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The origin of the adakitic signatures of the Ecuadorian magmatic arc

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Recent to present-day volcanic rocks across the Ecuadorian arc have been interpreted as slab melts (adakites) from the subducted Nazca plate, and partial melting episodes of the mantle, metasomatized by these slab melts, at different depths (Bourdon et al., 2003). We report new extensive isotope (Pb, Sr, Nd) and geochemical data (major, trace and rare earth elements, REE) on rocks of a transect across the Ecuadorian arc including recent to active volcanic centers from the frontal arc (Pilavo, Pululagua, Pichincha), the main arc (Ilalo and Chacana caldera) and the back-arc (Sumaco), which suggest a different origin for the adakitic rocks of the Ecuadorian arc.

Increasing incompatible element concentrations (e.g., Zr, Y, Ce, Sr) and decreasing Pb/Ce and Ba/La ratios indicate decreasing melt fractions and slab fluid contributions towards the back-arc as already suggested by Barragan et al. (1998). The direct association between decreasing slab fluid contributions and decreasing melt fraction across the arc suggests the occurrence of slab fluid metasomatism rather than, or at least besides, slab melt metasomatism. Magmatic rocks of the frontal, main and back-arc are characterized by the absence of Eu anomalies and by depleted heavy REE values (Yb$\leq$1 ppm in the frontal and main arc, $\leq$2 ppm in the back-arc) suggesting an evolution outside the stability field of plagioclase and possibly within the stability field of garnet, even though La/Lu ratios are not very high (50-500). These features have been attributed either to slab melts or to their metasomatic imprint on the mantle wedge (Bourdon et al., 2003).

The investigated magmatic rocks of the frontal, main and back-arc have ^{87}Sr/^{86}Sr values between 0.7039 and 0.7044 and ε_{Nd} values between +2 and +8, apparently indicating a limited crustal contribution. Pb isotope compositions of the frontal and

back-arc rocks are characterized by the same narrow range of $^{207}Pb/^{204}Pb$ values (15.57-15.61), whereas those of the main arc have more radiogenic $^{207}Pb/^{204}Pb$ values (15.61-15.65). $^{206}Pb/^{204}Pb$ (18.8-19.1), but not $^{207}Pb/^{204}Pb$, as well as $^{87}Sr/^{86}Sr$ and, to a lesser extent, $^{143}Nd/^{144}Nd$ values of rocks from the frontal, main and back-arc correlate with SiO_2, TiO_2, MgO, Fe_2O_3 suggesting assimilation of a non-radiogenic Pb (+Nd) and a radiogenic Sr source, which is isotopically compatible with high-grade metamorphic rocks of the continental basement of Ecuador or their partial melting products. $^{206}Pb/^{204}Pb$, $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ values correlate also with Al_2O_3 and Na_2O as well as with middle REE (Gd) and heavy REE (Lu) suggesting evolution through an assimilation-fractional crystallization (AFC) process and/or mixing outside the plagioclase stability field and with fractionation of amphibole and possibly garnet, at depth and under high P_{H2O}. Additionally, because they do not correlate with evolution indices, the high $^{207}Pb/^{204}Pb$ values of the main arc magmatic rocks, which have been attributed to crustal contamination by Bourdon et al. (2003), must be indeed a primary feature acquired by magmas in the mantle. The high $^{207}Pb/^{204}Pb$ values of main arc rocks can be explained by the fact that the latter derive from magmas with the highest [radiogenic slab fluid]/[non-radiogenic mantle melt fraction] ratio due to the different gradients of decrease of these two parameters across the arc. In conclusion, our data indicate that across-arc geochemical and isotopic features of magmatic rocks of Ecuador, rather than indicating slab melting can be consistently explained by a decreasing flux melting of the mantle wedge induced by decreasing amounts of slab-derived fluids. These mantle-derived melts subsequently pond at depth where they acquire an adakitic imprint by evolving through AFC and/or mixing processes that involve fractionation of amphibole and possibly garnet (but not plagioclase) and assimilation of non-radiogenic Pb (+Nd) and radiogenic Sr crustal rocks or their partial melting products.

References

Bourdon, E., Eissen, J.-P., Gutscher, M.-A., Monzier, M., Hall, M. L., Cotton, J. (2003) Magmatic response to early aseismic ridge subduction: the Ecuadorian margin case (South America). Earth Planet. Sci. Lett. 205, 123-138.

Barragan, R., Geist, D., Hall, M., Larson, P., Kurz, M. (1998) Subduction controls on the composition of lavas from the Ecuadorian Andes. Earth Planet. Sci. Lett. 154, 153-166.