

DESCRIPTION OF FERROANTHOPHYLLITE, AN ORTHORHOMBIC IRON AMPHIBOLE FROM IDAHO, WITH A NOTE ON THE NOMENCLATURE OF THE ANTHOPHYLLITE GROUP.

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INTRODUCTION.

In the summer of 1919 Mr. Frank Barker, of Kellogg, Idaho, sent to the United States National Museum for identification a lot of an asbestiform mineral which he had found in the Tamarack-Custer mine near Gem, in the Coeur d'Alene district. This material has been investigated and found to be an orthorhombic amphibole similar in properties to anthophyllite but practically free from magnesium. For this iron end member of the anthophyllite group the name *ferroanthophyllite* is here proposed. Requests for additional specimens of the amphibole and associated minerals and for detailed notes regarding the occurrence have elicited no reply from Mr. Barker. The type material is preserved in the United States National Museum (Cat. No. 93998).

OCCURRENCE.

The only facts regarding the occurrence of this interesting mineral which are available are the statement in the letter accompanying the material that it came from the mine and the fact that galena is intergrown with the amphibole in the specimens received. The latter circumstance apparently proves that the mineral occurred in the ore of a galena-bearing vein. While the Tamarack-Custer mine is located no great distance from the contact of an intrusive mass of quartz-monzonite and several dikes of quartz-monzonite porphyry are cut by the workings of the mine, the inclosing rocks are relatively unaltered quartzites in which metamorphic silicates in megascopically visible aggregates have nowhere been found. The occurrence of considerable masses of a fibrous amphibole intergrown with galena in the vein is therefore decidedly unusual. Ransome<sup>1</sup> found a similar asbestiform mineral intergrown with galena in the ore of the

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<sup>1</sup> Ransome, F. L., and Calkins, F. C., *Geology and Ore Deposits of the Coeur d'Alene District, Idaho*: U. S. Geol. Survey, Prof. Paper 62, p. 99, 1908.

Hercules mine in the same district. This mineral, which was in amount too small for analysis, had in general the properties of anthophyllite. Determination of refractive indices made by the writer on the material of Ransome's original specimen which is preserved in the United States National Museum (Cat. No. 77071-91) indicate that this also is the iron amphibole entirely similar to that from the Tamarack-Custer mine.

#### DESCRIPTION.

The material as received consists of splintery-fibrous masses of a pale grayish-green color when dry and olive green when moist. In all, about 250 grams of the mineral were received. The individual fibers reach a maximum length of 6 centimeters. The material separates readily into very fine silky fibers, which are quite strong and flexible, being comparable to a poor quality of chrysotile, which the material greatly resembles. The true hardness of the mineral could not be determined as its fine fibrous structure renders it too weak to scratch any mineral harder than calcite. The specific gravity as determined on the Kraus modified Joly balance on pieces, probably not entirely free from included air, is 3.24 (mean of 5 determinations). The only associated mineral is fine granular galena, which occurs as minute veinlets cutting across the fibers, as thin fillings between the fibers, and as small nodules around which the fibers are curved.

#### OPTICAL PROPERTIES.

Under the microscope the ferroanthophyllite is seen to consist of aggregates of exceedingly fine fibers, which singly appear colorless and transparent. Aggregates of a number of fibers show the green color and pleochroism of the mineral. The extinction is in all cases exactly parallel to the edges of the fibers. No regular terminations could be seen nor could the shape of cross section of the fibers be determined owing to their extreme thinness. The elongation is positive, as in anthophyllite, while the birefringence is slightly lower than that of anthophyllite. The indices of refraction and the birefringence as determined by immersion are as follows:

$$\alpha = 1.668 \pm .003$$

$$\gamma = 1.685 \pm .003$$

$$\gamma - \alpha = .017 \pm .003$$

The pleochroism is distinct in the aggregated fibers, as follows:

$\alpha$  = pale brownish green.

$\gamma$  = deep brownish green.

Since the fibers are exceedingly minute and adjacent fibers are not in parallel position, the optic axial angle and the intermediate value for refractive index ( $\beta$ ) could not be accurately determined although the axial angle ( $2V$ ) is apparently moderately large.

## CHEMICAL PROPERTIES.

An analysis made upon selected fibrous material, which optical study had shown to be pure, yielded the following results:

*Analysis of ferroanthophyllite from Idaho.*

Silica (SiO <sub>2</sub> ).....	49.30
Alumina (Al <sub>2</sub> O <sub>3</sub> ).....	1.30
Ferric oxide (Fe <sub>2</sub> O <sub>3</sub> ).....	2.15
Ferrous oxide (FeO).....	30.50
Manganous oxide (MnO).....	3.48
Lime (CaO).....	10.73
Magnesia (MgO).....	.66
Water (H <sub>2</sub> O) below 110° C.....	.18
Water (H <sub>2</sub> O) above 110° C.....	2.13
Total.....	100.43

The above analysis yields the following ratios:

*Ratios of ferroanthophyllite from Idaho.*

SiO <sub>2</sub> .....	0.8176	8176
Al <sub>2</sub> O <sub>3</sub> .....	.0127	} 262
Fe <sub>2</sub> O <sub>3</sub> .....	.0135	
FeO.....	.4246	} 7996
MnO.....	.0491	
CaO.....	.1913	
MgO.....	.0164	
H <sub>2</sub> O.....	.1182	

For the sake of simplifying consideration of the ratios, the ferric oxide and alumina may be deducted as the gedrite molecule, RO.R<sub>2</sub>O<sub>3</sub>.SiO<sub>2</sub> (×262), the ratios remaining after this deduction being:

RO.....	7734	1×1.00
SiO <sub>2</sub> .....	7914	1×1.02

The formula thus derived for the mineral is:



or RSiO<sub>3</sub> with R = Mn:Ca:H<sub>2</sub>:Fe = 2:8:5:17 approximately.

It will be noted that the water given off above 110° C. is here included among the bases as an essential constituent, although present views as to the occurrence of water in minerals hold that it is quite possible for such an amount of water to be mechanically held through adsorption by a mineral of this kind. In the present case the analysis requires that the water be considered basic in order that the composition of the mineral may be expressed as that of a normal metasilicate. It seems more plausible here to regard the water as constitutional than to reject it as extraneous and leave the analysis with an excess of silica which can not be otherwise accounted for. Water is frequently considered to be a basic constituent of amphiboles.

## PYROGNOSTICS.

Before the blowpipe the mineral fuses at a moderately high temperature to a black strongly magnetic slag. In the borax bead it reacts for iron and when fused with a large excess of sodium carbonate it reacts for manganese. It yields a small amount of water at a high temperature in the closed tube and is insoluble in acids.

## NOMENCLATURE.

The above chemical and optical descriptions indicate that this asbestiform material from Idaho is an orthorhombic amphibole very similar in properties to anthophyllite yet practically free from magnesia, being in fact essentially an iron end member of the anthophyllite group despite the fact that the iron is replaced to some extent by calcium, manganese, and basic hydrogen. Search of the literature has revealed two previously described occurrences of practically pure orthorhombic amphiboles of the same sort. C. H. Warren<sup>2</sup> in 1903 described such a mineral, an orthorhombic pure iron metasilicate resembling anthophyllite, occurring as reaction rims surrounding inclusions of fayalite in pegmatite in the granite of Cape Ann, Massachusetts. No quantitative analysis of this material was made, but a qualitative analysis established the practical absence of alumina and magnesia. While recognizing the fact that an entirely new and distinct member of the anthophyllite group was here represented, the author did not give the mineral a distinctive name, but referred to it as anthophyllite, doubtless because enough of the mineral had not been separated for a quantitative analysis. Palmgren<sup>3</sup> in 1917 found a similar amphibole in the eulysite of Soedermanland, Sweden, which upon analysis gave the following results:

*Analysis of orthorhombic amphibole from Sweden.*

Silica (SiO <sub>2</sub> ).....	47.46
Titanium dioxide (TiO <sub>2</sub> ).....	.03
Alumina (Al <sub>2</sub> O <sub>3</sub> ).....	.14
Ferric oxide (Fe <sub>2</sub> O <sub>3</sub> ).....	.34
Ferrous oxide (FeO).....	42.23
Manganous oxide (MnO).....	3.88
Magnesia (MgO).....	5.05
Lime (CaO).....	1.05
Water (H <sub>2</sub> O).....	.07
Total.....	100.25

Palmgren also emphasizes the fact that this amphibole is distinct from anthophyllite, but, following Warren, whom he cites, he uses

<sup>2</sup> Warren, C. H., Anthophyllite with the fayalite from Rockport, Mass., Amer. Journ. Sci., vol. 16, p. 339-340, 1903.

<sup>3</sup> Palmgren, John, Bull. Geol. Inst. Univ. Upsala, vol. 14, p. 133, 1917.

the name eisenanthophyllite, which becomes iron anthophyllite in English. The present writer prefers the form ferroanthophyllite as the name for the iron end member of the anthophyllite group despite the fact that the magnesium end member of the series will then require the rather unwieldy name magnesioanthophyllite. This nomenclature is in accord with that recently used by American mineralogists to designate end members of isomorphous groups.<sup>4</sup> The group name anthophyllite will then indicate intermediate mixtures of the two end members of the series, while the name gedrite will continue to indicate important admixture of the aluminous molecule. The possibility of occurrence of lime and of manganoous members of this series is remotely indicated.

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<sup>4</sup> See Wherry, E. T. (Bariohitecockite, strontiohitecockite, etc.), Proc. U. S. Nat. Mus., vol. 51, p. 83, 1916; Schaller, W. T. (magnesioludwigite, ferroludwigite), Journ. Wash. Acad. Sci., vol. 7, p. 29, 1917, and (manganoaxinite, ferroaxinite, etc.), Bull. U. S. Geol. Survey No. 490, p. 47, 1911.