THE AMERICAN MINERALOGIST, VOL. 56, MARCH-APRIL, 1971

SCHMITTERITE—A NEW URANYL TELLURITE FROM MOCTEZUMA, SONORA

RICHARD V. GAINES

ABSTRACT

A new mineral, uranyl tellurite UO_2TeO_3, has been found at the Moctezuma Mine, Moctezuma, Sonora. The mineral is pale straw yellow in color and occurs in minute rosettes of micaceous crystals, usually associated with emmonsite. It is orthorhombic, space group *Pmab* with *a* 7.860, *b* 10.089, and *c* 5.363 Å; there are four formula units per cell, $H=1$; $G=6.878$ (meas), 6.916 (calc). The mineral is biaxial negative with indices above 2.00. Principal powder lines are 3.682 (10), 5.35 (9), 3.099, (9), 4.73 (8), 3.170 (8), and 1.971 (7). The name is for Eduardo Schmitter V. of the University of Mexico.

INTRODUCTION

While studying the Moctezuma tellurium-gold deposit in 1961, an unidentified light yellow mineral was noted in small tufts and micaceous scales growing on emmonsite. Subsequent study at the Instituto de Geologia showed that this mineral was new and consisted of uranium, tellurium, and oxygen only. The description of this mineral was delayed because its scarcity and the lack of measurable crystals made a complete description difficult to achieve. These problems were finally solved, and the name schmitterite is now proposed for this species.

OCCURRENCE

Schmitterite was found at the Moctezuma Mine, Moctezuma, Sonora, along with a number of other new oxy-salts of tellurium (Gaines, 1965).

In the great majority of samples of schmitterite that have been collected the mineral is sparingly scattered on knobs or typical groups of curved fibers of emmonsite, or is on limonite surfaces adjacent to emmonsite encrustations. The schmitterite may occur as single crystals or grains, or more commonly as small rosettes rarely exceeding 1 mm in diameter. The groups of crystal blades making up these rosettes are so thin and plastic that they smear or disintegrate when touched with a needle.

Another less common form of occurrence is scattered on quartz fracture surfaces with crusts of small crystals of moctezumite, sometimes pseudormorphously replacing the latter. In such instances it has a glistening, micaceous appearance.

The total amount of mineral found, thinly scattered on matrix, was probably not over two grams.

Only one specimen collected from the San Miguel prospect showed schmitterite, which was thickly scattered on a druse of mackayite crystals.

Chemical Properties

X-ray fluorescence analysis on schmitterite showed only uranium and tellurium to be present. The mineral when heated to 600°C shows no change in appearance and a weight loss of less than 1 percent, hence it is assumed to be anhydrous. Schmitterite is readily soluble in dilute hydrochloric acid and in alkalis. Insufficient pure natural material was available for chemical analysis, for which reason it was necessary to synthesize the mineral to get enough material for this purpose.

It proved relatively easy to synthesize schmitterite but difficult to prepare a product absolutely free from extraneous phases. One method of synthesis used with considerable success was to heat a mixture of TeO_2 and $UO_3 \cdot H_2O$ in 1:1 stoichiometric proportions in water solution to a temperature ranging from 100° to 400°C.

Because of the high pressure this reaction was carried out in vycor tubes in a stainless steel bomb. The product was a slurry of fine crystals of $UO_2 \cdot TeO_3$, often contaminated with a little tetragonal TeO_2 (synthetic paratellurite). Varying the temperature up to 400°C seemed to make little difference in the size of crystals produced, which were usually less than 50 microns in size. Only one run, in which the vycor tube accidentally broke within the bomb, produced some coarse crystals up to 3 mm long mixed with iron oxides and other extraneous products.

Synthesis was also carried out at room temperature using the method of Khodadad (1962), giving a pure product which was, however, even finer in grain size than the high temperature product.

Analysis of the synthetic product gave 63.48 percent UO_3 and 36.95 percent TeO_2, total 100.43 percent. This compares with 64.19 percent UO_3 and 35.81 percent TeO_2 theoretical for $UO_2 \cdot TeO_3$. The powder photograph of this product matched that of natural schmitterite, therefore the chemical formula of schmitterite is $UO_2 \cdot TeO_3$.

Crystal Geometry

Single crystal X-ray studies were made with both Weissenberg and Buerger precession cameras, using filtered copper radiation. Natural crystals were unsuitable for this work, since their small size and extreme thinness caused them to bend upon the slightest contact. However, one lot of synthetic crystals gave individuals of sufficient size to permit handling and resulted in excellent photographs.

Extinctions observed were as follows: $h00$ present when h is even,

TABLE 1. X-RAY POWDER DATA OF SCHMITTERITE CU RADIATION, NI FILTER

hkl	d(calc.) Å	d(obs.) Å	I (vis. est.)	hkl	d(calc.) Å	d(obs.) Å	I (vis. est.)
001	5.363	5.35	9	003	1.788	1.788	4
020	5.045	5.03	2	421	1.734	1.734	5
011	4.736	4.73	8	242	1.664	1.666	2
120	4.246	4.25	1	061	1.605	1.604	1
111	4.056	4.06	2	223	1.549	1.549	6
200	3.930	3.933	2	422	1.512	1.512	2
021	3.675	3.682	10	441	1.489	1.489	2
121	3.329	3.324	1	043	1.459	1.459	3
201	3.170	3.170	8	004	1.341	1.340	1
220	3.100	3.099	9	153	1.319	1.318	1
211	3.024	3.025	3	522	1.310	1.305	2
031	2.849	2.850	1	541	1.295	1.292	2
221	2.684	2.686	4	253	1.266	1.266	4
012	2.592	2.594	2	461	1.243	1.242	1
040	2.522	2.525	3	263	1.169	1.170	3
112	2.461	2.466	1	244	1.134	1.134	2
022	2.368	2.365	4	273	1.079	1.080	1
202	2.215	2.214	3	373	1.031	1.032	1
212	2.164	2.158	2	391	1.012	1.012	1
032	2.097	2.093	3	1·10·0	1.001	1.001	1
132	2.026	2.026	4				
241	1.974	1.971	7				
312	1.842	1.843	4				
411	1.815	1.815	1				

$0k0$ present when k is even, $hk0$ present when k is even, $h0l$ present when h is even, hkl—no extinctions.

Schmitterite is orthorhombic, space group *Pmab* with a 7.860±.004, b 10.089±.002, and c 5.363±.002 Å. The cell volume is 425.31 Å^3, and $Z=4$.

Powder photographs of schmitterite give a pattern in which the three strongest lines correspond to 3.675, 5.363 and 3.100 Å. Forty-four lines were measured; a complete list of spacings is given in Table 1. Whenever possible, single crystal intensities were used to help with the indexing of lines that could be ascribed to more than one reflection.

CRYSTAL MORPHOLOGY

The crystal habit of schmitterite is blade-like, with elongation parallel to a and the width parallel to b. The thickness of the blades, which in natural material is probably 2 μm or less, is in the c direction. The most prominent form is 001. Becuase of the thiness of the blades morphological measurements could not be made, but several prisms, domes, and pyramids could be seen upon microscopic examination of synthetic crystals.

The only cleavage observed is taken as (100) with reference to the conventionally chosen orthorhombic cell in which the long dimension of the blade like crystals is *a*, their wide dimension is *b*.

Physical Properties

Color. Schmitterite varies from colorless to light yellow, the most common color being a very pale straw yellow. Synthetic schmitterite is pale creamy yellow. The luster is pearly.

Hardness. Schmitterite is very soft, with a hardness probably close to 1 on Moh's scale. Testing of hardness is uncertain because the minute scales are so exceedingly thin that they break or bend when the slightest pressure is exerted on them.

Specific Gravity. It was not possible to isolate a sufficiently large pure sample of natural schmitterite for specific gravity determination. After the mineral was synthesized, it was finally possible to make a gravity determination on a 1.00-gram sample of finely crystalline synthetic material. This material gave an X-ray powder pattern identical to that of the natural mineral with only a few extra faint lines caused by a trace of contaminating tetragonal TeO_2. The resulting specific gravity of 6.878 (average of two determinations) is in good agreement with the theoretical 6.916 calculated from the cell volume and contents, although it is appreciably lower than the 7.57 reported by Khodadad (1962) on artifical $UO_2 \cdot TeO_3$.

Optical Properties. Schmitterite is biaxial negative, with $2V$ near 75°. It shows parallel extinction but no discernible pleochroism. $X=c$ (the acute bisectrix), $Y=b$, and $Z=a$. $\beta=2.05$ using Cargille liquids. $\gamma>2.11$, probably near 2.15. α could not be measured because the thinness of the crystal blades in relation to their width made observation of the Becke line difficult, particularly in conjunction with the dark-colored index liquids. The optic orientation was determined in the universal stage.

Type Specimens

Samples of schmitterite have been deposited at the museum of the Institute of Geology and at the Smithsonian Institution of the U. S. National Museum, Washington, D.C., under specimen number NMNH 122475.

Name

The name schmitterite is in honor of Professor Eduardo Schmitter Villada, for more than 35 years Professor of Mineralogy and Petrology at the National University of Mexico and also Research Petrologist at the Mexican Institute of Geology at the University. The mineral and name schmitterite have been approved by the Committee on New Minerals and New Mineral Names of the International Mineralogical Association.

Acknowledgments

Most of the work on schmitterite was done at the Instituto de Geologia of the National University of Mexico, Guillermo P. Salas, Director, and the writer wishes to express his appreciation to Ing. Salas for his sponsorship of this work. He also wishes to thank Quim. Alberto Obregon who made the chemical analysis; Dr. Gabrielle Donnay of the Geophysical Laboratory, who checked the X-ray single crystal work; to Dr. Maria Luisa Crawford of Bryn Mawr College, who determined the optical constants of schmitterite; and to D. C. Appelman and Judith Konnert for help in computer refinement of the unit cell dimensions.

References

Gaines, R. V. (1965a) Mineralizacion de telurio en la mina Moctezuma, cerca de Moctezuma, Sonora. *Univ. Nac. Autonoma Mex., Inst. Geol. Bol.* **75,** (pt. 1).

——— (1965b) Moctezumite, a new lead uranyl tellurite. *Amer. Mineral.* **50,** 1158–1163.

Khodadad, M. P. (1962) Sur le tellurite neutre d'uranyle (UO_2) (TeO_3) *C. R. Acad. Sci. Paris (France)* **255,** 1617–1618.

Manuscript received, May 3, 1970; accepted for publication, November 7, 1970.