Along and across-arc profiles in He-C systematics: New data from El Salvador and Honduras

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We sampled volcanic and geothermal gases in El Salvador and Honduras for their CO_2 and He abundances and isotope ratios to investigate along and across-arc (depth) controls on the release of volatiles from the subducting slab. Results show a typical volcanic arc-signature for El Salvador with $^3He/^4He$ ratios of 6.0 – 7.6 R_A, $\delta^{13}C$ values of –1.3 ‰ to –3.2 ‰ and $CO_2/^3He$ ratios of $8 - 25 \times 10^9$. In Honduras, we find similar values for volatiles collected in the Sula Graben ($^3He/^4He$: 4.5 – 6.0 R_A, $\delta^{13}C$ values of –2.2 to –3.7 ‰ and $CO_2/^3He$ ratios of $9 - 29 \times 10^9$) even though the sample locations lie ~200 km from the volcanic front. All other sample locations in Honduras show lower $^3He/^4He$ ratios (0.6 – 3.5 R_A), lower $\delta^{13}C$ values (< –6.4 ‰) and either higher or lower $CO_2/^3He$ ratios ($2 - 258 \times 10^9$): characteristics consistent with fractional degassing of CO_2 and/or interaction with crustal reservoir rocks.

Samples collected along the volcanic front in El Salvador and from the Sula Graben are used to calculate relative proportions of mantle wedge, and subducted marine carbonate and sedimentary organic carbon contributing to the CO_2 flux in the volcanic arc and back-arc. Given their similar He-C characteristics, the two sample suites show similar results for mantle (5–19 %), carbonate (77 – 90 %) and organic sediment (3–11%) contributions to the CO_2 output flux. Our results imply that devolitalization of carbon from the subducting slab extends to distances up to 200 km behind the volcanic front. We contrast these results with trace element/isotope data of alkaline lavas erupted at similar distances behind the arc that lack evidence for a slab-derived component (Patino et al., 1997; Walker et al., 2000).

Hydrogen isotope variations in Mariana Arc melt inclusions

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Although it is well established that water plays a pivotal role in triggering melting within the mantle wedge and controls the transport of many elements, its absolute flux and details of the transfer processes at convergent margins remain elusive. A fundamental aim of this study is to understand how water is transferred from the slab to the surface within the Mariana Arc subduction zone.

We present new hydrogen isotope data and volatile contents of olivine-hosted melt inclusions from various volcanoes along the Mariana Arc, as well as from Guguan cross-chain seamounts. δD values, and H_2O, CO_2, S, F and Cl abundances have been determined by SIMS [1]. Water contents in the cross chain samples show similar values to the Guguan arc-front samples, suggesting that volatile release is a continuous process across the arc. This finding is consistent with experimental results [2] and melt inclusion studies across the Central American arc [3]. We observe significantly higher CO_2 contents in the cross chain samples (up to 820 ppm) as compared to the arc samples (max CO_2= 550ppm at Agrigan), suggesting either enhanced decarbonation at depth, or that the cross chain samples have experienced less degassing. Although δD values show a significant range, all samples are significantly higher than typical MORB values (-70‰). The inclusion populations with the highest water contents, from Agrigan (5.2 wt.% H_2O) and Alamagan (4.7 wt.% H_2O) volcanoes, show δD values greater than seawater (up to +20 ‰). The positive δD values suggest that isotopic fractionation during dehydration from the slab is a key process and that the sense of δD fractionation is consistent with experimentally determined fractionation factors [4]. Samples with lower water contents show evidence for both degassing (low δD values), and diffusive H loss (high δD values).

References

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