MAFIC AND ULTRAMAFIC XENOLITHS FROM THE KAO KIMBERLITE PIPE, LESOTHO

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Mantle xenoliths from the Kao kimberlite pipe include both spinel and garnet harzburgites and lherzolites, eclogites and a suite of discrete nodules which resemble the phase assemblages characteristic of xenoliths from many other South African kimberlite pipes (Rolfe, 1973; Nixon and Boyd, 1973; Boyd and Nixon, 1975; MacGregor, 1975). Similarly, the range of textures observed in the ultramafic xenoliths are comparable to those described by Boullier and Nicolas (1975).

Estimates of the temperatures and pressures of equilibration of the ultramafic xenoliths using the experimentally defined diopside-enstatite solvus (Mori and Green, 1976), and the Al_2O_3 solubility in enstatite (MacGregor, 1974) yield the following. The coarse grained granular, tabular and porphyroclastic textured samples form a roughly linear array of data points that is comparable to estimates of shield geothermal gradients and similar to gradients derived for other Lesotho xenolith suites. In general the granular textured samples are more deformed with increasing temperature and pressure. The most highly deformed, or mosaic textured, xenoliths have equilibrated at the highest temperatures (>1200°C) but do not form part of the linear array illustrated by the less deformed suite. Rather they form a separate population that cluster over a range of pressures (53 Kb to 80 Kb) in the temperature range from 1200°C to 1450°C. Discrete pyroxene xenoliths indicate minimum equilibration temperatures of 1400°C, and although no pressure estimates are available they are presumed to be comparable to that for the mosaic textured suite. The partition of Mg and Fe between coexisting clinopyroxene and garnet in eclogites suggest equilibration over a wide range of temperatures and pressures (Räheim and Green, 1974).

The mineral chemistry of the highly sheared, mosaic textured suite is distinctly different from the granular textured samples. The minerals from the mosaic textured xenoliths have lower Mg/Mg+Fe ratios and the pyroxenes and garnets have higher TiO_2, Na_2O and Al_2O_3, and lower Cr_2O_3 contents. Similarly the orthopyroxenes have higher and the clinopyroxene lower CaO contents reflecting their higher temperatures of equilibration. Comparable to other studies (Boyd and Nixon, 1975; MacGregor, 1975) the mosaic textured suite appears to be enriched in those components normally concentrated is basaltic liquids during partial melting of ultramafic compositions.

Mantle xenoliths from the Kao kimberlite pipe are very similar to other suites from northern Lesotho kimberlites. Of prime importance to further interpretive analysis is the observation that regionally two main populations of xenoliths are found. The first composed of essentially underformed samples, whose chemistry indicates that they are refractory residuates after, at least, one period of partial melting and which have equilibrated to the conditions defined by the ambient geothermal gradient. These xenoliths are truly 'accidental' and have a passive role with respect to the origin of kimberlites. The second population of xenoliths are highly deformed and may well have been in the process of deformation at the time of eruption (Kohlstedt and Goetze, 1974). Their chemistry indicates that they represent a portion of the mantle richer in the fusible components and hence are more 'primitive'. They have formed at higher temperatures and pressures and are associated with an 'inflection' or 'perturbation' of the anticipated geothermal gradient. The sheared xenoliths appear to the dynamically associated with kimberlite formation.

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