Unravelling the C systematics of the Central American volcanic output

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He-CO_2 relationships have proven to be particularly useful for determining the relative contributions of CO_2 from the various subduction zone reservoirs: a) the mantle wedge, b) the overlying arc crust through which the magmas erupt and c) the subducting slab. The Central American arc presents a unique opportunity to investigate the He-CO_2 approach given prior studies which show dramatic variations in subduction forcing functions (eg. the angle of subduction, the amount and type of sediments subducted and crustal thickness). Several geochemical parameters including Ba/La, ^{10}Be and La/Yb have been shown to effectively track changes along the arc due to these forcing functions. This geochemical data provides strong evidence for a high slab flux and recycling of sediments beneath Nicaragua, with a minimal contribution to the volcanic output in Costa Rica, despite similar sedimentary inputs. Here, we report ^{3}He/^{4}He ratios, He, Ne, and CO_2 abundances as well as _^{13}C values for volatiles from the volcanic output along the Costa Rica and Nicaragua segments of the arc utilising fumaroles, geothermal wells, water springs and bubbling hot springs.

CO_2/^{3}He ratios are relatively constant throughout Costa Rica (av. 3.0 _ 10^{10}) and Nicaragua (av. 2.6 _ 10^{10}) and similar to arcs worldwide (~2 _ 10^{10}). _^{13}C values range from –6.5 ‰ (MORB-like) to –0.3 ‰ (similar to marine carbonate = 0 ‰). ^{3}He/^{4}He ratios are essentially MORB-like ($8 \pm 1R_A$) with some samples showing evidence for crustal additions – water spring samples are particularly susceptible to modification.

The He-CO_2 relationships are consistent with a large input of marine carbonate/limestone carbon to magma sources in both Costa Rica and Nicaragua. The average ratio of CO_2 derived from carbonate/limestone (L) to subducted sediment (S) is 11 vs. 5 for arcs worldwide. An elevated L/S ratio in Costa Rica supports geochemical and geophysical evidence suggesting that most of the uppermost (organic-rich) sediments on the slab subducting beneath Costa Rica either are scraped off or underplated before reaching the magma generation zone. A high L/S ratio in Nicaragua (essentially indistinguishable from Costa Rica) shows that despite a higher sedimentary flux to the arc volcanics, a higher proportion of sedimentary organic C is not observed in the volatile output. The implication is that this C does not survive the subduction process and make it into the magma generation zone in Nicaragua. This apparent decoupling of sedimentary derived organic C and sediment tracers in the volcanic output along the arc may be explained by volatile loss in the forearc – a suggestion consistent with the occurrence of off-shore mud volcanoes and methane-rich seeps in the region.

Petrogenesis of the largest intraplate volcanic field on the Arabian plate (Jordan): evidence for a mixed asthenosphere- lithosphere source

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Miocene to Recent volcanism (14-0 Ma) in Jordan occurs along the Dead Sea plate boundary eastern margin and as the areally extensive (~46000km^2) volcanic field Harrat Ash Shaam. The chemically and isotopically diverse volcanic field comprises alkali basalts and basanites. The erupted lavas do not represent primary magmas and have undergone fractional crystallisation of ol ± cpx ± plag; some samples have assimilated small amounts (< 10%) of Late Proterozoic crust *en route* to the surface. Sr-Nd-Pb isotopic variations and unusual correlations with trace element ratios (such as a negative correlation between Sm/Nd and ^{143}Nd/^{144}Nd) require mixing of two isotopically distinct sources: 1) a deeper asthenospheric source with a chemical and isotopic composition intermediate between MORB and OIB and 2) a shallower isotopically enriched lithospheric mantle source. These distinct isotopic signatures require the sources to have been separated for a considerable period of time. New data from volcanic centres along the Dead Sea plate boundary overlaps the most depleted end of the Harrat volcanism. Lower Hf isotope ratios (at a given ^{87}Sr/^{86}Sr) than Harrat Ash Shaam samples suggest a dominantly asthenospheric source. Likewise, Saudi Arabian and Israeli intraplate volcanism have similar depleted isotopic signatures that suggest the involvement of an asthenospheric component. In contrast, Yemen intraplate volcanism tapped shallow mantle hydrated and metasomatised by the Afar plume. In Jordan, La/Nb ratios vary widely (0.46-0.92) and independently of isotopic composition. Melt modelling suggests that this heterogeneity is the result of small degrees of melting of an asthenospheric garnet-phlogopite bearing source. The lithospheric mantle source was spinel-bearing and produced relatively larger melt fractions (~2-5%). Lithospheric thinning and thermal erosion in response to upwelling asthenosphere triggered by tectonism began in the mid-Miocene (~14Ma) and resulted in a progressive switch from magmas dominated by a lithospheric source to those generated by deeper asthenospheric sources after thinning of the lithosphere.