ON POLLUCITE

W. E. Richmond and F. A. Gonyer,
Harvard University, Cambridge, Mass.

1. POLLUCITE AND PETALITE FROM GREENWOOD, MAINE

Introduction. Several years ago in the course of feldspar mining at a quarry at the base of Noyes Mountain in Greenwood, Maine, a mineral supposed to be spodumene was found in quantity and about eight tons of it were taken to the grinding mill at West Paris, Maine. There it lay in a bin for a year or more before it was examined by the late W. D. Nevel of Andover, Maine, who identified the mineral as petalite. He sorted out the petalite and the rejects were sacked and retained until the summer of 1937.

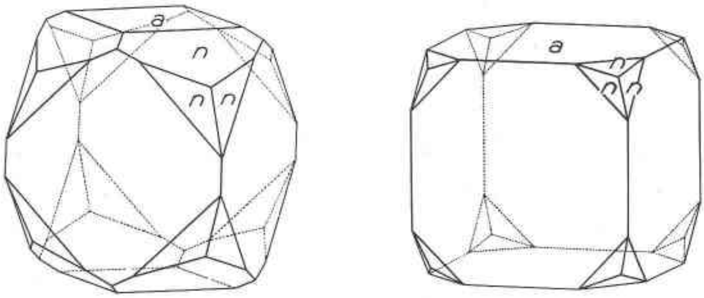
On a visit to the mill that year Richmond selected a quantity of petalite for the Harvard Mineralogical Museum and also carried away some of the waste reject material for examination. This proved, after a delay of months, to contain glassy crystals of pollucite. The effort to secure more of this mineral was unsuccessful, however, since on returning to the mill it was found that the lot had been sent through the grinder.

Occurrence. The specimens studied are clearly replacements of petalite by pollucite and quartz. The pollucite is for the most part massive granular but preserves the laminated structure peculiar to the petalite with which it is associated. Some layers are composed of quartz grains, and elsewhere there are fractures showing indistinct faces of pollucite crystals. In a few cavities in massive pollucite the walls are covered with small crystals of pollucite, the first to be reported from an American locality.

Crystallography. The six crystals measured range in size from two to four millimeters. The forms $a\{100\}$ and $n\{211\}$ are established by the following measurements:

Table 1. Measurement of Angles

Form	No. of Faces	Measured Mean		Calculated	
		ϕ	ρ	ϕ	ρ
a 100	6	90°02′	90°00′	90°00′	90°00′
n 112	36	44 57	35 12	45 00	35 16
n 121	18	65 59	26 26	65 54	26 34



FIGS. 1*a* and 1*b*. Typical crystals of pollucite from Greenwood, Maine, showing the varying development of *a* 100 and *n* 211.

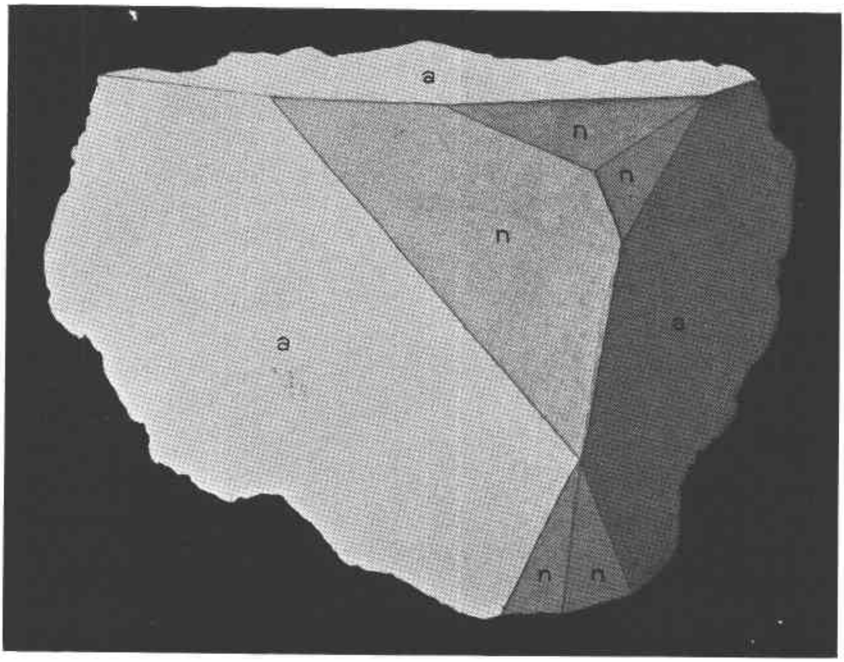


FIG. 2. Drawing of a quartz pseudomorph from the Harvard Mine, Greenwood, Maine. (½ natural size.)

The two forms are present in varying proportions as shown in the two figures (Figs. 1a and 1b). It is interesting to compare these drawings and Fig. 2 with the reproduction of a quartz pseudomorph described by Landes (1925) in his memoir on the Greenwood ledge near the top of Noyes Mountain. The nature of this pseudomorph is there discussed, and in a footnote on page 409 it is suggested that it might have been after pollucite. This discovery of crystals with the same habit in so near a locality practically establishes this conclusion. Pollucite in formless glassy masses, often of large size, has been found in various Maine pegmatites. It occurred in the Tamminen pit only a few hundred feet north of the locality here described, as well as in feldspar quarries at Hebron, Buckfield, and Mt. Mica, and in particularly large spherical masses at Newry.

Optical properties. The index of refraction, lower than any previously recorded for pollucite, was determined to be $n(Na) = 1.507$. This figure, as well as those given for pollucite from other localities, was established by four independent determinations by four observers using two methods, the various readings differing by amounts less than 0.002. Table 2 shows the recorded variations of refractive index in pollucite with decreasing content in Cs_2O. It also shows a corresponding decrease in specific gravity. The figures recorded for the two Greenwood localities were determined by suspension in methylene iodide.

TABLE 2. REFRACTIVE INDEX AND SPECIFIC GRAVITY OF POLLUCITE WITH VARYING CONTENT OF Cs_2O AND H_2O

	Hebron	Greenwood Tamminen	Mt. Mica	Elba	Buck-field	Greenwood Crystals
n	1.526	1.522	1.520	1.520	1.520	1.507
G	2.98	2.97	2.94	2.90	2.90	2.68
$\%Cs_2O$	36.06	35.83		34.30		24.48
$\%H_2O$	1.52	1.62		2.40		3.80

X-ray study of lattice constants. Strunz (1936) determined the lattice parameter of pollucite, $a_0 = 13.71$. Berman (1937) also established a similar constant, $a_0 = 13.66$. The results obtained in our study are as follows:

A. Massive pollucite, Greenwood. Tamminen Quarry, $a_0 = 13.65$.
B. Crystals of pollucite, Greenwood. Oxford Mining and Milling Co. Quarry, $a_0 = 13.64$.

Chemistry. The generally accepted formula for pollucite is $Cs_4Al_4Si_9O_{26} \cdot H_2O$. Here sodium in important amounts and smaller amounts of potassium and lithium are included with cesium. Berman (1937) accepted this formula and found the unit cell to contain two molecules. Strunz (1936), on the basis of analyses of pollucite from Rumford, Maine, and from Elba, together with space group criteria, found the unit cell to contain 8 molecules of $Cs_2Al_2Si_4O_{12} \cdot H_2O$.

Dissatisfied with this apparent discrepancy, we prepared two samples of pollucite from the two Greenwood localities and these were analyzed by Gonyer. His analyses are shown in Tables 3 and 4, and analyses by Wells, together with other analytical data, are contained in Table 5.

TABLE 3. ANALYSIS OF POLLUCITE A, GREENWOOD

	1	2	3		4	5
SiO_2	44.28	44.21	0.7361	Si	0.7361	33×0.02230
Al_2O_3	16.32	16.29	0.1600	Al	0.3200	15×0.02133
CaO	0.13	0.13	0.0023	Cs+Ca+ K+Na	0.3159	15×0.02160
Cs_2O	35.83	35.78	0.1270			
Na_2O	1.59	1.59	0.0257	H	0.1800	8×0.02250
K_2O	0.38	0.38	0.0041	O	2.2036	100×0.02204
H_2O	1.62	1.62	0.0900			
	100.15	100.00				
Cs:Na=4:1						
H_2O 4				$Cs_{15}Al_{15}Si_{33}O_{96}\cdot 4H_2O$		

1. Analysis of pollucite A by Gonyer.
2. Analysis calculated to 100%.
3. Molecular proportions.
4. Atomic proportions.
5. Number of atoms in the cell formula derived from the x-ray constants.

TABLE 4. ANALYSIS OF POLLUCITE B, GREENWOOD

	1	2	3		4	5
SiO_2	50.07	49.92	0.8312	Si	0.8312	34×0.02445
Al_2O_3	17.19	17.14	0.1674	Al	0.3348	14×0.02391
CaO	0.09	0.09	0.0016	Cs+Ca+ K+Na+Li	0.3246	14×0.02320
Cs_2O	24.54	24.46	0.0868			
Li_2O	0.09	0.09	0.0030	H	0.4222	18×0.02346
Na_2O	4.34	4.33	0.0700	O	2.5388	105×0.02417
K_2O	0.17	0.17	0.0017			
H_2O	3.81	3.80	0.2111			
	100.30	100.00				
Cs:Na=1:1						
H_2O 9				$Cs_{14}Al_{14}Si_{34}O_{96}\cdot 9H_2O$		

Columns 1–5 have the same significance as in the preceding table.

TABLE 5. COMPARISON OF ANALYSES AND THEORETICAL COMPOSITIONS

	1	2	3	4	5	6
SiO_2	44.21	49.92	43.51	44.37	43.05	49.65
Al_2O_3	16.29	17.14	16.36	16.08	16.61	17.32
Cs_2O	35.78	24.46	36.06	34.30	36.76	24.03
Na_2O	2.10	4.68	2.55	2.85	2.02	5.08
H_2O	1.62	3.80	1.52	2.40	1.56	3.92
	100.00	100.00	100.00	100.00	100.00	100.00
Cs:Na=	4:1	1:1	4:1	3:1	4:1	1:1
H_2O	4	9	4	6	4	9

1. Massive pollucite, A.
2. Crystals of pollucite, B.
3. Massive pollucite, Hebron. Analyst, Wells. Recalculated to 100%.
4. Massive pollucite, Elba. Analyst, Wells. Recalculated to 100%.
5. Theoretical composition, $Cs_{15}Al_{15}Si_{33}O_{96} \cdot 4H_2O$.
6. Theoretical composition, $Cs_{14}Al_{14}Si_{34}O_{96} \cdot 9H_2O$.

It is interesting to note that the amount of water is inversely proportional to the content of Cs_2O. The significance of this fact is not apparent.

The formulae given for the massive and crystallized pollucite agree well with the theoretical compositions as given in Columns 5 and 6 of Table 5.

In Berman's silicate classification he includes pollucite in the silica type where $2(Al+Si)=O$. The formulae of Tables 3 and 4, which show $(Al+Si)$ equal to 48 atoms, agree with the formula of Strunz and not with that of Berman. But pollucite remains in the silica type.

The above formulae may be generalized to: $Cs_{14+x}Al_{14}(Al_xSi)_{34}O_{96} \cdot 4\text{–}9H_2O$, where x may be 0, 1, or 2. For the crystals here described, as well as the material from Elba, the composition is such that $x=0$; when x equals 1, cesium and aluminum are increased and silica decreased 1 atom, giving the formula of material from Noyes Mountain and Hebron; when x equals 2, cesium and aluminum are increased and silica decreased 2 atoms. In the latter case the formula given by Strunz is obtained; his formula may then be considered correct for an ideal pollucite which is not too closely approached in nature.

The writers, therefore, suggest that the generalized formula for pollucite be accepted.

PETALITE

The petalite occurs as cleavage masses with typical laminated structure. The general relations of this mineral in the quarry are unknown;

judging from the available specimens petalite is earlier than albite and lepidolite but appears to be contemporaneous with spodumene.

The exceptional purity of the mineral is noteworthy. Several fragments consist of clear gem material, some of which were used for chemical analysis and optical study.

The optical properties, which appear in the following table, agree with those given by Larsen and Berman (1934):

$$\left.\begin{array}{ll} X\wedge a=-8° & =1.504 \\ Y & =1.510 \\ Z=b & =1.516 \end{array}\right\} +0.003 \qquad \begin{array}{l} \text{positive} \\ 2V=84°\pm 2° \\ r>v, \text{ slight} \end{array}$$

The chemical analysis by Gonyer yields the accepted formula $LiAlSi_4O_{10}$. The analysis is given below.

	1	2		3	
SiO_2	78.10	78.44	Si	1.3004	4×0.3251
Al_2O_3	16.64	16.64	Al	0.3264	1×0.3264
Li_2O	5.13	4.92	Li	0.3294	1×0.3294
H_2O	0.22		O	3.2551	10×0.3251

1. Petalite, Grennwood, Maine. Analyst, F. A. Gonyer.
2. Theoretical composition from $LiAlSi_4O_{10}$.
3. Atomic proportions and number of atoms.

Acknowledgment. The writers are indebted to Professor Charles Palache for his interest and criticism in the preparation of this paper.

2. POLLUCITE FROM LEOMINSTER, MASSACHUSETTS

Pollucite was first found in Massachusetts in 1937 by Roscoe J. Whitney of Leominster. Through his courtesy specimens sufficient for thorough study reached the Harvard Mineralogical Museum and Richmond was given an opportunity to examine the occurrence.

Occurrence. Spodumene has been reported from Sterling, Massachusetts, for a very long time. It was known, however, only from boulders until Mr. Whitney located a series of ledges of spodumene pegmatite extending into the town of Leominster. At a single point in one of these ledges pollucite has been found in irregular masses up to an inch in diameter. It is associated with green tourmaline, spodumene, amblygonite, cassiterite, columbite, microcline and albite feldspars, quartz, topaz, pyrite and arsenopyrite. Apparently the feldspars and quartz are replaced by spodumene, which in turn is altered to pollucite. Minerals earlier than spodumene have been mechanically deformed, while later minerals show no evidence of disturbance.

Chemistry and Physical Properties. The results of the chemical analysis by F. A. Gonyer are contained in Table 6.

TABLE 6. CHEMICAL ANALYSIS OF POLLUCITE

	1	2	3		4	5
SiO_2	45.20	45.25	0.7534	Si	0.7534	33×0.02283
Al_2O_3	16.98	17.00	0.1668	Al	0.3336	15×0.02224
Cs_2O	33.02	33.06	0.1216	Cs+Na+K	0.3220	15×0.02147
Na_2O	2.04	2.04	0.0329			
K_2O	0.61	0.61	0.0065	H	0.2266	10×0.02266
H_2O	2.04	2.04	0.1133	O	2.2815	101×0.02259
	99.89	100.00				
Cs:Na=3:1			$(Cs, Na)_{15}Al_{15}Si_{33}O_{96}\cdot 5H_2O$			
H_2O 5						

1. Analysis by F. A. Gonyer.
2. Analysis calculated to 100%.
3. Molecular proportions.
4. Atomic proportions.
5. Number of atoms in the cell formula derived from the cell edge $a_0=13.65$Å.

The formula derived from the analysis and the cell edge $a_0=13.65$Å agrees well with the generalized formula: $Cs_{14+x}Al_{14}(Al_xSi)_{34}O_{96}\cdot 4\text{–}9H_2O$.

The specific gravity 2.89 was determined by suspension; the index of refraction $n(Na)=1.520$.

If we tabulate the characters of the new pollucite as is done in Table 2 on a preceding page for other occurrences, we have:

	Leominster
n	1.520
G	2.89
$\%Cs_2O$	33.06
$\%H_2O$	2.04

The figures bring it very close to the Elba pollucite with a slightly lower water content.

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