WHERRYITE, A NEW MINERAL FROM THE MAMMOTH MINE, ARIZONA*

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ABSTRACT

A new mineral from the Mammoth Mine, Arizona, having the formula $PbCO_3 \cdot 2PbSO_4 \cdot Pb(Cl, OH)_2 \cdot CuO$ is named in honor of Dr. Edgar Theodore Wherry. The indices of refraction are $\alpha = 1.942$, $\beta = 2.010$ and $\gamma = 2.024$, and $2V = 50°$ (calculated). The specific gravity is 6.45. Wherryite was found in a vug just above the 760-foot level associated with chrysocolla, diaboléite, and paralaurionite.

INTRODUCTION

In May of 1943 one of the authors, E. B. Daggett, then mining engineer at the Mammoth Mine, discovered a small vug of leadhillite crystals associated with cerussite, anglesite, phosgenite, paralaurionite, hydrocerussite, diaboléite, boléite, matlockite, and quartz. Within the cavity was some friable chalcocite with a relict structure of the galena which it has replaced.

The massive wall of the vug consisted of a light-green fine granular mineral enclosing some bluish chrysocolla, and at the cavity some blue diaboléite and greenish paralaurionite. This green matrix was up to five cm. in thickness and extended to the silicified wall of the vein—an altered quartz monzonite.

The minerals of this remarkable vug, and the crystallography of the leadhillite will be described in a later paper; some observations on the paragenesis will be given here in order to describe the occurrence of the green matrix which has proven to be a new mineral.

The name wherryite is given to this new mineral in honor of Dr. Edgar Theodore Wherry, first editor of the *American Minerologist,* formerly curator of mineralogy at the U. S. National Museum, and now professor of plant ecology at the University of Pennsylvania.

LOCALITY

The Mammoth mine was named for the town of Mammoth, on the San Pedro River, which is about 3 miles to the northeast. It is in Pinal County, about 46 miles northeast of Tucson. An earlier post-office at the mine was called Schultz after the discoverer of the deposit. The present designation of the post-office is Tiger, so named by one of the owners

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of the mine in allusion to his alma mater. The locality should not be confused with the famous Mammoth Mine in the Tintic District of Utah. Discovered between 1879 and 1882, it has been worked at various times for gold, in World War I for the molybdenum content of the wulfenite, in 1933 for the vanadium content of the vanadinite and descloizite, and more recently for the lead, zinc, and silver values of the primary galena and sphalerite.

GEOLOGY AND ORE VEINS

The basement rock is a quartz monzonite, intruded by dikes of aplite and by bodies of andesite porphyry, now altered, as well as by later dikes and sills of rhyolite, and intrusive breccias of the earlier rocks.

The two important veins are the Mammoth vein and the Collins vein, which occupy premineral fissures with a general northwestward strike and a steep dip. Between them is the Mammoth fault, a brecciated zone about 20 feet in width. There can be little doubt that the Mammoth vein is the faulted apex of the Collins vein. The veins are thoroughly oxidized, with but few remnants of primary sulfides except in the lower levels. The approximate, but varying boundary between the oxides and the sulfides in the Collins vein lies between the 600-foot and 700-foot levels.

The leadhillite vug was found in the "hanging wall vein," a small block of ore which had been broken by the hanging wall fault from the Mammoth vein, and occurs between the Mammoth vein and the Mammoth fault, which in this part of the mine was more than 400 feet from the Collins vein. The vug was just above the 760-foot level, and close to the water table (Fig. 1).

Part of the paragenesis of the vug may be interpreted as follows: A mass of primary galena, close to the water table, was partly replaced by chalcocite in the course of secondary enrichment of the copper. Advancing oxidation altered some of the galena to anglesite, which was gradually replaced by cerussite, while some of the chalcocite was altering to chrysocolla. The sequence, galena to anglesite to cerussite, is the normal course of the weathering process.

At some stage of this normal sequence, lead sulfide to lead sulfate to lead carbonate, a remarkable reversal took place with the formation of complex sulfates with CO_2 and Cl_2 (leadhillite and wherryite), as well as the formation of the rare basic carbonate hydrocerussite, and the rare oxychlorides diaboléite, paralaurionite, and the chlorofluoride matlockite. It may be that this strange paragenesis was caused by the influx of solutions containing Cl ions in channels opened up by fault movements (perhaps formation of the Mammoth fault system).

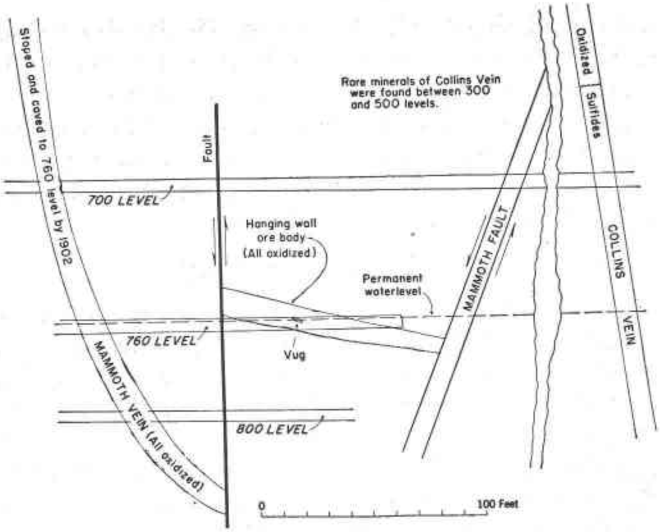

FIG. 1. Site of leadhillite vug in the hanging wall (faulted block) ore body in which wherryite was found.

OPTICAL PROPERTIES

Under crossed nicols most grains of wherryite showed no extinction, being made up of tiny particles, each with its own orientation. A few grains showed wavy extinction. A few more gave sharp extinctions and with these the indices of refraction were measured using sodium light and piperine iodide melts:

$$\left.\begin{aligned}\alpha&=1.942\\ \beta&=2.010\\ \gamma&=2.024\end{aligned}\right\}\text{all} \pm 0.005$$

$$2V=50^\circ \text{ (Calculated).}$$

X-RAY ANALYSIS

X-ray powder diffraction photographs (Fig. 2) were made, using copper radiation and a nickel filter, of wherryite, caledonite, leadhillite, hydrocerussite, and cerussite. The dissimilarities are evident. The lines of the powder diffraction pattern of wherryite are listed in Table 1. Visual estimates of the intensities of the lines were made on a scale of 10, where 10 represents the intensity of the strongest line.

PHYSICAL AND CHEMICAL PROPERTIES

The color of wherryite matches Plate XVIII, Light Oriental Green in Color Standards and Nomenclature by Robert Ridgway. No variation

TABLE 1. PLANAR SPACINGS AND RELATIVE INTENSITIES OF THE DIFFRACTION LINES IN THE X-RAY POWDER SPECTRUM OF WHERRYITE

Spacing, Å.	Intensity	Remarks
4.77	3	
4.57	8	
4.19	1	
4.02	1	
3.52	2	broad
3.39	1	
3.28	1	
3.14	8	
3.05	10	
2.88	4	
2.79	1	
2.74	6	
2.67	1	
2.51	2	
2.45	2	
2.29	3	
2.22	2	
2.11	2	broad
2.05	2	
1.877	7	
1.800	1	
1.740	2	
1.719	2	
1.664	1	
1.642	1	
1.600	1	
1.575	1	
1.521	1	
1.441	2	
1.399	1	
1.382	1	
1.347	1	
1.334	1	
1.302	2	very broad
1.180	2	broad
1.133	1	
1.124	1	

in the color was noticed among the individual grains of the sample analyzed. The mineral has a fine granular texture and is usually intimately associated with leadhillite, paralaurionite, and chrysocolla. Paralaurionite is present as radial aggregates of acicular crystals with a slightly pearly-lustered cleavage; the leadhillite is found as tabular grains showing a basal cleavage.

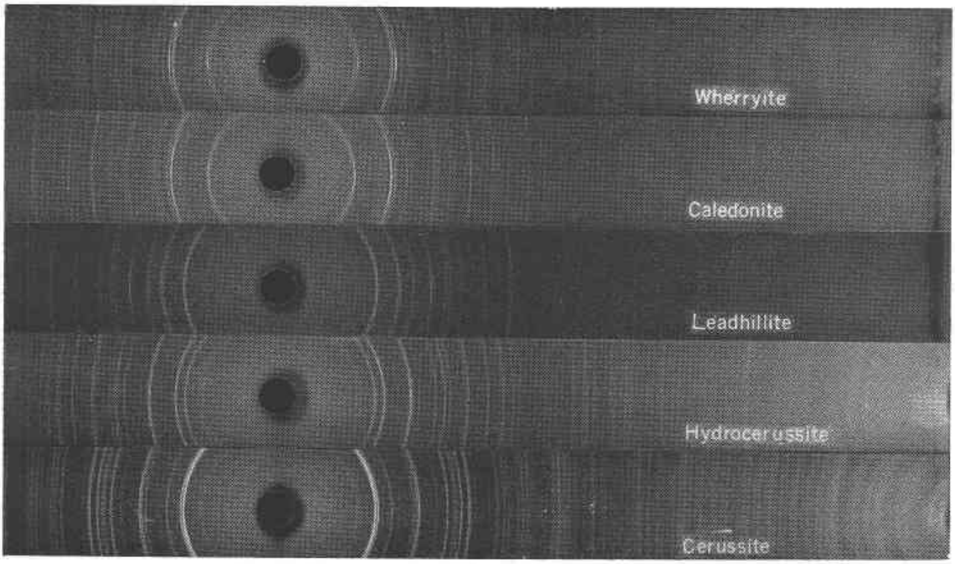

FIG. 2. *X*-ray powder diffraction photographs taken with copper radiation, nickel filter.

The specific gravity of the analyzed sample, determined with an Adams-Johnston pycnometer of fused silica, is 6.25. A correction for the 2.2 per cent quartz present raises the figure to 6.45, the specific gravity of wherryite.

Heated in a closed tube the mineral turns black without decrepitation and then melts.

It is slowly soluble in cold HCl (1:1) and in cold HNO_3 (1:1). Boiling H_2SO_4 (1:1) very slowly decomposes wherryite, leaving a white residue of $PbSO_4$.

CHEMICAL ANALYSIS

The chemical analysis was made on 280 mg. of the 400 mg. sample. The 2.2 per cent that was insoluble in HCl was identified under the petrographic microscope as quartz. Carbon dioxide[1] was determined by measuring the volume of the gas. All other constituents were determined by the well-known methods outlined in Applied Inorganic Analysis by Hillebrand and Lundell. The analysis and computation of formulas are given in Table 2.

A spectrographic examination by K. J. Murata of the U. S. Geological

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[1] Fahey, Joseph J., A volumetric method for the determination of carbon dioxide: *U.S. Geol. Survey*, Bull. **950,** 139–141 (1946).

TABLE 2. ANALYSIS AND FORMULA OF WHERRYITE

	Per cent			Ratios
PbO	72.9	0.327		4.0 {3.0 PbO 1.0 Pb}
CuO	7.3	0.092		1.1
SO_3	13.0	0.162		2.0
CO_2	3.1	0.070		0.9
Cl	0.9	0.025	0.160	2.0
$H_2O-110°$ C.	none			
$H_2O+110°$ C.	1.2 (OH)	0.135		
Insol.	2.2			
	100.6			
	−0.2 oxygen correction			
	100.4			

Formula: $PbCO_3 \cdot 2PbSO_4 \cdot Pb(Cl, OH)_2 \cdot CuO$.

Survey showed Cu, Pb, and Si to be present in quantities greater than 1 per cent, Al in tenths of 1 per cent, Ca, Zn, and Mg in hundredths of 1 per cent and Fe and Na in thousandths of 1 per cent.

ACKNOWLEDGMENTS

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