The importance of mantle wedge heterogeniety to arc geochemistry

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The geochemistry of arc volcanics reflects contributions from the slab, variations in the wedge melting regime, crustal overprinting, and the original composition of the mantle wedge. To constrain the importance of variations in the original wedge compositions we use the compositions of rear-arc volcanics, which have only minor subduction signatures, and therefore may represent relatively uncontaminated melts of the ambient mantle.

A global database of rear-arc volcanism, and a regional database from the rear of the Chilean Southern Volcanic Zone (SVZ), share the following characteristics: 1) On a plot of $^{87}Sr/^{86}Sr$ vs. $^{143}Nd/^{144}Nd$, the data form a tight linear array between the compositions of depleted MORB, and EM-1 type OIB. 2) Rear-arc $^{143}Nd/^{144}Nd$ corresponds on a near 1-to-1 basis with $^{143}Nd/^{144}Nd$ from associated arc-front volcanics. 3) $^{143}Nd/^{144}Nd$ isotopes in arc-front settings *do not* correlate strongly with trace element ratios dominated by the slab component, and *do* correlate with trace element ratios that are variable among depleted MORB and EM-1. These observations are consistent with ambient mantle wedges that vary primarily due to the addition of a component that is compositionally similar to EM-1. Further, this ambient mantle heterogeneity is the origin of much of the $^{143}Nd/^{144}Nd$ variation both among arcs globally and among the arc-front volcanoes of the SVZ. For arc-front samples both globally and within the SVZ, correlations between $^{143}Nd/^{144}Nd$ and certain trace element ratios, such as Zr/Nb and Th/U, indicate that these trace element ratios may also vary primarily as a function of ambient mantle wedge heterogeneity.

Based on these observations, a quantitative model of ambient mantle heterogeneity has been constructed by inverting for the source composition of the EM-1 type Gough Island Basalts and adding variable proportions of that component to depleted MORB. Combining these wedge compositions with variations in mantle wedge thermal structure owing to lithospheric thickness and convergence rate [1] successfully reproduces the systematic along strike compositional variability within the SVZ and globally.

[1]Turner and Langmuir (2015) *Geochem, Geophys., Geosys.*