1—quartz
2—sphalerite
3—miargyrite
4—quartz
5—miargyrite
6—tetrahedrite
7—quartz

The Flint district in which these specimens were found is not far from the mines in which miargyrite was found in the Silver City District. This is the only region in the United States where the mineral occurs except the Randsburg district in California where, within the past few years, very fine both massive and crystallized miargyrite has been found as the most abundant silver mineral of the ore. The crystallography of this California material is now being studied and will shortly be described by the present writer.

THE IMPORTANCE OF POLLUCITE

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Introduction

Pollucite, $2Cs_2O \cdot 2Al_2O_3 \cdot 9SiO_2 \cdot H_2O$, the principal source of caesium, was named in 1846 by Breithaupt from Pollux (the genitive form of which is Pollucis) of heathen mythology. Breithaupt found two minerals constantly associated in the cavities of the Isle of Elba granite, hence the fitness of his choice in applying the names of Castor and Pollux, famous for their fraternal affection and inseparable companionship. Castorite, the associated mineral, is now known as petalite, $Li_2O \cdot Al_2O_3 \cdot 8SiO_2$.

The writer prepared a brief paper (which he did not publish) about three years ago on the occurrence of caesium. Since that time he has changed his views regarding the abundance of pollucite. Quarrying pollucite has commenced since that time and the writer visited the quarry from which this mineral was being obtained during the summer of 1927.

Commercial Application of Caesium

The application of caesium was for several years practically limited to the use of its compounds as reagents in the rapidly developing field of chemical microscopy. Owing to its habit, possessed in common with rubidium, of forming salts of marked crystalline structure, it is almost indispensable as a microchemical reagent.

More recently it was discovered that thermionic effects caused by caesium in the radio vacuum tube increases the efficiency of the tube at a much lower consumption of electric current than has been found in other types of tubes.[1] Caesium was and remains a very rare metal, hence a search was made for a substitute occurring in greater abundance. Thorium, which has a smaller electron affinity, also gives pronounced thermionic effects but it is not a satisfactory substitute. It appears as though caesium is the best suited for use in the vacuum tube.

Source of Caesium

The sporadic production of pollucite from true pegmatites was always sufficient to satisfy the small demands for caesium in the past. This remains the only source at present but the demand is greater than the supply. Pollucite contains 34% Cs_2O and is by far the richest caesium mineral ever found.

The quarry in Newry, Maine, located near Andover, operated by the General Electric Company, is, as far as the writer knows, the only one producing pollucite. While it has been found in other quarries in the Maine gem-bearing pegmatites, at present they have no commercial significance. The cavities in the granite of the Isle of Elba have likewise produced a small quantity of this mineral.

Other caesium minerals known are: Caesium beryl or vorobyevite, containing about 3% of caesium; it is a rare mineral found in the Urals, Madagascar, and in the Maine pegmatites.

Rhodizite, $(Rb_2O, Cs_2O, K_2O)\cdot 2Al_2O_3\cdot 3B_2O_3$, is a very rare mineral first identified as minute octahedral crystals on pink tourmaline occurring in the vicinity of Ekaterinburg in the Urals and has since been noted in the pegmatites of Madagascar.

Lepidolite, $Al_2O_3\cdot 3SiO_2\cdot 2(K, Li)F$, from some localities is said to contain as high as 3% of rubidium oxide and also a small, variable amount of caesium oxide. Lepidolite occurs in deposits of commercial importance in California and South Dakota. Its chief use, probably, is as a flux in glass-making.

Caesium together with rubidium are reported to have been

[1] See especially; Thermionic effects caused by alkali vapors in vacuum tubes: Irving Langmuir and K. H. Kingdon, *Science*, **57**, 58–60 (1923).

recovered from carnallite in the Stassfurt region.[2] Since rubidium appears to show a marked preference for potassium[3] it is probable that the quantity of isomorphous caesium present in carnallite is very small. No figures are available on the actual amount found. Certain mineral waters also carry caesium.

Probable Abundance of Pollucite

Pollucite resembles quartz very closely. A characteristic specimen of pollucite was presented to several mineralogists and geologists for identification. Every one to whom the specimen was presented appeared certain that the mineral was quartz. While the pegmatites have always been the favorite hunting ground of the gem miner and mineralogist, it is probable that pollucite has been mistaken for quartz on many occasions. The mineralogist on the watch for the many spectacular minerals of a pegmatite might easily overlook the inconspicuous pollucite. The occurrence of the minerals found associated with pollucite, in many widely separated localities, lends support to the idea that pollucite may have been overlooked. Undoubtedly it is a very rare mineral but the writer, at least, feels convinced that it occurs in other pegmatites besides those of the Maine area.

According to Clarke and Washington[4] the original ratio of rubidium to caesium in the magma yielding pegmatite appears to be approximately Rb:Cs=10:1. This may explain why the amount of isomorphous rubidium always exceeds the quantity of caesium in lepidolite.

Origin of Pollucite

The process by which caesium becomes concentrated from a magma with the approximate ratio Rb:Cs=10:1 is suggested by the association of lepidolite with pollucite. It is known that rubidium shows a marked preference for potassium, therefore the suggestion presents itself that potassium-bearing lepidolite has robbed the magma of its rubidium, thus concentrating the caesium.

While none of the suggested formulae for pollucite indicate the presence of potassium it may be present in small quantity according to Clarke and Washington.[5] Microscopic study indicates

[2] Dictionary of applied chemistry: Thorpe, N. Y. p. 597, (1912).

[3] Clarke and Washington: The composition of the earth's crust, *U. S. G. S. Prof. Paper*, **127**, p. 203, (1924).

[4] *Op. cit.*, p. 25.

[5] *Op. cit.* p. 80.

the presence of finely disseminated feldspar intermixed with the pollucite. Since oligoclase was determined in this disseminated material it is possible that the potassium content may be accounted for by this mineral known to contain, in some cases, as high as 7% of a potassium feldspar molecule.

It may be possible that lepidolite, which occurs in much greater abundance than pollucite, can account for the excess of rubidium in the ratio but it is equally possible that a physico-chemical process has taken place of which we have no knowledge.

Identification of Pollucite

While pollucite resembles quartz, its luster is slightly different and may be best described as somewhat "oily." Conchoidal fracture is common to both minerals but appears to be more completely developed in pollucite. Pollucite is, of course, more apt to show alteration. The hardness of the two are close (pollucite 6.5, quartz 7). The specific gravities are also fairly close (pollucite 2.90, quartz 2.65) and feldspar may be intimately intermixed affecting the determination.

The slight difference in luster and the fact that pollucite is decomposed by acid are of greatest use in the field.

If a microscope is available the distinction becomes simple. Pollucite is isotropic with a refractive index of 1.525 while quartz is uniaxial (+) with $\epsilon = 1.553$ and $\omega = 1.544$.

Mineral Associations

Pollucite at Newry, Maine, occurs frozen in a pegmatite which has been intruded into what is now a chlorite schist. Lepidolite and colorless caesium beryl appear to be the best indicators of the possible presence of pollucite. A great many minerals have been found in this pegmatite, including the following noted by the writer upon the occasion of his visit to the quarry; tourmaline (black, pink, red, and green), purpurite, lithiophilite, columbite(?), cassiterite, caesium beryl, spodumene and lepidolite.

The above mineral association suggests several localities in the world in which pollucite may occur.

Other Possible Sources of Caesium

Among the other possible sources of caesium, lepidolite alone appears to offer any commercial possibilities. If the demand for caesium cannot be satisfied by the production of pollucite, which is improbable at the present at least, it is possible that lepidolites containing caesium could be worked as a source of lithium salts. The added value as a result of a caesium content undoubtedly would enable lepidolite to compete with amblygonite, the present source of lithia.

If the lepidolite produced by California during 1920 amounting to 10,046 short tons, contained the amount of Cs_2O reported in the mineral at Pala, San Diego, there would have been 30 short tons of caesia involved.[6] Although the analysis shows, Rb_2O 0.97, and Cs_2O 0.30, some doubt exists with regard to the amount of caesium reported in lepidolites and how representative such analyses are of the lepidolite mass.

Conclusion

Mineralogists should be on the watch for pollucite whenever an examination is being made of a granite pegmatite. A ready market exists for the mineral at present and perhaps it occurs in many unsuspected localities.

THE MINES AT THE FALLS OF FRENCH CREEK, CHESTER COUNTY, PENNSYLVANIA

George Vaux, Jr.,[1] *Philadelphia Mineralogical Society.*

The vicinity of Philadelphia has long been known as one which abounds in rare and interesting minerals. One needs only mention such occurrences as the pyromorphite and anglesite of Phoenixville, the brucite from Wood's Chrome Mine, the amethyst, garnet, and titanite of Delaware County, to bring to mind some of the more important and beautiful specimens which have been found here in the past. As early as 1818, Isaac Lea published in the *Journal of the Academy of Natural Sciences of Philadelphia* (volume 1, pp. 462–82) "An account of the minerals at present known to exist in the vicinity of Philadelphia," and the bibliography of the subject has been quite extensive from that time to this.

Leaving out of consideration the enthusiasm which so many collectors exhibit towards specimens found locally, which enthusi-

[6] Non-Metallic Minerals: Raymond B. Ladoo, New York, p. 306, (1925).

[1] This locality was but an hour's drive by automobile from his home and was frequently visited by Mr. Vaux. This article was completed within a few days of his untimely death on October 24, 1927. (S. G. G.)