

ART. XX.—*Pyroxmangite, a New Member of the Pyroxene Group and its Alteration Product, Skemmatite*; by W. E. FORD and W. M. BRADLEY.

THE minerals to be described in this paper were found four and one-half miles east of Iva, Anderson county, South Carolina, by Mr. George Letchworth English, of Shelby, N. C., who kindly submitted them to the Mineralogical Laboratory of the Sheffield Scientific School for investigation.

On preliminary examination one of them proved to be essentially a silicate of manganese and ferrous iron with the general characteristics of a pyroxene. It was at first thought to be a schefferite, but further study proved it to be quite distinct from that species. It differs from schefferite in that it contains only a little lime, no magnesia, and much higher percentages of iron and manganese oxides. Further, the crystallographic and optical properties show that it is triclinic. As far as the analysis goes it might be a highly ferriferous rhodonite, for the analysis given below does not differ materially from that of a rhodonite from Vester Silfberg given by Weibull and quoted by Dana as analysis 9, page 380, of the System of Mineralogy. The crystallographic and optical characters of the two minerals do not, however, agree as shown below. The cleavage angle of pyroxmangite differs from that of rhodonite by about half a degree. The extinction directions of the two minerals differ by angles ranging from 10 to 13 degrees. The axial angle of pyroxmangite is small and its optical character is positive, while the axial angle of rhodonite varies between 72° and 76° and it is optically negative. Pyroxmangite differs markedly in its composition from that of babingtonite. The conclusion, therefore, is that it is a new member of the Pyroxene Group, belonging in the triclinic section.

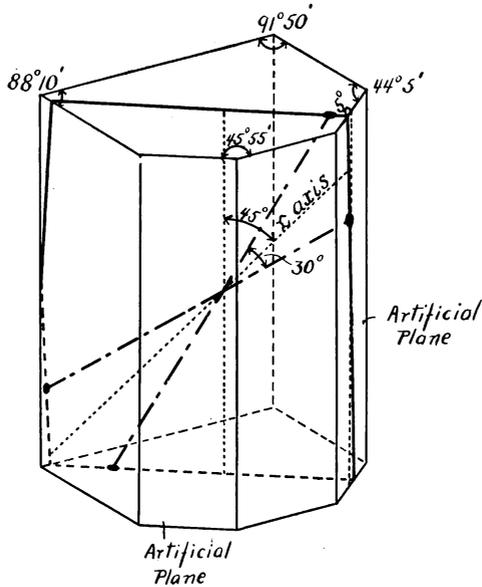
It was found only in cleavable masses, no indication of crystal forms being observed. It is triclinic as proved by the character of its cleavages and its optical structure. It shows two cleavages, one of which is quite good while the other is rather poor. The difference in the quality of the two cleavages is very distinct. The average of a number of measurements gave the angle between the two cleavage planes as $91^{\circ} 50'$. A parting plane, occupying the position of the crystal face b (010) was occasionally to be observed. The angle between this plane and the better cleavage was measured as $45^{\circ} 14'$, giving the angle between it and the poorer cleavage as $42^{\circ} 56'$.

The hardness is 5.5–6. The specific gravity was determined as 3.80. The luster is vitreous, inclining to resinous. Its color

is amber, yellowish brown, reddish brown to dark brown, the darker colors predominating. It is translucent to opaque. It fuses quietly about 3 to a black and magnetic globule. It gives the manganese color reactions with the fluxes. It is insoluble in acids.

The mineral was poorly adapted for optical observations and measurements, but the following facts were established. It is biaxial and optically positive. A section cut in the prism zone and making an angle of $44^{\circ} 5'$ with each of the cleavages

FIG. 1.



(i. e., a section near the position of the parting plane, $b(010)$), showed an extinction angle measured to the trace of the prismatic cleavage of about 5° . A section cut parallel to the parting plane showed an extinction practically parallel to the lines of cleavage. The axial plane is normal to the parting plane, $b(010)$. A section cut in the prism zone at right angles to the first section mentioned above and making an angle of $45^{\circ} 55'$ with both cleavage planes, showed an extinction angle of approximately 45° with the trace of the cleavage. The refractive index was measured by immersion of fragments of the mineral in high refracting liquids and by applying the Becke test to them it was found to range between 1.75 and 1.76. The optical angle was measured under the microscope

by the drawing table method of Becke and was determined as approximately $2V = 30^\circ$. The above facts are shown graphically in fig. 1. It is to be understood that because of the lack of crystal faces the exact orientation of the cleavage pieces is impossible, and therefore the position of the extinction directions might be the reverse of that shown in the figure.

The mineral was intimately associated with a black iron-manganese oxide, a description of which will be found beyond. This oxide is evidently an alteration product. The material used for analysis was selected from the purest specimen. It was crushed and the fragments sifted to an uniform grain. By experimentation it was found that the pyroxmangite was not attacked by hydrochloric acid, even at boiling temperature, but that the black oxide was completely soluble under such conditions. Consequently the powdered material was boiled in dilute hydrochloric acid until the decanted acid showed no further test for iron. After such treatment the grains of pyroxmangite, when examined under a lens, appeared of an uniform character, showing bright and unetched surfaces.

The method of analysis was briefly as follows. Water was determined by the direct method of Penfield.* Silica was determined as usual. The sesquioxides were separated by the basic acetate precipitation, dissolved in nitric acid and reprecipitated by ammonium hydroxide. The filtrate from the basic acetate and that from the ammonium hydroxide precipitations were evaporated separately and any further precipitates collected. The manganese was precipitated in the combined filtrates by means of bromine water, dissolved by strong sulphur dioxide water and again precipitated by acid sodium phosphate. Calcium was precipitated as the oxalate in the filtrate from the first manganese precipitation. No magnesium was found. Total iron and alumina were determined as usual. Careful qualitative tests proved that the iron was all ferrous in valence. The results of the analyses by Bradley follow:

	I	II	Average Ratios		Subtract ratios equivalent to RO. Al ₂ O ₃ . SiO ₂ .
SiO ₂	47.17	47.11	47.14	0.78	-0.023 = 0.757 = 1.00
MnO	20.72	20.55	20.63	0.29	} 0.717 -0.023 = 0.694 = 0.917
FeO	28.30	28.38	28.34	0.394	
CaO	1.85	1.91	1.88	0.033	
Al ₂ O ₃	2.50	2.26	2.38	0.023	-0.023
H ₂ O	0.37	0.29	0.33		
	<u>100.91</u>	<u>100.50</u>	<u>100.70</u>		

* This Journal, *xlvi*, 31, 1894.

The analysis yields molecular ratios that agree with the accepted type of a pyroxene formula. The small amount of water was disregarded. It was probably due to incipient alteration. The alumina was presumed to be present in the combination $RO \cdot Al_2O_3 \cdot SiO_2$. After subtracting the proper amounts from the silica and protoxide ratios to satisfy this formula, the resulting ratios $SiO_2 : RO$ reduce to $1.00 : 0.917$ which gives the metasilicate formula, $RSiO_3$. The name *pyroxmangite* was given to the mineral in order to indicate that it is a *manganese pyroxene*.

As stated above, there was a black oxide of iron and manganese intimately associated with the pyroxmangite. The oxide

FIG. 2.



is unmistakably an alteration product. It surrounds the unaltered silicate, occurring on the outside of the specimens. The change from one substance to the other while confined to a small space is nevertheless gradual, there being no sharp dividing line between the two. In certain instances prominent cleavage and parting planes, which were evidently formed before the alteration took place, could be traced unbrokenly from one mineral into the other. Fig. 2 represents the change as shown in a thin section under the microscope. The alteration penetrates the pyroxmangite first along the cleavage cracks. The beginning of the alteration is shown in the section by a darkening of the color of the silicate to brown, which gradually intensifies until the substance becomes black and opaque.

This oxide is metallic in luster, giving a dark chocolate-brown streak. It is fusible about 4 to a black magnetic globule. Its hardness is between 5.5 and 6.0. When heated in the closed tube it yields abundant water and also gives off

oxygen gas. It gives manganese reactions with the fluxes. It is readily soluble in hydrochloric acid, giving off chlorine gas.

The method of analysis was as follows. The mineral was crushed and then dissolved in hydrochloric acid, the weight of the insoluble residue being deducted from that of the original portion. The sesquioxides were separated by the basic acetate precipitation and determined as usual. The manganese was determined as outlined above in the case of pyroxmangite. The available oxygen in the manganese oxide was determined by means of the oxalic acid method. The iron was proved to be all ferric in valence. The water was determined by the Penfield direct method.

The results of the analyses by Bradley follow :

	I	II	Average
MnO	31.71	31.96	31.84
O	6.50	6.56	6.53
Fe ₂ O ₃	43.67	44.24	43.95
Al ₂ O ₃	2.43	1.49	1.96
H ₂ O	15.57	15.55	15.56
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	99.92	99.76	99.84

The ratio of the manganous oxide to the available oxygen is as 0.448 : 0.408 or as 1 : 0.910. This indicates that the oxide of manganese present must be almost wholly the dioxide, MnO₂. In the calculations to follow it has been assumed that the sum of the percentages of manganous oxide and available oxygen represent the percentage of manganese dioxide present. Considered in this way the analysis becomes as follows :

	Average	Ratios	Theoretical Composition
MnO ₂	38.36	0.441 or 1.48 or 3.00	37.88
Fe ₂ O ₃	43.95	0.298	46.44
Al ₂ O ₃	1.96		
H ₂ O	15.57		
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	99.83		100.00

From the ratios given above is derived the following formula, which closely expresses the composition of the mineral, 3MnO₂.2Fe₂O₃.6H₂O. The theoretical percentage composition corresponding to this formula is given in the last column above and agrees closely with the results of the analysis.

Although many oxides of manganese have been described, no one of them agrees with this mineral in its composition. Two new oxides of manganese from India, vredenburgite,

$3\text{Mn}_2\text{O}_4 \cdot 2\text{Fe}_2\text{O}_3$, and sitaparite, $9\text{Mn}_2\text{O}_3 \cdot 4\text{Fe}_2\text{O}_3 \cdot \text{MnO} \cdot 3\text{CaO}$, have been recently described by Fermor.* They contain ferric oxide in considerable amounts, but do not correspond in other respects to this mineral. Consequently, if this material is to be taken as a distinct species it must be considered as new. The grave question arises, shall a mineral which is so obviously an alteration product, and which shows no crystal form, be dignified by a species name? The close agreement of the analysis with the assumed formula is an argument in favor of its being a distinct species, but yet such an agreement might very well be accidental. Other analyses of material from the same locality, or better, of material from some other occurrence, would help to settle the problem. In order, however, that the above description and analysis be not overlooked in any future work on similar minerals, the name *skemmatite*, derived from the Greek, *σκέμμα*, a *question*, is proposed for the material.

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