The Identification of Pollucite

Aids to work in the field and laboratory are described

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Abstract

The economic importance of caesium is increasing rapidly and hence pollucite—the only mineral in which the element occurs as a major constituent—is certain to be sought for much more diligently than in the past.

As the mineral is generally not readily recognized amongst the other pegmatite minerals with which it is normally associated simple field and laboratory tests have been devised to facilitate its identification and these are described in the text.

Introduction

Recently the economic importance of caesium—the most reactive of all the elements—has been increasing in a most spectacular way and it was reported in the *Northern Miner* for March 3, 1960, " that experts foresee a more promising future for caesium than was the case for uranium about 12 years ago." Despite the high cost of the element (*c.* $4.00 per gram.) and its compounds comparatively large quantities of these are now being used for experimental purposes and already the results of these experiments have been quite spectacular. Thus, within the past two years, a caesium plasma thermocouple has been developed for the direct conversion of heat to electricity and also two photomultiplier tubes have been designed which employ caesium telluride and caesium-antimony, respectively. The element is also regarded as a potentially important catalyst in the manufacture of certain fuels for guided missiles and the isotope Cs-137 is tending to take the place of Co-60 in the treatment of cancer.

This list by no means exhausts all the real and potential uses of the element.

Caesium, like rubidium and potassium, tends to become concentrated in the granitic (and to some extent the syenitic) fractions of magmas. It is, therefore, not surprising that potash feldspars and certain micas—particularly of granite pegmatites—may contain up to a few per cent. of caesia (Cs_2O) and that some of the other pegmatite minerals—notably, lepidolite and the beryls vorobyevite and rosterite—may do likewise. Even the adularia of late hydrothermal veins may hold significant amounts of the element. In addition, largely because the ionic radius of caesium (1·63 Å) differs appreciably from that of potassium (1·33 Å), whereas that of rubidium (1·49 Å) is much closer to that of the latter element, rubidium can be accommodated much more effectively than caesium in the "normal" pegmatite minerals. The result of this is that, while no mineral exists in which rubidium is a dominant component, there is one in which caesium is and that is pollucite. This mineral is discussed further later.

Both caesium and rubidium are brought into solution by weathering processes, but they are strongly absorbed by argillaceous sediments and so sea-water and evaporites derived from it are comparatively poor in these elements. Nevertheless, despite this paucity, the potassium salts of evaporites are important sources of caesium and rubidium. However, these two alkali elements are also obtained in commercial quantities from pegmatite minerals and it seems that, if the economic importance of caesium approaches the expectations of many, deposits of pollucite will be exceedingly valuable. Already a number of zoned pegmatites are known which contain important concentrations of this mineral and outstanding amongst these are those of Varuträsk (Northern Sweden), Bikita (Southern Rhodesia), and Bernic Lake (Manitoba, Canada).

In all these deposits pollucite (the general properties of which are noted in Table 1) occurs in lenses associated more or less intimately with lepidolite and other lithium minerals, quartz, feldspar, etc. Pollucite, however—as Goldschmidt remarks (1954, p. 171)—" is not always easy to recognize because it has a peculiar similarity in surface lustre and transparency to the ordinary quartz of granite pegmatites " and it is

"probably less rare than usually believed." Because this important mineral is difficult to recognize by inspection and the application of simple physical tests the chemical aids, described below, have been devised.

Field Tests

It must be pointed out that a spectroscope—even a small one—will enable caesium to be detected rapidly and with certainty in a mineral, unless the element is present in very small quantities. It is only necessary to examine the lines which appear when a little of the powdered specimen (mixed, if necessary, with potassium bisulphate or bifluoride) is introduced into a flame on a cylindrical coil of platinum wire. Caesium is indicated by the presence of two strong blue lines (4555 and 4593 Å) which, when a small spectroscope is used, appear as one line.

Although this is an excellent laboratory method, a chemical test involving simple and cheap apparatus, a limited number of readily available reagents, and few operational steps, is clearly superior for work in the field. The *Northern Miner* (June 9, 1960, p. 15) reports that Kjollesdal has developed such a test for pollucite : it is, in fact, an adaptation of the well-known potassium bismuth iodide test for caesium (which is described in detail by Feigl, 1947, p. 182). Kjollesdal recommends placing first a drop of hydrofluoric acid on the sample to be tested and then a drop of potassium bismuth iodide ($KBiI_4$) reagent. The presence of caesium in considerable amount, and hence the presence of pollucite, is indicated by the immediate development of a vermilion precipitate. The reagents are carried in plastic bottles—that containing the $KBrI_4$ being brown—and they are dispensed by means of plastic pipettes or droppers. In Canada $KBiI_4$ may be obtained from British Drug Houses (Canada).

Table 1

General Properties of Pollucite

(*Based on Winchell's data, 1933, p. 293*)

Formula :—$Cs[AlSi_2O_6]H_2O_{<1}$.

Crystal system and habit :—Isometric ; sometimes as cubes, often massive.

Cleavage :—Only in traces.

Hardness :—6·5.

Specific gravity :—2·9.

Fusibility :—6.

Colour :—Colourless.

Optical properties :—Isometric : refractive index is 1·5215 in lithium light, 1·5247 in sodium light, 1·5273 in thallium light.

Although the test is rapid, simple, and reliable, it suffers from the great drawback that hydrofluoric acid is a very dangerous reagent which should only be used by those who are fully aware of its properties. Therefore the present writer suggests a modification in which a fusion with ammonium fluoride replaces the hydrofluoric acid attack. Ammonium fluoride is far safer to handle and to transport than the acid and though a source of heat is required to carry out the modified test this is not a real drawback, as even a match or a cigarette lighter can be used if no better means of heating are available.

Briefly, a little of the powdered sample is mixed with about twice its volume of ammonium fluoride and the mixture is heated until incipient fusion occurs. Fusion may be carried out in a silica crucible, on a piece of asbestos paper, or even in a capillary tube. The source of heat can be a Primus stove, an alcohol lamp, a candle, an open fire, or a cigarette lighter. If, however, a thread of the mixture—about 0·5 in. long—is packed into a capillary tube by repeatedly pressing the end into a small pile of the mixture the small charge can be adequately fused by the flame of a match.

Having carried out the fusion, a drop or two of $KBiI_4$ reagent is added to the product and the immediate development of a vermilion precipitate indicates pollucite. If the fusion has been effected in a capillary tube the end containing the charge is dipped into a drop of the reagent to complete the test.

Preparation of the $KBiI_4$ Reagent. (Feigl's method, 1947, p. 182.)

Dissolve 1 g. Bi_2O_3 in a saturated aqueous solution of 5 g. KI by boiling and treat the resulting solution with 25 ml. acetic acid which should be added in small amounts; store in a dark polythene bottle.

Methods of Staining Pollucite

Pollucite in thin and polished sections of rock and as grains in a plastic briquette may be readily stained by the method noted below and hence its distribution may be readily determined in such specimens. The technique is particularly valuable when examining thin sections as it enables rapid and certain differentiation to be made between pollucite and any other minerals which may be isotropic between crossed nicols. It is also very helpful when dealing with mill products.

Procedure

Clean the surface to be stained with

detergent in order to remove oil, etc., then rinse it in water and dry it on a hot-plate. If a thin section is to be treated cover the glass slide with a thin film of vaseline to protect it from subsequent attack by acid fumes. Carry out all subsequent operations under a well-ventilated hood. Select a shallow polythene container of such a size that the specimen can rest on it and fill this to within a quarter of an inch of the top with hydrofluoric acid. Place the specimen, with the surface to be stained facing the acid, on the container and cover the whole with an inverted polythene beaker. After about $2\frac{1}{2}$ min. (experience may show that a longer or a shorter time may be necessary for the best results) remove the specimen (use rubber gloves) and press spot-reaction paper saturated with $KBiI_4$ on to the surface. (It may be necessary to dab the specimen several times with the reagent paper in order to obtain a satisfactory depth of colour.) This treatment causes the pollucite to be stained vermilion, while other portions of the specimen may be coated with the yellow reagent. Dry the specimen by holding it near a bunsen flame and then very briefly immerse it in water : this removes the unused reagent. Finally dry the specimen in the manner noted above.

If it is a thin section which has been stained, remove the vaseline by means of a paper handkerchief and coat the rock slice with a very thin veneer of 1 : 1 Durofix/amyl acetate, then allow it to dry below 50° C. Finally cover with a cover slip—using Canada Balsam as adhesive—in the usual way. (The Durofix mixture protects the stain during the subsequent heating and it allows any bubbles to be squeezed out after the cover slip has been placed in position without fear of the slice fracturing. In addition, it facilitates the transference of the slice to another slide should this be deemed desirable. After this treatment the pollucite areas, when examined under the microscope, appear to be densely stippled with red dots.

References

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Ore-Dressing Notes

(14) *Iron Ore*

A New Spiral Plant

Writing in the *Mining World* of San Francisco for January S. E. Sjöberg describes the treatment of a magnetite-hematite ore at Sweden's new Stora Kopparbergs mill. Preliminary test work showed that the magnetite should be separated magnetically but that, with the choice between tables, flotation, cyclones, and Humphreys spirals for concentrating the hematite, the last of these best suited the requirements. Flotation gave best grade and recovery but entailed undesirably fine grinding and a problem of sintering. The ore is crushed underground to *minus* 10 in., hoisted from a 2,000-ton skip pocket, and dumped into a 1,500-ton headframe bin. From here it goes through two stages of secondary crushing in Symons machines and thence, at *minus* 1 in. to the fine-ore bin. The mill building has exterior walls insulated by wood-wool panels. Structural steel is used for the machinery foundations to facilitate transfer of the machinery should the present layout be changed. Ore is fed at 150 tons per hour to two parallel rod-mills and reduced to *minus* 8 mesh. It then goes to magnetic separators with permanent magnets, where some 70 tons per hour are recovered as a 63% to 65% concentrate. The tailings pass on to a battery of 80 five-turn spirals which rough out a middling that goes from each spiral to a three-turn spiral below for cleaning, the reject returning to the rougher spirals ; 30 tons are recovered hourly at a grade of 63%.

This flow-sheet marks a considerable simplification from standard Swedish iron-ore practice. Following Minnesota's taconite practice cobbing has been eliminated. Concentrates and tailings are dewatered on top-feed filters, each of which handles up to 40 tons hourly. The 50 tons of tailing made hourly assays from 7% to 8% Fe and 2% P, the phosphorus content of the ore being 1%.

The article ends with a few working tips on the installation of the Humphreys spirals. An operating pulp density of 25% solids is recommended, maximum tolerance being 30%. Floor levels should allow the shiftsman