European Mineralogical Conference
Vol. 1, EMC2012-592, 2012
European Mineralogical Conference 2012

Mantle chemistry revealed by osmium isotopes in sulphides from Mid-Ocean Ridge Basalts

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The decay of 187Re to 187Os potentially provides an exceptional tracer of chemical heterogeneities in Earth's upper mantle, and the radiogenic Os isotope compositions of many Mid-Ocean Ridge Basalts (MORB) have been taken to indicate the presence of recycled oceanic crust in their source [1]. Global data, however, indicates that nearly all MORB has been affected by seawater derived contamination [2]. Despite this the isotope signal of the mantle source can be accessesed in sulfide globules in MORB [2], which yield an isotope composition indistinguishable from that of abyssal peridotites (e.g. [3]), considered to be residues of mantle melting. The same MORB samples, clearly affected by seawater contamination, show evidence for fractionation of incompatible elements during magmatic differentiation, but it is not clear whether this relates to source differences on a global scale or the magmatic processes themselves.

This study presents comprehensive Os isotope and elemental data for MORB glass, and Os isotope data for sulphides from a single ridge segment from the FAMOUS region (36°50'N) on the Mid-Atlantic ridge. These data, like those for the global dataset, indicate that MORB glass has been systematically affected by seawater derived contamination. Sulphides with low Os concentrations have also been modified by exchange with their contaminated host glass. Whereas, although those sulphides with a high Os concentration (>100 ppb) may have also been affected by such exchange they nevertheless yield the least radiogenic 187Os/188Os compositions yet observed in normal MORB samples, consistent with derivation from a source that has experienced long term depletion of Re (and other incompatible elements). These results, indicate that for Os isotopes, at least, there is no evidence for a signficant mantle heteroegeneity in the MORB source, and that the heterogeneity preserved on a bulk-rock scale (in glass or crystalline MORB) relates to magmatic differentiation and seawater derived contamination. It remains to be seen to what extent other isotope and elemental variations reflect the same process.

[1] Schiano et al. Earth Planet. Sci. lett. 150, 363-369 (1997)
[2] Gannoun et al. Earth Planet. Sci. lett. 259, 541-556 (2007)
[3] Harvey et al. Earth Planet. Sci. lett. 244, 606-621 (2006).