OLIGONITE, A MANGANOSIDERITE FROM LEADVILLE, COLORADO

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The specimen, from Leadville, Colorado, described in this paper, came from the Iron Silver Mining Company's Tucson Shaft. The depth at which it was collected is not known.

The appearance of the specimen is shown in figure 1. The darker portion is mainly chalcopyrite and sphalerite in which hollows have been etched or dissolved, probably by hot vapors, and which has then been encrusted with galena that is now traversed by a network of black sphalerite. The emanations which brought about the solution of blende and chalcopyrite, and which were doubtless also responsible for the deposition of the encrusting galena on the resulting ridge-and-hollow surface, are thought to have issued from small orifices, over which during a closing stage, the remarkable mushroom-like structures, shown in the photograph, were built. The "mushrooms" each consist of an outer shell, about 1/16 inch thick, partially enclosing a bundle of tiny radiat-

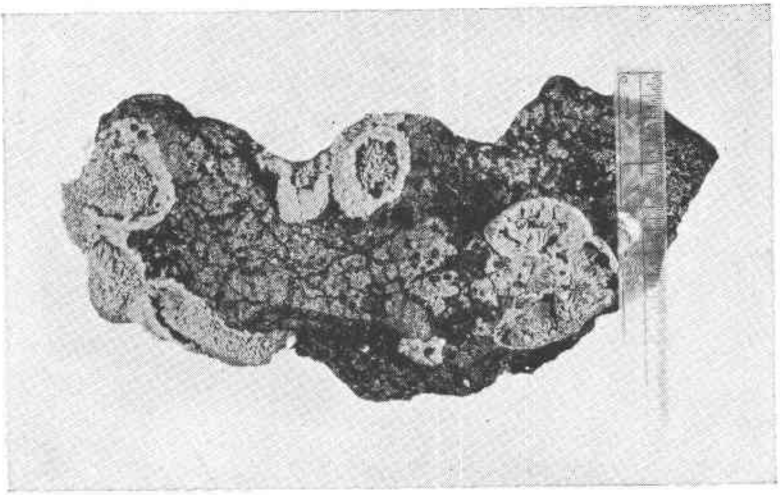

Fig. 1. Photograph of the specimen of oligonite, a manganosiderite, on chalcopyrite, galena, and sphalerite.

ing columns that converge toward the supposed apertures from which the mineralizing solutions escaped. These odd structures are composed of a pale, taffy-colored, slightly iron stained substance which proves to be oligonite, the central member of the rhodochrosite-siderite series. A manganosiderite, apparently almost identical in chemical composition with this one, has already been reported from the zinc ores of Leadville by Loughlin.[1]

The carbonate is so finely crystalline that its identification was, at first, a matter of some difficulty. A preliminary spectroscopic examination revealed the presence of iron, manganese, and carbon; the latter was found by chemical methods to be present as carbonate. An x-ray analysis disclosed a crystal structure similar to that of rhodochrosite. Later, tiny rhombohedra were detected in the "mushrooms" with the aid of a binocular miscroscope, and minute cleavage rhombs were found among the crushed fragments. The material was not homogeneous, but consisted of a mixture of a small proportion of brown, opaque particles in the main bulk of tiny, transparent, colorless rhombs, some of which were coated with the opaque substance. The indices[2] or these rhombs follow:

$$\epsilon' = 1.695 \pm .003$$
$$\omega = 1.840 \pm .002$$

From these values it is evident that the mineral is optically negative.

The material was crushed in an agate mortar, taking care to avoid any loss of carbon dioxide by prolonged grinding,[3] was dried at 105°C., and analyzed as follows:

The carbonate was determined by evolution as CO_2 from sulfuric acid solutions of weighed samples of the mineral, and was absorbed in ascarite, using a train similar to that recommended by Hillebrand and Lundell.[4] Since most of the iron present was found to be in the ferrous state, the solutions were oxidized with nitric acid and bromine; the excess nitric acid was removed by evaporat-

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[1] Loughlin, G. F., The oxidized zinc ores of Leadville, Colorado: *U. S. Geol. Survey, Bull.* **681,** p. 47, 1918.

[2] The index of the ordinary ray was determined by immersion in a solution of phosphorus in methylene iodide. Details of the preparation and use of this series of liquids will be published later.

[3] Johnston, J., and Niggli, P., *Journ. Geol.*, vol. **21,** p. 614, 1913.

[4] Hillebrand, W. F., and Lundell, G. E. F., Applied Inorganic Analysis, p. 623, John Wiley and Sons, *New York,* **1929**.

ing to fumes of SO_3. The iron was then separated from manganese by means of cupferron, following the procedure of Hillebrand and Lundell,[5] and was determined as Fe_2O_3; from this the total iron content of the mineral was calculated to FeO.

The filtrates were then evaporated with sulfuric and nitric acids to destroy the excess cupferron, and the manganese was determined as pyrophosphate.[6] Confirming the spectroscopic examination, no lead, zinc, calcium, or magnesium was found by chemical methods. The results of the analyses are listed in the subjoined table. Stated as carbonates, the analysis shows approximately 57 per cent $MnCO_3$, 42 per cent $FeCO_3$.

TABLE I

ANALYSIS OF OLIGONITE

Sample taken	Grams found			Per cent found			Total
gm	CO_2	Fe_2O_3	$Mn_2P_2O_7$	CO_2	FeO	MnO	
0.2000	0.0757	0.0580	0.1419	37.85	26.09	35.45	99.39
0.5000	0.1899	0.1455	0.3530	37.98	26.18	35.28	99.44

As the table shows, there is a difference of approximately 0.6% unaccounted for, which is assumed to be oxygen; there is also an excess of combined FeO and MnO over the amount required for the CO_2 present. Although the total iron content is reported as FeO, a little of it was in the ferric state; all the manganese is reported as MnO, but some may also have been present as a higher oxide. The heterogeneity of the material, however, accounts for these discrepancies.

The chemical and optical data given above are shown with others in the diagram (Fig. 2). In constructing this figure, only those analyses were chosen which reported no more than one per cent of any substance other than iron and manganese carbonates, and which were accompanied by measured values of ω. Even so, an analysis by N. Sundius,[7] of a siderite from Ivigtut, Greenland, has been omitted because, if plotted, it would have fallen in the

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[5] Hillebrand, W. F., and Lundell, G. E. F., *loc. cit.*, p. 109.

[6] Blair, A. A., The Chemical Analysis of Iron, p. 106, J. B. Lippincott Co., *Philadelphia*, **1918.**

[7] Sundius, N., Optische Bestimmung an $FeCO_3$, $MnCO_3$, und $CaMg(CO_3)_2$; *Geol. För. Förh.*, vol. **47**, pp. 269–270, 1925. (*Mineral. Abs.*, vol. **3**, p. 59, 1926–28.)

cluster of siderite analyses shown in the diagram. The straight diagonal line, marked ω in figure 2, connects the values reported by Ford[8] for the refractive index of the ordinary ray in the pure end members. The close agreement of the observed value of ω in the oligonite with the theoretical value is confirmatory evidence of the straight line relationship between chemical composition and optical properties throughout the entire series.

FIGURE 2

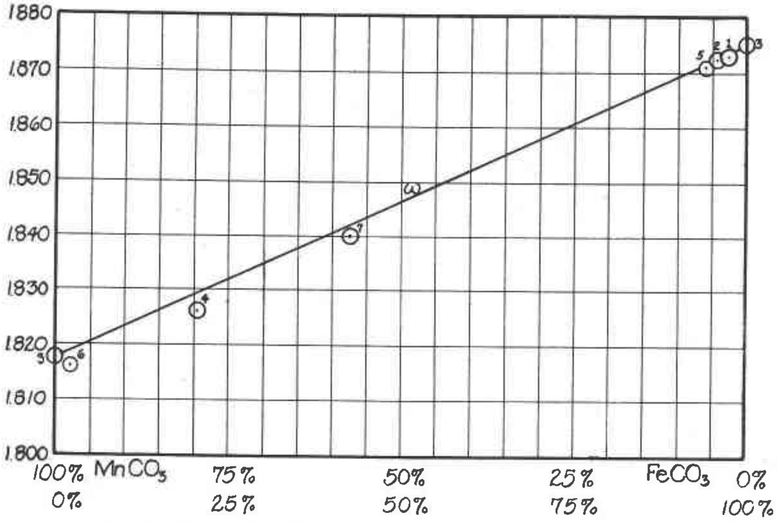

Fig. 2. Measured indices of the ordinary ray in some analyzed members of the rhodochrosite-siderite series.

(1) "Chalybite" from Cornwall. Hutchinson, *Mineral. Mag.*, vol. **13**, p. 209, 1903.

(2) Siderite from Greenland. Ford, *Trans. Conn. Acad. Arts and Sci.*, vol. **22**, p. 243, 1917.

(3) Pure carbonates. Ford, *ibid.*

(4) Rhodochrosite (?) from Branchville, Conn. Ford, *ibid.*

(5) Siderite from Ivigtut, Greenland. Wherry and Larsen, *Jour. Wash. Acad. Sci.*, vol. **7**, pp. 365–368, 1917.

(6) Rhodochrosite from Alma, Colorado. Sundius, *Geol. För. Förh.*, vol. **47**, pp. 269–270, 1925. (*Mineral. Abs.*, vol. **3**, p. 59, 1926–28.)

(7) Oligonite from Leadville, Colorado.

The name oligonite was given more than a century ago by A. Breithaupt[9] to a mineral containing approximately 60% $FeCO_3$

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[8] Ford, W. E., Studies in the calcite group: *Trans. Conn. Acad. Arts and Sci.*, vol. **22**, pp. 211–248, 1917.

[9] Breithaupt, A., *Journ. f. Chemie u. Physik*, vol. **54**, p. 283, 1828.

and 40% $MnCO_3$, and the term could well be applied to central members of the rhodochrosite-siderite series, in which the amounts of iron and manganese carbonates do not vary more than 20% from the 50:50 ratio. In 1901, K. Busz[10] proposed the name "manganosphärit" for a mineral practically identical in chemical composition with Breithaupt's material. Unless Busz's term has some special paragenetic significance, its use should be discontinued, because the name adopted in this paper undoubtedly has priority. Both names are applied synonymously by Ford,[11] but oligonite alone is preferred by Kraus and Hunt[12] and by the Winchells.[13]

Although analyses of oligonite have been in existence for many years, the Leadville mineral, herein described, appears to be the first for which any optical properties are given.

The best value obtained after numerous attempts to measure the specific gravity of the mineral is 3.722. This result is doubtless somewhat low, because of the porous nature of the material and the consequent difficulty of eliminating included air. In accordance with expectation, the hardness of the mineral proves to be slightly greater than 3.5.

The writers wish to express their appreciation to Professor H. Ries for lending them the specimen and for his constructive criticism of the manuscript, and to Professor Paul F. Kerr, of Columbia University, who kindly furnished the *x*-ray data.

SUMMARY

Oligonite, the central member of the rhodochrosite-siderite series, has been described, and a definition of the term oligonite has been suggested.

The optical properties of oligonite have been recorded.

The relationship between chemical composition and optical properties has been pointed out in the case of oligonite, and a comparison made with the other members of the rhodochrosite-siderite series.

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[10] Busz, K., *Neues Jahrb.*, II, pp. 129–132, **1901.**

[11] Ford, W. E., Dana's Textbook of Mineralogy, p. 519, John Wiley and Sons, *New York*, **1932.**

[12] Kraus, E. H., and Hunt, W. F., Mineralogy, p. 277, McGraw-Hill, *New York*, **1928.**

[13] Winchell, N. H., and Winchell, A. N., Elements of Optical Mineralogy, **2**, p. 78, John Wiley and Sons, *New York*, **1927.**