Mineral/melt partitioning of U and Th during partial melting of garnet pyroxenite

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The range of isotopic variability found in ocean island basalts (OIB) points to the presence of several distinct components in their source regions. At least one of these components is thought to comprise mafic material such as recycled oceanic crust. Many ocean islands are characterized by silica-poor, alkalic lavas that Hirschmann et al. [1] showed can plausibly be produced by partial melting of silica-deficient garnet pyroxenite. Here we place additional constraints on this hypothesis through an experimental determination of the mineral/melt partitioning of U and Th during partial melting of garnet pyroxenite. Our results demonstrate that the U-Th systematics of most OIB can be explained through mixing of partial melts of peridotite and pyroxenite.

Experiments were carried out in a piston-cylinder device at 2.5 GPa and 1450 °C on a synthetic basalt with the composition of a 21% partial melt of the silica deficient garnet pyroxenite MIX1G of Hirschmann et al. [1]. The major element compositions of coexisting clinopyroxene, garnet and silicate melt were determined by electron microprobe and the concentrations of U and Th by ion microprobe.

The garnet/melt and clinopyroxene/melt partition coefficients determined in this study are at the high end of the range of previously published partitioning data. They exceed partition coefficients predicted by the model of Salters et al. [2] by up to three orders of magnitude. Dynamic melting calculations for peridotite and MIX1G pyroxenite at depths of 100 km, using these partition coefficients and a moderate upwelling rate of 5 cm/yr, reveal that mixing trajectories between peridotite and pyroxenite melts can account for the U-Th isotope systematics of most OIB rocks. These same calculations can explain the Sm/Nd systematics of many OIB as well. Our results support the conclusion of Hirschmann et al. [1] that partial melting of silica-poor garnet pyroxenite may play a role in the generation of nepheline-normative OIB.

References

[1] Hirschmann M.M., Kogiso T., Baker M.B., and Stolper E.M. (2003) *Geology* **31**, 481-484.

[2] Salters V.J.M., Longhi J.E., and Bizimis M. (2002) *Geochem Geophys Geosys* **3**, 2001GC000148.