MAGNESIOSUSSEXITE, A NEW MINERAL FROM A MICHIGAN IRON MINE, ISOMORPHOUS WITH SUSSEXITE AND CAMSELLITE

JOHN W. GRUNER, *University of Minnesota.*

Two years ago Mr. A. L. Foss, at that time mining engineer at Ramsay, Michigan, sent the writer a specimen for identification. The exact occurrence of the specimen was given by Mr. Foss as a drift on the 25th level of the Eureka mine, Gogebic iron range. The mineral occurs as veinlets in the iron ore where the SiO_2 content gradually rises from 10 per cent to 30 per cent. The veins were discovered in the more siliceous ore.

The specimen is a part of a veinlet about $\frac{3}{4}$ of an inch wide as may be seen from the hematite attached on both sides. It is fibrous, though the fibers are hard without flexibility or elasticity. They are almost normal to the walls of the vein. The color is straw yellow to buff. The hardness is 3. The specific gravity is close to 2.83. Luster is dull to silky. Fusible at about 3 to a nearly black mass. It gives a boron green flame. Soluble in HCl giving a peculiar opalescent solution. A borax bead shows the presence of manganese.

The indices of refraction are $\alpha = 1.595 \pm .005$ and $\gamma = 1.660 \pm .005$. Birefringence about .065. Elongation $-$. Parallel extinction.

A complete chemical analysis (Table I) was made in the Rockefeller Rock Analysis Laboratory at the University of Minnesota, T. Kameda, analyst. The following paragraph gives a short description of the analytical methods used.

SiO_2, Fe_2O_3, $MgO + MnO$, and CaO were determined in one portion of the mineral. SiO_2 was separated in the usual manner by double evaporation with HCl. Before treating with HF, the SiO_2 was tested for, and found to be free from boron. The small amount of iron was separated from the silica filtrate by double precipitation with ammonia. Calcium, magnesium and manganese were then precipitated together as phosphates. The ignited precipitate of $Ca_3(PO_4)_2$, $Mg_2P_2O_7$, and $Mn_2P_2O_7$ were weighed, dissolved in sulphuric acid, and treated with alcohol to precipitate $CaSO_4$. The $CaSO_4$ was filtered off, reprecipitated as oxalate and ignited to CaO. The manganese was determined in a separate portion, after removal of silica and iron, by precipitation as MnS, followed by precipitation as the phosphate and ignition to $Mn_2P_2O_7$. The com-

TABLE I

CHEMICAL AND PHYSICAL PROPERTIES OF CAMSELLITE, MAGNESIOSUSSEXITE AND SUSSEXITE

Composition	Camsellite*	Magnesiosussexite	Sussexite**
MgO	45.24	29.32	16.29
MnO	1.09	23.48	37.58
FeO	1.28		
ZnO	none	none	3.87
Fe_2O_3	0.85	0.34	0.60
Al_2O_3	0.29		
B_2O_3	40.40	36.18	33.16 (diff.)
$H_2O+110°$	10.55	10.18	7.80
$H_2O-110°$	0.26	0.22	0.10
SiO_2	—*	0.43	0.50
CaO	—*	0.05	0.10
K_2O	0.04	none	
Na_2O		none	
P		none	
	100.00	100.20	100.00
Optical data			
Indices:	$\alpha=1.575\pm.005$ $\gamma=1.649\pm.005$	$1.595\pm.005$ $1.660\pm.005$	$1.639\pm.003$ $1.704\pm.003$
Elongation	—	—	—
Hardness	3−	3	3
Spec. Grav.	2.60?	2.83	3.12
Color	white	buff to yellow	buff to yellow
Structure	fibrous	fibrous	fibrous
Soluble in	HCl	HCl	HCl

* The analysis of camsellite was recalculated by Ellsworth and Poitevin. They found considerable amounts of silica and calcite in the original analysis, *op. cit.*

** Analysis by Poitevin and Ellsworth, *op. cit.*, p. 189.

bined weight of the manganese and calcium phosphates was deducted from the weight of the mixed phosphates to give the amount of $Mg_2P_2O_7$. Boron was determined in a separate portion by Chapin's distillation method.

The small amounts of SiO_2, Fe_2O_3, CaO and H_2O- are regarded as impurities. A recalculated analysis gives the following molecular proportions if Mg and Mn are considered to be isomorphous,

TABLE II

X-RAY DIFFRACTION MEASUREMENTS ON POWDERS OF CAMSELLITE, MAGNESIOSUSSEXITE AND SUSSEXITE

No.	Camsellite		Magnesiosussexite		Sussexite	
	Film mm.	I*	Film mm.	I	Film mm.	I
1	14.20	vs	14.20	m	14.15	m
2	17.15	m				
3	27.50	m				
4	29.70	m				
5	31.70	m				
6	33.70	vs	33.45	m	33.05	m
7	35.30	vs	34.95	w	34.45	w
8	37.05	s	36.85	m	36.60	m
9	38.90	s				
10	40.90	vs	40.60	w	40.15	vw
11	43.50	s	43.20	w	43.00	vw
12	45.35	s	45.15	vw	44.65	vw
13	46.95	w	47.10	vw		
14	51.10	m				
15	52.85	m	52.40	vw	51.70	w
16	54.15	w				
17	57.20	m	56.75	vw		
18	59.65	s	58.75	vw		
19	61.10	m			60.10	vw
20	62.00	m	61.50	w	61.50	vw
21	62.90	w				
22	65.40	vw				
23	67.95	w	67.90	vw		
24	70.65	m	70.10	vw		
25	73.05	w				

* Intensities.
vs = very strong
s = strong
m = medium
w = weak
vw = very weak

$2(Mg, Mn)O:B_2O_3:H_2O = 2.000:0.976:1.069$. The theoretical formula of the mineral, therefore, is $2(Mg, Mn)O \cdot B_2O_3 \cdot H_2O$.

A comparison of this new mineral with sussexite from Franklin Furnace, New Jersey,[1] and camsellite from its type locality in

---

[1] Poitevin and Ellsworth, New optical data for analyzed sussexite: *Am. Mineralogist*, vol. **9**, p. 199, 1924.

British Columbia,[2] shows a close relationship of the three. Their chemical and physical properties have been listed in Table I. Camsellite has also been described by Eakle[3] from California. Eakle claims that SiO_2 replaces a part of B_2O_3.

In order to be certain regarding isomorphism of these minerals *x*-ray powder diagrams were made. A circular camera with a radius of 57.3 mm. and Cu radiation ($K_\alpha = 1.537$Å) were used. The diameters of the samples were about 0.6 mm. Distances in the films were read from the outer edge of one line to the outer edge of the corresponding line on the other side of the zero beam. The measurements given in Table II, however, are the distances as they would have been if read from the zero beam to the outer edges of the lines. A correction for the diameter of the samples was also applied.

There is an abundance of lines in the film of camsellite. The other two minerals give only relatively few and weak reflections though taken under the same conditions. It is possible that the large amount of manganese in these minerals absorbs most of the Cu radiation emitted by the *x*-ray tube. The agreement of the three powder diagrams is satisfactory, however, when the following points are considered:

1. Due to the substitution of the larger manganese atom for magnesium the dimensions of the space lattices increase. The distances therefore measured in the films decrease correspondingly.
2. Since the minerals probably have relatively low symmetry (orthorhombic?), the magnitude of the expansion depends on the direction just as in the case of any other vector property of a crystal.
3. On account of the greater absorption of the diffracted *x*-ray energy in magnesiosussexite and sussexite only those lines correponding to relatively strong lines in camsellite are recorded in the films. The weak lines of camsellite have no equivalent in the other minerals.

CONCLUSIONS

Magnesiosussexite is the name of a new borate mineral from a deep iron mine of the Gogebic range in Michigan. The composition

---

[2] Ellsworth and Poitevin, Camsellite, a new borate mineral from British Columbia, Canada: *Trans. Royal Soc. Canada*, vol. **15**, section 4, p. 1, 1921.

[3] Eakle, A. S., Camsellite from California: *Am. Mineralogist*, vol. **10**, p. 100, 1925.

of the mineral, $2(Mg, Mn)O \cdot B_2O_3 \cdot H_2O$, places it between sussexite and camsellite with which it forms an isomorphous series. Judging by its composition, occurrence and relationship to the end members of this series it is probably hydrothermal in origin. As all these minerals are relatively inconspicuous and resemble other common fibrous aggregates of minerals they are probably much more common than reported. Incidentally this is not the first notice of a borate mineral from an iron mine in Michigan. Seamanite,[4] a phosphoborate of manganese was reported two years ago from the Chicagon mine on the Iron River range. The circulation in the iron ores of solutions containing boron is suggestive of hydrothermal leaching of silica from the ores, an hypothesis proposed recently by the writer.[5] In conclusion the writer wishes to thank Dr. H. V. Ellsworth for a specimen of camsellite used in this investigation.

Note: After this paper had gone to press the writer found a note by W. T. Schaller (The probable identity of camsellite with szaibelyite, *Am. Mineral.*, vol. **13**, p. 232, 1928) in which the close relationship of camsellite to sussexite is mentioned.

---

[4] Kraus, Seaman and Slawson, Seamanite, a new manganese phosphoborate from Iron County, Michigan: *Am. Mineralogist*, vol. **15**, p. 220, 1930.

[5] Gruner, J. W., Additional notes on secondary concentration of Lake Superior iron ores: *Econ. Geol.*, vol. **27**, p. 189, 1932.