XXII—*On Serpentinous Minerals from the Saas Thal and from Scotland.*

By Captain Marshall-Hall and Professor Heddle.

IN a letter to Dr. Heddle, Capt. Marshall Hall writes—"On the next page I give you, in complement of my last letter, the analysis of a serpentine from the Saas Thal. For the specimen I am indebted to M. Henri de Saussure. It will be interesting to compare it on the spot, and study it in its relations to the accompanying rocks and minerals.

Whether the stone is fairly serpentine with so much iron is perhaps to be questioned; I send the analysis as that of a "reputed" serpentine, and I send it to *you* as you have been doing serpentines, ... as it is possible that additional data may be of use to you.

The specimen was a rounded flattish pebble, compactly schistose.

Sp. gravity 2·56;—tough to break.

SiO_2	40·56
Al_2O_3	1·40
FeO	10·83
CaO	0·16
MgO	35·20
Loss on ignition (H_2O?)	11·80
	99 95

This analysis was made under the difficulties of no laboratory, no gas, and imperfect appliances generally.

In order to get at the lime, of which I found traces, I took too large a weight of substance, hence the pyrophosphate of magnesia *may* not be quite washed, the precipitate being too bulky. But as this does not appear to me to tend to misguide as to the nature of the rock, I shall not do the analysis overagain. The colour of my solutions indicated *chromium*, but nitrate of silver and acetate of lead did not afford me confirmative evidence. I valuemy domestic peace too highly to take a great lot and examine the H_2S and the NH_4HS precipitates on a large scale. I am rather a nuisance to my family as it is!

With the exception of this, I made a pretty complete qualitative analysis, and *failed* to find Cl, BO_3, SO_3, PHO_5, HFl or CO_2. I did find

SiO_2, FeO, Al_2O_3, CaO and Mg_3O, and the emerald and brownish colourations which make me suspect chromium. Also a brownish violet bead seemed to indicate mixed nickel and cobalt, in the NH_4HS group. C_yKS gave so feeble a re-action that any little quantity of Fe_2O_3 might have become oxidised during fusion, solution, and evaporation."*

This is an interesting illustration of the transmutation of what had probably been *enstatite*, into serpentine. It seems to stand nearly intermediate in the amount of its change between the two following Scotch specimens.

On the north-west slope of the Green Hill of Strathedon in Aberdeenshire, there are to be found specimens very similar to *bronzite*. These may be traced, with a gradual disappearance of their brown colour and their metallic lustre, to a bed of rock which upon a first inspection appears to consist of an *unaltered hornblende*. Closer inspection, however, discloses a certain amount of greasy lustre, while the knife shows that there is a deficiency of hardness. The mineral breaks into broad cleavable masses, of a dark-green colour, and a structure which is broad-foliated, but is also obscurely-fibrous.

The specific gravity is 3·01.

Analysis :—

Silica	50·921
Alumina	1·893
Ferric Oxide	9·427
Ferrous Oxide	2·085
Manganous Oxide	·307
Lime	8·645
Magnesia	21·582
Potash	·343
Soda	·433
Water	4·536
	100·172 (H.)

In this mineral, in this its less-altered condition, the *apparent* change is so slight that the eye alone could not have detected it; and it would not have been selected for analysis, had not the bronzy and more-altered specimens rendered it desirable to ascertain what were the *first steps* of the alteration.

The other specimens were found much further down the slopes of the same side of the hill. These much more resembled an alteration product of sahlite or enstatite. They occurred loose, and had palpably suffered much

* The serpentine was difficult to fuse with alkaline carbonates. M.H.

change. They were of a dull olive-green colour passing to fawn: they had a laminated or flatly-cleavable structure, with cleavages having angles near to those of augite. They were devoid of lustre, slightly porous, but had plates of talc of extreme tenuity lying between the cleavage planes. Their specific gravity was 2·158; they were brittle and easily friable.

Analysis:—

Silica	37·412
Ferric Oxide	12·925
Ferrous Oxide..	·056
Manganous Oxide	·24
Lime	·179
Magnesia	34·764
Water	13·594
	99·787 (H.)

With traces of alkalies, and 4·545 per cent. of hygroscopic water.

Both of the above contained traces of carbonic acid. Of the first it has to be said that so extensive an amount of peroxidation of the iron could not have been supposed to be compatible with the retention of a bright-green colour and a brilliant lustre; of the second, that the substance bore no resemblance to the *mass* of serpentine, but did much resemble the *brown crust* which so frequently envelopes serpentine rocks.

Compared with these specimens, it has to be remarked of that examined by Capt. Marshall-Hall, that the point most to be noted is the fact of the iron remaining in the state of protoxide, while so much water has been introduced, and silica abstracted;—the small quantity of lime, and the absence of carbonic acid have also to be noted. Its *compactly-schistose* character goes some way in indicating hornblende and not enstatite as the original mineral.

The accumulation of analyses of such substances is the first step in arriving at a knowledge as to the nature of the formation of serpentine.