

# A METHOD FOR THE PREPARATION OF POLISHED THIN SECTIONS OF MINERAL GRAINS

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## ABSTRACT

This paper describes a method of preparing polished thin sections of crushed mineral grains for microscopic examination. Polished thin sections permit the examination of a section of each grain in both reflected light and transmitted light. The technique described is applicable to the study of ores containing intimate associations of transparent minerals with semiopaque or opaque minerals.

During work on the concentration of a Bolivian tin ore at Battelle Memorial Institute in 1948, a method was developed for the preparation of polished thin sections of mineral grains. The purpose of this method was to permit the examination of a section of each grain both by vertically reflected light and by polarized transmitted light.

In the study of this ore, the standard methods of microscopic examination were not adequate. Examination of polished briquettes was of limited value because several of the minerals appeared similar in reflected light and, therefore, could not always be identified by this method alone. Petrographic examination of grains in refractive index media was also unsatisfactory because the intimate association of minerals caused most of the grains to be nearly opaque. However, by the use of polished thin sections, which combined most of the advantages of polished briquettes and thin sections, it was possible to identify the different minerals in each mineral aggregate. This method permitted a statistical study of the ground ore and the products of concentration to determine the degree of association of the valuable mineral (cassiterite) with each of the gangue minerals.

Several articles have been published on the preparation of polished thin sections of individual pieces of rock. The most recent of these are the papers by Kennedy (1) and Meyer (2). A method for preparing thin sections of crushed grains is described by Gibbs and Evans (3). However, to the author's knowledge, no literature exists on the preparation of *polished* thin sections of crushed *grains*.

Because it is considered probable that the use of polished thin sections of grains will be helpful in concentration studies on complex ores, the method used to prepare the specimens is described herein.

## GENERAL PROCEDURE

Briefly, the procedure in preparing the specimens is as follows: A single layer of sized grains is mounted in a film of plastic on a flat surface of the same plastic. The layer is ground to nearly the center of the grains,

and this ground surface is remounted on more of the same plastic. The original piece of plastic is then cut off and the other side of the layer of grains is ground until the section is of the desired thickness. The surface is then polished.

The completed specimens can best be examined by means of a polarizing petrographic microscope equipped with a vertical illuminator. An electrical switch for changing from reflected light to transmitted light, and vice versa, while observing a grain through the microscope, facilitates the examination.

#### MOUNTING MEDIUM

The resin selected for mounting the mineral grains was diallyl phthalate prepolymer,\* a solution of the polymer in the monomer. It is a thermosetting resin which, unlike Lucite and Bakelite, cannot be melted after polymerizing. Thus it can readily be sawed, ground, and polished without the difficulty caused by softening encountered in the use of Lucite. The color is light amber, but a section 1/10 inch thick appears practically colorless under the microscope. One of the reasons for selecting diallyl phthalate was that its refractive index, 1.57, is between the indices of quartz and tourmaline, the major gangue minerals in the ore.

Because of the shrinkage on polymerizing, slow curing is necessary to minimize strains in the plastic. If the curing is too rapid, the strain birefringence in the plastic interferes with determination of birefringence in the mineral grains.

#### PREPARATION OF SPECIMENS

The grains to be mounted should be reasonably well sized; the fractions obtained from the standard Tyler  $\sqrt{2}$  screen series are suitable. The mounting of grains within the size range from 10 to 150 mesh falls into seven steps. For grains finer than 150 mesh and for elutriation products, some of the steps are omitted. These are discussed under Special Cases. Details of grinding and polishing techniques and equipment used are omitted because of the variation in equipment in different laboratories and because no special grinding and polishing equipment is required other than that used for preparing ordinary thin sections and polished sections.

##### *Step 1—Preparation of Liquid Plastic*

Prepare a quantity of the plastic by adding 1 gram of catalyst, tertiary

\* Diallyl phthalate prepolymer is produced by the Shell Chemical Corporation, 500 Fifth Avenue, New York 18, N. Y.

butyl perbenzoate,† to each 100 grams of diallyl phthalate prepolymer. Stir well and store in a closed bottle. This prepared solution will keep for several months at room temperature without becoming noticeably more viscous.

#### *Step 2—Preparation of Blanks*

Prepare a number of blanks as follows. Apply silicone stop-cock grease to the inside surface of a glass vial or test tube with an inside diameter of one inch. Fill with diallyl phthalate and cure for 24 hours at 80° C, 24 hours at 90° C, 24 hours at 100° C, and 24 hours, or until hard, at 110° C. (The long curing cycle in this step is necessary because of the large size of the casting. If cured more rapidly, the plastic may crack in several places.) Allow to cool and then shake the plastic loose from the tube. Saw the plastic cylinder into discs about  $\frac{1}{2}$  inch thick. A large number of these blanks may be prepared at one time and stored for future use.

#### *Step 3—Mounting Grains on Blanks*

To mount a single layer of grains on a blank, proceed as follows. Grind one surface of the blank to make it smooth enough that the depth of the remaining scratches is less than one-tenth the diameter of the grains which are to be mounted. Wash the smooth surface of the blank with alcohol. Place 2 to 6 drops of diallyl phthalate on the blank, depending on the size of grains, and spread it over the surface. Add enough of the mineral grains to form not more than one layer and distribute them evenly over the surface by means of a piece of fine wire. Add more diallyl phthalate if necessary to completely cover all the grains. (Surface tension will keep the liquid from running over the edge of the blank.) Place on a level surface in an oven and cure for 48 hours at 110° C.

#### *Step 4—Grinding to Near Center of Layer of Grains*

Grind the specimen, starting with coarse abrasive and finishing with fine, until ground nearly to the center of the layer of grains. This step requires practice to prevent grinding out some of the grains. For the final grinding, any method which has been found satisfactory for ordinary thin sections may be used.

#### *Step 5—Remounting the Ground Surface*

To remount the ground surface, form a cup  $\frac{1}{2}$  inch high above the layer of grains by wrapping Scotch cellophane tape around the specimen.

† Obtainable from the Union Bay State Co., Cambridge, Mass.

Fill the cup with diallyl phthalate and cure at 110° C for 48 hours or until the plastic is hard.

*Step 6—Grinding and Polishing Opposite Side of Grains*

To provide a means for measuring the thickness of the sections, grind four sides of the cylinder perpendicular to the layer of grains until a few grains are exposed on each side. Then saw off most of the original blank. Grind the layer of grains starting with coarse abrasive and finish-

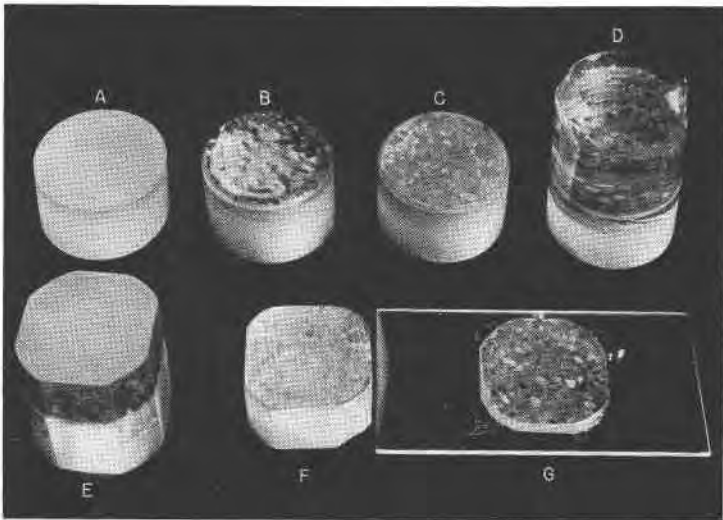


FIG. 1. Stages in Preparation of a Polished Thin Section of Mineral Grains.

- (a) Blank ready for mounting grains.
- (b) Layer of grains mounted in plastic on surface of blank.
- (c) Specimen ground to near center of layer of grains.
- (d) Ground surface remounted on plastic. Wavy surface of Scotch tape is due to shrinkage of plastic on curing.
- (e) Four sides ground on specimen to provide a means for measuring thickness of section.
- (f) Opposite side of layer of grains ground and polished. Note that (f) represents top half of (e) inverted.
- (g) Plastic reduced in thickness and mounted on glass slide.

ing with fine until the section is the desired thickness. During the grinding, the thickness of the grains on all four edges of the specimen should be checked at intervals by observing through the petrographic microscope with a micrometer ocular.

The specimen may now be polished by any method which is suitable for ordinary polished briquettes of the same minerals, provided it does not remove too much of the thickness of the section.

*Step 7—Reducing Thickness of Plastic and Mounting on Glass Slide*

For some purposes, the specimen may be considered completed at the end of Step 6. However, if the color or birefringence of the plastic is objectionable, the thickness of the plastic mount can readily be reduced to about 1/10 inch by grinding. If desired, the specimen can be mounted on a glass slide with a few small drops of Duco cement around the edge.

*Special Cases*

In the case of sized grains finer than 150 mesh, it is not necessary to grind both sides of the layer of grains, as the sections are sufficiently thin after grinding to the center of the layer. Therefore, the specimens can be polished after Step 4 and completed as in Step 7.

In the case of elutriated products, where there is a difference in size between minerals of different specific gravities, the following variation is suggested. Omit Steps 2 and 3. Mix one or two grams of the grains in a vial with sufficient diallyl phthalate to cover, and cure at the same temperatures as used in Step 2. With a diamond saw, cut the cylinder perpendicular to the axis into two equal parts. Grind the cut surface of one of the halves, and complete the specimen as in Steps 5, 6, and 7.

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