Potash	7 08	1·2		
Soda	1·64	·42		
Water	2·85	2·75		

Being the same as the Scotch mineral, and standing forward as unimpeachable evidence of its distinctiveness.

In its atomic ratios the mineral stands intermediate between Biotite and lepidomelane, but that which really constitutes the distinctive features of these three micas is the state of oxidation of the iron.

In Biotite the relative proportion of ferrous to ferric oxide is about as 25 to 1.

In Haughtonite (Scotch) it is as 4 to 1.

In Lepidomelane it is as 1 to 9.

There are the following additional chemical distinctions:—

Biotite differs from Haughtonite in containing an amount of magnesia which is twice as great as that of the ferrous oxide; while in Haughtonite the relative proportions of the above protoxides are more than inverted. In the last mineral the iron is chiefly in the ferrous state, in lepidomelane it is chiefly in the ferric.

Altogether there can be no doubt that the mineral is a new one, and I conceive that it is most fitting that it should be named after the gentleman who first analysed the black micas of Ireland, and so established firmly the claim of lepidomelane to be considered a distinct mineral.

It is also happily fitting that it should be called after Dr. Haughton, seeing that it is in Scotland the distinctive mineral of the grey granite, a variety of that rock in the study of which Dr. Haughton has been for long engaged.

The geognostic relations of this mineral are well marked.

In Scotland Biotite occurs in limestones and serpentines, and never in granite.

Haughtonite is never found in the two former rocks, and affects granite more than any other.

We find it chiefly, however, in granitic veins, especially in exfiltration veins. It is the mica special to the mass of that grey granite which covers so large a tract of the county of Aberdeen; muscovite is hardly to be seen in this granite. And the veins of this granite almost invariably show the dark mica in large crystals.

It also occurs in the felspathic bands of gneiss, especially in the highly metamorphosed gneisses.

It is a fact, the bearing of which I have not yet attained to, that oligoclase is its almost invariable associate, and sphene and allanite also frequently accompany it.

I have never yet seen it in distinct crystals, but it has an orthorhombic habit. It frequently occurs in long tortuous crystals—an appearance which I have never seen either Biotite or lepidomelane assume.

Before the blowpipe it fuses with difficulty to a strongly magnetic bead;—the plates of the mineral assume a black of great intensity; Biotite and lepidomelane both pale in colour when heated.

It is more difficultly decomposed by acids than either Biotite or lepidomelane. Chlorhydric acid does not thoroughly effect its decomposition; it gives way to sulphuric however, the silica being left in scales which retain the original lustre of the mineral, or have even acquired a still greater brilliancy.

It does not resist the decomposing power of the atmosphere, as muscovite does; the large amount of ferrous oxide becomes an element of weakness; and some granites crumble from the changes so entailed.