

STATE OF CALIFORNIA  
DEPARTMENT OF NATURAL RESOURCES  
GEORGE D. NORDENHOLT, Director

DIVISION OF MINES  
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY

State Mineralogist

Vol. 35

OCTOBER, 1939

No. 4

CALIFORNIA JOURNAL  
OF  
MINES AND GEOLOGY



QUARTERLY CHAPTER  
OF  
STATE MINERALOGIST'S REPORT XXXV

STATE DIVISION OF MINES  
FERRY BUILDING, SAN FRANCISCO  
CALIFORNIA

printed in CALIFORNIA STATE PRINTING OFFICE  
SACRAMENTO, 1940 GEORGE H. MOORE, STATE PRINTER

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## SULPHATE MINERALS AT THE LEVIATHAN SULPHUR MINE, ALPINE COUNTY, CALIFORNIA

By GEO. L. GARY, Mineral Technologist

At the Leviathan sulphur mine, about seven miles east of Markleeville, the county seat of Alpine County, five exceptionally interesting sulphate minerals have been recently identified. These are secondary minerals formed by the oxidizing action of surface water upon certain sulphide or sulphur-bearing minerals.

During the 60's this property, which now consists of 90 unpatented claims, covering an area of 1800 acres, was operated as a copper mine on a body of high-grade ore.<sup>1</sup> In recent years large bodies of low-grade and considerable amounts of high-grade sulphur ore have been developed. The Calpine Corporation of Los Angeles, owners of the property, have a mill at the mine and an experimental plant for recovery of the sulphur from the low-grade ore by steam liquation.

On September 30, 1939, Walter W. Bradley, State Mineralogist, J. C. O'Brien, Mining Engineer, Dr. Adolf Pabst, Associate Professor of Mineralogy, University of California and the writer visited the mine, inspected the workings and obtained specimens through the courtesy of the management. It is from this material that the following minerals were determined.

### CHALCANTHITE

Chalcantite,  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ , a hydrous cupric sulphate, formed through the oxidation of copper sulphides and deposited from mine waters was identified by its chemical and physical properties. It occurs in groups of brittle flattened crystals; also in massive and stalactitic forms. This mineral in considerable amounts was noted in most of the mine openings. It also occurs in small veinlets in tuff breccia impregnated with sulphur. The combination of the Berlin-blue color of this mineral with the yellow sulphur as a background forms a beautiful underground picture.

### IRON-COPPER CHALCANTHITE

Iron-copper chalcantite,  $\text{FeO} \cdot \text{CuO} \cdot 2\text{SO}_3 \cdot 10\text{H}_2\text{O}$ ,<sup>2</sup> a hydrous iron-copper sulphate, was identified by its chemical and optical properties. It occurs in pale-blue massive forms in several places in the lower adit of the mine.

### HALOTRICHITE

Halotrichite,  $\text{FeSO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 22\text{H}_2\text{O}$ , a hydrous iron-aluminum sulphate, was identified by its chemical and physical properties. It occurs as white and yellowish silky fibrous growths, four to five inches long, grouped together in tuft-like masses in several places in the lower adit of the mine.

<sup>1</sup> California Div. Mines, State Mineralogist's Report XXVII, p. 491, 1931.

<sup>2</sup> Esper S. Larsen and Harry Berman, The microscopic determination of the nonopaque minerals: U. S. Geol. Survey Bull. 848, p. 156, 1934.

### MELANTERITE

Melanterite,  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ , a hydrous ferrous sulphate, was identified by its chemical and optical properties. It occurs as white brittle massive crusts and stalactites of various shades of green in all the mine openings. This mineral results from the decomposition of the pyrite present in the mine. It becomes yellowish on exposure.

### RÖMERITE

Römerite,  $\text{FeSO}_4 \cdot \text{Fe}_2(\text{SO}_4)_3 \cdot 14\text{H}_2\text{O}$ , a very rare hydrous iron sulphate was identified by its optical properties, obtained from the examination of crushed fragments. Biaxial negative.  $B = 1.571$ . Birefringence .059. Strong crossed dispersion. Abnormal interference colors. It occurs in brittle chestnut-brown tabular triclinic crystals in masses and implanted on melanterite stalactites in one of the stopes of the lower adit of the mine. This mineral has only been noted twice before in California; from Island Mountain in Trinity County,<sup>3</sup> and in the Calico Hills near Borate, about six miles northeast of Yermo, San Bernardino County.<sup>4</sup>

The above minerals are on display in the museum of the State Division of Mines in the Ferry Building, San Francisco.

<sup>3</sup> Landon, Robert E., Römerite from California: Am. Mineralogist, vol. 12, pp. 279-283, 1927.

<sup>4</sup> Foshag, William F., Krausite, a new sulfate from California: Am. Mineralogist, vol. 16, pp. 352-360, 1931.