Secondary crustal effects on MORB composition at the Kolbeinsey Ridge

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We present results for the systematic crustal alteration of basalts from the shallow, slow-spreading Kolbeinsey Ridge (67°05'-70°26'N). Age-constrained Kolbeinsey lavas are isotopically depleted (e.g. $^{87}Sr/^{86}Sr$ = 0.70272-0.70301) with $(^{230}Th/^{238}U)$ = 0.95-1.30, low U ($\geq$11ppb), and low Th ($\geq$33ppb). The basalts have a narrow range of $(^{230}Th/^{232}Th)$ ratios (1.20-1.32) over a large range in $(^{238}U/^{232}Th)$ (0.94-1.32), producing a horizontal array on a $(^{230}Th/^{232}Th)$ vs. $(^{238}U/^{232}Th)$ diagram. However, we observe that the range of $(^{230}Th/^{238}U)$ (0.96-1.30) is inversely and nearly linearly correlated with $(^{234}U/^{238}U)$, reflecting shallow crustal alteration of the basalts. Variations in U and Th concentrations and Cl/K_2O ratios are not systematic, indicating a combination of crustal alteration mechanisms. For example, samples with elevated Cl/K_2O ratios but no elevated $(^{234}U/^{238}U)$ ratios have likely experienced the addition of subsurface brines with low oxidation states and, thus, low U solubilities; the addition of those fluids is not expected to systematically affect the U isotope composition of the basalts. $^{87}Sr/^{86}Sr$ and $(^{234}U/^{238}U)$ isotope variations, on the other hand, support the systematic addition of material from hydrothermally altered crustal rocks to the basalts.

Unaltered Kolbeinsey lavas have high $(^{230}Th/^{238}U)$ values ($\geq$1.2), which are consistent with melting in the presence of garnet and with production of thick ocean crust by large degrees of melting.

Fractionation of Li and Mg isotopes in mantle derived materials– Promise, perils and progress

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Li and Mg provide an intersting pair of elements with which to explore the process that influence high temperature fractionation of cationic species in geological environments. There are large relative mass-differences between the isotopes of Li (17%) and Mg (8%) that should should promote discernible fractionations. Both elements are hosted in major lattice sites in common mantle minerals and so the energetics of exchange between different minerals can be reasonably well understood. Neither show multiple valences over mantle conditions, that can dominate fractionation behaviour. The value of understanding the processes that lead to their high temperature fractionations, aside from intrinsic curiosity, is that signatures related to processes of planetary differentiation and recycling may be discerned over later magmatic influences

The importance of diffusion in isotopic fractionation in the Li system has been highlighted in a number of earlier studies. Our new *in situ* studies re-emphasise the complexity and magnitude of fractionations that can occur by late-stage diffusion. Moreover, we show that Mg isotopic variations in bulk xenoliths co-vary with those of Li. Again diffusion is implicated although it is not obvious what drives the ingress of Mg. We suggest it may be related to volatile loss *en route* to surface. In samples uninfluenced by diffusive fractination, as identified from unzoned, mineral Li isotope profiles, natural fractionation factors can be gleaned from analyses of co-existing bulk minerals. Clinopyroxenes are heavier in both Li and Mg systems, as predicted in the latter by computational studies of equilibrium partitioning. More experimental data could yield better constraints over a wider range of conditions.