In situ Pb isotope analysis of MORB melt inclusions and the origin of garnet signatures

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The Pb isotopic composition of basalts can be a sensitive detector for an altered oceanic crust component in mantle source regions, because of potential increase in U/Pb ratios during alteration (e.g. Hart and Staudigel, 1989) and consequent HIMU signatures. This approach can be used as a test for the 'garnet pyroxenite hypothesis' for the origin of garnet signatures in MORB (Hirschmann and Stolper, 1996). Indeed, Prinzhofer *et al.* (1989) observed that MORB glasses (EPR, 12°50'N) with light rare earth element (*LREE*) enrichment possess Pb isotopic compositions shifted toward HIMU relative to *LREE*-depleted ones, and ascribed the correlation to melting of the 'marble cake mantle'.

We have developed techniques for in-situ Pb isotope analysis of silicates and sulphides using a Cameca IMS 1270 ion microprobe (Layne and Shimizu, 1998; Layne and Shimizu, this volume). With a mass resolving power (MRP) = 3500, interferences of major element-based molecules (e.g. $^{23}Na^{40}Ca^{27}Al^{28}Si_3{}^{16}O_2$ on 206), heavy *REE* (*HREE* and Hf double oxides (e.g. $^{176}Lu^{16}O_2$ on 208) and (*MREE*) triple oxides (e.g. $^{160}Gd^{16}O_3$ on 208) are adequately separated from Pb peaks and their effects on measured isotopic compositions are negligible. A 'sensitivity' value of ~20 cps/ppm/nA was obtained for Pb in basalt glasses. With a primary beam spot size of ~40 × 60 μm, replicate analyses of a basanite glass standard from Loihi (Garcia *et al.*, 1995) has produced precisions of ±0.14% (σ) for $^{207}Pb/^{206}Pb$ and ±0.18% for $^{208}Pb/^{206}Pb$. Mass fractionation was found to be less than 0.2%/amu.

A suite of high-Mg olivine-hosted primitive melt inclusions from a FAMOUS lava (ALV 519-4-1) displays large and systematic trace element variations which were interpreted to be produced by critical melting of depleted MORB source mantle (DMM) beginning in the presence of garnet (Shimizu, 1998).

Salient features of the results include:

(1) Pb ion intensities (and hence Pb concentrations) were found to be uniformly low and unrelated to *REE* abundance patterns, suggesting that exsolution of sulphide melt occurred prior to entrapment;

(2) Pb isotopic ratios (207/206 and 208/206) measured in *LREE*-enriched melt inclusions with garnet signatures (G-melts) display a total range of variations of more than 3% (from 2.028 to 2.091 for 208/206 and from 0.821 to 0.858 for 207/206), forming a quasi-linear array in a general direction from DMM to HIMU;

(3) *LREE*-depleted melt inclusions without garnet signatures (S-melts) form a tight cluster at one end of the G-melt array, farthest away from DMM;

(4) Isotopic compositions of the S-melts are similar to those of glasses from the same general area (e.g. Frey *et al.*, 1993).

References

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