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Os isotopic variations in lavas from Kohala Volcano, Hawaii: constraints on melt/crust interaction

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Ocean Island Basalts provide important information on the chemical and physical characteristics of their mantle sources. However, the composition of an ascending magma may be modified during transport through the oceanic crust. In order to extract accurate information regarding the mantle sources of ocean island basalts, it is therefore necessary to constrain the extent to which melt/crust interaction has affected isotope ratios in individual basalt suites.

Os isotopes are particularly sensitive to melt/crust interaction because of the extreme Re/Os fractionation between the Earth's crust and mantle. Crustal rocks have very high Re/Os and therefore high $^{187}Os/^{188}Os$, whereas mantle-derived rocks typically span a limited range in unradiogenic Os-isotope values. In contrast, Sr-, Nd-, and Pb-isotope ratios often show small differences between oceanic crust and mantle-derived lavas. Moreover, the compatible behaviour of Os during melt fractionation makes evolved lavas with low Os content very sensitive to any crustal contamination. We have examined Os isotopes in a suite of variably-fractionated lavas from Kohala Volcano, Hawaii to constrain the role of melt/crust interaction in the evolution of these lavas.

MgO contents of Kohala tholeiites range from 8.7 to 5.9 wt.%. Os concentrations vary from 374 to 4 ppt and are positively correlated with MgO. From this correlation, we estimate a bulk Dos of 50 during fractional crystallization. This value is significantly higher than the estimate for most suites of Hawaiian lavas with higher MgO content. A steeper decrease of Os content in evolved lavas may reflect the onset of sulfide saturation and fractionation in Hawaiian melts at an MgO content of around 9 wt.%.

Os-isotopes of Kohala tholeiites range from 0.130 to 0.159 and are inversely corre-

lated with Os concentrations. Less-fractionated lavas with > 80 ppt Os span a narrow range, from 0.130 to 0.133. These values are similar to high-MgO lavas from Mauna Kea and Kilauea and most likely reflect the composition of the plume source of these lavas. In contrast, lavas with lower MgO and Os content extend to higher $^{187}Os/^{188}Os$, ranging from 0.154 to 0.159. The correlation between Os-isotopes and indices of fractionation suggests that assimilation of pre-existing oceanic crust coupled to fractional crystallization (AFC) is responsible for the elevated Os-isotopes in the more evolved lavas.

We have modelled the Os-isotope composition of the $\sim$100 Ma Pacific crust beneath Hawaii using published average Re and Os concentrations for upper and lower oceanic crust. AFC modeling suggests that the observed MgO-[Os]-$^{187}Os/^{188}Os$ trends for tholeiites are best matched by assimilation of upper oceanic crust, with a ratio of assimilation/fractional crystallization r = 0.5. The most radiogenic samples may contain up to 4% assimilated oceanic crust. This minor amount of crustal assimilation is unlikely to significantly alter other isotopic systems such as Sr or Nd. For example, the calculated effect on Nd of 4% assimilation of oceanic crust by typical Hawaiian lavas is $\sim$0.12 epsilon units, which is within measurement error. Thus, even evolved Hawaiian tholeiites are likely to accurately reflect the Sr-, Nd-, and Pb-isotope composition of their mantle source.

Finally, highly fractionated alkaline lavas from Kohala extend to significantly more radiogenic values, ranging from 0.194 to 0.243. Os contents in Kohala alkaline lavas are low, but in contrast to Kohala tholeiites are not clearly correlated with either MgO or $^{187}Os/^{188}Os$. We will discuss whether variations in the type or quantity of assimilate Pacific crust and/or variations in the composition of the mantle source of Kohala alkaline lavas are responsible for the extremely elevated $^{187}Os/^{188}Os$ values in these lavas.