CESIUM BIOTITE FROM CUSTER COUNTY, SOUTH DAKOTA

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FOREWORD. (F. L. H.) In 1927 when there was considerable interest in the discovery of cesium minerals, Judge Harry E. Way of the Custer County Court at Custer, South Dakota, who had formerly been actively engaged in mining, undertook the spectroscopic examination of the minerals of the Black Hills for the rare alkali metals. He did not confine his efforts to any particular class of minerals but tested many. Among specimens submitted by George B. Grant he found cesium in lepidolite, beryl, and in another mineral which proved to be the rare pollucite. All three specimens were collected from Tin Mountain, about 7 miles west of Custer, and appear to belong to the higher temperature pegmatite minerals. Judge Way also found cesium, rubidium, and lithium in a dark mica, which forms the basis of this article.

It is worthy of remark that I had collected from the vicinity specimens of beryl which two interested chemists tested spectroscopically for cesium with negative results. It seems possible either that part of the beryl from the pegmatite is barren of cesium or that the temperature of the flames used was not high enough. Judge Way ground his sample and mixed it with fluorspar. A little of the powder was then wet and some of the mixture was applied to a charred match, which was held in a prestolite (acetylene) flame in front of the spectroscope. His results were excellent.

OCCURRENCE. In 1928, with Mr. George B. Grant of Custer, I visited Tin Mountain and made a reconnaissance of the neighborhood. The "Mountain" has an altitude of somewhat more than 6,400 feet and rises about 100 feet above Warren Creek, a rivulet which has cut it off from a ridge at the north.

The country rock, a dark gray quartz-mica schist, forms the body of the hill, but the crest is a pegmatite which shows in the outcrop large masses of pink and buff colored microcline, and quartz with imbedded crystals of spodumene 8 or 10 feet long. In the quartz are crystals of amblygonite, several inches in diameter, and in an indistinct quartz vein and the adjacent pegmatite, is

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cassiterite, whence the name of the hill. At one time an effort was made to work the pegmatite for tin. The property is owned by the Maywood Chemical Works and in the course of mining the firm has exposed very much larger crystals of amblygonite and spodumene, and heretofore unheard of masses of pollucite. The mass of pegmatite in Tin Mountain is an enlargement at the west end of a vertical pegmatite which strikes N. 80° E. On the east side of Warren Creek the pegmatite is about 60 feet wide and extends eastward possibly a half-mile as an incongruous mixture of feldspar and quartz, becoming disconnected masses. Near the east end on the Lithia claim of the Maywood Chemical Works, a short drift has been driven into the pegmatite, which is here only 5 to 8 feet thick, seems to be almost flat and dips slightly N. 40° E. It consists mostly of quartz with a little muscovite in diamond shaped plates, at most 4 or 5 inches across, and some amblygonite crystals which reach the size of a man's head. Two small chunks greatly cracked but, fresh, were said to be pollucite carrying 27 per cent Cs_2O. Near the margins are masses of microcline mixed with muscovite in books ½ inch across and thick, tiny crystals of cassiterite and a little black tourmaline. The pegmatite also carries some white beryl and columbite, all in small crystals.

The quartz-mica schist grows coarser near the pegmatite. Inclusions of the schist one to two inches thick have been replaced by a black mica with the foliae lying parallel to the wall, and similar mica forms part of the schist wall. It was this mica from which Judge Way obtained strong spectrographic tests for caesium, rubidium, and lithium.

It was unpromising looking material, particularly as it came from the outside, the coolest part of the pegmatite, whereas the known cesium-bearing minerals, are found in that part of the pegmatite which has been the hottest.

Under the microscope a section appeared to be fairly pure, the principal inclusions were tiny grains of apatite, but the mica flakes contained numerous cloudy pleochroic halos, without rings, each surrouding a tiny zircon (?).

ANALYSIS: (J. J. F.) The mica was crushed and carefully selected under a binocular microscope. It seemed to be remarkably pure and after the rejection of a small quantity of extraneous material no gangue could be seen under the microscope. The mica is strongly pleochroic, from nearly colorless to deep brown. It is biaxial, optically negative, and the indexes, measured by immersion in oil were: $\alpha = 1.573$; $\beta = 1.620$; $\gamma = 1.620$. The specific gravity at 25° C. = 3.10.

In analysis the methods of Hillebrand were followed with the exception of those for K_2O and Cs_2O. Unfortunately there is no satisfactory direct method for the quantitative determination of K_2O and Cs_2O occurring in the same specimen. The following indirect method was found to give very good results.

The alkalies of a 0.5000 gram sample were obtained as chlorides by the method of J. Lawrence Smith. To the water solution of these alkali chlorides an excess of chloroplatinic acid was added. This solution was evaporated to dryness on the steam bath and then drenched and scrubbed with alcohol until any excess of chloroplatinic acid and any alcohol-soluble chloroplatinates were removed. The insoluble residue, which consisted of K_2PtCl_6 and Cs_2PtCl_6, was collected on a weighed ground glass filter, dried at 110° C. for one hour to remove adhering alcohol and weighed. The weight of the K_2PtCl_6 plus Cs_2PtCl_6 was 0.2450 gram. This was then dissolved in hot water and the platinum contained therein precipitated by magnesium, the excess magnesium dissolved in hydrochloric acid, the platinum filtered, ignited, and weighed. The platinum weighed 0.0942 gram.

From the above data; *i.e.*, the weight of the K_2PtCl_6 plus Cs_2PtCl_6 and the weight of the platinum derived therefrom, the percentages of K_2O and Cs_2O in the sample were determined as follows:

If all of the 0.2450 gram were K_2PtCl_6, the Pt would weight 0.0984 gram. The 0.2450 gram actually yielded Pt that weighed 0.0942 gram. If all of the 0.2450 gram were Cs_2PtCl_6 the Pt would weigh 0.0710 gram.

$$0.2450 \times \frac{(0.0942-0.0710)}{(0.0984-0.0710)} = 0.2074 \text{ gram } K_2PtCl_6$$

$$0.2450-0.2074=0.0376 \text{ gram } Cs_2PtCl_6$$

$$0.2074 \text{ gram } K_2PtCl_6 = 0.0402 \text{ gram } K_2O = 8.04 \text{ per cent } K_2O$$

$$0.0376 \text{ gram } Cs_2PtCl_6 = 0.0157 \text{ gram } Cs_2O = 3.14 \text{ per cent } Cs_2O$$

The complete analysis of the sample follows:

	Per cent
SiO_2	36.97
TiO_2	2.64
Fe_2O_3	2.26
Al_2O_3	17.51
FeO	14.81

MnO	0.22
MgO	8.45
Li_2O	0.65
Na_2O	0.45
K_2O	8.04
Cs_2O	3.14
$H_2O-110°C$	0.32
$H_2O+110°C$	2.48
F	3.17
	101.11
Minus Oxygen equiv. of F	1.34
Total	99.77

MINERAL AFFILIATIONS. (F. L. H.) The physical characteristics and the analysis throw the mineral into that micaceous scrap heap known as biotite, although it is only a little too low in iron oxides to fit in the lepidomelane group.

It is the first mica, other than lepidolite, known to carry cesium. Micas of similar appearance were found at the border of the pegmatite on Tin Mountain, the west terminus of the pegmatite described earlier in this paper, at the border of cesium bearing pegmatites in the town of Newry, and on Hodgeon Hill, near Buckfield, Maine. Judge Way found no cesium in the biotite from Tin Mountain but got very strong rubidium lines. We obtained strong lithium and rubidium and faint cesium lines. Mr. Fahey's spectroscopic tests of the mica from Hodgeon Hill showed neither cesium nor rubidium. The biotite from Newry has not been tested, but a biotite from the wall of the Morefield pegmatite at Winterham, Va. (3 miles west of Richmond) gave good lithium lines.

It is of interest to a geologist to find a cesium mineral in the cooler parts of a pegmatite. As already stated, pollucite, lepidolite, and beryl, the principal known cesium-bearing minerals, are found in those parts of the pegmatite through which the hottest solutions have apparently flowed. The explanation seems to lie in the type of solution which brought the element from the depths, and the fluorine, which is above the average reported for biotite, may have carried it into the cooler parts of the pegmatite, just as tin seems to travel with antimony and sulphur, into much cooler parts of veins than can be reached by tin which deposits only as oxide.