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RAPID PREPARATION OF POLISHED THIN SECTIONS FOR CATHODOLUMINESCENCE STUDY OF CARBONATE ROCKS

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ABSTRACT

Polished thin sections of carbonate rocks for use in cathodoluminescence studies should have a minimum of surface irregularities and should render a clear image of high optical resolution. Rock chips are prepared by grinding with 600-grit silicon carbide and then polishing with 5 μm alumina. After cementing the chips to glass slides with high-temperature epoxy, they are trimmed, ground to approximately 30 μm with 800-grit silicon carbide and polished with 6 μm diamond paste. Final polishing is accomplished in two stages using 0.3 and 0.05 μm alumina. The sequence of abrasives, though important, is not as critical to the rapid, economical production of the polished thin sections as are the techniques of fabrication. The method described here is particularly suited to use by small laboratories not equipped with automatic polishing equipment.

Keywords: polished thin sections, cathodoluminescence, carbonate rocks.

SOMMAIRE

La surface des lames minces polies de roches carbonatées à étudier par cathodoluminescence doit présenter un minimum d'irrégularités de surface et donner une image nette de haute résolution optique. On prépare l'échantillon de roche en égrisant au carbure de silicium (granulométrie 600) et en polissant avec de la poudre d'alumine (5 μm). Une fois le bloc collé à une lame de verre par une résine epoxy de haute température, il est taillé, égrisé à environ 30 μm avec de la poudre de carbure de silicium (granulométrie 800) et poli à la pâte de diamant (6 μm). Le polissage final se fait en deux stades avec de la poudre d'alumine à granulométrie plus fine (0.3 et 0.05 μm de diamètre). L'ordre d'utilisation des abrasifs, quoique important, est moins critique pour la préparation rapide et économique des lames que ne le sont les techniques employées. Cette méthode convient particulièrement bien aux petits laboratoires qui ne possèdent pas l'outillage de polissage automatique.

(Traduit par la Rédaction)

Mots-clés: lames minces polies, cathodoluminescence, roches carbonatées.

INTRODUCTION

The advantages of polished thin sections over conventional thin sections for petrographic studies have been well documented (Amstutz 1960, Moreland 1968, Woodbury & Vogel 1970, Allman & Lawrence 1972). With respect to cathodoluminescence (CL), the quality of the CL image is dependent upon the quality of the specimen surface: the better the finish, the sharper the resolution of the CL image (Kopp 1981). Since microphotography is used universally in conjunction with CL studies (Sippel & Glover 1965, Meyers 1974, 1978, Ebers & Kopp 1979, Kopp 1981, Pierson 1981), and since "documentation of CL phenomena demands colour photography" (Nickel 1978), clear imaging with the best possible optical resolution is desirable.

The sequence of abrasives employed in making polished thin sections is fairly standard and involves the use of either increasingly finer-sized diamond pastes or diamond paste followed by fine alumina polishes. The methods by which the abrasives are applied and the time spent at each stage of the procedure are, in our experience, more critical to the production of good polished thin sections than is any unique sequence of abrasives.

The technique described here was developed to make polished thin sections of clean carbonates for standard petrographic and CL studies. As a large number of samples were needed in a limited time, methods requiring long polishing cycles (*e.g.*, Spray 1970) were deemed unsuitable. The technique has not been applied to microprobe, TEM or fluid-inclusion work, where double polishing and the elimination of all relief may be more critical.

PREPARATION

Carbonate rock chips of appropriate size are prepared by grinding on one side with 600-grit silicon carbide on a cast iron lap until saw marks are removed, followed by grinding on a glass plate, also with 600-grit silicon carbide, for about a minute. The chip is then ground on a glass plate for three to five minutes using 5 μm Polishing Alumina No. 1 (liquid); this step is optional but it enhances work by trans-

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TABLE 1. SUMMARY OF STEPS FOR MAKING POLISHED THIN SECTIONS

Step	Stage	Materials
Preparation		
	Stage 1	600 grit silicon carbide cast iron lap/water
	Stage 2	600 grit silicon carbide glass plate/water
	Stage 3	5 μm Polishing Alumina No. 1 (liquid)/ glass plate
Rough Polishing		6 μm diamond paste/nylon cloth/ Hyprez OS or kerosene lubricant
Final Polishing		
	Stage 1	0.3 μm Polishing Alumina No. 2 (liquid) - (mixed three parts by volume of distilled water to one part alumina liquid) Texmet® (unperforated) cloth
	Stage 2	Gamma Alumina, 0.05 μm liquid (mixed as above) Microcloth®

*Texmet® and Microcloth® are registered trade names of Buehler Ltd., Evanston, Illinois

mitted light. The *entire surface* of the glass plate should be utilized during grinding to minimize the likelihood of wedging of the rock slice.

The polished surface is cemented with high-temperature epoxy to a frosted petrographic slide, and excess material removed by a diamond trim saw and carbide grinding wheel. After cementing, samples are ground to the desired thickness (usually 30 μm) with 800-grit silicon carbide on a glass plate. Alternatively, they can be ground using a coarser grit size and subsequently smoothed with 800 grit.

POLISHING

The sequence of abrasives employed (Table 1) is only a slight modification of that described by Woodbury & Vogel (1970), but there are some important differences with respect to the method of application. For rough polishing, the slide is placed on the lap and held by an even but very light pressure of the fingers. The lap is rotated at 155 r.p.m. for about 5 minutes. The slide should be turned 180 degrees fairly frequently (about every 30 seconds) so that the flat surface of the thin section is maintained (E.E. Foord, pers. comm. 1983). The slide will develop a matte or glossy surface. It is important not to underpolish at this stage, yet use of a high lap-speed, such as that suggested by Moreland (1968), is not recommended, because it may result in fracturing of the crystals and the development of massive false cleavage in carbonates.

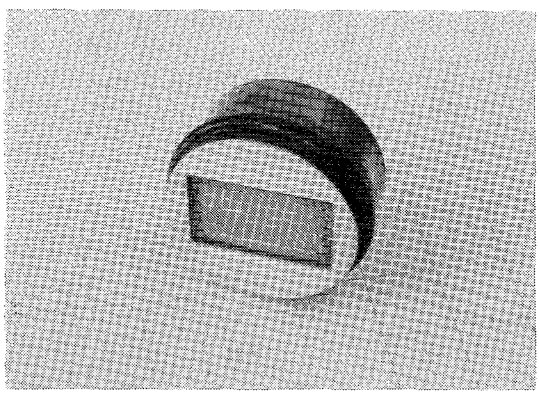

FIG. 1. Brass slide-holder machined on one side to accommodate a standard petrographic slide (46 × 27 × 1 mm).

All abrasives must be completely removed from the sample at each stage of the procedure. Satisfactory results can be obtained by using a soft camel's hair brush, warm water and detergent, preferably followed by rinsing in water in an ultrasonic cleaner.

For Stage 1 of the final polishing, slides are inserted into "home-made" brass jigs (see Addendum) and polished on a Vibromet polisher for about 30 minutes with the vibration setting at 4. Stage 2 is done on a conventional brass lap covered with Microcloth®. The slide is held very lightly with a Buehler AB petrographic slide holder, and the lap rotated at 155 r.p.m., for 2–3 minutes. (Should a Vibromet or similar polisher not be available, Stage 1 can also be done in this manner, using the appropriate cloth and polishing time.)

DISCUSSION

A high-quality polished thin section provides a surface on which irregularities are minimized and optical resolution is optimal. Because prolonged polishing of carbonates can cause plucking and hence relief, it is necessary to attain a balance between the highest polish possible and the retention of all constituents.

Spray (1970) described a four-stage final polishing technique that utilizes only successively finer-sized diamond abrasives (6, 3, 1 and 0.25 μm); he recommended a lapping time of 60 minutes per abrasive cycle. For carbonates, this was not as satisfactory as the method we describe. As well, such a time-consuming procedure is not practical, especially if large numbers of thin sections are required quickly. According to Taggart (1977), the use of exceptionally fine-grained polishing oxides will produce relief and may introduce contamination. Such problems were not encountered in this study.

The major differences between our technique and that of other workers are the method of holding the slide and the use of the Vibromet polisher, differences we believe to be critical to the *rapid* production of polished thin sections of carbonate rocks. Several specimens were polished using a semi-automatic polisher throughout, but problems with wedging and relief were encountered. Whereas manual methods are more tedious than automatic ones, the end product renders the extra effort well spent. In support of this, Barber (1981) recommended not only that specimens be hand-held, but also that stationary craft paper, rather than a rotating lap, be used as a polishing surface. The use of aluminum jigs in the Vibromet does not produce as satisfactory results as brass jigs, owing to the significant difference in weight between the two types of holders.

Our technique was employed in the preparation of more than 250 polished thin sections for CL studies (Mugridge 1981). It combines advantages of both automatic and hand-held methods, and, by its application, high-quality polished thin sections of carbonates can usually be produced fairly rapidly by a person with limited experience in making thin sections. Equipment required, except for the brass jigs, is basic to most geological laboratories, and the cost is minimal. Certainly, there is an art involved in making a good polished thin section, but such an art is impossible to develop without the benefit of reliable basic techniques.

Addendum

Slide holders (Fig. 1) of two sizes, 36 mm thick, 64 mm diameter and 30 mm thick, 72 mm diameter, were employed. Each holder weighs approximately 1 kg. They are of solid brass machined on one side to hold a petrographic slide 46 × 27 × 1 mm, so that the surface of the slide is flush with the surface of the brass. The holders were machined at a cost of $20 each. The 30-cm-diameter Vibromet can accommodate five or six brass jigs at one time.

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