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MINERALOGICAL NOTES

JOHANNSENITE FROM THE ARAVAIPA MINING DISTRICT, ARIZONA[1]

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INTRODUCTION

A manganiferous silicate found at various places in the Aravaipa mining district, Arizona, has been determined by optical, *x*-ray, and chemical tests to be johannsenite containing small amounts of magnesium, iron and aluminum. Two chemical analyses show the composition of the mineral to be about 81 per cent $MnO \cdot CaO \cdot 2SiO_2$, 13 per cent $MgO \cdot CaO \cdot 2SiO_2$, and 6 per cent $FeO \cdot CaO \cdot 2SiO_2$.

Johannsenite was named by Schaller (1938), who described the mineral from various places in the United States, Mexico and Italy. It has since been recognized elsewhere in New Mexico by Allen and Fahey (1953, 1957). The Aravaipa johannsenite resembles that described by Schaller from the Central mining district in New Mexico, from Oregon, and from Venetia, Italy. As far as we know the mineral has not been reported previously from Arizona.

The geologic study and determination of physical properties were done by Simons, and the silicate analyses by Munson. *X*-ray determination of the mineral as a monoclinic pyroxene was done by Fred Hildebrand, semiquantitative spectrographic analyses were made by J. C. Hamilton, and zinc was determined by Claude Huffman, all of the U. S. Geological Survey. We are indebted to our colleague L. B. Riley for advice on certain analytical procedures and to Riley and J. J. Fahey for review of the manuscript.

GEOLOGIC DATA

The Aravaipa mining district is in the Klondyke quadrangle, Arizona, about 55 miles northeast of Tucson. Small amounts of lead, zinc, and silver have been produced from an area underlain by Precambrian metamorphic rocks, Paleozoic and Cretaceous sedimentary rocks, and Cretaceous(?) and Tertiary volcanic rocks. A large pluton of alkali granite of Tertiary age is 1.5 miles or more east of the district.

Johannsenite forms tabular bodies or irregular masses replacing limestone of Mississippian and Pennsylvanian ages. These bodies range from radiating or spherulitic aggregates of prisms or needles a few cm across to large masses several feet thick and several tens of feet long. In the larger masses the johannsenite commonly has conspicuous layers a few

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mm to several cm thick. Within the layers the johannsenite prisms have well-developed columnar structure. Layers of coarse-grained material, with prisms as much as 2–2.5 cm long, may be separated by thin irregular layers of fine-grained material, or simply by partings. Some layers are separated by thin lenses or streaks of calcite or quartz, or less commonly sphalerite, galena, or chalcopyrite. Neotocite has also been found in drusy cavities by D. F. Hewett (written comm., 1961).

Johannsenite is a common gangue mineral in a number of small lead-zinc deposits but is not restricted to ore deposits. In most of its occurrences it is the only abundant silicate mineral; sizeable masses of garnetite or garnet-epidote skarn replace limestone or accompany some of the limestone-replacement ore deposits elsewhere in the district, but these ordinarily do not contain johannsenite. None of the limestone-replacement silicate or sulfide bodies is closely associated with intrusive igneous rocks, and many are remote from outcrops of such rocks.

The most homogeneous and least oxidized johannsenite was found at the Black Hole prospect, 2,000 feet northwest of Aravaipa in the NW ¼ sec. 36 (unsurveyed), T. 5 S., R. 19 E., and was selected for chemical analysis and determination of physical properties.

PHYSICAL PROPERTIES

The johannsenite is pale yellowish brown to light olive gray, and weathers to prominent black outcrops. It is finely prismatic to fibrous in habit, with most individual prisms less than 1 cm long; none seem to be more than a fraction of a mm wide, the apparently wider ones proving microscopically to be aggregates of several grains. Johannsenite is tough in large masses, but small aggregates of subparallel prisms are easily broken owing to the perfect prismatic cleavage.

Two determinations of specific gravity by the pycnometer method on 1.5–2 gram samples of millimeter-sized fragments gave 3.37 and 3.38, within the range 3.2–3.53 reported by Schaller (1938, p. 557).

Indices of refraction of fragments were determined by the immersion method using sodium light. The optic angle was measured approximately with the universal stage and also was estimated from the nomogram of Mertie (1942, p. 1). The data, together with those reported by Schaller, are in Table 1.

CHEMICAL ANALYSIS

The sample was broken into fragments a few mm across and was hand-picked under a binocular microscope to remove impurities. Fragments even slightly darkened by oxidation were rejected. The sample was then split and one-half analyzed without further treatment. The other half

TABLE 1. OPTICAL PROPERTIES OF JOHANNSENITE.

1	2
$\alpha = 1.700 \pm .002$	1.708–1.713
$\beta = 1.710 \pm .001$	1.717–1.721
$\gamma = 1.7325 \pm .001$	1.735–1.740
$\gamma - \alpha = .0325$	.026– .029
(+) 2V (measured) 60° (estimated) 67°	70°
Extinction angle $Z \wedge c = 47° - 52°$	48° ±
Dispersion (optic axis) — $r < V$ weak	$r > V$

1. Johannsenite, Aravaipa mining district, Arizona.
2. Johannsenite, various localities (Schaller, 1938, p. 578, Nos. 1–6c.

TABLE 2. CHEMICAL ANALYSES OF JOHANNSENITE

	1	2	3	4	5
SiO_2	48.81	50.93	48.15	47.62	48.63
Al_2O_3	.74	.62	.31	.81	
Fe_2O_3	.79	.43	1.58	.62	
FeO	1.54	1.78	4.28	4.31	
MgO	2.29	2.14	.48	2.74	
CaO	21.87	21.05	20.88	20.15	22.69
Na_2O	.07	.10	nd	nd	
K_2O	.02	.02	nd	nd	
H_2O^+	.32	.50	.96	.25	
H_2O^-	.35	.63	.24	.19	
TiO_2	.01	.01	nd	nd	
P_2O_5	.01	.01	nd	nd	
MnO	22.58	21.27	21.37	21.15	28.68
CO_2	nd	nd	1.39	2.07	
ZnS	nd	nd	.17	.25	
Total	99.40	99.49	99.81	100.16	100.00

1. Johannsenite, Black Hole prospect, Aravaipa mining district, Arizona. Field No. 59K-S-245; serial No. I4083. Analyst, Elaine Munson, U. S. Geological Survey.
2. Same location as (1), acid-treated. Serial No. I4084. Analyst, Elaine Munson, U. S. Geological Survey.
3. Johannsenite, Empire Zinc Company mine, Hanover, New Mexico (Schaller, 1938, p. 579).
4. Johannsenite, Venetia, Italy (Schaller, 1938, p. 579, analysis 6).
5. Theoretical composition of pure johannsenite, $CaMnSi_2O_6$ (Schaller, 1938).

was ground in a porcelain mortar to −35 mesh and leached in cold 1:5 HNO_3 for 40 hours with frequent agitation. The fine material was then decanted and the coarse residue leached in cold 1:10 HNO_3 for 96 hours with occasional agitation, washed in water and acetone, dried, and analyzed concurrently with the untreated split. The results appear in Table 2, together with analyses of johannsenite from New Mexico and Italy for comparison.

Separate determinations of zinc were made on samples 1 and 2, and both gave 0.18 per cent Zn. Inasmuch as the untreated and the acid-treated samples gave identical results, the zinc is considered to be a constituent of the johannsenite rather than of sphalerite incompletely removed during handpicking. No attempt was made to incorporate this small amount of zinc in the above silicate analyses; certainly it should not be added to the totals, since at least a part is distributed among several of the reported constituents.

Recalculated analyses, deducting all minor constituents as such, are expressed in terms of components as follows:

Component	1	2
$MnO \cdot CaO \cdot 2SiO_2$	81.7	80.8
$FeO \cdot CaO \cdot 2SiO_2$	5.5	6.7
$MgO \cdot CaO \cdot 2SiO_2$	12.8	12.5
Totals	100.0	100.0

Semiquantitative spectrographic analyses of johannsenite gave the following trace constituents:

Serial No.	I4083	I4084
B	.015	.015
Ba	.002	.0015
Co	.0015	.0015
Cr	.0007	.0007
Cu	.0005	.0007
Ni	.0005	.0007
Pb	<.003	<.005
Sn	.007	.007
Sr	.003	.003
V	.003	.002
Y	.002	.003

Results are reported in per cent to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, and 0.1, etc., which represent approximate midpoints of group data on a geometric scale. The assigned group for semiquantitative results will include the quantitative value about 30% of the time. Symbol <, with number, less than number shown—here usual detectabilities do not apply. Also looked for but not detected: Ag, As, Au, Be, Bi, Cd, Ce, Ga, Ge, Hf, Hg, In, La, Li, Mo, Nb, Pd, Pt, Re, Sb, Sc, Ta, Te, Th, Tl, U, W, Zr.

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HUNTITE, GABBS, NEVADA

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INTRODUCTION

Huntite, $Mg_3Ca(CO_3)_4$, first described from Currant Creek, Nevada, (Faust, 1953) has now been identified at Dorog, Hungary (Koblencz and Nemecz, 1953), la Clamouse, France (Baron, et al., 1957), Tea Tree Gully, Australia (Skinner, 1958), Kurgashinkan and Takfon, Russia (Golovanov, 1959), and Crestmore, California (Carpenter, 1961). The purpose of this paper is to report the occurrence of huntite at a new locality; Gabbs, Nevada (Fig. 1).

GEOLOGIC ENVIRONMENT

At Gabbs, huntite occurs in the mineralized dolomite of the upper Triassic Luning Formation as defined by Muller and Ferguson (1939, p. 40). The dolomite is exposed on the west flank of the Paradise Range in the upper plate of a major thrust fault, the Paradise Thrust. The mineralization of the dolomite is the result of the intrusion of a series of stocks, bosses, dikes, and sills that range in composition from diorite and andesite to granite. The mineralization has converted large bodies of the dolomite to magnesite and both have subsequently been intruded by granodiorite and in part converted to brucite. Finally, weathering of the brucite has produced a blanket of hydromagnesite and related minerals.

Huntite occurs in veinlets in the fractured and weathered carbonate,