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POUGHITE, A NEW TELLURITE MINERAL FROM MEXICO AND HONDURAS

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ABSTRACT

A new hydrous basic ferric tellurite-sulfate $Fe_2(TeO_3)_2(SO_4)\cdot 3H_2O$ has been found at the Moctezuma Mine, Sonora. It is identical with an unnamed mineral from Honduras partially described in 1944 by Frondel and Pough. The mineral is yellow to greenish yellow in color, orthorhombic $a=9.66$, $b=14.20$ and $c=7.86$ Å, with a habit and cleavage similar to barite. $H=2\frac{1}{2}$; $G=3.75$. Principal lines in the X-ray powder pattern are 7.10 (10), 5.74 (10), 3.239 (7), 3.564 (6), 3.336 (6), and 3.053 (6). The name is for Frederick H. Pough.

INTRODUCTION

In 1944 in an article on two new tellurites of iron, mackayite and blakeite, Frondel and Pough mentioned a further new iron tellurite from Honduras, of which insufficient material was found for a complete description. This mineral had first been observed by Dana and Wells in 1890 and thought to be tellurite; Larsen in 1921 further studied the mineral, which he mistook for "durdenite" (emmonsite). No further work was done on this new unknown mineral, but its macroscopic description and especially the d-values for its powder photograph published in that article enabled the author to establish its identity with material found at the Moctezuma mine in Sonora, Mexico. The name poughite is proposed for this new mineral.

OCCURRENCE

Up to the present time poughite has been found by the writer in only two specimens. One, from the mine dump, is a piece of limonite-stained quartz breccia abundantly coated with drusy crusts and small botryoidal rosettes of a brownish yellow mineral. The only other mineral on the specimen besides poughite, quartz, and limonite, is pyrite in small amounts in corroded grains which are in the course of being altered to limonite. The second specimen is a piece of vein quartz coated along cracks and in vugs with emmonsite and minor limonite. In one area there are some corroded pyrite grains, and in this area the emmonsite is replaced by a crust of greenish yellow crystals of poughite. Other minerals on the specimen are an undescribed uranyl tellurite and fine crystals of jarosite perched on hairs of emmonsite.

Properties

Physical and optical properties. In the specimens found poughite varies from dark yellow to brownish yellow and greenish yellow. Synthetic poughite is pale yellow to bright sulfur yellow. Hardness is about $2\frac{1}{2}$. Cleavage (010) is perfect and (10$\bar{1}$) good. Specific gravity, measured by pyknometer on synthetic material, varied between 3.70 and 3.80 and the average of three determinations on different samples was 3.758.

Poughite is biaxial negative, with $2V$ about 15°–20°. Indices of refraction are $\alpha=1.72\pm0.01$, $\beta=1.985\pm0.01$, and $\gamma=1.990\pm0.01$. Pleochroism is strong: X=colorless, Y=pale greenish yellow, and Z=pale yellow. X is parallel to b, and Y parallel to a.

Chemical tests. Poughite is easily soluble in hydrochloric acid and slowly so in hot dilute sulfuric acid. X-ray fluorescence analysis showed the presence on only iron and tellurium. When a drop of barium chloride solution is added to a hydrochloric acid solution of poughite, a milky white precipitate forms, indicating the presence of sulfate in the mineral.

Composition. Since it was not felt desirable to sacrifice the two specimens found for chemical analysis, even though such a course would have provided at least 100 mg of material, it was decided to try to synthesize the mineral. An additional reason for this approach was the unsuitability of the few crystals found for measurement or X-ray work, and it was hoped that some suitable ones could be made.

Initial efforts were unsuccessful because the presence of sulfate in the composition and the necessity of providing sulfate ions among the raw materials for synthesis were not recognized. Finally, sulfuric acid was added to the ingredients in an effort to duplicate the conditions in an oxidizing pyritic orebody, and with this addition the compound was formed easily. Best results were obtained by using stoichiometric quantities of TeO_2, $Fe(OH)_3$, and H_2SO_4 at about 240°C and 33 bars, in pyrex tubes within a stainless steel pressure vessel. Above 255°C a new compound in the form of honey-brown triclinic crystals forms at the expense of the poughite. This compound was analyzed and appears to be a hydrous basic ferric tellurite, probably $Fe_2(TeO_3)_2(OH)_2\cdot 2H_2O$.

Considerable trial and error was necessary before it was possible to determine the correct proportions of Fe, Te, and $SO_4{=}$ in the compound and make a product which gave a powder pattern free from lines repre-

TABLE 1. QUANTITATIVE CHEMICAL ANALYSIS FOR POUGHITE

	Synthetic poughite	$Fe_2(TeO_3)_2(SO_4) \cdot 3H_2O$
Fe_2O_3	26.34	26.05
TeO_2	50.56	52.08
SO_3	12.32	13.06
H_2O	9.40	8.81
Insoluble	0.97	
Total	99.59	100.00

Note: The insoluble in the analysis consisted of glass fragments from the pyrex tube.

senting extraneous compounds. When this was finally accomplished the synthetic product was analyzed by conventional wet chemical methods. The results of this analysis are given in Table 1. The resultant formula, $Fe_2(TeO_3)_2(SO_4) \cdot 3H_2O$ is the first compound to be recognized in nature in which the tellurite radical is in combination with other anions.

CRYSTALLOGRAPHY

Morphology. Crystals of poughite are orthorhombic, diamond shaped, with a tabular habit similar to that of barite. The tabular crystals are flattened parallel to (010). Forms observed were (010), (101), (011), (120), and (100) (Table 2).

X-ray powder diffraction data. Powder photographs of both natural and synthetic poughite give a pattern in which the six strongest lines, in order of decreasing intensity, are 7.10, 5.74, 3.239, 3.564, 3.336, and 3.053. It will be noted that in the original listing of the spacings for this mineral, published in 1944, the three strongest lines are given as 3.34, 5.74, and

TABLE 2. POUGHITE ANGLE TABLE

Orthorhombic $a:b:c=0.6803:1.000:0.5535$

$p_0:q_0:r_0=0.8136:0.5535:1.000$

$q_1:r_1:p_1=0.6803:1.2291:1.000$

$r_2:p_2:q_2=1.8067:1.4699:1.000$

Forms	ϕ	ρ	ϕ_2	B	A
b 010	0°00′	90°00′	0°00′	—	90°00′
a 100	90°00′	90°00′	0 00	90°00′	—
l 120	36 19	90 00	0 00	36 19	53 41
f 011	0 00	61 02	90 00	28 58	90 00
r 101	90 00	50 52	39 08	90 00	39 08

1.87. The reason for this, which becomes obvious from inspection of the reproduction of the powder photograph in question, is that this photograph is heavily fogged in the region of high *d*-values, and thus it was impossible for the original investigators to properly estimate the intensities of the lines in this region. A complete list of the spacings with corresponding *hkl* values is given in Table 3, and from this it becomes clear that the minerals from Honduras and from Sonora are identical.

Precession photographs were taken of the h0*l*, *h*1*l*, *h*2*l*, *hk*0, and *hk*1 planes of poughite. From these photographs, and with further refinement of the cell dimensions based on the powder data, it was determined that poughite is orthorhombic, space group *Pmnb*, and that the cell dimensions are: $a=9.66$ Å, $b=14.20$ Å, and $c=7.86$ Å, all dimensions ± 0.02 Å.

The cell volume for poughite is 1078.2 Å^3 and $Z=4$. The calculated specific gravity is 3.775, in good agreement with the average measured value of 3.758.

TABLE 3. INDEXED X-RAY POWDER DATA FOR POUGHITE
$a=9.66$ Å, $b=14.20$ Å, $c=7.86$ Å Cu radiation, Ni filter

Intensity	*d* (meas) Å	*d* (calc) Å	*hkl*	Intensity	*d* (meas) Å	*d* (calc) Å	*hkl*
10	7.10	7.100	020	2	2.053	2.052	261
1	6.11	6.097	101	2	2.034	2.036	412
10	5.74	5.721	120	1	1.931	1.925	171
1	4.82	4.830	200	1	1.906	1.908	114
1	4.62	4.626	121	2	1.872	1.876	501
3	3.926	3.930	002	2	1.858	1.858	124
1	3.744	3.739	131	1	1.819	1.820	204
6	3.564	3.560	221	2	1.782	1.780	442
6	3.336	3.331	140	2	1.764	1.762	413
7	3.239	3.239	122	2	1.747	1.746	180
6	3.053	3.048	202	2	1.719	1.723	423
4	2.983	{2.981	212	2	1.697	1.693	144
		{2.980	301	2	1.661	1.659	541
5	2.940	2.933	320	1	1.633	1.630	281
5	2.869	2.860	240	3	1.595		
5	2.806	2.801	222	2	1.558		
2	2.757	2.748	321	2	1.543		
3	2.639	2.634	042	1	1.519	1.519	523
5	2.543	2.542	142	2	1.475		
2	2.354	2.350	322	3	1.448		
2	2.279	{2.282	341	1	1.424		
		{2.273	213	3	1.411		
4	2.203	2.204	161	1	1.220		
5	2.130	2.125	260	3	1.180		

TABLE 4

	Composition	Symmetry	Specific gravity	Strongest powder lines
Emmonsite	$Fe_2(TeO_3)_3 \cdot 2H_2O$	Monoclinic?	4.55	3.12, 5.78, 3.66
Mackayite	$Fe_2(TeO_3)_3 \cdot 5H_2O$	Tetragonal	4.69	3.327, 3.17, 4.95
Sonoraite	$Fe_2Te_2O_5(OH)_4 \cdot H_2O$	Monoclinic	3.95	10, 40, 4.65, 3.099
Poughite	$Fe_2(TeO_3)_2(SO_4) \cdot 3H_2O$	Orthorhombic	3.78	7.10, 5.74, 3.329
Blakeite	?	?	?	3.00, 2.54, 1.72
Artificial $Fe_2(TeO_3)_3$	$Fe_2(TeO_3)_3$	?	?	1.71, 3.27, 2.54
Artificial $Fe(TeO_3)(OH) \cdot H_2O$	$FeTeO_3(OH) \cdot H_2O$	Triclinic	4.79	2.94, 3.36, 4.11

Table 4 lists the principal constants of the five iron tellurites which have up to now been observed in nature, plus those of two artificial compounds which may well be found in the future. It will be noted that the strongest powder lines for mackayite and emmonsite also differ from those published in the 1944 article. The reason for this is the same as in the case of poughite.

NAME

The name poughite (pronounced PŌ′ AIT) is proposed for this mineral in honor of Dr. Frederick H. Pough, for his many valuable contributions to the science of mineralogy over a span of thirty-five years, and for his collaboration in the first study of this mineral from Honduras.

TYPE MATERIAL

Since this mineral was first found in Honduras, the El Plomo Mine, Ojojona District, Tegucigalpa, Honduras must be considered the type locality. Material from this find is in the mineral collection at Harvard University. Poughite from Moctezuma, Sonora, Mexico, upon which the present description is based, is neotype material, a specimen of which is preserved in the collection of the U. S. National Museum, Washington, D. C.

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