

# NOTES ON ALLOPHANITE, FUCHSITE, AND TRIPHYLITE.

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## OBSERVATIONS ON ALLOPHANITE.

*Nomenclature of the hydrous aluminium silicates.*—There are among minerals a number of groups consisting of solid solutions of two or more theoretical end-compounds, in which, for convenience, certain intermediate members are assigned names. To cite one of these, the intermediate members of the plagioclase feldspar group are called oligoclase, andesine, labradorite, etc., although it would be equally possible to name them all by the proportions of the end-compounds, albite and anorthite, they contain.

While the hydrous aluminium silicates could also be named according to the proportions of the end-members present, it is perhaps better to assign names to the more important intermediate ones. Dana selected six of these: (1) halloysite, (2) cimolite, (3) montmorillonite, (4) allophane, (5) collyrite, and (6) schrötterite, as species, but of these 2 and 3 differ only in unessential particulars, as do also 4, 5, and 6, so only three are recognized here, the names assigned being those which have priority:

**Cimolite** (Klaproth, 1795).—Mostly soft, earthy clays with the ratio  $\text{Al}_2\text{O}_3:\text{SiO}_2$ =from 1:7.5 to 1:2.5; includes anauxite, confolensite, delanovite, erinite (Thomson), hunterite, montmorillonite, razumovskite, some smectite, steargillite, stolpenite, and termierite.

**Halloysite** (Berthier, 1826).—Mostly soft, earthy clays with the ratio  $\text{Al}_2\text{O}_3:\text{SiO}_2$ =from 1:2.5 to 1:1.5; includes ancudite, some allophane, bole, catlinite, dillnite, galapectite, glagerite, glossecollite, gummite (Breithaupt), indianait, some kaolinite, keffekilite, lenzinite, lithomarge, meerschaluminate, milanite, nerchinskite, ochran, oropian, pholerite, pseudosteatite, samoite, severite, smectite, teratolite, and tuesite.

**Allophanite** (Stromeyer, 1816).—Harder, more vitreous minerals, with the ratio  $\text{Al}_2\text{O}_3:\text{SiO}_2$ =from 1:1.5 to 1:0.25; includes carolathite, collyrite, and schrötterite. Only allophanite will be discussed here.

*Name.*—The name "allophan," from two Greek words meaning "to appear different," was given by Stromeyer<sup>1</sup> to a waxy, amorphous

<sup>1</sup> Gel. Anz. Königl. Ges. Wiss., Göttingen, 1816, p. 1250.



mineral containing alumina, silica, and water. In adapting German mineral names to American use the usual rule is to add *ite* to the ending *phan*; thus, leukophan, meliphan, and rhabdophan become leukophanite, meliphanite, and rhabdophanite; only *e* is added in other cases, as allophan, glaukophan, and uranophan, which are ordinarily written allophane, glaukophane, and uranophane. For the sake of uniformity, however, it seems best to have all mineral names, except those which have come down to us from the ancients, end in *ite*, so *allophanite* is adopted as the name of the substance under discussion.

*Composition.*—Considerable disputation has been indulged in during the last few years, chiefly by German mineralogists, as to whether allophanite and other similar minerals are variable mixtures or definite compounds. Most that has been written consists of mere quibbling over the meaning of terms; but Stremme,<sup>1</sup> after summing up the arguments on both sides, has shown that the noncrystalline clay-minerals are best interpreted as adsorption compounds of colloidal alumina and silica with variable amounts of water. The observations described in the following paragraph confirm the correctness of this view as far as one sample of allophanite is concerned.

*A new occurrence of allophanite.*—Material sent to the Museum for identification labeled as occurring "20 miles from Salt Lake City, Utah," proved to correspond in most of its properties with allophanite.<sup>2</sup> But its refractive index did not agree with that given in the books for this mineral (1.49), and as the exact nature of the mineral on which this value was determined is not recorded, further study of the matter seemed desirable.

The following are the properties of the sample in question:

Color: White to yellowish white.

Luster: Vitreous to dull; subtransparent.

Hardness: 3. Sp. gr.: 1.88 to 1.90.

Structure: Granular.

Fracture: Subconchoidal.

Optical properties: Isotropic (amorphous, colloidal) in large part, also showing confusedly anisotropic (metacolloidal) patches.

Index of refraction:

	Observed.	Calculated.
Saturated with H <sub>2</sub> O (H <sub>2</sub> O about 45 per cent).....	1.465	1.466
Air-dried.....40 per cent.....	1.480	1.479
Dried at 120°.....10 per cent.....	1.565	1.564
Ignited.....0 per cent.....	1.595	1.592

The calculated values were obtained as follows: The indices of the three constituents being (amorphous forms) Al<sub>2</sub>O<sub>3</sub> 1.68,<sup>3</sup> SiO<sub>2</sub> 1.46,

<sup>1</sup> Doelter's Handbuch der Mineralchemie, vol. 2, pt. 2, 1914, p. 36.

<sup>2</sup> Cat. No. 87438, U.S.N.M.

<sup>3</sup> An approximate determination on ignited Al(OH)<sub>3</sub>.



and H<sub>2</sub>O 1.31, the first two were averaged in the ratio of 3:2, giving 1.592 as the index of anhydrous allophanite, and this was then averaged with the figure for H<sub>2</sub>O in the several proportions listed. The essential agreement between the observed and calculated values indicates clearly the additive character of the indices; that is, the index of any combination is the average of the indices of its components.

Qualitative tests: Decomposed by HCl, yielding granular silica; gives reactions for Al, Ca, and traces of Mg and Fe. Before the blowpipe: Gives reactions for Al, Si, and OH.

Analysis, made on microscopically homogeneous, amorphous material:

		Ratios.	
Al <sub>2</sub> O <sub>3</sub> .....	33.78	0.331	1.0
Fe <sub>2</sub> O <sub>3</sub> .....	1.08	.007	...
SiO <sub>2</sub> .....	21.70	.360	1.1
CaO.....	2.04	.036	...
MgO.....	0.45	.011	...
H <sub>2</sub> O below 100°.....	4.86	.270	...
H <sub>2</sub> O above 100°.....	35.82	1.990	6.0
Total.....	99.73		

The tendency of the colloidal alumina and silica to unite in the definite ratio 1:1 here shown is a good example of Cornu's law of homoisochemism, but the additive character of the indices of refraction of the constituents indicates that no complete chemical combination has occurred between them.

TWO NEW OCCURRENCES OF FUCHSITE.

The name fuchsite, proposed by Schafhäütl in 1842, is used to refer to the isomorphous series of which H<sub>2</sub>K (AlSiO<sub>4</sub>)<sub>3</sub> and H<sub>2</sub>K (CrSiO<sub>4</sub>)<sub>3</sub> are the end members, the first being usually present in excess over the second.

*Fuchsite from Chester County, Pennsylvania.*—On Young's farm, 2 miles west of Harmony Hill, on the north side of the road to Romansville, West Bradford Township, a deposit of a bright-green mineral has long been known to local mineralogists, and specimens from it included in collections, usually under the name epidote, but it was identified as fuchsite in 1907.<sup>1</sup> The rock consists of a fine-grained dolomite, containing considerable granular quartz, and in certain zones and streaks abundant flakes of colorless to intense green mica.<sup>2</sup> Although occurring only as isolated ledges in the bank of a brook, surrounded by soil containing fragments of mica schist and gneiss, and showing no determinable relations with any known formation of the region, it is probably the result of alteration of a dike of some basic igneous rock, such as chromite-bearing serpentine. A somewhat similar occurrence has been described in Montgomery County, Mary-

<sup>1</sup> Mineral Collector, vol. 14, 1908, p. 172. <sup>2</sup> Cat. No. 87610, U.S.N.M.



land,<sup>1</sup> and on excursion A 5 of the XII International Geological Congress in Canada, 1913, rocks identical in every respect with the present material were observed in connection with some of the serpentine masses in the asbestos region of Quebec.

The micaceous constituent of the rock can be seen under the hand lens to be partly colorless, but in certain zones it has a brilliant emerald-green color. In thin section both show the optical properties of muscovite, but the green material has in addition the intense pleochroism, greenish blue to emerald green to pale green, characteristic of fuchsite. A sample of the rock was treated with hydrochloric acid to remove dolomite and with a heavy liquid (acetylene tetrabromide, diluted with benzene) to remove the quartz. The mixture of micas, containing, as estimated with the microscope, about 10 per cent of the green variety, was fused with sodium carbonate and the chromium determined colorimetrically, the result being 0.33 per cent  $\text{Cr}_2\text{O}_3$ . The green mica therefore contains approximately 3 per cent of  $\text{Cr}_2\text{O}_3$ , or 14.4 per cent  $\text{H}_2\text{K}(\text{CrSiO}_4)_3$ .

*Fuchsite from Marble, Colorado.*—A specimen of a bright-green micaceous mineral was collected by Dr. George P. Merrill at the marble quarries of Colorado in 1914 and turned over to the writer for examination.<sup>2</sup> In his report on these quarries Doctor Merrill states:

In the face of the cliffs between quarries Nos. 2 and 3 there occurs for a short distance a bed of white marble traversed by green veins. This is a purely local phenomenon due to the presence of a small amount of chromiferous mica and not to copper carbonate, as popularly supposed.

By dissolving out the inclosing marble with very dilute hydrochloric acid an intense green micaceous powder was obtained, which under the microscope appeared to be homogeneous and showed a most brilliant pleochroism. A sample was tested colorimetrically for chromium and 6.08 per cent  $\text{Cr}_2\text{O}_3$  obtained, which corresponds to 29.2 per cent of  $\text{H}_2\text{K}(\text{CrSiO}_4)_3$ .

#### TRIPHYLITE FROM A NEW LOCALITY NEAR GRAFTON, NEW HAMPSHIRE.

The material described in this note was sent personally to Dr. George P. Merrill by Mr. L. Clough, of East Concord, New Hampshire.<sup>3</sup> It consists of a dull gray massive mineral with a greasy luster, showing blue films on joint planes, due to incipient alteration, and is penetrated by narrow veins of crystalline red garnet and black biotite. The locality is stated to be a mica prospect on the farm of N. M. Kilton, about 4 miles from Grafton station, several miles from the formerly famous locality of triphylite, graftonite, etc. Several hundred pounds of it were obtained.

A sample was submitted by Doctor Merrill to J. E. Whitfield for analysis and his results are given in column 1 below. For comparison

<sup>1</sup> Williams and Gill, Johns Hopkins Univ. Circular No. 85, 1889.

<sup>2</sup> Cat. No. 88332, U.S.N.M.

<sup>3</sup> Cat. No. 88253, U.S.N.M.



Penfield's analyses of material from the old Grafton locality and from Norwich, Connecticut,<sup>1</sup> are added, in columns 2 and 3, respectively.

The indices of refraction, determined by the immersion method, and the specific gravity are also compared with the corresponding values of the older material.

	1.	2.	3.
FeO.....	27.66	26.23	26.40
MnO.....	16.63	18.21	17.84
CaO.....	trace	0.94	0.24
MgO.....	2.30	0.59	0.47
Li <sub>2</sub> O.....	8.49	8.79	9.36
Na <sub>2</sub> O.....	0.35	0.12	0.35
K <sub>2</sub> O.....	0.06	0.32	.....
P <sub>2</sub> O <sub>5</sub> .....	43.85	44.03	44.76
SiO <sub>2</sub> .....	0.27	.....	.....
H <sub>2</sub> O.....	0.41	1.47	0.42
Total.....	100.02	100.70	99.84
Sp. gr.....	3.531	3.520	3.534
α.....	1.690	1.688	.....
β.....	1.690	1.688	.....
γ.....	1.695	1.692	.....
γ-α.....	.005	.004	.....
Sign.....	+	+	

In so far as the percentages of ferrous and manganous oxides are concerned, the present mineral is closer to that from Norwich (3) than to the old Grafton occurrence (2). Since the specific gravities in this group vary with the relative amounts of these oxides, the former yielding the higher values, the gravity of 1 might be expected to exceed that of 3. The slightly lower figure found is probably to be correlated with the relatively large amount of magnesium oxide present.

The group to which the mineral here described belongs comprises triphylite, LiFePO<sub>4</sub>, lithiophilite, LiMnPO<sub>4</sub>, natrophilite, NaMnPO<sub>4</sub>, and the still unnamed members LiMgPO<sub>4</sub>, NaFePO<sub>4</sub>, NaMgPO<sub>4</sub>, KMnPO<sub>4</sub>, KFePO<sub>4</sub>, etc. In accordance with the writer's plan for simplifying mineralogical nomenclature<sup>2</sup> it is recommended not only that no new names be given to the last of these, but also that lithiophilite and natrophilite be dropped.<sup>3</sup> Triphylite then becomes the series name, and chemical prefixes may be applied to it to refer to any desired end-member.

The mineral from the new Grafton locality may be described, accordingly, as a triphylite containing 60 per cent lithio-ferro-triphylite, 37 per cent lithio-mangano-triphylite, and small amounts of several other members of the series.

<sup>1</sup> Amer. Journ. Sci., ser. 3, vol. 13, 1877, p. 425; vol. 17, 1879, p. 226.  
<sup>2</sup> Science, new ser., vol. 39, 1914, p. 575; Proc. U. S. Nat. Mus., vol. 47, 1914, p. 504.  
<sup>3</sup> This disregard of the "rule of priority" is believed to be justified by the gain in clearness resulting from the use of names with chemical prefixes.



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