STUDIES OF URANIUM MINERALS (II):

LIEBIGITE AND URANOTHALLITE*

HOWARD T. EVANS, JR. AND CLIFFORD FRONDEL, *Massachusetts Institute of Technology and Harvard University, Cambridge, Mass.*

ABSTRACT

Liebigite, $Ca_2U(CO_3)_4 \cdot 10H_2O$, from Joachimsthal, Bohemia, has a_0 16.71 Å, b_0 17.55, c_0 13.79; $a_0{:}b_0{:}c_0 = 0.952{:}1{:}0.786$ ($a{:}b{:}c = 0.9539{:}1{:}0.7826$, morphology, Brezina, 1890). Space group *Bbam* or *Bba*. Cell contents $8[Ca_2U(CO_3)_4 \cdot 10H_2O]$. Specific gravity 2.41 (measured), 2.43 (calculated). The *x*-ray powder data, morphological data and new measurements of the optical constants are tabulated. Optically biaxial positive with $r > v$ and $2V \sim 40°$; $nX = 1.497$, colorless; $nY = 1.502$, pale greenish yellow; $nZ = 1.539$, pale greenish yellow, as an average of values varying slightly among 12 different specimens. Uranothallite is shown to be identical with liebigite. A new occurrence of liebigite at Wheal Basset, Redruth, Cornwall, England, is noted and the occurrence at Schneeberg, Saxony, is verified.

Liebigite was described in 1848 by the American chemist J. Lawrence Smith, at that time geologist to the Sultan of Turkey, Abdul Medjid. The mineral occurred as an alteration product of uraninite and was associated with chalcopyrite, gypsum, and a supposed new sulfate of uranium and calcium for which the name medjidite was proposed. The locality was given only as in the neighborhood of Adrianople, Turkey. The liebigite was very briefly described as forming mammillary concretions, apple-green in color, with an apparent cleavage in one direction and a hardness of 2–2½. Two analyses made on samples weighing 85 and 65 mg. indicated the substance to be a hydrated carbonate of calcium and uranium. The percentage weights reported, however, differ considerably from the values required by the formula $Ca_2U(CO_3)_4 \cdot 10H_2O$ established by later analyses on uranothallite—a species here shown to be identical with liebigite.

In 1917 E. S. Larsen showed that the optical properties of material labelled liebigite from Schneeberg, Saxony, were identical with those of the well-defined mineral uranothallite, and on these grounds urged the identity of the two species. Liebigite had not been earlier described or analyzed from Schneeberg, however, and while there is no question of the identity of Larsen's particular material with uranothallite, there is of course no certainty that his mineral is identical with the original liebigite of Smith. The writers were privileged to borrow an authentic specimen of liebigite and medjidite from Adrianople in the collection of the

---

* Contribution from the Department of Mineralogy and Petrography, Harvard University, No. 312.

American Museum of Natural History through the courtesy of Dr. F. H. Pough. This material (no. 16847) comprised two small pieces of botryoidal uraninite (pitchblende) with thin crusts of an apple-green cleavable mineral. Qualitative tests proved this to be a hydrated carbonate of calcium and uranium, and the optical properties and x-ray powder diffraction pattern were identical with those of crystals of uranothallite from Joachimsthal, Bohemia. The identity of liebigite and uranothallite thus appears to be certain. The name liebigite has priority of five years over the *kalk-uran-carbonate* of Vogl from Joachimsthal to which the names flutherite and uranothallite were later applied by Weisbach in 1875 and Schrauf in 1882, respectively.

TABLE 1. OPTICAL DATA FOR LIEBIGITE

Biaxial positive (+). Dispersion $r>v$, perceptible to moderate. Pleochroism: X nearly colorless, Y pale greenish yellow, Z pale greenish yellow

Locality	nX	nY	nZ	$2V$	Source
Joachimsthal	1.494	1.498	1.538	42°	New data
Joachimsthal	1.494	1.501	1.541	40°	New data
Joachimsthal	1.496	1.502	1.541	40°	New data
Joachimsthal	1.498	1.502	1.535	41°	Larsen, 1921
Joachimsthal	1.499	1.501	1.540	small	Larsen, 1921
Joachimsthal	1.500	1.503	1.539	42°	Larsen, 1921
Joachimsthal		1.505		small	Larsen, 1921
Schneeberg	1.499	1.503	1.545	variable, mostly 40°	New data
Schneeberg	1.501	1.503	1.537	37°	Larsen, 1921
Schneeberg		1.505		small	Larsen, 1921
Wheal Basset	1.497	1.503	1.538	15°	New data
Adrianople	1.497	1.503	1.542	40°	New data
Average	1.497	1.502	1.539		

Liebigite was also identified in this study on five specimens from Joachimsthal, Bohemia (two of which were erroneously labelled as voglianite, a dubious hydrous sulfate of uranium), on one specimen from Schneeberg, Saxony (labelled liebigite), and on a specimen from the Wheal Basset, Redruth, Cornwall, England. The latter locality is new for the species. The Wheal Basset specimen was erroneously labelled bassetite. The optical data obtained on several of these specimens are given in Table 1 in comparison with the data of Larsen. The x-ray powder diffraction spacing data are given in Table 2.

Table 2. *X*-ray Powder Spacing Data for Liebigite

Copper radiation, nickel filter (in Å)

d	*I*	*d*	*I*	*d*	*I*
6.81	9	2.71	1	1.575	2
6.07	2	2.59	4	1.547	1
5.37	10	2.47	3	1.497	1
4.98	1	2.32	3	1.473	2
4.55	6	2.28	3	1.451	1
4.10	5	2.18	4	1.423	1
3.93	1	2.12	2	1.402	1
3.79	2	2.05	1	1.358	2
3.60	4	2.01	5	1.329	1
3.35	7	1.929	2	1.301	2
3.16	8	1.852	1	1.285	2
3.04	2	1.731	4	1.258	2
2.85	2	1.684	2	1.222	2
2.78	2	1.631	1	1.182	1
				1.167	1

Crystallography

Liebigite usually occurs as granular or scaly aggregates and as thin crusts or films. The films often occur as fillings of narrow cracks along the layers of mammillary masses of pitchblende that are undergoing alteration. The material from Adrianople is of this nature and doubtless gave rise to Smith's description of the mineral as forming mammillary concretions. Botryoidal aggregates are rarely observed. Crystals of liebigite are uncommon and generally are indistinct with rounded edges and convex or vicinal faces. Material suitable for single-crystal *x*-ray work was obtained from a specimen from Joachimsthal, Bohemia, in the Harvard collection (no. 84600). The following data were obtained by the precession method using molybdenum radiation.

a_0 16.71 Å Space group *Bbam* or *Bba*
b_0 17.55 $a_0:b_0:c_0=0.952:1:0.786$ (*x*-ray cell)
c_0 13.79 $a:b:c=0.9539:1:0.7826$ (morphology, Brezina).

The *x*-ray cell here found coincides with the cell selected by Brezina in his morphological study of crystals from Joachimsthal. The agreement in axial ratio of the *x*-ray and morphological cells is satisfactory, especially in view of the poor surface quality of the measured crystals. An angle table using the elements of the *x*-ray cell is given in Table 3. The space group must be given as either *Bbam* or *Bba* for lack of certain knowledge of the crystal class. The small size and fragility of the

TABLE 3. ANGLE TABLE FOR LIEBIGITE

Orthorhombic; probably holohedral
$a:b:c=0.952:1:0.786$; $p_0:q_0:r_0=0.826:0.786:1$
$q_1:r_1:p_1=0.952:1.211:1$; $r_2:p_2:q_2=1.272:1.050:1$

	ϕ	$\rho=C$	ϕ_1	$\rho_1=A$	ϕ_2	$\rho_2=B$
c 001	—	0°00′	0°00′	90°00′	90°00′	90°00′
b 010	0°00′	90 00	90 00	90 00	0 00	0 00
a 100	90 00	90 00	—	0 00	0 00	90 00
n 230	35 01	90 00	90 00	54 59	0 00	35 01
m 110	46 25½	90 00	90 00	43 34½	0 00	46 25½
o 210	64 33½	90 00	90 00	25 26½	0 00	64 33½
d 011	0 00	38 10	38 10	90 00	90 00	51 50
p 111	46 25½	48 45	38 10	57 00	50 26½	58 47
r 121	27 43	60 37	57 32½	66 05½	50 26½	39 31½
q 141	14 02	73 38	73 09½	76 32½	50 26½	21 26
t 311	72 24	68 57½	38 10	27 10½	21 58½	73 36½

Doubtful: *x* 787 *u* 343 *s* 232 *y* 8.15.8.

available crystals precluded making a test for piezoelectricity. The specific gravity, given as 2.14–2.15 by Brezina, was redetermined on 12 mg. of powder on the microbalance as 2.41. The five reported chemical analyses of uranothallite = liebigite from Joachimsthal (cited by Dana and by Hintze) indicate the formula of the mineral to be $Ca_2U(CO_3)_4 \cdot 10H_2O$. The calculated specific gravity for the unit cell contents $8[Ca_2U(CO_3)_4 \cdot 10H_2O]$ is 2.43. There is a distinct cleavage on {100}. Liebigite fluoresces a rather bright green in both long-wave and short-wave ultraviolet light.

REFERENCES

BREZINA, A.; *Ann. Naturhist. Hofmus. Wien.*, **5,** 495 (1890).
DANA, E. S., System of Mineralogy, 6th ed., New York, 307 (1892).
HINTZE, C., Handbuch der Mineralogie, **1,** Pt. 3A, 3503 (1929).
LARSEN, E. S., *Am. Mineral.*, **2,** 87 (1917).
———, *U. S. Geol. Surv., Bull.* **679,** 151 (1921).
SCHRAUF, A., *Zeit. Krist.*, **6,** 410 (1882).
SMITH, J. L., *Am. J. Sci.*, **5,** 336 (1848).
———, *Am. J. Sci.*, **11,** 259 (1851).
VOGL, J. F., *Jb. Geol. Reichsanst. Wien*, **4,** 221 (1853).
WEISBACH, A., Synopsis mineralogica, Freiberg, 48 (1875).