

RHODONITE, JOHANNSENITE, AND FERROAN JOHANNSENITE AT VANADIUM, NEW MEXICO*

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ABSTRACT

The occurrences and relations of rhodonite, johannsenite, and ferroan johannsenite at the Star, Hobo, and Princess mines, near Vanadium, Grant County, N. Mex., are described, and the optical properties and chemical compositions of these minerals are recorded. In the deep levels of these mines rhodonite replaces johannsenite and ferroan johannsenite and was probably formed by the introduction of manganese in the ore solutions that later deposited magnetite, sphalerite, and other sulfides.

INTRODUCTION

This paper describes the occurrences of rhodonite, johannsenite, and ferroan johannsenite at the Star, Hobo, and Princess mines near Vanadium, N. Mex., and is essentially a report of progress on our study of the pyroxenes associated with the pyrometasomatic zinc deposits of N. Mex. and Mexico. These mines are located in Grant County, about 12 miles east of Silver City, N. Mex., and are included in the Central Mining District, parts of which have been mapped and described by Lindgren, Graton, and Gordon (1910), by Paige (1916), by Spencer and Paige (1935), and by Lasky (1936).

Johannsenite was named by Schaller in 1938, so it appears appropriate to record here the extension of known occurrences of this manganese pyroxene and its association with rhodonite. Furthermore, the term ferroan johannsenite used here to designate the composition of another manganese pyroxene in this district indicates the usefulness of the adjectival modifiers to mineral names as proposed by Schaller in 1930.

The Central Mining District (Fig. 1) contains several stocks of granodiorite and allied rocks that are associated with ore deposits. The Hanover stock is known from the excellent paper of Schmitt (1939) on the Pewabic mine, one by Schaller (1938) on johannsenite from the Hanover Mine (1938), and earlier papers by Paige (1916), Spencer and Paige (1935), and others. A stock containing the important disseminated copper deposit that is mined by the Kennecott Copper Corporation in a

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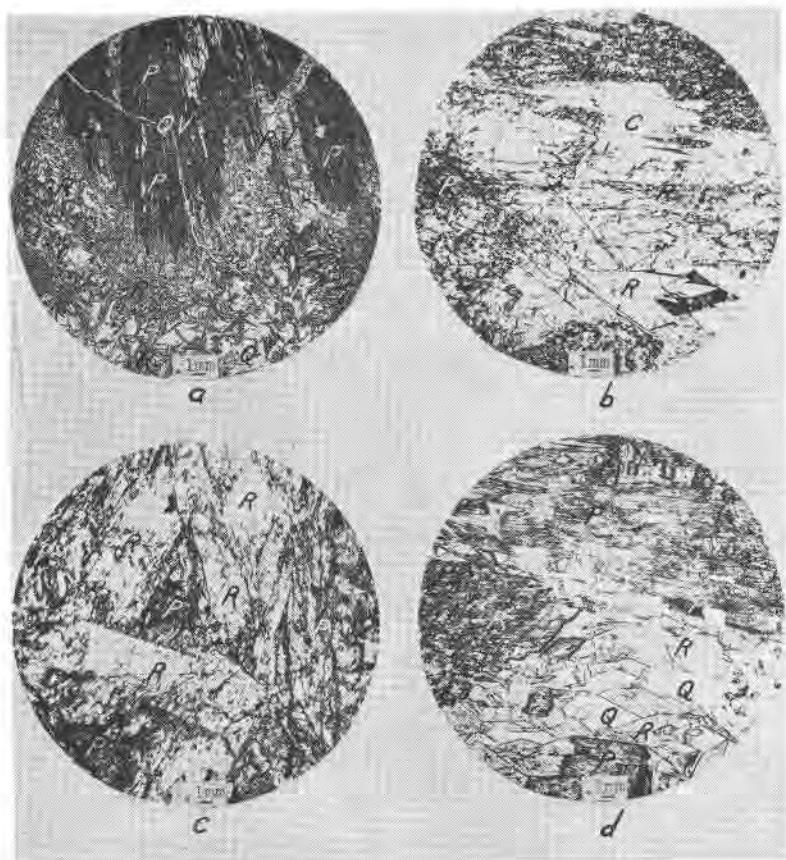


FIG. 2. Photomicrographs of rhodonite. a. Rhodonite (R) replaces pyroxene (P). Q is quartz (white). QV is a tiny quartz vein. RV is rhodonite cutting pyroxene (P). 1950-foot level, Star mine, Vanadium, N. Mex. b. Rhodonite (R) replaces pyroxene (P). C is calcite; 1950-foot level, Star mine, Vanadium, New Mex. c. Rhodonite crystals (R) developed in pyroxene (P). 1950-foot level, Star mine, Vanadium, N. Mex. d. Rhodonite crystals (R) in quartz (Q) formed from pyroxene (P). Hobo mine, Vanadium, N. Mex.

OCURRENCES AND PROPERTIES OF RHODONITE

In the development of the deep levels of the mines near Vanadium, N. Mex., a pink or flesh-colored silicate was observed that had not been recorded previously at the Ground Hog, Star, Hobo, and Princess mines (Northrop, 1944). Optical, spectrographic, chemical, and *x*-ray data indicate that this mineral is rhodonite with $\alpha = 1.717$; $\beta = 1.721$; $\gamma = 1.729$; $\gamma - \alpha = 0.012$; $2V = 76^\circ$; positive; $Z' \wedge C = 32^\circ$. These values are slightly low for pure rhodonite but agree with those of rhodonite containing some Mg, Fe, and Ca in addition to the Mn and SiO_2 required by its formula

(Larsen and Berman, 1934). Harry Rose of the U. S. Geological Survey estimated from the spectrograms examined by him that specimens from the Star and Hobo mines contain approximately 4 or 5 per cent Ca, 2 per cent Fe, and 1 or 2 per cent Mg, in addition to abundant manganese.

The textural relations in thin sections indicate that rhodonite has replaced the pyroxenes. In figure 2a, showing material from the 1950-foot level of the Star mine, needles of rhodonite occur in quartz at the end of the pyroxene, and a vein of rhodonite cuts the early pyroxene. Small quartz veins cut across the pyroxene and the rhodonite. The change of a

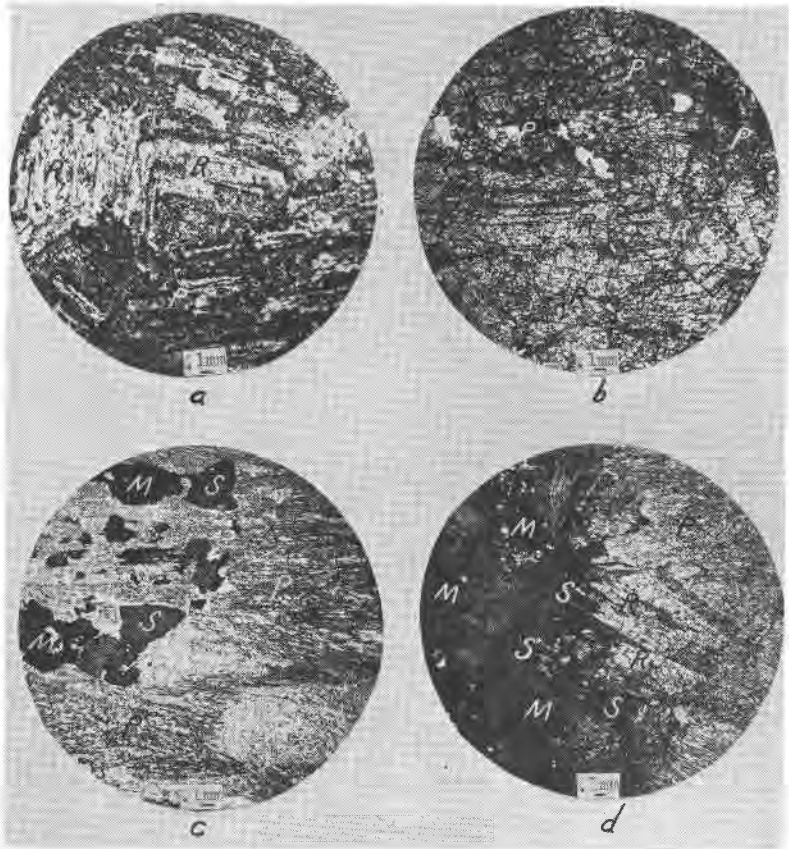


FIG. 3. Photomicrographs of rhodonite, pyroxene, magnetite, and sphalerite. a. Rhodonite (R) replaces pyroxene (P). Hobo mine, Vanadium, N. Mex. b. Rhodonite (R) replaces pyroxene (P). Princess mine, Vanadium, N. Mex. c. Magnetite (M) and sphalerite (S) are later than pyroxene (P). 1950-foot level, Star mine, Vanadium, N. Mex. d. Magnetite (M) and sphalerite (S) cut and fill space in pyroxene (P) and rhodonite (R). 1950-foot level, Star mine, Vanadium, N. Mex.

pyroxene containing Ca, Mg, Fe, Mn, and SiO_2 to rhodonite with a composition of MnSiO_3 would liberate Ca, Mg, Fe, and probably some silica. Schaller (1938) has suggested that the hydrous calcium silicate xonotlite, at Pueblo, Mexico, was formed under these conditions. No xonotlite has been observed at Vanadium, N. Mex., but the calcite, which occurs at the Star mine between rhodonite and pyroxene (see Fig. 2b), may represent calcium liberated from pyroxene. At the same locality large crystals of rhodonite occupy space formerly taken by pyroxene (see Fig. 2c). At the Hobo mine terminated crystals of rhodonite have grown at the expense of pyroxene (see Fig. 2d). Rhodonite replaces columnar pyroxene in a sample from the Hobo mine (Fig. 3a) and in another from the Princess mine (Fig. 3b). These relations were photographed in plane polarized light, but replacement features stand out even more clearly under crossed nicols because the birefringence of rhodonite is low as compared with that of the associated pyroxenes.

OCCURRENCE AND PROPERTIES OF FERROAN JOHANNSENITE

Some of the pyroxene that occurs at the Star mine in contact with rhodonite was separated by hand picking and by using heavy solutions. The partial analysis of it (No. 3, Table 1) by Fahey shows 10.9 per cent MnO and 9.7 FeO. Two specimens of salite described by Schmitt from the Pewabic mine, Hanover, N. Mex., contain 2.17 and 2.66 per cent MnO and 14.84 and 18.56 per cent FeO, respectively (Nos. 1 and 2, Table 1). The possibility that the high manganese content of the pyroxene from the Star mine is due to intergrown rhodonite is remote, because no rhodonite could be detected in the sample by optical tests or in the x -ray pattern of it studied by Fred A. Hildebrand, of the Geological Survey.

Two specimens of the pyroxene from the Star mine were selected and prepared for complete analyses, because they were free from any visible rhodonite in thin section. Sample 4, Table 1, contains 14.13 per cent MnO and 11.30 per cent FeO, and no rhodonite could be detected in its x -ray pattern. No. 5, Table 1, contains 15.53 per cent MnO and 10.68 per cent FeO, but the x -ray pattern of some reddish grains isolated from the sample suggests to Hildebrand that a very small amount of rhodonite may be present. The estimate of the number of pyroxene grains of the type that gives the broad, weak lines suggestive of rhodonite indicates that the amount of rhodonite in the total sample is so small that it can be neglected.

The indices of refraction of the pyroxene at the Star mine increase directly with increased amounts of MnO (Table 1, Nos. 3, 4, 5). This suggests that the manganese is an essential part of the pyroxene, and

the composition of the mineral can be best expressed by the name ferroan johannsenite.

Typical occurrences of needles and prismatic columns of ferroan johannsenite are shown in Figure 2a, b, c associated with rhodonite and in Figure 3c, d associated with the ore minerals.

OCCURRENCE AND PROPERTIES OF JOHANNSENITE

The pyroxene in contact with the rhodonite at the Hobo mine (Fig. 2d) contains 25.90 per cent MnO and 2.58 per cent FeO (No. 6, Table 1) and has the optical properties of johannsenite (No. 8, Table 1). The

TABLE 1. ANALYSES AND OPTICAL PROPERTIES OF SOME PYROXENES

	1	2	3	4	5	6	7	8
SiO ₂	52.20	48.52		48.98	48.94		48.15	48.62
Fe ₂ O ₃	0.74	1.86	0.97	1.07	0.93	0.20	1.58	
FeO	14.84	18.56	9.70	11.30	10.68	2.58	4.28	
Al ₂ O ₃	0.26	1.67		0.84	0.48		0.31	
TiO ₂	0.01	0.08		0.14	0.10			
MnO	2.17	2.66	10.90	14.13	15.53	25.90	21.37	28.69
CaO	22.19	21.71		20.64	21.10		20.88	22.69
MgO	7.50	4.11		2.19	2.36		0.48	
Na ₂ O	nd*	nd		0.10	nd		nd	
K ₂ O	nd	nd		0.05	nd		nd	
H ₂ O	0.38	0.99		0.44	nd		1.20	
CO ₂							1.39	
ZnS							0.17	
Total	100.29	100.16		99.88	100.12		99.81	100.00
α	1.687	1.690	1.695	1.703	1.708	1.708	1.713	1.710
β	1.692	1.693	1.702	1.711	1.718	1.718	1.721	1.719
γ	1.721	1.715	1.723	1.732	1.736	1.737	1.740	1.738
$\gamma - \alpha$	0.034	0.025	0.028	0.029	0.028	0.029	0.027	0.028
Sign	+	+	+	+	+	+	+	+
Z/c	54°	38°	46°±	46°±	47°±	40°±	48°±	
2V	60°±	60°±	60°±	70°±	70°±	70°±	70°±	

* nd=not determined.

1, 2. Salite, Pewabic mine, Hanover, N. Mex. Chemical and optical data after Schmitt (1939).

3, 4, 5. Ferroan johannsenite, Star mine, Vanadium, N. Mex., J. J. Fahey, analyst.

6. Johannsenite, Hobo mine, Vanadium, N. Mex., J. J. Fahey, analyst.

7. Johannsenite, Empire Zinc Company mine, Hanover, N. Mex., Schaller (1938, 579).

8. Theoretical composition and optical properties of pure johannsenite, CaMnSi₂O₆. Schaller (1938, p. 581).

MnO content of the johannsenite at the Hobo mine is higher than that of the johannsenite from the Empire Zinc Company mine, Hanover, N. Mex., analyzed by Schaller, but it does not exceed the theoretical amount (compare Nos. 6, 7, 8, Table 1). The *x*-ray pattern contains weak, broad lines, suggesting that a very small amount of rhodonite may be present in the hand-picked sample.

ORIGIN AND SEQUENCE OF MINERALS

The observation that ferroan johannsenite with 10.9 per cent MnO is replaced by rhodonite as easily as is johannsenite with 25.9 per cent MnO strongly supports the petrographic evidence that most of the MnO for the formation of rhodonite was introduced by the ore solutions rather than being supplied by the alteration in place of the pyroxenes with small amounts of manganese. The source of the ore solutions was the intrusive magma of the Ground Hog district, which invaded the limestones of Paleozoic age and formed replacement deposits with a typical pyrometamorphic mineral assemblage.

The sequence of minerals observed at the Star, Hobo, and Princess mines is as follows: Quartz was the earliest mineral to form, but quartz veins cut other minerals indicating that the veins continued to form throughout the period of ore mineralization. The pyroxenes ferroan johannsenite and johannsenite crystallized early and were changed locally to rhodonite, with the formation of some calcite. Magnetite, sphalerite, galena, and pyrite are later than the silicates (Fig. 3c, d). This order agrees with the paragenetic sequence of mineralization observed by Harrison Schmitt (1939, p. 802) at the Pewabic mine, Hanover, N. Mex.

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