

## A staining technique for barium silicates in thin section

BARIUM aluminosilicates (celsian, hyalophane, and rare cymrite) have recently been discovered in association with the Aberfeldy Ba,Zn,Pb deposit (Coats *et al.*, 1981), which occurs in Middle Dalradian garnet-amphibolite facies rocks (Moles, 1983) in Perthshire, Scotland. The deposit is hosted by a muscovite schist containing cryptic Ba enrichment in the form of barian muscovite. Celsian and hyalophane also occur in stratigraphically equivalent uneconomic mineralized horizons elsewhere in Scotland, e.g. in Glen Lyon, Perthshire (M. J. Gallagher, pers. comm., 1981). Such barium minerals may thus indicate more generally the nearby presence of base metal sulphides and baryte. A quick and inexpensive method of detecting Ba in feldspars, micas, and other silicates would therefore be a useful tool in mineral exploration.

Staining techniques can be easily employed to distinguish between numerous white or near-white minerals (Hosking, 1957), both in hand specimen and, more usually, in thin section. One of the commonest is that used to distinguish plagioclase from alkali feldspar, quartz, cordierite, and feldspathoids (Hutchison, 1974). This method uses the potassium or sodium salt of rhodizonic acid, which stains plagioclase ( $\text{NaAlSi}_3\text{O}_8$ - $\text{CaAl}_2\text{Si}_2\text{O}_8$ ) bright red, provided the (etched) rock has previously been immersed in barium chloride. This replaces the calcium in the plagioclase structure with barium, and is effective if there is at least 3% of the calcium end-member present. It is therefore to be expected that feldspars already containing Ba will stain if the chloride immersion stage is omitted, and that barium-free feldspars will not. An isomorphous solid solution series exists between orthoclase ( $\text{KAlSi}_3\text{O}_8$ ) and the barium feldspar celsian ( $\text{BaAl}_2\text{Si}_2\text{O}_8$ ), with a composition gap between 65 and 80% celsian; feldspar with 15-65% of the celsian component is called hyalophane (Fortey and Beddoe-Stephens, 1982). By analogy, any feldspar with more than 3% celsian component should stain, since Ba replaces Ca 1:1. Staining is a more sophisticated test than Portable Induced Fluorescence Analysis (Grout and Gallagher, 1980), which only reveals the presence of Ba within a rock, and does not identify its host mineral.

To test this idea that barian minerals should stain directly with rhodizonate reagent, eleven uncovered thin sections were prepared. Five con-

tained celsian from the Aberfeldy deposit, one as a vein and four disseminated in metasediments. A barium-free plagioclase from Skye provided a check that the stain only reacts with barian minerals. To determine whether mica merely takes up stain along the cleavage, a single thin section (to eliminate variations in technique) was made from two micaceous rocks; one from Glen Lyon, Perthshire, containing barian muscovite and hyalophane, the other a barium-free sample of Moine Schist. Several crystals of the barium zeolite, harmotome ( $\text{BaAl}_2\text{Si}_6\text{O}_{16} \cdot \text{H}_2\text{O}$ ), from Strontian, Argyllshire, and various barium-free calcium zeolites of unknown provenance: chabazite,  $\text{CaAl}_2\text{Si}_4\text{O}_{12} \cdot 6\text{H}_2\text{O}$ ; heulandite,  $(\text{Ca}, \text{Na}_2)\text{Al}_2\text{Si}_7\text{O}_{18} \cdot 6\text{H}_2\text{O}$ ; and stilbite,  $(\text{Ca}, \text{Na}_2, \text{K}_2)\text{Al}_2\text{Si}_7\text{O}_{18} \cdot 7\text{H}_2\text{O}$ , were mounted in epoxy resin and ground down to provide an etchable surface. Three samples of baryte ( $\text{BaSO}_4$ ) from Aberfeldy, Castleton (Loch Fyne, Argyllshire) and Leadhills, Lanarkshire, were included, although baryte is very difficult to etch. The identification of these barian minerals was confirmed by X-ray diffraction except in the case of the Glen Lyon sample, which was analysed by microprobe and found to contain about 10% BaO (N. J. Fortey, pers. comm., 1983). The sections were etched over 35% hydrofluoric acid for 15-30 seconds (60 for baryte) and then immersed in fresh rhodizonate reagent (a saturated solution of the sodium salt) for 5 minutes (10 for baryte). Surplus stain was then rinsed off with deionised water and the slide dried and covered in the normal way.

The barium feldspars all stained as predicted; the barium-free plagioclase did not stain. This method thus successfully distinguishes celsian and hyalophane from other feldspars. The barium-containing half of the two-lithology mica section also stained. Care must be taken here because all micas will adsorb the stain along the cleavage after prolonged immersion; truly barian mica stains between the cleavage planes as well. The crystals of harmotome became a pale pink; the technique should therefore also work on other barium silicates which were unobtainable for this experiment, for instance the hydrated barium silicate, cymrite ( $\text{BaAl}_2\text{Si}_2\text{O}_8 \cdot \text{H}_2\text{O}$ ). The calcium zeolites were unaffected. Apparent staining of the baryte was in fact due to infilling of pits and cracks; etching problems make

this technique applicable only to more soluble barium minerals.

An attempt was also made to stain hand specimens, but this was less successful; the 15 mm-wide coarse-grained celsian vein etched well and became pink and friable when treated with the stain, but the fine-grained rocks with disseminated celsian did not stain. This result, plus the hazard of carrying hydrofluoric acid in the field, makes the technique unsuitable as a portable field test, but a small mobile laboratory could easily be set up for rapid identification of barium silicates.

*Acknowledgements.* Samples for this experiment were kindly donated by B. R. Bell, N. J. Fortey, M. J. Gallagher, A. J. Hall, I. M. Samson, and R. C. R. Willan. Thin sections were expertly prepared by P. Wallace and the epoxy mounts by J. Gilleece. This work was done

while the author was in receipt of a NERC/IGS Case studentship.

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[Manuscript received 16 November 1984]

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KEYWORDS: barium silicates, staining.

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