Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 937

Low $^{187}Os/^{188}Os$ Isotope Ratios in Icelandic Basalts

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The unique geological environment of Iceland provides an excellent opportunity to study the origin of material sampled by a mantle plume, the interaction of the plume with the MORB reservoir and the processes taking place during melt migration. Melt generation processes beneath Iceland are controlled both by the plume, and by the extensional tectonic setting. One of the objectives of the project is to understand how batches of melt, possibly originating in different reservoirs interact and are transported to the surface.

Detailed analyses have been carried out on the major and trace element contents of a selection of Neovolcanic rocks (<10,000 yr) from Snæfellsnes and the Langjökull Volcanic System (Western Rift Zone), Iceland. The rocks, sampled in a broadly east-west transect, vary in composition from alkaline to sub-alkaline basalts, reflecting their position relative to the rift zone and the inferred centre of the plume.

$(La/Yb)_n$ ratios range from 1.3 to 10.7 and the $(Dy/Yb)_n$ $_n$ratios range from 1.1 to 1.6, both increasing away from the rift zone. Modelling of these trace element ratios gives insight into the depth of melting of these rocks with less than 2% melt generated in the garnet-lherzolite field and up to 6% melt in the spinel-lherzolite field. The more alkalic melts seem to originate from only slightly greater depths than less alkalic melts. This nearly constant initial depth of melting is in contrast to that predicted by models of partial melting across a radial section of a plume head. However, the amount of melt generated does vary along the transect with higher degrees of melting towards the rift zone and smaller degrees of melting at the outer end of the peninsula. In between these two areas there is a transition zone where melt generation is intermediate and variable.

Published Sr and Nd isotope data suggest that there are two distinct sources, with enriched source material sampled furthest from the rift zone and more depleted sources nearer to the rift. In the transition zone Sr isotope ratios are highly variable, perhaps due to mixing of different melt fractions from these two main sources.

Os isotope ratios have been determined by N-TIMS on at least 35 samples, and $^{187}Os/^{188}Os$ ratios vary from 0.1269-0.1347 with Re concentrations of 219-735 ppt and Os concentrations of 1.3-690 ppt. Unexpectedly, the more alkalic rocks, which have higher Sr isotope ratios, have the lower $^{187}Os/^{188}Os$ values of 0.1269 to 0.1284, and such low values have not been previously reported for other OIB suites. In contrast, the lower $^{87}Sr/^{86}Sr$ rocks from closer to the rift zone have higher $^{187}Os/^{188}Os$ ratios of 0.1319 to 0.1347. Overall, there is therefore an intriguing negative correlation between Os and Sr isotope ratios in source materials sampled at broadly similar inferred depths of melting along this section from Snæfellsnes to the Western Rift Zone. In the simplest explanation the Sr and Os isotope ratios of the analysed basalts reflect different depletion and enrichment processes in the evolution of their mantle source regions. The $^{187}Os/^{188}Os$ ratios for samples from both sources are independent of their Os concentrations, which indicates that there is very little or no melt-matrix interaction and magma mixing during melt ascent.