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.

Acknowledgements: We thank D. K. Bailey and R. Macdonald for a pre-publication copy of their paper. A modified computer programme originally by R. Till is gratefully acknowledged.

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[*Manuscript received 2 May 1975, revised 5 June 1975*]

MINERALOGICAL MAGAZINE, DECEMBER 1975, VOL. 40, PP. 416–17

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

our data is that these four samples are richer than any of the 173 rocks (from 7 volcanoes) they have studied. But three of their seven volcanoes have *no* pantellerites of any kind so they are no measure for pantellerite analyses (this removes 3 volcanoes and 83 samples!). One volcano, Nasaken (Kenya), has 24 analysed rocks, of which 9 are designated pantelleritic *trachytes*, containing 'up to 20 % modal quartz' (Weaver *et al.*, 1972; reference list above); those of the 9 with more than 10 % quartz might perhaps have been called trachytic pantellerites, but they are still no yardstick for the vast majority of pantellerites, typified by those of Eburru, where 12 of our 15 samples have normative quartz in excess of 28 %. In the remaining 3 volcanoes there are 44 rhyolitic samples that may be directly comparable with ours from Eburru: 39 of the 44 come from only 2 volcanoes, the remaining 5 coming from Eburru itself. Apparently what is being proposed is that, compared with pantellerites from 2 volcanoes in Ethiopia, our highest 4 Eburru samples are abnormal, and should be left out!

Furthermore, they imply that the correlation analysis on eleven samples leaves only a Zn anomaly unexplained by solid–liquid equilibria. Even if they can ignore the Zn problem (which we cannot) the facts are these:

For the best correlated elements, F, Zr, and Rb, our analyses (using all fifteen samples) gave coefficients better than 0·994, their new correlation (on eleven samples) yields *inferior* correlation coefficients. Hence, the 95 % uncertainty limits on the intercepts are increased so as to include the origin, and Weaver and Gibson's objective is attained. But only at the expense of precision.

The only other highly correlated pair, using all fifteen samples, is Nb *v.* Yt (0·995). This correlation is slightly improved by using eleven samples (0·996) *but* the intercept does not include the origin at the 95 % confidence level! So this anomaly also persists.

Thirdly, even using only eleven samples the Rb distribution still demands a partition coefficient for Rb (between alkali-feldspar and liquid) of *zero*. Since the observed partition coefficients are $> 0{\cdot}3$, any fractionation of feldspar (and its Rb) must require an influx of Rb to the magma system from an external source, if Rb is to masquerade as 'residual' element.

In summary, we do not feel scientifically justified in ignoring > 25 % of our data merely to fit a hypothesis, which does not explain all the remaining data anyway.

We would like to clear up any misunderstanding about our use of the term 'open system'. We believe it to be self-evident that any volcanic system is 'open' to *losses* at the top. Our data require, however, that the Eburru magma system had to be open to *ingress* of volatile elements *at depth*.

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[*Manuscript received 5 June 1975*]