

neighbourhood in 1832–3. In any event, the proximity of the date of publication to the date of discovery seems to preclude the existence of an earlier account.

It would appear, therefore, that in his letter to von Leonhard, Kämmerer was merely quoting from the article that had appeared in *Gornyi Zhurnal* some 4½ months earlier, without giving any reference—as was then common. The discoverer of volkonskoite must therefore remain unknown, at least for the present—a conclusion also reached by Pustovalov in 1928, but completely overlooked in the interim.

In connection with volkonskoite it is interesting to note that a grass-green clay, described in virtually identical terms to volkonskoite and discovered in Sweden in 1782, was analysed by Hisinger in 1815 and found to have 10% Cr<sub>2</sub>O<sub>3</sub>. It seems highly likely that this material, although somewhat aluminous, contained a considerable proportion of volkonskoite. Had a 1:1 mineral been present the colour would probably have been blue (Maksimovic and White, 1973); moreover, the USSR material underlies cupriferous sandstone (Chukhrov, 1955) and the Swedish clay was found in a copper mine (Hisinger, 1815).

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#### REFERENCES

- Anon. (1830) *Gorn. Zh., Mosk.* Part IV, 261–7.  
 Berthier, P. (1833) *Ann. Mines*, 3, 39–62.  
 Chukhrov, F. V. (1955) *Kolloidy v Zemnoi Kore* [Colloids in the Earth's Crust]. *Izd. Akad. Nauk SSSR*, Moscow, p. 561.  
 Helm, F. G. (1832) *Bull. Soc. Imp. Nat. Moscow*, 4, 347–91.  
 — (1833) *Ibid.* 6, 73–125.  
 Hey, M. H. (1955) *An Index of Mineral Species and Varieties Arranged Chemically*. 2nd Edn. British Museum (Natural History), London, p. 640.  
 Hisinger, W. (1815) *Afhandl. Fys. Kemi Mineral.* 4, 350–2.  
 Kämmerer, A. (1831) *Jahrb. Mineral. Geogn. Geol. Petrefakt.* 2, 420.  
 Maksimovic, Z., and White, J. L. (1973) *Proc. Int. Clay Conf. 1972*, CSIC, Madrid, 61–73.  
 Nemeč, E. (1981) *Clay Minerals*. Akademiai Kiado, Budapest, p. 173.  
 Pustovalov, L. V. (1928) *Trudy Inst. Prikl. Mineral.* No. 36.  
 Ross, C. S., and Hendricks, S. B. (1945) *US Geol. Surv. Prof. Pap.* 205-B, p. 28.  
 Strunz, H. (1966) *Mineralogische Tabellen*. 4th Edn. Akademische Verlagsgesellschaft, Leipzig, p. 391.

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## A one-stage precision polishing technique for geological specimens\*

HIGH-QUALITY flat polished surfaces on geological specimens for reflected light, microprobe, or cathode luminescence studies have always been difficult to achieve quickly and simply. The most common polishing technique is to use diamond compounds in decreasing grain sizes involving up to five or six changes of polishing grade. For specimens of moderate hardness each grade may

need to be used for several hours followed by meticulous cleaning prior to using a finer grade. This paper outlines a technique that requires only one aluminium-oxide polishing stage with a total polishing time only a fraction of that of conventional diamond techniques but the standard of polish meets the highest standards required.

The technique was first developed using the Kent Mk II polishing machine but the method and times given here are for the Buehler Ecomet III and the

\* Read on 27 April 1983

Buehler Whirlimet petro-thin attachment. However, any polishing machine with a moving sample holder would be suitable for this technique. The Buehler Ecomet III has an 8" lap with variable speed up to 500 r.p.m. and the Petro-thin attachment is a motorized counter-rotating specimen holder able to hold three thin sections or three ore mounts. The polishing cloths used are low nap textile cloths such as 'Texmet' (Buehler) or PSU (Engis), adhesive-backed cloths available for all lap diameters. The abrasive used is 0.3  $\mu\text{m}$  aluminium oxide readily available from abrasive and polishing materials suppliers.

The technique is best employed on thin sections rather than resin embedded blocks. This is because the problems of plucking and mineral deformation during the polishing stage are less evident in thin sections than in blocks because of the surface impregnation effect of the mounting medium. With low viscosity resins such as Epo-Tec 301 and Petropoxy 154 the amount of penetration into the rock chip is proportional to the porosity of the specimen. Therefore, friable specimens, or those more likely to pluck during polishing, will acquire a higher degree of impregnation, which usually results in a 'well behaved' surface during polishing. Where the finished thickness is not critical, specimens can be left at a maximum thickness of 0.5 mm thereby leaving ample stock for re-polishing.

Before its polishing stage the section should be lapped to an F600 grade finish. If it is to be polished down to 30  $\mu\text{m}$ , then the thickness at this stage should be between 40 and 80  $\mu\text{m}$  depending on specimen hardness. Determining the amount of stock removal for a given specimen is essentially a matter of experience. Initially the cloth should be charged with a concentrated suspension of 0.3  $\mu\text{m}$  aluminium oxide plus distilled water (approx. 1 + 1 by volume) and, after ultrasonic cleaning, the specimen should be loaded with the maximum weight recommended for the machine used and set in motion at the machine's maximum speed.

A distilled water drip-feed of approximately one drop per second should be directed as near as possible to the centre of the lap during the entire polishing process. Once the lap is up to maximum speed a slurry should be maintained on the cloth for between 30 and 45 seconds by dripping the aluminium-oxide distilled water mix on to the centre of the lap. The lap can then be left running with just the water drip for 10–20 minutes. This has the effect of clearing the lap of slurry and the polishing is continued by the aluminium oxide left impregnating the cloth. The cycle of slurry to just impregnated cloth should be repeated at 10–20 minute intervals if necessary. A simple rule of thumb would be:

Coal	1 cycle
Limestone	2–3 cycles
Basalt/Sandstone	3–4 cycles
Granite/Quartzite	4–5 cycles
Harder rocks	> 5 cycles

The optimum for a given specimen can only be ascertained by regular checking under the reflected-light microscope but once the decision is made that the specimen is on its last cycle then the water flush part of the cycle can be left running for up to 2 hours for hard specimens with no detrimental effects.

The essence of the technique is therefore that the specimen is given a rapid 'slurry' polish which gradually changes as the slurry is washed away to the standard polishing action of the impregnated cloth. The purpose of the 'slurry' stage is to give a rapid polishing action but it should not be used for too long otherwise the specimen may show high relief. The impregnated cloth gives the final high-grade minimal relief finish. Additional advantages are gained by using the continuous water flush during polishing as this helps to reduce the problems of airborne contamination as well as keeping the lap and specimen temperature low, never exceeding 35 °C, which is essential when polishing for fluid inclusion work.

The standard of polish achieved can be judged in fig. 1. Fig. 1a and b shows transmitted- and reflected-light photomicrographs respectively of a metatextite with biotite (B), garnet (G), quartz (Q), plagioclase (P), and magnetite (M) all in contact with each other yet showing a high-quality relief free polish. The total polishing time was 1½ hours with four cycles. Fig. 1c shows the area marked on Fig. 1b with biotite (B), garnet (G), plagioclase (P), quartz (Q), magnetite (M), and zircon (Z) all in close proximity. The reflected-light crystal boundaries are in places smaller than the true crystal size as shown in transmitted light yet the 'wedged' contacts are intact and free from plucking, a fragile detail that is normally difficult to preserve especially in micas. Fig. 1d shows exinite, inertinite, and fusinite in a polished coal section. Total polishing time 10 minutes with one cycle.

Mineral mounts polished by this technique and used as calibration standards for the Oxford University Electron Microprobe have themselves been probed to see if contamination from the aluminium oxide has occurred. None was detected. The author is yet to investigate fully the problems associated with polishing water-soluble or hygroscopic specimens, but preliminary trials have shown that a similar standard of polish may be achieved by using a low viscosity spirit, such as

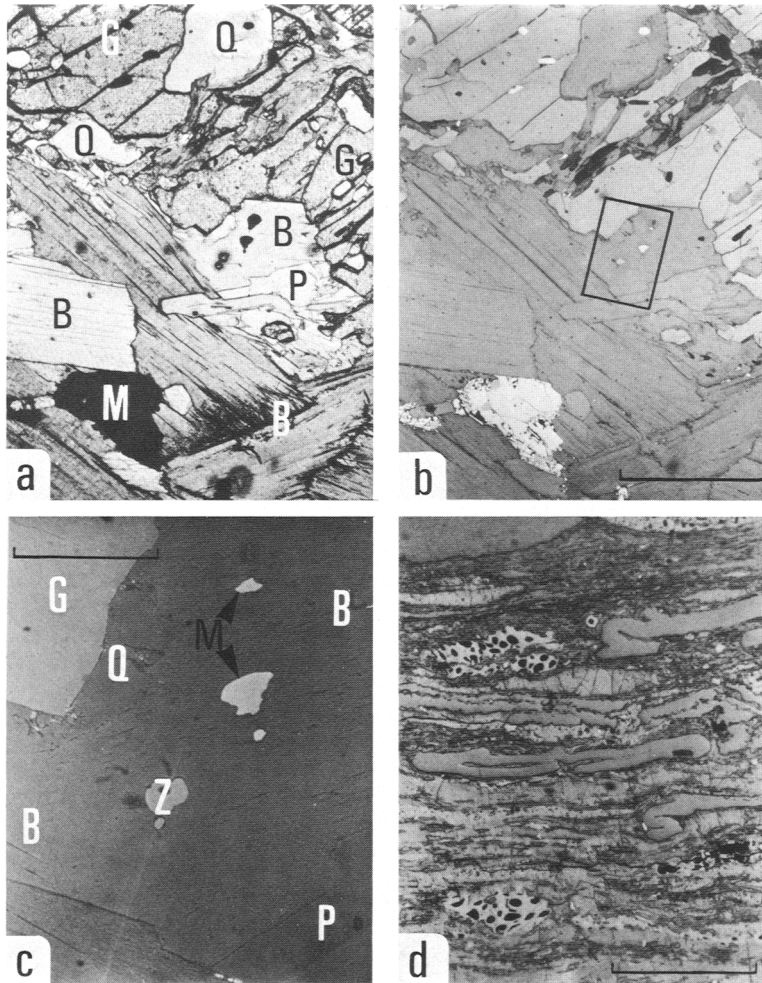


FIG. 1 (a-d). (a and b). Transmitted- and reflected-light views respectively of a metatexite. Scale bar 1 mm. (c). Area shown on fig. 1(b). Scale bar 0.2 mm. (d). Coal, scale bar 1 mm. For key see text.

paraffin or absolute alcohol, in place of distilled water.

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