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MINERALOGICAL NOTES

PHENAKITE FROM THE MOUNT WHEELER AREA, SNAKE RANGE, WHITE PINE COUNTY, NEVADA[1]

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INTRODUCTION

The mode of occurrence of the nonpegmatite beryllium deposits at the Mount Wheeler mine, White Pine County, Nevada, has been described by Stager (1960). Whitebread and Lee (1961) report the discovery of similar mineralization more than a mile north of the Mount Wheeler mine (sample 54-MW-60, below) and outline the geology of the mine area. Briefly, the known beryllium mineralization in this area replaces the Wheeler limestone member, of local usage, of the Cambrian Pioche Shale. The mineralization is invariably associated with quartz veins in this limestone, but the exact relationships between the two are not clear.

In order to investigate the physical and chemical properties of the phenakite (Be_2SiO_4) present in this area, pure fractions of this mineral were recovered from three separate field samples. The locations of these samples (Table 1) can be related to the geology of the area by reference to Whitebread and Lee (1961) and Drewes (1958). Sample 2-MW-60 was collected about 3,920 feet back in the Pole Canyon adit of the Mount Wheeler mine. The phenakite in this sample was not observed in thin section, but separation work shows that it is present in an irregularly shaped beryl veinlet that cuts a sandy layer below(?) the Wheeler limestone member. This beryl veinlet is 1–3 inches wide. Along with beryl and phenakite, the minerals present are quartz, carbonate, fine-grained muscovite (predominantly $2M$, but with minor amounts of $1M$), scheelite and pyrite.

Samples 54-MW-60 and 122-MW-60 were collected at the surface. In each of these samples the phenakite is part of a limestone replacement deposit in an area cut by quartz veins and veinlets. Along with phenakite the minerals present are fluorite, carbonate, fine-grained muscovite (mostly $2M$, but also smaller amounts of $1M$), and minor amounts of scheelite, pyrite, quartz and beryl. The phenakite is most closely associated with fine-grained muscovite, carbonate and fluorite, and it is present as euhedral to anhedral crystals; the euhedral crystals are prismatic and attain a length exceeding 2 mm in some cases. The pure -150 mesh phenakite analyzed has a snow-white color. Bertrandite was not identified in any of the three samples described.

[1] Publication authorized by the Director, U. S. Geological Survey.

TABLE 1. LOCATIONS OF PHENAKITE-BEARING SAMPLES

Sample	N. Lat.	W. Long.	Elevation (feet)
2-MW-60	38°53′52″	114°19′12″	7,900
54-MW-60	38°54′49″	114°20′2″	8,760
122-MW-60	38°54′06″	114°20′15″	7,960

PHYSICAL AND CHEMICAL PROPERTIES OF PHENAKITE

A pure phenakite fraction was recovered from each of these three samples by centrifuging -150 mesh material in heavy liquids checked with a Christian Becker specific gravity balance. Thus the specific gravity figures listed (Table 2) apply to individual grains in the given fraction, as well as representing a bulk value for the fraction as a whole. Refractive indices (Table 2) were determined in sodium light by the immersion method. For comparison, Table 2 also includes data for a phenakite from Minas Gerais, Brazil; there is very little difference among the figures listed for these four phenakites.

Quantitative spectrographic analyses are listed in Table 3 along with spectrographic data for the phenakite from Minas Gerais, Brazil. The figures listed for Ge and B are perhaps the most noteworthy feature of Table 3. These elements are present in each of the Mount Wheeler phenakites and possibly in the Brazilian phenakite too in amounts that well exceed their crustal abundances. In this connection it is interesting to note that the beryl present with phenakite in sample 2-MW-60 contains neither B nor Ge in detectable amounts (*i.e.*, less than 20 ppm for each element).

Apparently it is not uncommon for phenakite to carry minor amounts

TABLE 2. SPECIFIC GRAVITY AND OPTICAL PROPERTIES OF ANALYZED PHENAKITES

Sample	Specific gravity	ϵ	ω	ϵ-ω	Optic Sign
2-MW-60	2.964 ± .007[1]	1.670 ± .002	1.654 ± .002	.016	uniaxial (+)
54-MW-60	2.964 ± .007[1]	1.669 ± .002	1.653 ± .002	.016	uniaxial (+)
122-MW-60	2.966 ± .007[2]	1.669 ± .002	1.653 ± .002	.016	uniaxial (+)
Minas Gerais, Brazil	2.960 gm/cm^3 [3]	1.669[3]	1.653[3]	.016	uniaxial (+)[3]

[1] Centrifuged at 2.970 and at 2.957.

[2] Centrifuged at 2.973 and 2.960.

[3] Density at 25°C. as calculated from the NBS lattice constants. Data for density, refractive indices and optic sign from Swanson *et al.*, 1959. See Table 3 for spectrographic data.

TABLE 3. SPECTROGRAPHIC ANALYSES OF PHENAKITE

	2-MW-60[1]	54-MW-60[1]	122-MW-60[1]	Minas Gerais, Brazil[2]
Cu	<.0002	<.0002	<.0002	.001– .01
Ge	.010	.015	.013	.001– .01
Sn	<.001	<.001	<.001	.01 – .10
Pb	<.002	<.002	<.002	.001– .01
Zn	<.04	<.04	<.04	.01 – .10
Mn	<.0002	.015	.0003	.001– .01
Ni	<.0004	<.0004	<.0004	.01 – .10
Fe	.15	.16	.10	.01 – .10
Cr	<.0002	<.0002	<.0002	.001– .01
Al	.25	.23	.02	.10 –1.0
Ti	<.001	<.001	<.001	.01 – .10
Zr	<.002	<.002	<.002	.001– .01
Be	M	M	M	
Mg	.032	.050	.0052	.01 – .10
Ca	.0030	.0019	.0041	.01 – .10
Sr	.0004	.0004	.0004	.001– .01
Ba	.0050	.011	.0004	
B	.020	.060	.030	.001– .01
Na	—	—	—	.01 – .10

[1] Robert Mays, analyst. Looked for but not found: Ag, Au, Ru, Rh, Pd, Os, Ir, Pt, Mo, W, Re, As, Sb, Bi, Se, Te, Cd, Tl, In, Co, V, Ga, Sc, Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Th, Nb, Ta, U and P. For limits of sensitivity, see Bastron *et al.*, 1960.

The above results have an overall accuracy of ±15 per cent except near limits of detection where only one digit is reported.

[2] Swanson, *et al.*, 1959.

of B, for Harder (1959) reports the following: 100 ppm B in phenakite from a pneumatolytic apatite vein at Tangen, near Kragerö, Norway; 60 ppm B in phenakite from granitic rock in the Ilmen Mountains of Miask; and 30 ppm B in phenakite from Minas Gerais, Brazil. The same author, incidently, reports only 0.3 and 4 ppm B in two samples of beryl, and he remarks on the fact that beryl appears to carry only insignificant amounts of B, a finding that is supported by the present results.

Wickman (1943) reports 20 ppm Ge in phenakite from Kragerö, Norway, and this, taken with the results listed in Table 3, indicates that it may not be uncommon for phenakite to carry minor amounts of Ge. In view of the fact that fluorite accompanies the Mount Wheeler beryllium mineralization, and each of the phenakites described here contains 100–150 ppm Ge, it may be pertinent to note that the silicates topaz and lepidolite that are high in germanium (Papish, 1929) are formed in fluorine-rich environments.

A complete analysis is presented for the phenakite from sample 122-

TABLE 4. CHEMICAL AND SPECTROGRAPHIC ANALYSIS OF PHENAKITE (Be_2SiO_4) 122-MW-60 FROM WHITE PINE COUNTY, NEVADA[1]

	Wt %	Elements	
SiO_2	54.5[2]	6.005	
Al_2O_3	.04	.005	
Fe_2O_3	.14	.012	
MgO	.009	.001	6.024
CaO	.006	—	
GeO_2	.019	.001	
B_2O_3	.097	.019	11.952
BeO	45.08	11.933	
Total	99.89		

[1] SiO_2 and BeO determinations by R. E. Stevens and A. C. Bettiga. All other oxides calculated from Table 3. Specific gravity and optical properties of this phenakite given in Table 2.

[2] Average of 2 determinations.

MW-60 (Table 4). An *x*-ray diffractometer pattern of this phenakite (122-MW-60) was prepared using tungsten as an internal standard. The sample was scanned at $\frac{1}{4}°$ 2θ from 17–142° 2θ using Fe/Mn radiation, $\lambda FeK\alpha_1 = 1.93597$ Å. The maximum variation for d-spacings in the region 76-142° 2θ from those given by Swanson *et al.* (1959) for phenakite from Minas Gerais, Brazil, is $\pm 0.0004°$ Å. This appears to be random error only as there is no consistent variation suggesting larger or smaller unit cell dimensions than those given for the Brazilian phenakite. See Table 3 for a spectrographic analysis of this Brazilian phenakite and Table 2 for its specific gravity and optical properties.

CONCLUSION

Pending further field and laboratory study of the beryllium mineralization in the Mount Wheeler area it is not possible to assess the significance of the relatively large boron and germanium contents of the phenakites described here. The beryllium borate, hambergite ($Be_2(OH)BO_3$), is not isostructural with phenakite. Hambergite is a rare mineral that appears to be confined to granitic and syenitic pegmatites (see for example, Warner *et al.*, 1959), and the writers have not yet identified this mineral in the Mount Wheeler area.

Apropos of the boron content of these phenakites, there is a further shred of intriguing information. Several miles north of the known beryllium mineralization here, in the general area of 114°18′W. and 39°04′N., the intrusive rock is well jointed, and one set of joints strikes E-W and dips about 75°S. The surfaces of this joint set are coated to a thickness of 1 to 2 mm with black tourmaline that is extremely fine grained. (The field identification of this material was "manganese oxide"). While this type of tourmaline occurrence has not been observed in the larger intrusive that is present closer to the beryllium mineralization (for relative locations, see the compilation map of Adair and Stringham, 1960), it is interesting to note that the main structural control in the Mount Wheeler mine itself may be similar to the attitude of the tourmaline-coated joints, for Stager (1960) states: "The ore shoots are localized in the lower 15 feet of the 'Wheeler limestone,' along quartz veinlets in steeply dipping fault fissures that strike east or northeast." A study is in progress to investigate the possibility of a direct relationship between the beryllium mineralization and the intrusive rocks that are exposed in the Mount Wheeler area (Lee and Bastron, 1962), and in this connection the tourmaline mentioned above is under study.

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