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TECHNIQUE FOR THINNED POLISHED SECTIONS*

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Techniques that have been developed to make thinned polished sections simplify some of the problems concerned with their manufacture. In contrast to polishing a thin section, thinning a polished section is independent of the polishing operation. Any polishing method can be used on the sample, and a laboratory's established techniques need not be changed to adapt to this application.

Thinned polish sections have one primary use—to study the relationship between transparent and opaque materials. Neither thin sections nor polished sections by themselves are satisfactory for this type of study. For certain problems or materials the use of all three techniques would be required.

TECHNIQUE

The methods used in the laboratory comprise three basic operations: polishing, thinning, and transfer of the section.

Polishing

As the polishing step is independent of thinning, it will be briefly summarized. Basically the process is done in five steps: (1) sawing, (2) embedding, (3) impregnating with plastic, (4) prepolish surfacing, and (5) polishing.

The area of the rock specimen, selected for the desired exposure of textures of minerals, is sawed to form a wafer about $\frac{1}{4}\times 1\times\frac{3}{4}$ inch. Sawing is done with a 12-inch water-cooled glass-cutting saw blade made from loosely bonded silicon carbide.

The chip is embedded in phenol-formaldehyde resin, and the surface ground with size $303\frac{1}{2}$ emery in water. Next the briquette is dried with infrared lamps and then impregnated with an epoxy resin.[1] This impregnation is done either by flooding the surface with a few drops of plastic and allowing the chip to absorb as much plastic as possible or by forcing the plastic into the chip with air pressure. The sample is surfaced before polishing by grinding with sizes $303\frac{1}{2}$ and 305 emery on brass laps.

The actual polishing is a technique developed by Professor Edward

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[1] Bonding agent R-313 plus hardener, Carl H. Biggs Co., 2255 Barry Ave., Los Angeles, Calif., or AL-105, LV, AL-107, Acme Wire Co., New Haven, Conn.

Sampson, Princeton University (personal communication). He uses silk-covered laps, diamond abrasive in oil, and pressure against the specimen as it is being polished.

The polishing step is independent of later thinning, and any adequate method can be used. The only requirement of the polishing method is that it should produce sections having little relief.

Thinning

The briquette is sawed with a cut parallel to and about $\frac{1}{8}$ inch below the polished surface. A gentle sawing action is recommended to prevent shattering in the soft brittle minerals. Either a saw blade composed of small diamond fragments sintered into bronze around the entire periphery or a silicon carbide blade has proved satisfactory. The edges are trimmed on the embedding plastic to fit a standard petrographic slide. The sample is washed in perchlorethylene to remove any oil that might remain from polishing and then dried on a hot plate at about 150° C.

The polished surface is temporarily mounted against a petrographic slide with Lakeside 70-C cement. The entire top surface of the slide is covered with a smear of the cement.

When cooled, the temporarily mounted chip is reduced to standard petrographic thickness by a modified thin-section grinding method. This grinding is accomplished in three stages: (1) size 600 silicon carbide in water on an 8-inch 600-rpm. lap, (2) size 303½ emery[2] in water on an 8-inch 600-rpm. lap, and (3) size 305 emery in water on an 8-inch 170-rpm. lap.

Rough grinding during the thinning operation causes the polished surface to be damaged. Accordingly the section is left extrathick (compared to usual thin sections) after the 600 silicon carbide and 303½ emery grinding stages to prevent this damage. The 600 silicon carbide grinding should reduce the section to a thickness of about 0.25 mm. After grinding with 303½ emery the section should be about 60 or 70 microns thick.

All the grinding should be done in water that is about 20° to 30° C. If the water is below 20° C. the thermoplastic cement becomes too brittle and the section will pluck. If the water is above 30° C. the cement becomes too soft and the section may warp. The temperature can be controlled either by using large reservoirs in which the water has come in equilibrium with room temperature or by adding a mixing valve between the hot and cold water supply to the lap table. Speeds faster than about 170 rpm. at the 305 emery grinding stage will damage the sections.

During the last stages of thinning with the 305 emery, the sample may pluck and thus become badly scratched. This effect is more pro-

[2] Sizes 303½ and 305 emery, American Optical Co.

nounced when thinning a polished section than when making the usual thin section. The Lakeside bond is weaker between a polished surface and the temporary slide than between a slide and a ground surface; thus more plucking can be expected. Certain materials, such as sandstones, galena, and sphalerite, have a tendency to pluck at the thin edges of a specimen. If the section can be ground uniformly flat and thin, this tendency is minimized. Such a grinding skill is acquired only with practice. Plucking can best be controlled by starting with a polished surface that is well impregnated with epoxy resin. This kind of resin will bond the surface material together and thus may prevent fragments from plucking A slight increase in the temperature of the grinding media will also minimize plucking.

As the section is being ground and approaches 30-micron thickness, soft minerals such as galena or sphalerite may warp and wrinkle. This particular damage is caused by shear against the minerals as they drag on the lap surface and can be prevented by slower lap speeds and smaller abrasive particle sizes. The combination of a 170-rpm. 8-inch lap and 305 emery is satisfactory. Unfortunately 305 emery from different manufacturers can vary considerably in its average particle size. Some batches that were tried were completely unsatisfactory and the polished surfaces were ruined.

Transfer

When the thinning with 305 emery is completed, the thinned polished section is essentially finished. The rock section has the polish on one surface and has been ground to standard petrographic thickness. However, it is mounted in reverse and accordingly must be transferred so as to expose the polished surface. This transfer is accomplished by cementing the permanent petrographic glass slide to the ground surface of the rock with the epoxy plastic bonding agent, R-313, and then removing the temporary slide. Any exposed glass on the temporary slide should first be coated with a silicone stopcock grease to prevent the two glass slides from bonding to each other. A minimum amount of plastic should be used, one drop or less. After the R-313 has polymerized overnight the sandwich of slides and thinned section is chilled. The two slides can then be separated by wedging a razor blade between them. As the R-313 forms a better bond to the rock and is less brittle than Lakeside 70-C, especially when chilled, the rock slide adheres to the new slide and is transferred from its former position. The polished surface is washed with 2-ethoxyethanol solvent which removes the Lakeside. The section is thus completed.

Different kinds of materials have been prepared with this technique. The photographs show some of the results that can be expected.

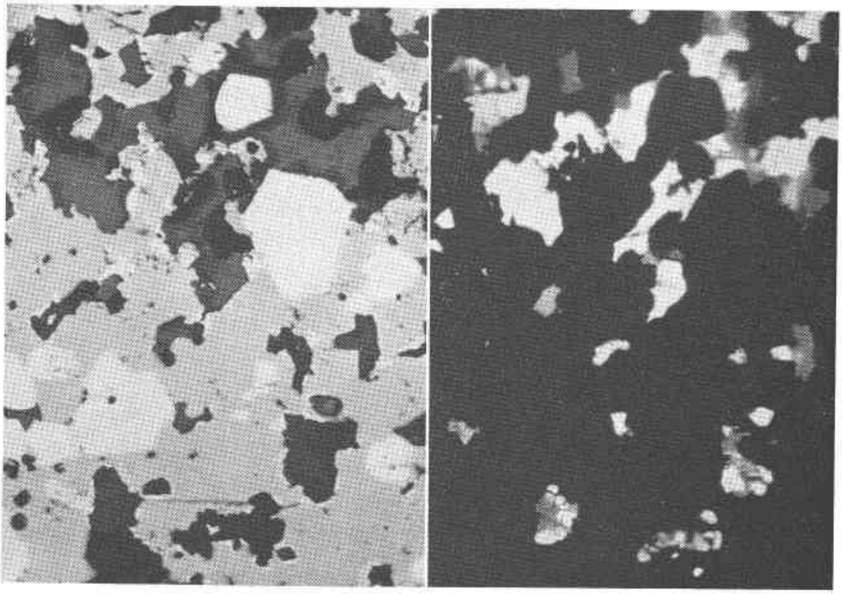

FIG. 1. Enargite, pyrite and quartz. (left) Vertical illumination; (right) Transmitted light, crossed nicols. Magnification 150×.

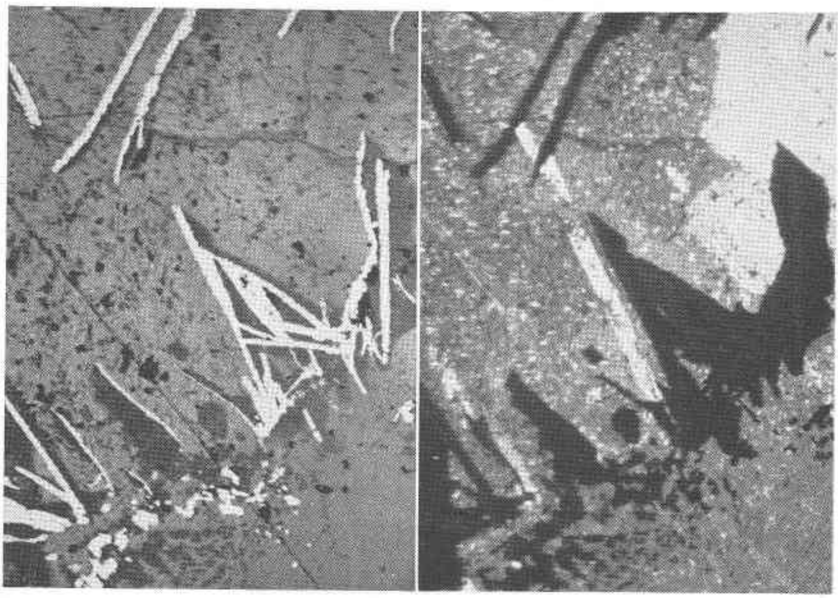

FIG. 2. Marcasite and calcite. (left) Vertical illumination; (right) Transmitted light, crossed nicols. Magnification 150×.

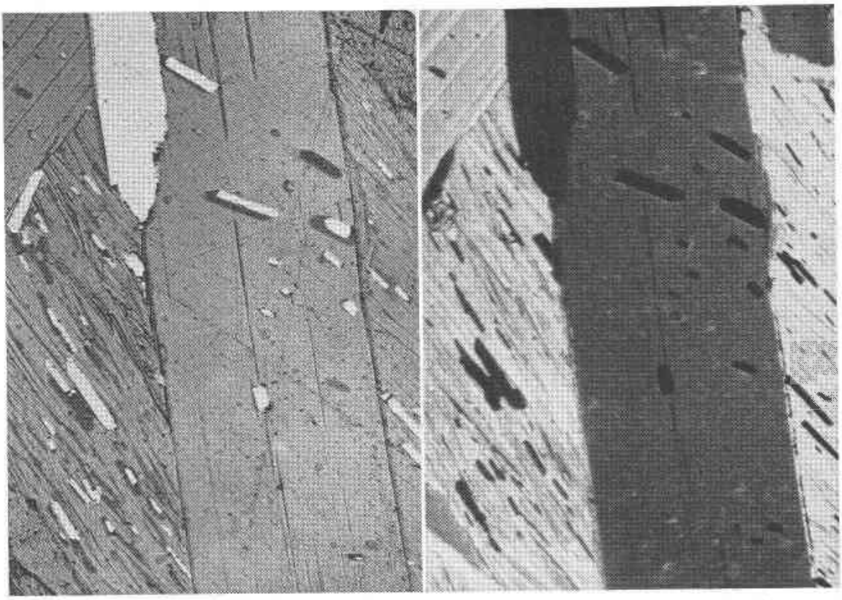

FIG. 3. Magnetite and muscovite. (left) Vertical illumination; (right) Transmitted light, crossed nicols. Magnification 150×.

SUMMARY

The technique described above produces high quality thinned polished sections. As the thinning technique is independent of the polishing process and does not require special equipment—with the exception of a slow lap, the technique is readily adaptable in different laboratories. Two difficulties of this method are (1) plucking and (2) damage to the polished surface. The former can be controlled by plastic impregnations and temperature regulation of the grinding media. The latter can be controlled by using slow lap speeds, fine abrasive sizes, and gentle grinding technique.

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AN APPARATUS FOR HAND-PICKING MINERAL GRAINS

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Separation of pure samples of finely powdered (−50 to +200 mesh, A.S.T.M.) minerals from a mixture involves the tedious process of hand-picking under a binocular microscope. The apparatus described below (Fig. 1) makes use of a soft plastic water-pistol as a suction device for collecting grains through an intravenous needle and polyethylene tubing into a glass vial. Both hands are used in the operation, which consists of segregating grains with a needle held in one hand and collecting them with the apparatus held in the other. This speeds up the process and lessens the strain inevitable in conventional hand-picking procedures.

Making the Apparatus

The following components, all of which are readily available, are required to make up the apparatus: (1) a soft plastic toy water-pistol, or alternatively a polyethylene bottle used for nasal sprays, (2) an intravenous needle, 18 or 19 gauge and two inches long, (3) a 3-inch length of polyethylene tubing with a 0.1 inch bore, commonly found in polyethylene wash bottles, (4) a small glass vial with hard plastic cap, and (5) a hard rubber check valve of the type used in rubber pressure or vacuum bulbs.

Two holes with diameters slightly less than those of the rubber valve at A and the plastic cap of the vial at B (Fig. 1) are punched into the water-pistol. The holes can easily be made with the tip of a glass rod of suitable diameter. Two holes are drilled into the plastic cap of the vial (C); the larger to take the polyethylene tubing, and the smaller to allow for the evacuation of air from the vial when using the apparatus. The hub of the intravenous needle is cut off, and the pointed end ground to a 45° angle with a narrow sharp tip.

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