XVII.—*On the Magnetism of Rocks and Minerals,*—I. *Serpentine.*

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In a former paper* I pointed out that it was likely that some of the rocks and minerals at present classed as magnetic were so only by reason of intermixture of a silicate of iron having the formula of $Fe_3 O_4 2 Si O_2$, or $Fe_3 Si_2 O_8$, and that when purified from the particles of this body by pulverization and magnetic sifting, they might be found to be either much less magnetic or even diamagnetic.

A portion of serpentine from Aberdeen was chosen, and a careful analysis made of it with the following results:—

$Si O_2$	42·91
MgO	40·04
$Fe_2 O_3$	0·77
Fe O	2·90
$Al_2 O_3$	0·65
Mn O	0·18
Ca O	0·62
$H_2 O$	11·89
	99·96

This was the average of three analyses done from a sample of about 1lb. and no alkalies were found. About 100 grammes were then taken and finely pulverized and sifted through magnetised wire gauze, again pulverized and again sifted till the wire gauze took out nothing more. Strong magnets were then used, and everything taken out which adhered to them. After this an electro-magnet capable of lifting 200 lbs. was made to revolve in a dish so as to stir the powder for about an hour, when the substance was again pulverized and warmed to render it perfectly dry and dusty, and again the electro-magnet was made to stir it. This was repeated till everything magnetic seemed to be removed, the powder was slightly moistened with water containing 0·1 per cent. of gelatine, placed in a tube stopped at one end by a plug, and rammed down till it was hard. It was then heated to about 90° C. and thus formed into a rod. This was forced out of the tube and suspended by a fibre of unspun silk, and allowed to take up a position of rest. The electro-magnet was then brought up from beneath, so that the bar hung between its poles. The rod proved to be slightly magnetic. As it was only faintly so, I determined to carry the work further, so the

* On the Magnetic constituents of Rocks and Minerals, Min. Mag., No. 4.

mineral was again subjected to pulverization and magnetic sifting for some hours, and a portion of it formed into a rod and suspended between the poles of the electro-magnet. It now proved to be diamagnetic as it slowly took up a position at right angles to the line joining the poles. Thus it was proved that my surmise was correct, and one supposed magnetic mineral was shown to be diamagnetic. It remained to determine how much of the mineral and of the iron it contained belonged to the magnetic portion, so an analysis of the diamagnetic portion was done.

The following are the results:—

SiO_2	46·25
Mg O	43·46
Fe_2O_3	0·01
Fe O	1·22
Al_2O_3	0·24
Mn O	0·06
Ca O	0·52
H_2O	8·16
	99·92

Two facts are shown by this analysis—1st, That all the ferric iron had gone with the magnetic portion; and 2nd, that pulverizing and warming the mineral had driven off some of its moisture. The temperature was never over 40° C, and the moisture so driven off was not "quarry sap," as the mineral had lain in a dry cabinet for years. The amount of magnetic substance yielded by the serpentine was 1·95 per cent. The sp. gr. of the original mineral was 2·549, of the diamagnetic portion 2·530, and of the magnetic 3·278.

Checked by the formula—

$$\frac{D}{100} = \frac{1}{\frac{x}{\Delta} + \frac{x^1}{\Delta^1}}{}^{*}$$ we have ·02549=·02543,

which shows that the work was accurately done.

An analysis of the magnetic portion gave the following results:—

Fe_3O_4	60·27
Fe O	0·85
Mn O	1·42
SiO_2	33·31
Al_2O_3	4·02
	99·87

* D=Density of original mineral, x percentage of magnetic, Δ density of magnetic, x^1 ,, ,, diamagnetic Δ^1 ,, diamagnetic.

From these analyses we see that a portion of the iron as a ferrous compound was not magnetic, or that its slight magnetism was overcome by the diamagnetism of the bulk of the mineral. The presence of ferrous and manganous oxides in the residue in conjunction with alumina is curious, and as it occurs in increased quantity in the magnetic portion, it leads to the supposition that manganous oxide and alumina may form a magnetic combination, as MnO, Al_2O_3 analogous to FeO, Fe_2O_3. I hope to be able to extend this investigation soon to other minerals or mineral mixtures.