Light Fe-isotopic composition of oceanic arc basalts implies highly depleted mantle wedge compositions: Is oceanic subduction initiated against low density, refractory, peridotite zones in the upper mantle?

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New Fe-isotope data on > 60 primitive basalt samples from throughout the currently active global network of arcs, is used to investigate whether there is systematic variation in Fe isotopic compositions that may reflect either the composition of the mantle wedge, or variation in oxidation potentially due to differing slab fluid flux to different arc's mantle wedges.

Our δ^{57}Fe data span a wide range from -0.2 to +0.2 (± 0.04), significantly greater than MORB (δ^{57}Fe = 0.11‰ ± 0.01‰) and with a lower mean value (δ^{57}Fe = 0.04±0.10‰). The data show positive correlations between δ^{57}Fe and Pb- or Sr-isotope ratios, and with $Fe^{3+}/\Sigma Fe$. Many suites show a trend of slight increase in δ^{57}Fe with decreasing MgO or Mg#, presumed the result of fractionation. The ≈0.4‰ span in δ^{57}Fe in arc basalts to andesites, combined with the fact that our modelling shows that crystal fractionation and feasible variation in partial melting or variation in oxidation state of Fe are not likely to generate a variation of more than ≈0.1‰ in δ^{57}Fe, implies that this range reflects a large component of source variation.

The pervasively light composition of projected arc parental basaltic magmas relative to MORBs suggests that these sources are significantly more refractory peridotite than at MORs. Modelling shows that this degree of depletion requires multiple episodes of melt extraction, implying this mantle was already depleted prior to becoming trapped to form the mantle wedge of oceanic arcs. Perhaps "rafts" of buoyant refractory peridotite in the upper asthenosphere become the localised sources for oceanic subduction initiation?