

## MICROLITE AND STIBIOTANTALITE FROM TOPSHAM, MAINE

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In a paper by the senior author (1934) describing the minerals found in a topaz pegmatite in Topsham, there occurs the following statement: "In the pocket, gahnite is associated with albite. In the lower portions nearly every block of albite that was broken showed a band of scattered minute crystals of emerald-green gahnite about half an inch beneath the free surface of the block. They must have been deposited simultaneously for a very short time while the albite was still growing and when this zone was the surface zone. In vugs of the albite, octahedrons or flat distorted hexagonal plates of gahnite reach a maximum dimension of one inch."

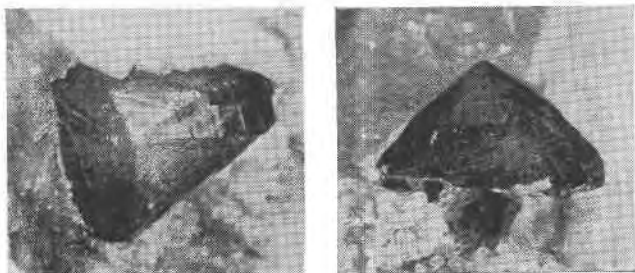


FIG. 1. Two views of a microlite crystal showing pseudo-hexagonal distortion.

The facts of this statement were correct except that the mineral reported as *gahnite* is now known to be *microlite*. The mistake was perhaps a natural one for large crystals of dark green gahnite had been found in the same quarry outside the pocket, and when these minute green octahedrons appeared they were assumed, without special examination, to be of the same species. In the course of a study of the Topsham mineral series made in the Harvard Mineralogical Laboratory by Mr. G. W. Stewart, it was found that this assumption was a mistake. Since microlite is a sufficiently rare mineral to deserve record whenever found, the analysis and description of this occurrence is here presented.

With few exceptions the Topsham microlite is green, a color not before recorded for this mineral. It varies from dull grass green in the larger crystals to vivid emerald green in the smaller transparent crystals. The dominant form of the crystals is octahedral with an occasional narrow

face of the dodecahedron. There are, however, numerous extreme distortions which give the appearance of a hemimorphic hexagonal crystal. One of these was photographed and is shown in Fig. 1. The largest crystal is one half of an octahedron an inch on an edge; it is implanted on sericite with an irregular bounding surface.

The study of several hundred specimens from the pocket revealed the following associations of microlite:

1. Enclosed in albite as described in the quotation.
2. Minute crystals embedded in topaz crystals without apparent relation to crystal boundaries of the latter.
3. Enclosed in lepidolite crystals; always a single layer of minute octahedrons rather widely but regularly spaced and arranged parallel to three or more of the bounding pseudoprism faces of the mica.
4. In sharp crystals at a boundary between quartz and lepidolite.
5. Implanted on tourmaline needles.
6. Encrusted with stibiotantalite crystals—a single specimen of minute size.
7. Microlite is often coated with sericite.

All of these associations are in harmony with its having formed late in the period of pocket filling; all of the minerals listed were deposited on free surfaces towards the end of deposition. Where enclosed in another mineral it always appeared as if the microlite were deposited for a short time on a free surface to be afterwards covered over by later growth of the host mineral. There was no evidence that could be seen favoring deposition by replacement.

Since the high density of this microlite was the property which first led to its proper identification, special care was devoted to this determination. Table 1 contains the record of the observations made on selected fragments with the microbalance and reveals figures which are in part much higher than any hitherto reported. They are believed to be justified by the discussion of the  $x$ -ray study which follows.

TABLE 1. SPECIFIC GRAVITY OF MICROLITE

Observer	No. of Observations	Locality	Color	Specific Gravity
Berman	2	Topsham, Me.	green	6.41
Draisin	4	Topsham, Me.	green	6.42 ± .04
Draisin	6	Topsham, Me.	dark brown	6.36 ± .03
Draisin	3	Amelia Courthouse, Va.	amber yellow	6.05 ± .01
Draisin	3	Newry, Me.	pale yellow glassy	5.85 ± .12
Draisin	2	Embudo, N. Mex.	pale yellow glassy	5.90

The index of refraction  $n_{Na}$  was determined by Dr. Richmond as  $2.023 \pm 0.003$ , a somewhat higher figure than has been previously reported. Both density and refractive index probably reflect the low water content of this microlite. The new determinations of density for microlite from other localities given in Table 1 confirm the usual lower densities previously found; the lower values will probably be found, when analyses are available, to be due to a general higher water content.

*X-ray study.* The x-ray powder picture is very sharply defined. The edge of the unit cell, calculated from this photograph by Prof. Shaub, is  $10.39 \pm 0.01 \text{ \AA}$ . This figure agrees closely with previous determinations made by Reuning (1933) and Bjørlykke (1934) on microlite of lower density. Hence the density variations would seem to be closely dependent on compositional variations and not on variation in cell dimension.

The cell contains 8 molecules of  $X_2Z_2O_6(O, OH)$  with a total molecular weight of 4259, according to the analytical results which follow, and a calculated specific gravity of 6.27.

*Chemistry.* The chemical analysis was made by the junior author on several grams of selected clear green fragments without visible impurity. He followed the method of Hillebrand and Lundell. The results of the analysis, as shown in the following table, indicate a tantalum-rich sample of microlite with an unusually low water content. The discussion is by Dr. Berman and leads to a formula in agreement with Machatschki's (1932) earlier work on minerals of the same type.

TABLE 2. ANALYSIS OF MICROLITE, TOPSHAM, ME.

	1.	2.	3.	4.
Ta <sub>2</sub> O <sub>5</sub>	74.27	.336	14.63	74.67
Cb <sub>2</sub> O <sub>5</sub>	3.56	.027	1.18	3.50
WO <sub>3</sub>	0.17	.001	.04	
SnO <sub>2</sub>	1.61	.011	.48	1.70
CaO	15.03	.268	11.68	14.33
MgO	0.07	.002	.09	
UO <sub>3</sub>	0.77	.003	.13	0.54
Y <sub>2</sub> O <sub>3</sub>	0.35	.003	.13	0.78
Ce <sub>2</sub> O <sub>3</sub>	0.26	.002	.09	
Na <sub>2</sub> O	3.37	.109	4.75	3.49
K <sub>2</sub> O	0.41	.009	.39	
H <sub>2</sub> O	0.27	.030	1.31	1.00
Total	100.14	1.289	0 = 56.08	100.00
G	6.41			6.265

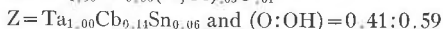
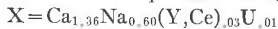
Molecular Weight

4259.38

1. Analysis by F. A. Gonyer.
2. Atomic ratios.

3. Atoms per unit cell with  $Vd/A=4358$  (from the x-ray data).

4. Calculated composition for  $X_2Z_2O_6(O,OH)$  with



In column 3 of this table the agreement with the theoretical formula  $8[X_2Z_2O_6(O,OH)]$  is shown. The  $X$  and  $Z$  atoms are somewhat in excess and the number of oxygen atoms is in excellent agreement. Column 4 is the calculated composition, with the atoms found in the analysis adjusted to conform with the formula. The simple  $Ca,Na$  microlite must contain equal atomic proportions of  $Na$  and  $(OH)$  in order to conform with the valence requirements. In this instance, however, the valence adjustments are somewhat more complex because  $Sn$ , a quadrivalent atom, substitutes for some of the quinquevalent  $Ta$  in the  $Z$  part of the formula; in the  $X$  part not only does  $Na$  substitute for  $Ca$  but also the rare earths which are trivalent, and a small amount of  $U$ , which is hexavalent. All of these substitutions lead to a net requirement of 0.59  $(OH)$  in the formula, or 1.00 per cent of  $H_2O$  in the analysis. The most serious discrepancy is in the water, but by the method of calculation the errors in other parts of the analysis are thrown into this figure.

*Brown microlite.* In masses of the albite which lined the topaz pocket at Topsham there were observed occasional brown spots, at the center of each of which could be seen a tiny blackish crystal. Examination in the laboratory shows that these crystals are octahedrons, more or less distorted by intergrowth with the platy albite. The fracture is conchoidal and shows a resinous lustre. The powder under the microscope is quite transparent and of a rather brownish-yellow color. Similar crystals were later found in one or two specimens of lepidolite; these were perfectly symmetrical octahedrons with narrow to broad truncations by the dodecahedron. The maximum diameter was  $\frac{1}{4}$  inch. The density of these dark crystals was determined by Mr. Draisin on three different samples. As shown in Table 1, the specific gravity is 6.36, nearly as high as that of the green microlite. Closely associated with the dark microlite are a few small crystals of columbite.

*Stibiotantalite.* In the list of paragenetic relations, mention is made of stibiotantalite. The specimen referred to is one of the two that were found at Topsham, each very small. Notwithstanding this relatively unimportant occurrence, it seems worthwhile to add some note upon it, since stibiotantalite has hitherto been found in America only at Mesa Grande, California.

The specimen, about half a square centimeter in area, consists of a crystal of microlite, one surface of which is coated with albite, a little sericite and about 30 tiny crystals of stibiotantalite. The pale gray to

brownish crystals are about 1 mm. long and .3 mm. in greater diameter. Most of them are implanted by one end of the *c*-axis and show a single prism and a pyramid which are the forms *g*(130) and *w*(4.12.9) of Penfield and Ford (1906). The pinacoidal cleavage is perfect and truncates the thin edge of the prism.

Penfield and Ford (1906), who were the first to describe crystals of stibiotantalite, were convinced that this mineral was isomorphous with columbite; they therefore assigned to the principal forms complex indices whereby the elements were brought into a rather remote correspondence with those of columbite. They showed that stibiotantalite was hemimorphic with respect to the direction of the *a*-axis, that is normal to the perfect cleavage.

Ungemach (1909) was the next author to describe crystals of this mineral. He denied the relationship to columbite on purely chemical grounds; took the principal forms as unit forms; and, in order to follow ordinary convention, placed the hemimorphic axis vertical, that is he made the cleavage basal.

The strongest zone of stibiotantalite with five prisms and two pinacoids is the zone [001] of Penfield and Ford, which in Ungemach's position becomes [010]. With present usage this zone should be retained as [001], but the principal prism and pyramid should be unit forms as suggested by Ungemach. Our choice of position therefore is a third alternative, with Penfield and Ford's axes *a* and *b* interchanged and their form (4.12.9) made (111).

The transformation formulae relating these three positions are the following:

Penfield-Ford to Ungemach	$0\bar{1}\frac{1}{2}0/00\frac{1}{2}/\frac{1}{2}00$
Penfield-Ford to Palache	$0\bar{1}\frac{1}{2}0/\frac{1}{2}00/00\frac{1}{2}$
Ungemach to Palache	$100/001/010$

The elements of stibiotantalite as given by Ungemach are:  $a:b:c = 0.8879:1:2.1296$ . The work of Dählström (1938) confirms this axial ratio. He found the unit cell to have the dimensions  $a_0 = 4.916\text{Å}$ ,  $b_0 = 5.542\text{Å}$ ,  $c_0 = 11.78\text{Å}$ ; or  $a_0:b_0:c_0 = 0.888:1:2.126$ . There are four molecules of  $SbTaO_4$  in the unit cell, and in our position the space group symbol is *Pcn*.

Recalculated to Palache's position, the elements become

$$a:b:c = 0.4169:1:0.4696.$$

The Topsham crystals show no evidence of hemimorphism or twinning. The faces are dull and give poor reflections but could be identified as the unit forms. Figure 2 illustrates their form. In this position perfect

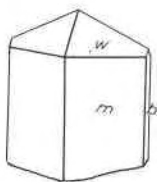


FIG. 2. Crystal of stibiotantalite.

cleavage is parallel to (010) and the  $b$  axis is the axis of hemimorphism. The following angle table has been calculated from Penfield's measurements with slight emendation of his elements. The form list follows Ungemach (1909) with correction of two mistakes of transformation made by him and recurring in *Goldschmidt's Atlas*, 8, 85.

Since no angle table has been published for stibiotantalite, one is presented here, based on the measurements of Penfield and Ford.

TABLE 3. ANGLE TABLE OF STIBIOTANTALITE— $\text{SbTaO}_4$   
Orthorhombic; hemimorphic— $m2m$ -

$a:b:c=0.4169:1:0.4696$ ;  $p_0:q_0:r_0=1.1264:0.4696:1$   
 $q_1:r_1:p_1=0.4169:0.8878:1$ ;  $r_2:p_2:q_2=2.1295:2.3986:1$

Forms	$\phi$	$\rho=C$	$\phi_1$	$\rho_1=A$	$\phi_2$	$\rho_2=B$
$c$ 001	—	0°00'	90°00'	90°00'	90°00'	90°00'
$b$ 010	0°00'	90 00	90 00	90 00	—	0 00
$\alpha$ 190	14 55½	90 00	90 00	75 04½	0 00	14 55½
$\beta$ 170	18 55	90 00	90 00	71 05	0 00	18 55
$\gamma$ 150	25 37½	90 00	90 00	64 22½	0 00	25 37½
$n$ 130	38 38½	90 00	90 00	51 21½	0 00	38 38½
$m$ 110	67 22	90 00	90 00	22 38	0 00	67 22
$\eta$ 012	0 00	13 13	13 13	90 00	90 00	76 47
$e$ 011	0 00	25 09½	25 09½	90 00	90 00	64 50½
$h$ 032	0 00	35 09½	35 09½	90 00	90 00	54 50½
$l$ 021	0 00	69 55	69 55	90 00	90 00	20 05
$\delta$ 101	90 00	48 24	0 00	41 36	41 36	90 00
$w$ 111	67 22	50 40	25 09½	44 26½	41 36	72 41
$x$ 133	38 38½	31 01	25 09½	71 14½	69 25	66 16
$y$ 132	38 38½	42 03	35 09½	65 16½	60 36½	58 27½
$\epsilon$ 171	18 55	73 56½	73 05	71 51	41 36	24 37

The identity of the Topsham stibiotantalite was further established by optical and density determinations. The specific gravity was deter-

mined with the microbalance on 3.5 mg. of fragments as 6.57. This figure is intermediate to the two determinations made by Penfield and Ford on two samples, 6.299 to 6.818. The optical properties were compared by Dr. Berman with those of material from Mesa Grande and were found to be qualitatively the same. Exact measurements were not made, however.

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