Geophysical Research Abstracts
Vol. 15, EGU2013-2501, 2013
EGU General Assembly 2013

Extreme Chemical Variations in 25 to 0 Ma Central Andean Arc Magmas at 25.5°S to 28°S related to Changing Slab Geometry, Forearc Subduction Erosion and Lithospheric Foundering

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The central Andes is the type locality for magmas erupted through thickened crust in a continental margin arc. A compilation of some 600 chemical analyses shows that 25-0 Ma andesites erupted in the southern Central Volcanic Zone region (25.5- 28.2°S) north of the Chilean flatslab exhibit among the greatest range of trace element and isotopic ratios in continental arcs. This range reflects their evolution in a region with a changing subducting slab geometry, a crust thickening to 65-75 km, an arc and backarc rising to elevations of 5000-6800 m, a frontal arc that migrated ∼45 km eastward at 8-3 Ma, and volcanism that terminated to the south. To a first order, all of these lavas evolve towards steeper REE patterns and more enriched chemical signatures reflecting interaction of mantle melts in a thickening crust in line with Pb isotopic ratios, which largely correlate with crustal domains that last equilibrated in Ordovician and late Paleozoic magmatic events. A trend to lower Ba/La ratios might partially reflect a terriginous sediment-free trench by 10 Ma. In more detail, the arc lavas north of the flat-slab at ∼28.2-26.8°S show a distinct evolution from those at ∼26.8-25.5°S in parallel with tomographic images that show a highly attenuating crust and upper mantle interpreted to reflect partial melting under the backarc in the north and diminished attenuation in the backarc mantle and crust to the south. Andesites at 28.2- 26.8°S show the most variable and extreme heavy REE patterns (Sm/Yb =2-9), Na2O (3-5.5%), HFSE depletion (La/Ta = 15-110) and Ba/La ratios (15-55) with some of the world's highest values occurring in 9-3 Ma lavas erupted as the frontal arc migrated and the slab shallowed to the south. The high Sm/Yb ratios and wt % Na2O are consistent with generation of a garnet-bearing, feldspar-free residue in the thick underlying crust as well as in a mantle wedge into which crust was injected in a peak of forearc subduction erosion as the arc migrated. A correlation of high Sm/Yb and La/Ta ratios temporally links heavy REE retaining residual garnet with residual titanite and amphibole retaining Ti and HFSE. In contrast, andesites at 26.8-25.5°S, west of the Puna where the slab is inferred to have shallowed at 18-7 Ma and then steepened after 7 Ma as lithospheric delamination occurred, mostly lack extreme REE and HFSE ratios and high Na2O. These features along with a more upper crustal-like chemistry reflect eruption in a mixed stress regime and incorporation of radiogenic Puna crust, whose ductile flow to the west was facilitated by crustal and mantle partial melting in the aftermath of lithosphere foundering and slab steepening. Thus although forearc subduction erosion likely accompanied frontal arc migration across the region, the variability of the magma chemistry along strike is largely due to the extensive partial crustal and mantle melting that began in the late Miocene in the north and the late Miocene shallowing of the subducting slab that produced a rigid backstop and backarc cooling in the south.