REE determination in olivine by LA-ICP-MS: An analytical strategy and applications

C. V. STEAD*, E. L. TOMLINSON, B. S. KAMBER AND M. G. BABECHUK

Geology Dept., Trinity College Dublin, Dublin 2, Ireland (*correspondence: steadcv@tcd.ie)

Olivine is the most abundant mineral in the upper mantle, making up approximately 90% down to a depth of 410 km and it is one of the first crystals to form in crystalizing mafic magmas on both sides of the thermal divide. It also occurs as an inclusion in diamonds and in meteorites. Thus olivine offers huge, untapped potential for improving our understanding of magmatic and metasomatic processes, for example in addressing the long-standing question over the origins of the sinusoidal rare earth element (REE) patterns seen in some harzburgitic garnets. To date, there have been relatively few studies of trace elements in olivine, in particular data is lacking for REEs. The scarcity of REE data reflects the analytical difficulty associated with analysing concentrations in the low ppb range and of excluding the effects of LREE contamination [1].

We have developed an analytical procedure for determinaton of REE in olivine by LA-ICP-MS. Using this method we have achieved limits of determination at sub-ppb levels and accuracies of ~5%. Natural partition coefficients calculated using our determined olivine compositions agree with experimental [2] and theoretical [1] values, indicating that the measured REE are structurally bound in the olivine crystal lattice, rather than being present as micro-inclusions.

We investigate the global range of REE contents in olivine using samples from mantle, metamorphic and magmatic settings as well as meteoritic olivine, and discuss the observed trends. The olivines show uniformly low and restricted LREE abudances, while the HREE vary from low concentrations in meteoritic samples, through variably enriched peridotitic olivine to high HREEs in magmatic olivines. Compiling this REE data for olivine aids the constraining of global REE abundances and enrichment patterns.

[1] Lee et al. (2007) *Geochim. Et Cosmochim. Acta*, **71**, 481-496. [2] McDade, et al. (2003) *Phys. Earth Planet. Int.* **139**, 129–147.