in degree of oxidation within the sample, with accompanying variation in cell size.

The cell size also should vary with the amount of radiogenic lead present ($Pb^{IV}=0.84$ Å; $U^{IV}=1.05$ Å) (2). As Wasserstein (1*d*) has pointed out this offers a means of age determination by measurement of cell size. For the ideal application of this method, allowance must be made for the effect on a_0 of secondary oxidation, the presence of thorium and other elements in solid solution, and radiation damage.

All of the present samples were run on the Philips *x*-ray diffractometer and paper recorder. An internal standard of ThO_2 was employed. The Mansfeld and Palermo specimens also were photographed on film in 114 mm. cameras. None of the samples had been heated or otherwise treated. The ThO_2 value was 5.59543 Å ± 0.00005 Å, earlier obtained from a precision back-reflection camera. The value of a_0 for the synthetic UO_2 (Synthetic "C. P. Brown UO_2" prepared by the Shattuck Company, Denver), thus obtained was 5.468 Å ± 0.002 Å. The best value available for this substance is 5.4682 Å at 20° C. (3).

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REMOVAL OF MINERAL GRAINS FROM THIN SECTIONS*

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A simple method by which individual mineral grains may be removed from a thin section and isolated for study by oil immersion, *x*-ray, or microchemical techniques has been used by the writer with considerable success. The basic concept of removing material from a thin section is

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undoubtedly not a new one. However, during the past 5 years the writer has talked with several workers in mineralogy who were not familiar with this technique and it may serve some purpose to present it here. An example is given to illustrate the usefulness of the method.

METHOD

The basic method of grain removal is to make a series of perforations around a selected grain, and then pick the freed grain from the section. Any uncovered section may be used, but the writer found that best results were obtained if a second section were made especially for the purpose. This has several advantages: (1) the original section is not damaged and may be kept for reference, (2) the second section can be made thicker, preferably 0.06 to 0.09 mm. thick; the grains are more apt to break up in a section of standard thickness and more material is obtained from thicker sections—this is especially important if an *x*-ray is required, (3) the process of grain removal is less difficult if there is no balsam on the upper surface of the rock slice.

After the grain to be removed has been selected, a series of pricks are made along the periphery of the grain with a small fine-pointed needle; the point can be kept sharp by dressing with fine sand paper.

The operation is observed under the microscope and the space required for manipulation necessitates the use of a long focal length objective. The needle cannot be held exactly vertical; to prevent the grain from shattering, the needle should be in such a position that the horizontal component of the perforation is parallel with the edge of the grain. The holes should be spaced about 2 to 3 diameters apart and when the grain has been completely encircled these will appear as a dark band surrounding the grain (Fig. 1).

Next, a small drop of acetone, ether, or some other suitable solvent is applied to the spot. For this purpose the writer found that a thin stirring rod drawn out to a long fine point and then fire burnished was more effective than a micro-pipette. A small drop of solvent on the end of the rod can be held just over the grain until it has nearly evaporated and then applied to the proper spot. The solvent spreads rapidly on the surface of the slide, and this method prevents "flooding" the slide with a single large drop; several applications may be needed to soften the balsam.

The solvent attacks the balsam through the perforations and after several drops have been placed on the spot, the dark band around the grain will disappear and the perforations appear as holes in the slide. These holes are enlarged using the needle with a drawing motion and by chipping until a channel has been cut all the way around the grain. During this process it is sometimes necessary to apply more solvent and if the rock material surrounding the grain is especially hard and cohesive it may be necessary to prick additional holes. When the grain has been freed from the rock, and the balsam beneath the grain is soft enough so that the grain may be moved, the point of the needle is placed under one edge of the grain, the grain pried up and removed from the slide.

Commonly the grain (especially if it is large), will break up during the process of removal but the larger pieces can usually be salvaged; grain boundaries are natural lines of weakness and it is not unusual to remove a grain intact. Some grains will fracture when the perforations are being made along the grain boundaries. No harm is done unless the grain is poorly bonded to the mounting medium and fragments of the grain chip loose and fly off. Loss of material in this manner can generally be prevented by adding a small drop of acetone to the slide after the first hole has been made. This makes the balsam beneath the grain tacky and holds the fragments in place.

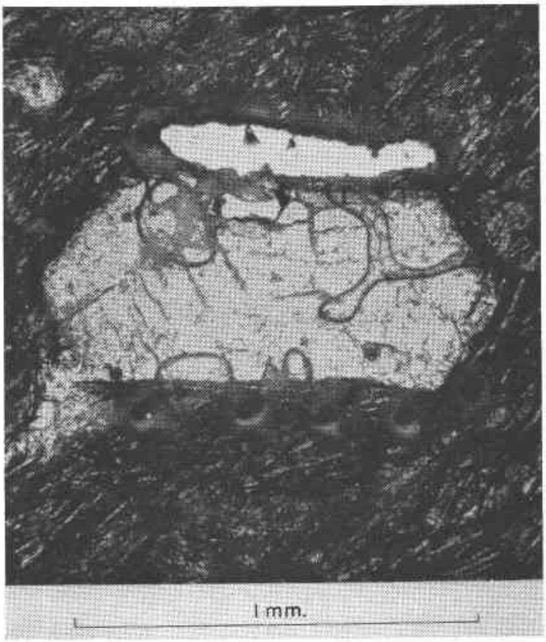

FIG. 1. Photomicrograph of pseudomorphic aggregate of natrolite after sanidine from tinguaite, showing two steps in the method of grain removal from thin section. Small "craters" along bottom margin of grain are needle perforations; elongate white space along top of grain is channel made by enlarging and connecting needle holes. Irregular spots are bubbles beneath grain.

When the grain is removed from the section it is transferred to a glass slide and cleaned by adding a drop of solvent and agitating the grain, and the process repeated until it is free of balsam. It is then ready for testing—by oil immersion, micro-chemical, or x-ray methods. An amount equal to 3 to 4 thick grains 1 mm. in diameter was found sufficient for an x-ray determination. In determining the indices of anisotropic minerals, grains of suitable orientation must be selected from the section, as the grains will generally have the same orientation when tested by immersion methods.

Example

In a thin section of a tinguaite from the Judith Mountains, Montana, several small euhedral grains of an isotropic, low-index substance occurred as micro-phenocrysts in an extremely fine-grained groundmass. The grains were 5, 6, and 7 sided to roughly circular in outline, and the shape together with the optical data and the geologic occurrence suggested that they were either sodalite, haüyne, analcime, leucite, or basal or near basal sections of nepheline. In order to identify the mineral it had to be isolated for further study.

The euhedral grains were a minor constituent of the rock, and the section also contained anhedral masses of a similar appearing substance, patches of partially devitrified glass, and zeolites. Because of the probable similarity in specific gravity and indices of these various substances with the euhedral mineral, and because of the scarcity of the euhedral grains and their small size (less than 1 mm), the use of heavy liquids seemed to be a difficult, if not impossible, solution to the problem of separation.

In an attempt to solve this problem, several grains were picked from the thin section and the refractive index determined as 1.487. This eliminated all except two possibilities—analcime or sodalite. A micro-chemical test for the chloride ion was then made with nitric acid and silver nitrate. The test was positive, suggesting sodalite, but more material was removed from the section and examined with x-ray; the powder pattern identified the mineral as analcime. Several additional thin sections of the rock specimen were then made at different orientations and all gradations in outline from hexagons to stubby rectangles were noted. These facts suggest that original nepheline crystals were in part replaced by sodalite, and later, the remaining nepheline and most of the sodalite were replaced by analcime.

Conclusions

The method will probably find limited application and will supplement other methods of separation. For determinations in which only small amounts of material are required, this method is less time consuming than a heavy liquid separation; with ideal conditions enough material for an x-ray analysis may be obtained in less than an hour. For rocks in which unknown minerals occur as isolated masses greater than $\frac{1}{4}$ to $\frac{1}{3}$ mm. in diameter, a pure sample (barring inclusions) may be removed, tested, and identified and can be positively referred to the mineral observed in the thin section. This is especially useful when the unknown mineral is present in minor amounts and is associated with minerals having similar properties.

A SIMPLE COLLECTOR FOR CONCENTRATING A MINERAL PHASE FOR ANALYSIS

V. D. Frechette*

It is not uncommon to encounter the necessity for concentrating a mineral phase from a granular specimen for analysis by x-ray diffraction, spectroscopy, or other means. This may be done conveniently by a simple apparatus which is used in conjunction with the microscope.

The apparatus consists of an 8 mm. sample vial into which the specimen is to be collected and a two-hole stopper from one opening of which a tube extends to fit a length of rubber tubing whose free end is held in the mouth. From the other opening a glass tube drawn to a fine tip extends in an inverted L-shape. The vial may be manipulated by hand or preferably may be supported mechanically with the glass tip just above the grains at the center of the microscope object stage. Gentle suction will induct a mineral grain from beneath the tip and deposit it in the sample vial.

With care in sprinkling the sample over the object slide, not too great a suction, and the use of a tip of appropriate bore, a single grain may be collected at a time without drawing in neighboring unwanted grains. If too many other grains are collected it may occasionally be necessary to repeat the process on the collected sample. The time required for the process depends very much on the size of the particles and these should be as large as possible. In many cases it is feasible to eliminate the fines by sieving prior to the collecting process.

A small pamphlet of 45 pages with 7 maps entitled "Maine Mines and Mineral Locations" has been prepared by Philip Morrill. It can be purchased through John Dillingham, Naples, Maine. Price $1.00.

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