

LITHOPHILE TRACE ELEMENTS IN PERIDOTITE XENOLITHS FROM LASHAINE VOLCANO, TANZANIA

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Large ion lithophile trace elements have been determined in three xenoliths of garnet peridotite and a spinel peridotite, using isotope dilution techniques. The xenoliths occur in an ankaramite lava at Lashaine volcano in N. Tanzania, and they are closely associated with carbonatite. REE, Rb, and Sr have also been determined in pyroxenes and garnets separated from two of the garnet peridotites (BD730, BD738) and in primary phlogopite separated from BD738 using the same techniques as above.

The REE patterns, normalized to chondritic abundances, are of two distinct types. One garnet peridotite, BD730, has a flat, chondrite-like pattern, with about three times chondritic abundances, but with slight depletion in La, Ce, and Nd relative to the heavier rare earths. In this respect it resembles patterns for some oceanic tholeiites. The other two garnet peridotites (BD738, BD776) and the spinel peridotite (BD787) have more fractionated rare earth patterns with Ce/Eu ratios between 2 and 5. The light rare earths have maximum values 3-6 times chondrites but the heavy rare earths are as low as 0.4-0.1 times chondrites. The spinel peridotite shows the smallest concentration of REE as well as low Rb (1 ppm), and Sr (6 ppm). In contrast, BD776 contains 5 ppm Rb and 96 ppm Sr, and BD738 contains 3.8 ppm Rb and 41 ppm Sr.

In two garnet peridotites the separated garnet and chrome-diopside show heavy rare earth and light rare earth enrichment, respectively. However, these minerals in BD738 are approximately twice as enriched in total REE compared to BD730 garnet and clinopyroxene, and are also more enriched in Rb, and Sr. Titanium-rich phlogopite from BD738 contains 4540 ppm Ba, 660 ppm Rb, and 62 ppm Sr. It is enriched in Ba, and Rb but depleted in Sr, relative to phlogopite from Jan Mayen Island, for which a mantle origin has also been proposed. The phlogopite rare earth pattern shows light rare earth enrichment (up to 5.5 times chondrites) relative to heavy rare earths, which have sub-chondritic abundances. The Ce/Eu ratio of approximately 2.5 is within the range of this ratio for some of the xenoliths.

Assuming that the xenoliths represent residual mantle material, then REE distribution coefficients for pyrope-liquid and diopside-liquid allow an estimate of the REE characteristics of possible liquid in equilibrium with the garnet and chrome-diopside in BD730 and BD738. Within each xenolith, both these minerals indicate equilibrium with a melt strongly enriched in light relative to heavy rare earths, but both xenoliths could not have equilibrated with the same melt. BD738 minerals could have equilibrated with a liquid having up to 350 times chondritic abundances of some light rare earths, but these minerals in BD730 would only be in equilibrium with a liquid having approximately 150 times chondritic abundances for these elements. It appears that these two peridotites, and probably BD776 and BD787 show varying degrees of trace element depletion that could have resulted from one or several periods of partial melting.

The liquids theorized to be in equilibrium with BD730, and BD738 have REE patterns that are very similar to ankaramites and some carbonatites. In addition the absolute levels of REE enrichment in the liquid in equilibrium with BD738 minerals are similar to those found in highly alkaline rocks. This suggests that there may be a genetic link between the xenoliths, the host ankaramite, and the closely associated carbonatites i.e. the peridotites are not simply accidental xenoliths of upper mantle material. Although the fractionated rare earth patterns for some of the peridotites, as well as high Rb and Sr, may be the result of intergranular contamination from the host magma, it is equally possible that these features may reflect the presence of intergranular fluid in equilibrium with the high pressure xenolithic minerals (intergranular partial melt).

Trace element data for the peridotite minerals suggests that partial melting involving phlogopite would enrich the melt in Ba, Rb, K, Ti, and this mineral is probably the major source of these elements for very small degrees of partial melting. However whether the phlogopite is totally melted into the liquid phase or remains as a residual phase during small degrees of partial melting will be critical in determining the lithophile trace element content of the resulting magma. It appears probable that for degrees of partial melting greater than 1-3 percent, then melting of chrome diopside and garnet will determine the REE abundances in the melt phase.