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THE AMERICAN MINERALOGIST, VOL. 45, NOVEMBER–DECEMBER, 1960

BERTRANDITE FROM MICA CREEK, QUEENSLAND

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Bertrandite, $Be_4(OH)_2Si_2O_7$, a mineral whose occurrence in Australia has not previously been recorded, has been observed in a beryl-bearing pegmatite from the Mica Creek area, near Mt. Isa, Queensland. Specimens of this pegmatite were submitted to the Mineragraphic Investigations section of the Commonwealth Scientific and Industrial Research Organization by Mr. A. K. Denmead, Chief Geologist of the Queensland Geological Survey. An analysis of one of the specimens was reported as follows:

SiO_2	54.9
Al_2O_3	17.7
Fe_2O_3	2.6
BeO	13.1
MgO	0.9
CaO	—
K_2O	3.9
H_2O^+	5.2
H_2O^-	0.2
Total	98.5 wt. per cent

The analyzed specimen is a micaceous pseudomorph after beryl, but, despite the extensive alteration, the analysis shows 13.1 per cent BeO, compared with 13.4 per cent BeO previously found for unaltered beryl from the same locality. The other specimens are mostly composed of massive mica, without apparent beryl, and such material has been reported to assay up to 14.1 per cent BeO.

Examination of thin sections has shown that the specimens consist of bertrandite, residual beryl, abundant fine-grained mica, quartz, albite, and limonitic material. Bertrandite contains 42.0 per cent BeO, which explains the high BeO contents reported in the analyses.

The bertrandite is colorless when viewed under the binocular microscope and in thin section. It is biaxial negative, and its refractive indices (measured in sodium light by the immersion method) are $\alpha=1.589 \pm 0.003$, $\beta=1.603 \pm 0.002$ and $\gamma=1.613 \pm 0.002$ ($\gamma-\alpha=0.024$). Its birefringence, as measured with the Berek compensator, is 0.025. Its 2V, calculated from the refractive indices, is approximately 80°. It shows weak dispersion, $r<v$. The bertrandite has two good cleavages parallel to (001) and (010), assuming $X=a$, $Y=b$ (Winchell and Winchell, 1951, p. 479). Some sections also show a weak cleavage parallel to (100) and a weak oblique ?(110) cleavage. Some grains show simple twinning, but the trisector twinning described and figured by Phemister (1940) and others was not observed.

The bertrandite grains always show negative elongation, indicating that they are tabular, flattened parallel to (001).

An *x*-ray powder diffraction pattern of the Mica Creek bertrandite, prepared from material drilled from a thin section, matches exactly a pattern of bertrandite from Mt. Antero, Colorado (Table 1). The Mt. Antero specimen was kindly provided by Dr. Brian Mason, of the American Museum of Natural History.

Bertrandite is present in all of the specimens examined. It comprises up to 30 and locally even 50 volume per cent of some specimens, and it is

TABLE 1. BERTRANDITE $Be_4(OH)_2Si_2O_7$—*X*-RAY POWDER PATTERN
Bertrandite, Mica Creek, Queensland†
CuK_{α_1} radiation; $\lambda=1.5405$ Å Camera diameter 114.6 mm.

d(Å)*	$I_{(est.)}$	d(Å)*	$I_{(est.)}$	d(Å)*	$I_{(est.)}$	d(Å)*	$I_{(est.)}$
7.56	1	2.02	0.5	1.305	4	0.940	0.5
4.85	<0.2	1.983	2	1.251	1	0.899	0.5b
4.38	10	1.923	0.5	1.233	0.5	0.860	1
3.94	4	1.787	0.5	1.220	2b	0.843	0.2
3.80	0.7	1.698	1.5	1.167	1b	0.838	0.3
3.19	9	1.650	1	1.117	1.5	0.828	0.5
{2.93	1	1.628	<0.2	1.105	0.3	0.813	2
{2.88	1	1.579	0.3	1.090	<0.2	0.800	0.2
2.54	8	1.555	3	1.076	1	0.790	1
2.42	0.5	1.491	<0.2	1.057	<0.2	0.783	1
2.28	6	1.465	3	1.015	<0.2	0.778	1
2.22	6	1.440	1	0.986	0.2b		
2.18	0.2	1.363	0.2	0.970	0.2b		
2.10	0.3	1.338	0.3	0.953	<0.2		

* Interplanar spacings corrected for film shrinkage.
† An identical pattern was obtained for bertrandite from Mt. Antero, Colorado.
b Denotes broad line.

most abundant where beryl is absent. It occurs as scattered, generally subhedral, prismatic grains up to 2.3 mm. long and 0.5 mm. wide, and also as aggregates of prismatic to granular grains. It is generally enclosed in areas of fine-grained, yellowish green, sericitic mica (Fig. 1). Such areas may be veinlets in large crystals of beryl; more commonly they are more extensive, and the most completely altered specimens consist of sericitic mica containing scattered residual grains of beryl, beryl plus bertrandite, or bertrandite alone. Most of the bertrandite shows marginal replacement by the mica. A pure bertrandite concentrate for analysis was

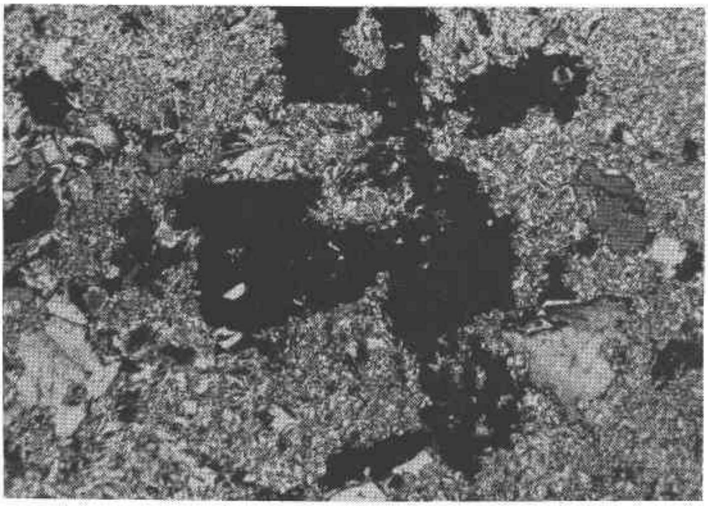

FIG. 1. Bertrandite (largely at extinction) intergrown with and partly replaced by fine-grained sericitic mica. Transmitted light, crossed nicols. ×60.

not prepared, because of the intimate nature of the bertrandite-mica intergrowths (Fig. 1).

The beryl has commonly been extensively altered along fractures to sericitic mica. The optical continuity of the beryl residuals and the hexagonal form of the pseudomorphs indicate that some of the original beryl crystals were up to ten or more centimeters long and several centimeters wide. The beryl is uniaxial negative and has $\omega = 1.570 \pm 0.002$ and $\epsilon = 0.565 \pm 0.002$ (sodium light).

Less abundant constituents of these specimens include muscovite, quartz and albite. The muscovite occurs in small patches containing flakes averaging 0.3 mm. long and, more rarely, as "books" up to 2 cm. wide and several mm. thick. X-ray powder diffraction photographs of both the muscovite and fine-grained "sericite" were prepared, and distinctly different patterns were obtained. The differences are due to polymorphism, and comparison with the x-ray data of Yoder and Eugster (1955) suggests that the coarse-grained "books" of mica consist of muscovite with a two-layer monoclinic (2M) structure, whereas the fine-grained "sericite" has a one-layer monoclinic (1M) structure. Yoder and Eugster indicated that 1M muscovite polymorphs are not uncommon in nature, and suggested by analogy with experimental results, that they would form most commonly in relatively low temperature geological environments, namely "the sediments, low grade metamorphic rocks, secondary alteration zones, and some pegmatite deposits" (p. 249). The present occurrence is in accord with this concept.

Quartz occurs as scattered grains, up to 0.5 mm. wide, intergrown with beryl or enclosed in the sericite. Albite is slightly more common, occurring as small inclusions in the sericite and also as larger aggregates, up to 3.5 cm. across.

One specimen consists mainly of felspar and quartz, with a few hexagonal micaceous pseudomorphs after beryl, up to 5 cm. long. These suggest that the alteration has affected the beryl, but not the adjacent felspar. The sericite-rich specimens, therefore, presumably represent large, altered crystals of beryl or local phases of the pegmatite in which felspar has also been converted to mica.

Since bertrandite is most abundant where beryl is absent, it appears most probable that the bertrandite was formed during the alteration of the beryl, with the beryllium from the beryl entering the hydrous bertrandite. The fact that most of the bertrandite also shows marginal replacement by the sericitic mica suggests that it was formed by hydrothermal processes and not by the later action of meteoric waters.

Apart from accounting for the apparently anomalous analyses, this discovery of bertrandite also shows that material rich in beryllium may easily be overlooked in the field. In the Mica Creek specimens, the bertrandite could only be detected by microscopic examination and, moreover, the specimens containing the most bertrandite are those which are least impressive in hand specimen—massive aggregates of fine-grained greenish mica which display no obvious evidence of their high beryllium content.

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