XIX.—*Pilolite, an unrecognised species.*

By Professor Heddle.

ONE and all of the writers who notice the substance or substances which have received the trivial names of *mountain cork* and *mountain leather*, agree in placing them among the fibrous amphiboles, intermediate between asbestus and rock wood.

In a monograph of the hornblendes, lately published in the Transactions of the Royal Society of Edinburgh, I have indicated that the above view was probably incorrect; and having, since that monograph was issued, obtained and analysed several specimens from other localities, I now propose to show that this is a substance distinct from amphibole, and from any any other known mineral.

I found upon geognostic occurrence, and chemical difference, alike.

From the published descriptions of these substances, I select those by Phillips and Jameson as being the fullest and most precise,—supplementing their descriptions somewhat by those of other writers.

"*Mountain Cork.*—Berg cork, W.; Asbeste tressée, H.; Rock cork, J. Mountain cork has a fibrous texture, the fibres being interlaced so intimately as not to be recognisable, or capable of separation. It is opaque, has a meagre feel, somewhat resembling that of common cork; about the same hardness; is sectile like that substance; rather elastic, and swims on water. It forms veins in serpentine, and is met with in Norway, Saxony, Spain, and at Portsoy and the Lead Hills in Scotland."—*Phillips.*

"The fibres instead of being parallel, are entangled together like felt, leaving, however, numerous cavities, which give the mass a degree of buoyancy which enables it to float on water."—*Jackson*, "Minerals and their Uses."

"The particles present a loose felt-like texture, no longer recognisable or capable of separation."—*Allan.*

"Its colours are yellowish and greyish white, also ash-grey, and pale ochre-yellow. It occurs massive, in plates that vary in thickness, in forms which are composed of delicate and promiscuous fibrous concretions. Internally it is feebly glimmering or dull. The fracture is fine-grained uneven, inclining to slatey in the larger. The fragments are blunt-edged.

It is opaque. It is very soft. It becomes shining in the streak. It is sectile, almost like common cork. It is slighly elastic-flexible. It is difficultly frangible. It adheres slightly to the tongue. It emits a grating sound when we handle it. It feels meagre. S. G. 0·679 to 0·991. It occurs in veins in the serpentine of Portsoy, and in the red sandstone of Kincardineshire; in plates in the lead veins, at Lead Hills and Wanlockhead in Lanarkshire; and in small quantities at Kildrummie in Aberdeenshire."—*Jameson.*

Mountain Leather.—"Differs from asbestus in the position of the fibres. In common asbestus they are even and parallel, in mountain leather they are interwoven and interlaced. It occurs in flexible flat pieces, having much the aspect of leather, but when very thin it has been called mountain paper. It is of a whitish or yellowish or yellowish-white colour, and is meagre to the touch. It occurs at Strontian in Argyllshire, and at the Lead Hills in Lanarkshire."—*Phillips.*

"Occurs in flexible flat pieces, which have an interwoven fibrous structure, and much the aspect of leather."—*Allan.*

"The variety in plates has received the following names: *Mountain flesh*, berg flesh, carno montana, chaire de montagne, chaire fossil; *Mountain paper*, papiere fossile, berg papier; *Mountain leather*, berg leder, cerium montanum, cuir de montagne."—*Jameson.*

It thus appears that Jameson recognised that these were all varieties of one substance.

To these full and clear descriptions I have only to add, that when torn, which is accomplished with difficulty, the marked character of the stone is well seen with a glass,—namely, its *felted* structure; the minute interwoven downy fibres are hardly visible even when using the three combined powers of a pocket lens. I have also to add a property noticed by Dr. Thomson, that it greedily absorbs water like a sponge; and it then "puts on very much the appearance of wet leather." The fibres can, when it is thus saturated, be readily separated from one another.

I have said that in mineralogical works it is placed between asbestus and *rock wood.* This last I do not include with mountain cork and leather, as it manifestly is merely a structural variety of asbestus. On the south shore of Swinaness in Unst, dark-green rigid asbestus is seen passing into specimens resembling decaying wood. In a little quarry on the edge of the great wood of the Bin of Huntly on its north side, and about one and a half miles south west of the Rothiemay Station in Aberdeen, specimens of asbestus, simulating in a most remarkable manner recently split wood, are to be got. On the north slopes of the Hill of

Towanreiff, in Aberdeen, specimens harder, and resembling the fossil wood of Antigua are found; but in all these the nature of the mineral is so evident that I did not conceive it necessary to supply analytical proof.

Such being a full description of the substance itself, its geognostic relations, as contrasted with those of asbestus, have next to be noticed.

Two of the authorities above quoted,—Phillips and Jameson,—say that it is found in veins in serpentine at one locality—namely Portsoy; and serpentine, though generally associated with the augitic type of mineral, does frequently carry asbestus, and does so at Portsoy. I have failed, however, in finding the original author of the statement that mountain cork occurs at Portsoy *in serpentine*. Neither Cunningham, Macculloch, or Jameson, who all worked at this locality, say that they themselves found it in that rock.

In the collection of the late Colonel Imrie, there are specimens marked "Portsoy." This collection was purchased from a local dealer, Mr. Abraham Clark, and to him I believe the assertion is alone due. But this dealer was in he habit of attaching "Portsoy" to almost every specimen in the collections which he sold. The writer had one of these collections with specimens of the giant crystalled diorite of Glen Bucket, ticketted "Portsoy"; Glen Bucket is forty miles to the south of Portsoy. Inasmuch as the Boyne Burn, an undoubted locality of mountain leather, is but a couple of miles from Portsoy, there is great probability that the specimens above referred to were there obtained. The writer, who for three summers was located at Portsoy, searched and better searched in vain for the mineral in serpentine.

Another circumstance which tends to throw doubt on the occurrence of this substance in serpentine is this,—minerals taken from serpentinous rocks, from the nature of these rocks themselves, generally show upon their edges either a passage into the serpentine, or some fragment of that tough and tenaceous matrix adhering to them. Nothing of the kind is to be seen in the specimens ticketted "Portsoy" by Abraham Clark;—they are white or yellowish-white on their edges and surfaces throughout; there is nowhere the slightest tinge of green.

Passing to the consideration of the containing rock in those localities in which the mineral may now be or has been indubitably found, we have it occurring in crevices of granular limestone at the mouth of the Burn of the Boyne in Banffshire; in veins in a decomposing granite at the Burn of Daugh in Upper Cabrach, Aberdeenshire; in the middle of a calcareous vein which cuts the Conglomerate of the Old Red Sandstone at Tod Head, Kincardineshire; in calcareous veins in amygdaloid, near Tay Port in Fife; with some calcite in veins in silurian slate at Waulockhead; and

in sheets in the calcareous gangue of the galena at Strontian,—the vein lying between gneiss and granite.

In no one of these localities does asbestus or a hornblendic mineral occur; in no such association does any filamentous form of a hornblendic mineral occur in Scotland,—if we except the occurrence of tremolite in marble at Glen Tilt, and Shinness, and of augitic-amianthus in marble at Totaig in Invernesshire.

Of information as to the composition of mountain cork, we have the following analyses:

Silica	56·2	62·	57·2	51·75
Alumina	2·	2·8		1·95
Ferrous oxide	3·	3·2	4·37	18·90
Manganous oxide				1·85
Lime	12·7	10·	13·39	14·05
Magnesia	26·1	22·	22·85	10·85
Water			2·43	1·2
	100·	100·	100·24	100·55

The first two of the above analyses are given by Jameson, as by Bergmann; the second is by Scheerer, from the Zillerthal; the last is given by Thomson.

As this last is not stated to have been analysed by himself, has no locality attached to it, had a specific gravity of 2·442, and differs so markedly in the amount of iron and magnesia, it may at once be set aside as pertaining to an altogether different substance.

The others seem to be one and the same substance, but if so it is a substance of a nature totally different from the Scotch mineral.

The first analysis we have which relates in any way to the Scotch specimens is one by Dr. Thomson, which he published in his "Mineralogy," but as this, from the large quantity of water which he obtained, was excluded from all subsequent works on the science, and as my analyses fully bear him out in that respect, I have much satisfaction in inserting both analysis and description in full.

"*Mountain Leather.*

"This term has probably been applied to different mineral species. I confine it here to a mineral which occurs at Strontian, and which I subjected to analysis.

"Colour, light buff.

"Composed of fine threads felted like a hat.

"Feels soft, quite flexible, but tough, and like leather in appearance. Imbibes water like a sponge, and then puts on the appearance of wet leather.

"Opaque; specific gravity 1·334.

"Before the blowpipe curls up, and then fuses easily into an opaque bead. Melts with carbonate of soda into a transparent yellow bead. With borax fuses into a colourless transparent glass.

"Its constituents are,

Silica	51·65
Alumina	9·505
Ferrous oxide	5·805
Lime	10·005
Magnesia	2·065
Water	21·7
	100·73

"Whether the whole water is chemically combined or not is a question. But as the mineral feels quite dry, and may be exposed to the air without losing weight, the probability is that the greatest portion at least, is in combination with the mineral."

The phraseology here is peculiar; it will be seen further on that Dr. Thomson has in the above approached, but no more, to the observation of one of the singular points connected with this, as it is with some few other minerals,—namely, the character or nature of the connection between the water and the other constituents of the mineral—its mode of functioning in the mineral.

Undoubtedly his intention was to have written the last clause, or to have expressed it "is in combination *in* the mineral." But the suggestion as put, is in reality the correct one, though not intended, or perhaps in the least degree seen.

May there not be some part of this large quantity of water in combination with the silica of the mineral, as basic water; and may not some be in a looser state of combination with the constituents as a whole—as free water,—*aqua*,—and hence more readily separable through the operation of those agencies which physically affect water?

Some such mode of functioning as this is what the analyses of others of the minerals obtained in the north seem to indicate.

The analyses I have made are the following:

1. "From Portsoy," according to Abraham Clark's tickets, but in no collection of Clark's that I have seen are they stated to be *from serpentine*.

These specimens have formed part of a vein of about half-an-inch in thickness; they are of an appearance intermediate between that of cork and leather,—only they are nearly white; being old specimens, they are somewhat worn.

Any interstitial matter is a brownish calcite or ochry clay. Their specific gravity is about ·68, and they absorb water only slowly.

The specimens from all the localities were thoroughly air-dried before they were examined.

·77 grammes of this yielded,

Silica	51·428
Alumina	7·515
Ferric oxide	2·06
Ferrous oxide	2·486
Manganous oxide	1·298
Lime	·581
Magnesia	9·35
Water	25·043
	99·761

Of the above water 10·88 per cent. *is lost at a temperature of* 100° *C.*

2. From the limestone quarries at the mouth of the Burn of the Boyne, about two miles east of Portsoy. The mineral is only occasionally met with here; but it must then occur in considerable quantity, as a quarryman described it to the writer as being "like the rotten roots of trees."

It occurs in crevices of the limestone, which is here a high-tilted, much troubled bed, imperfectly stratified, and not highly crystalline.

The only other minerals are crystallised *calcite*, *pyrite*, and an ill-defined shining green substance, probably a mixture of saponite with steatite.

Here the mineral occurs apparently in both its forms of *cork* and *leather*. It can hardly be said that they pass into one another.

The cork adheres firmly to the limesone; the leather is prolonged from it into crevices, which are lined with a grey clay.

The leather is moderately flexible, but not very tough. Its external structure resembles the bundles of muscular fibres which, crossing each other in all direction, form the coats of a stomach or of a bladder. Its colour is pale yellowish grey.

25 grains yielded,

Silica	51·1
Alumina	6·81
Ferric oxide	2·268
Ferrous oxide	2·816
Manganous oxide	1·006
Lime	·86
Magnesia	10·163
Water	23·905
	98·928

Loss at 100° C. 9·2 per cent. of the water.

3. The "cork" which is associated with the leather at the Boyne is of quite a granular as well as fibrous character; it is also slightly yellow, and what is singular, it during the powdering falls down into a rich ochre powder.

It yielded,

Silica	39·88
Alumina	9·444
Ferric oxide	12·544
Ferrous oxide	4·975
Manganous oxide	·1
Lime	1·848
Magnesia	6·879
Alkalies	traces
Water	24·099
	99·769

Loses 7·453 per cent. of the water in the Bath. Notwithstanding the agreement in the amount of water, and in the loss in the bath, this is either a different substance, or is mixed with about 13 p.c. of iron-ochre.

4. The mineral found at the Burn of the Daugh in the Upper Cabrach, is perhaps the finest we know. Possibly this is the true locality alluded to by Jameson, when he speaks of Kildrummie, at least I was never able either to find it, or to hear of its having been found in that parish.

The Burn of Craig, north of Towanreiff, has been given as a locality, and notwithstanding my having myself failed to find it there, I regard it as a likely locality; and I have seen fine large slabs with tickets bearing that they had been there obtained.

I am indebted to a lady mineralogist, Mrs. More, of Portsoy, and to the Rev. A. Gordon, for the specimens which I analysed from the Burn of the Daugh.

The Rev. Mr. Gordon sent me fine pieces, over a foot in length, and nearly an inch in thickness. He informs me that it occurs hardly a quarter of a mile up the Burn, in veins of decomposing granite, and portions thereof are bedded in the specimens.

More than one of these shows a distinct slickenside marking on *one side* of the specimen: the other had manifestly been adherent to the granite during the motion which effected the furrowing.

These specimens show the property mentioned by Dr. Thomson, of greedily absorbing water. This they do in very large quantity, becoming like a wet glove; they are quite tender when wet. This water is, upon mere exposure, again given out, and *the specimen returns to the same state of hydration as before.*

The physical condition at this locality is solely that resembling cork. It is evidently here very pure; filaments may be stripped off, and the interior shows somewhat of a laminated structure, both in its more ready division into layers, and in its having a certain amount of that peculiar lustre which is seen on the glossy side of calves-skin. The colour is slightly yellower than that of rich cream.

It is somewhat sonorous when struck.

1·3 grammes yielded,

Silica	51·
Alumina	12·886
Ferric oxide	·094
Ferrous oxide	2·683
Manganous oxide	·076
Magnesia	7·538
Potash	·441
Soda	·265
Water	24 743
	99·726

Loss in bath 10·641 p.c. of the water.

5. The mode of its occurrence at the Tod Head in Kincardineshire is most peculiar.

This locality is on the geological horizon of one of the lower conglomerates of the Old Red Sandstone. In this locality these have been highly altered by interbedded sheets of amygdaloid, which are here clearly intrusive. This intrusion has occasioned frequent vertical rents in the stratified conglomerates, which rents cut through the imbedded pebbles, and the small amount of cement alike;—frequently shifting the two halves of the cut nodules.

In some localities wave action has on the coast removed the whole of the material which lay on one or other side of these cleavages, leaving a clean cut face studded with bisected nodules, fresh in appearance as when the rent cleft the rock. In other localities a rent which cuts from top to bottom a stratum forty to seventy feet in thickness, has its surfaces in such close approximation that the edge of a knife cannot be insinuated between them. While some remain gaping from a few inches to a foot and more apart, the chasm filled or not as the case may be with exfiltrated or injected matter.

At the promontory of the Tod Head itself there are instances of both of the above cases. At one spot a rent, which bisects conglomerate and amygdaloidal bed alike, is plugged up by injected close-grained but soft pale-green basalt.

A little north of this another rent is filled, though over a foot in width, with exuded calcite. In the very centre of this calcite there is a compound sheet consisting of mountain cork on one side, and of cyrstals of cockscomb-baryte on the other. The crystals of baryte have their free edges imbedded in the cork, so the latter was probably the last formed of the two.

The mineral here is intermediate in toughness and pliability between cork and leather, more resembling the latter however; it is nearly white in colour,—appearing merely slightly dirtied. It contains so much interstitial quartz grains and baryte that it was thrice picked and analysed before the results accorded with those obtained of specimens from other localities.

It was ultimately obtained pure by tearing it into shreds, which were gently beaten, till the grains of sand were dislodged from the fibres.

Of the *leather*, 17·3 grains yielded

Silica	52·483
Alumina	6·326
Ferric oxide	·6
Ferrous oxide	2·111
Manganous oxide	2·878
Lime	1·342
Magnesia	11·954
Water	21·702
	99·396

It lost in bath 5·995 per cent. of the water.

The fact that this vein of "leather" sometimes contains imbedded fragments of the conglomerate, seems to show that it has been formed by an exfiltrative process.

6. A specimen of the denser and more rigid variety yielded, on 25 grains.

Silica	51·606
Alumina	6·631
Ferrous oxide	2·702
Manganous oxide	2·77
Lime	1·113
Magnesia	10·811
Water	25·
	100·633

Loss in bath 9·27 per cent of the water.*

7. In the railway cutting not yet completed between Tay Port and New Port, on the south side of the Tay, I obtained the specimens next to be described.

The locality is about 200 yards west of the first of these ports.

The cutting was about 18 feet deep at the spot where the specimens were got, and the rock was perfectly firm and unaltered.

The rock is an amygdaloid with elongated steam-cavities of an inch or two in length, filled with pale green saponite; pear-shaped cavities filled either with agates or celadonite, and veins of calcite of about an inch in breadth and extending for many feet also occur. One side of these veins is sheathed with a variety of this mineral, which may be well described under the name of *rock silk*. Here the mineral is distinctly fibrous, the fibres being some inches in length; they are of extreme tenuity, generally disposed in parallel arrangement, and are rarely felted; they are highly lustrous, and pure white; occasionally passing into saponite green, or azure blue. The fibres are tough.

There being here no matting of the fibres, there are no free cavities, and the specific gravity is 2·108.

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*Two specimens as ordinarily occurring, that is not separated from included but almost invisible quartz grains,—yielded respectively.

Silica	66·026	...	63.384
Alumina	2·971		
Ferrous oxide	1·303		
Manganous oxide	1·383		
Lime	·645		
Magnesia	6·225		
Water	21·65	...	21·722
	100 203		
Loss in bath	5·045	...	6·112

1·201 grammes yielded,

Silica	54·371
Alumina	11·27
Ferric oxide	·212
Ferrous oxide	1·094
Manganous oxide	·333
Lime	·979
Magnesia	9·492
Water	22·407
	100·158

Loses in bath 9·259 per cent. of the water.

8. "From Lead hills." Such is the ticket attached to the next specimen I notice.

I found it in the collection of Mr. Jameson Torry, nephew of Professor Jameson, which collection I purchased.

As Mr. Jameson Torry collected most of his specimens with his own hands, I have every confidence in the correctness of the ticket.

The specimen was nearly white, very thin, very flexible and very tough. It seemed formed of matted fibres. It had a small portion of calcite attached.

19·8 grains yielded,

Silica	51·45
Alumina	7·981
Ferric oxide	·973
Ferrous oxide	3·286
Manganous oxide	1·487
Lime	1·97
Magnesia	10·15
Alkalies	traces
Water	21·7
	98·997

Loses 5·96 per cent. of the water in the bath; was probably contaminated with a little calcite, the carbonic acid of which may partly account for the loss.

The specimens I have of this substance from Strontian are, from its extreme levity, insufficient for analysis; they much resemble the Boyne leather, being, however, more flexible.

MOUNTAIN LEATHER.

	Loss in Bath.	$\ddot{Si}$	$\dddot{Al}_2$	$\dddot{Fe}_2$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{H}_2O$	Total.
Strontian, (Thomson)...		51·65	9·51		5·81		10·01	2·07	21·7	100·73
Tod Head	5·995	52·48	6·33	·6	2·11	2 88	1·34	11·95	21·7	99·39
Lead Hills.....	5·96	51·45	7·98	·97	3·29	1·49	1·97	10·15	21·7	98·99
Boyne Burn	9·2	51·1	6·81	2·27	2·82	1·01	·86	10·16	23·9	98 93

MOUNTAIN CORK.

Portsoy	10·88	51·43	7·52	2·06	2·49	1·3	·58	9·35	25·04	99·76
Cabrach	10·64	51·	12·88	·09	2·68	·08		7·54	24 74	99·73
Tod Head	9·27	51·61	6·63		2·7	2·77	1·11	10·81	25·	100 63
Tay Port	9·26	54·37	11·27	·21	1·09	·33	·98	9·49	22·41	100 16

This tabulation shows the two varieties to be merely allomorphs of one and the same mineral.

In calculating the formula from the average of these analyses we obtain,

		Atoms.			
Silica.....	51·636..	1·7212	1·7212=9·724	..	10
Alumina	8·616..	·1673	·177	1·	.. 1
Ferric oxide ..	·776..	·0097			
Ferrous oxide ..	2·873..	·0800	·6649	3·756	.. 4
Manganous oxide.	1·407..	·0396			
Lime	·978..	·0349			
Magnesia	10·208..	·5104			
Water	23·275..	2·5860	2·5860	14·61	.. 15

This formulated becomes,

$$Al_2O_3,\ 2\,SiO_2 + 4\,(MgO,\ 2\,SiO_2) + 15\,H_2O.$$

Making alumina the sole sesquioxide, and magnesia the only protoxide, the number of molecules of water balances all the others.

This formula gives,

Silica	52·956
Alumina	9·092
Magnesia	14·122
Water	23·83

But the formula may be written generally $(RO,\ R_2O_3)\ 2\,SiO_2 + 3\,H_2O$, which is, with the exception of RO, the formula of halloysite; here, however, $\frac{4}{5}$ of RO are intruded, making the mineral stand, in chemical characters, between halloysite and Deweylite, but in physical features it is altogether different from either of the minerals.

It can, however, be no longer associated with asbestus or the hornblendes; and for the following reasons:—

Firstly. It is never associated with any one of the many allomorphic forms of that mineral.

We have found that the formations in which it occurs are,—granular limestone,—in this, though augite is common, the hornblendic type of mineral is very rare; in *veins* of granite,—a mode of occurrence in which hornblende at least is never found; in veins in Old Red Sandstone conglomerate,—in such an association hornblende has never been described; in veins in Silurian slates,—these do not carry asbestus or hornblende; and along with calcite in a metallic gangue.

Secondly. When the fibrous varieties of hornblende become altered, they are transmuted into serpentine; and, as I have shown in the Transactions of the Royal Society of Edinburgh, the change is brought about, after the removal of the lime, by the introduction of water and the abstraction of silica; but here the silica is in full amount. And, moreover, in the formation of serpentine from hornblendic minerals, by the time that

one half of the water here present has been introduced, the magnesia has proportionally increased to an amount three times as large as that which this mineral contains.

Lastly. I argue that this mineral is related neither to an unaltered asbestus, nor to the serpentine into which that substance might be transmuted, *in virtue of the peculiarity of its mode of holding a large part of its constitutional water.*

It will have been seen above that, as regards the water which they contain, the specimens from different localities would appear to divide themselves into two varieties, *leathers* and *corks:*—the leathers containing about 21·7 per cent. of water, of which they lose about 6 per cent. at 100°;—and the corks containing about 24 per cent. of water, of which they lose about 9 per cent. at the same temperature. But these varieties alike *regain the lost water speedily from an ordinarily moist atmosphere;* and they regain it *up to the due amount and no more.*

Hornblendic minerals never function in such a way; they may be said to contain none, and they care for none.

But as I shall in future papers show, the class of minerals among which its composition places this substance, seems generally to have its peculiarity of relationship to water, as a well-marked property.

This substance therefore would seem to stand altogether apart from the mineral of which it has hitherto been considered a mere hydrated allomorph. It must also be regarded as being possessed of well-marked and very distinctive physical properties. Specimens coming from different localities and diverse geologic formations have a closely accordant composition; and that composition is capable of being reduced to an unusually simple formulaic expression.

It must therefore be regarded as a "simple mineral," and be distinguished by a specific name.

From the *felted* character which has been noticed by all those who have described it, I propose for it the name of *pilolite* (πιλος felt.)