

## SHORT COMMUNICATIONS

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### The origin of peralkaline obsidians: a discussion

THE origin of pantellerites and peralkaline trachytes (Bailey and Macdonald, 1975) continues to be a subject of heated debate; almost certainly because their genesis is controlled by both crystal-liquid and liquid-vapour equilibria.

Many of the volcanoes producing peralkaline silicic lavas have suffered caldera collapse. Gibson (1972) and Barberi *et al.* (1975) showed that in two Ethiopian volcanoes, both with caldera formation associated with large ignimbrite deposits, there are chemical differences between the pre- and post-caldera lavas that cannot be reconciled with crystal-liquid equilibria processes. The eruption of these ignimbrites must have entailed extensive loss of volatiles from the high-level magma reservoirs that clearly were 'open systems'. Gibson (1972) suggested that the loss of a 'halide-rich volatile phase' modified the composition of the remaining magma and hence of the post-caldera flows. This supports the plea of Bailey and Macdonald (1975) for pantellerite genesis in an 'open system'. We endorse their plea and suggest that any magmatic system involving high concentrations of volatile components is likely to be an 'open' one; moreover, these conditions are more typical of the closing stages of fractional crystallization.

Bailey and Macdonald (1975) calculated the reduced major axis equations (Till, 1973) relating the abundances of pairs of the elements Zn, Rb, Nb, Yt, Zr, F, and Cl in fifteen Eburru obsidians. Generally, these lines do not include the origin at the 95 % confidence limit. They contrast these observations with those of Weaver *et al.* (1972) who, using mixed crystalline-vitreous suites, noted that for seven rift volcanoes, the abundances of pairs of residual elements (Ce, La, Nb, Zr) from any one volcano could be related by linear equations that passed very close to the origin. These different observations are simply explained by the different rocks studied in the investigations. We intentionally studied basaltic, mugearitic, and trachytic compositions in addition to the pantellerites. In contrast, Bailey and Macdonald studied only the most silicic compositions and four of their samples contained more than 2500 ppm Zr and are richer in residual elements and volatiles than any of the 173 rocks studied in our investigation. Indeed, these four rocks may form a separate group from the remaining Eburru samples and the reduced major axis equations for the remaining eleven rocks alone generally include the origin at the 95 % confidence limits; the exceptions involve Zn, the anomalous behaviour of which is also referred to by Bailey and Macdonald (1975). Variation within the less evolved members of the Eburru obsidian suite might thus be explained by solid-liquid equilibria in a 'closed system' and 'open system effects' need be postulated to explain only the four more-enriched rocks. At both

Fantale (Gibson, 1972) and Ma'Alalta (Barberi *et al.*, 1975) the rocks richest in the residual elements are largely post-caldera flows.

We suggest that the high Cl and F, characteristic of peralkaline magmas, is instrumental in making elements such as Zr, Nb, Y, Ta, Hf, U, and Th particularly incompatible by forming large complexes with them. This inhibits the substitution of these elements in the crystallizing phases. Cl and F must also reduce the viscosity of a silicate melt and facilitate more rapid and efficient fractional crystallization. Parental halogen-rich alkaline basaltic liquids might be produced by the partial melting of mantle containing a halogen-rich phase such as Ti-phlogopite or K-richterite.

We stress that laboratory and field investigations clearly indicate that a halogen-bearing vapour phase can seriously modify the composition of some peralkaline silicic and trachytic magmas, particularly those of more extreme compositions but these effects are not yet proven in the earlier stages of the genesis of these rocks, stages that appear to have been dominated by fractional crystallization.

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## A reply

WEAVER and Gibson suggest that if we omit our four samples that are richest in 'residual' elements, the remaining eleven samples 'might be explained by solid-liquid equilibria'. The only additional warrant they give for throwing away > 25 % of