SPECTROGRAPHIC PROSPECTING FOR BERYLLIUM IN PEGMATITES OF WESTERN MONTANA

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The wartime demand for beryllium led to widespread search for this rather rare element, and since beryl is the most common beryllium mineral, and as the pegmatite dike is the home of beryl, prospecting for beryllium has been confined largely to pegmatites. Unfortunately the white massive variety of beryl closely resembles certain types of milky pegmatitic quartz, particularly those possessing a rudimentary cleavage or parting. This resemblance, together with close similarities in specific gravity and hardness, places limitations on sight identification of this type of beryl. On the other hand, spectrochemical analysis is unequivocal in detection of beryllium-containing minerals, the only disadvantage being that specimens cannot readily be determined in the field.

During the early days of the war the question arose as to whether some of the hundreds of milky-quartz pegmatites in southwestern Montana might not contain white beryl. Such a question was logical, because commercial quantities of beryl have been found in the Black Hills of South Dakota, near the southeastern corner of Montana, and in Idaho, near the southwestern edge of Montana; and the area between would seem a likely place to search for beryl, particularly since pegmatites are so plentiful in this region. In an attempt to answer this question the writers collected, as part of a Montana Bureau of Mines and Geology program, some fifty samples from pegmatites, most of which consisted of the suspect material, presumably quartz; and spectrochemical analyses for beryllium were made on all samples in the mineral dressing laboratory of the Montana School of Mines.

Although the results of the program were negative as far as the finding of beryllium was concerned, the rather scanty information available on Montana pegmatites has been somewhat augmented; and the project, in a negative sense, has served to delineate areas where beryl may possibly be found.

The pegmatite dikes of southwestern Montana are spread over an area about 100 miles across in each direction, and they are distributed at intervals of perhaps 100 yards up to about one mile. Seldom is their linear extent great; more commonly a width of 5 to 15 feet will continue 200 to 300 feet. Bodies stand vertically, inclined, or lie nearly horizontally. Probably quartz is the most plentiful mineral, but locally feldspar pre-

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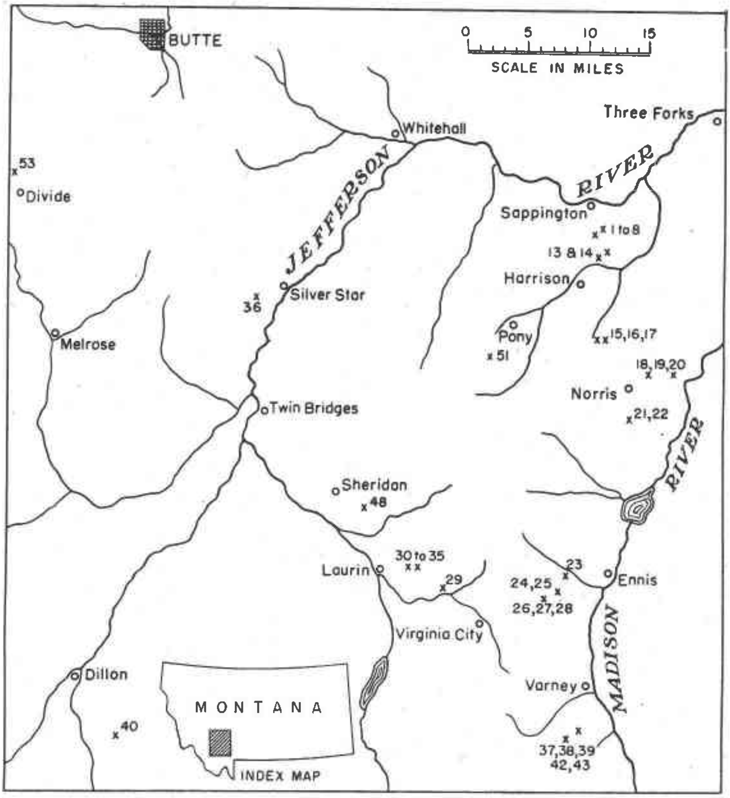

SKETCH MAP
SHOWING PEGMATITE LOCALITIES SAMPLED FOR BERYLLIUM
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dominates, and concentrations of muscovite occupy portions of some dikes. Coal-black tourmaline occurs as scattered crystals or irregular masses. Graphic intergrowths of quartz and feldspar are common, and more rarely feldspar and muscovite are intergrown. Other than minerals of the fergusonite and allanite groups[1] rare minerals have not been observed.

The pegmatites of southwestern Montana are believed to be of two distinctly different geologic ages, although superficially they are all

[1] Cooke, S. R. B., and Perry, Eugene S., Columbium and cerium minerals in Montana: *Am. Mineral.*, **30**, 623–628 (1945).

similar. Those of older age occur in a complex series of gneisses and schists of Huronian, or possibly Archean age. An upper pre-Cambrian conglomerate (Belt series) lying above the gneiss series contains pebbles and boulders of pegmatitic material similar to that in the dikes, and mainly for this reason the dikes of the gneiss series are considered pre-Cambrian, although they are of later age than the development of the structure of the gneiss.

The pegmatites of younger age occur in or near late Cretaceous or early Tertiary granitic rocks which form batholithic masses. The minerals of the fergusonite group were found in the older dikes, those of the allanite group in the younger dikes.

Sampling for beryl was confined mainly to the older dikes in the valley of Madison River. Chips of the white mineral resembling white beryl (which eventually proved to be quartz) were broken from the outcrop in ten to twenty places over a distance of 50 to 100 feet, mixed together, and given a number. Only the more conspicuous outcrops were sampled, and many more dikes were passed by than were sampled. All dikes sampled were of the quartz-feldspar type, although several samples were taken in the proximity of mica or tourmaline concentrations, and also close to the occurrences of fergusonite. The region covered is about 50 miles across.

All samples were reduced to 10-mesh, quartered, reduced to 200-mesh, quartered again, and then reduced to approximately 1,200-mesh in an agate mortar. Following careful mixing, a final sample of 15 milligrams was taken for spectrographic analysis.

The samples were volatilized in a graphite arc operating at 150 volts and 12 amperes. Eastman par-speed orthochromatic film was used, and each sample was completely volatilized.

The most sensitive lines of beryllium, those at 3,321.34, 3,321.09, 3,131.07 and 3,130.42 Ångstrom units, were used for identification. Traces of beryllium were detected in the spectra of only three samples, namely samples numbered 1, 42, and 47; the last is not shown on the accompanying map. All other samples gave negative results so far as beryllium is concerned.

For comparative purposes samples of green glassy beryl from Maine, and of white or milky beryl from the Black Hills of South Dakota, were also analyzed. The spectrographic and microscopic analyses of these samples show them to be essentially identical, although the green variety contains slightly more iron than the white variety. Both are uniaxial negative with $\epsilon = 1.575$, and $\omega - \epsilon$ equal to 0.006. Specific gravities of several of the Montana quartz samples were approximately 2.67. The green beryl from Maine has a specific gravity of 2.74, and the white beryl 2.78. The assigned specific gravity of beryl is 2.69 to 2.70, and of ordinary quartz is 2.65.

Conclusion

It is concluded that beryl in recognizable quantities is absent in the early pegmatite dikes lying in the pre-Cambrian gneisses of southwestern Montana, and probably absent in the late pegmatites which accompanied the late Cretaceous or early Tertiary batholithic intrusions characteristic of this region.

Although the gologic history of the early dikes is as yet untold, it now appears that they result from a pre-Cambrian phase of deep-seated igneous activity, later in age than the development of gneissic structure, but earlier than the laying down of the thousands of feet of late pre-Cambrian (Belt) sediments prevalent in southwestern Montana.

A search for beryl in southwestern Montana will probably prove to be a fruitless undertaking, although there is always the possibility that there may be found a more or less isolated area where this rather rare mineral may occur.