European Mineralogical Conference
Vol. 1, EMC2012-266, 2012
European Mineralogical Conference 2012

The lead isotope composition of abyssal peridotites

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Oceanic basalts are widely used as probes of mantle composition, on the assumption that mantle melts inherit the isotopic composition of their source. Recent evidence suggests that this is often not the case, and that during mantle melting, more 'enriched', relatively fertile mantle lithologies contribute more to melting [e.g. 1]. If so, then the upper mantle may be significantly more 'depleted' than is generally assumed. This hypothesis can be tested by analysing abyssal peridotites, which to some extent represent residues of the melting process beneath mid-ocean ridges.
Previous studies have shown that Nd and Hf isotope compositions of clinopyroxenes from abyssal peridotites overlap with MORB data but extend to more radiogenic values [2-6]. This observation is consistent with preferential melting of an enriched component with low 143Nd/144Nd and the existence of a 'hidden' refractory mantle component with high 143Nd/144Nd, which contributes less to melting. A key question is whether abyssal peridotites contain a refractory component with unradiogenic Pb, which might partly explain the fact that the major Earth reservoirs apparently have Pb isotope compositions that lie to the radiogenic side of the Geochron [7]. Pb isotope measurements of abyssal peridotites are challenging, due to their low Pb concentrations and high degrees of alteration. The few existing Pb isotope data suggest that at least some abyssal peridotites may have highly unradiogenic Pb isotope compositions [8,9].

We are carrying out a Pb isotope study of abyssal peridotites, ranging from relatively fertile lherzolites to highly depleted harzburgites, from different locations within the Pacific, Atlantic and Indian Oceans. Laser-ablation ICP-MS analyses of individual mineral phases show that orthopyroxene and clinopyroxene have similar Pb concentrations (20-80 ppb). Spinel contains significant amounts of Pb (70-200 ppb), which may be contained in small sulphide inclusions. Spinel is generally unaltered and easily separated, but rarely exceeds 3% by volume. In contrast, large crystals of orthopyroxene are abundant in most samples, but often altered along internal cracks. Although much of the Pb in abyssal peridotites may be hosted in sulphides, these phases as well as clinopyroxene may have formed during later melt impregnation in some samples. Similarly, orthopyroxene may crystallise during melting reactions, and therefore may not yield the true Pb composition of melting residues.
We will use mineral separation and sequential acid leaching methods to determine the Pb, Nd and Hf isotope compositions of different mineral phases. Pb isotope ratios and concentrations will be determined on <10 ng of Pb using a 202Pb-205Pb double-spike method.

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