Geophysical Research Abstracts
Vol. 18, EGU2016-8301, 2016
EGU General Assembly 2016

Sr-Nd-Pb isotope variability across and along the Ecuadorian volcanic arc

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Determining the contribution of different potential sources in arc magma genesis is of paramount importance for discriminating the role of deep-seated processes at work in the slab and mantle wedge, as well as the process occurring during the magma ascent through the arc crust. The Ecuadorian volcanic arc (2°S - 1°N) results from the subduction of the oceanic Nazca plate below the continental south-American plate. This volcanic province, developed in front of the subducting Carnegie ridge, is characterized by at least 50-60 volcanic centres of Pleistocene-Holocene age, which are distributed along the Western and Eastern Cordilleras and in the back-arc region. Previous studies on this province focused on two main issues: (1) the role of the deep-seated process occurring at the level of the subducting slab and the mantle wedge ([1], [2]), and (2) the role of crustal process ([3]).

In this work, we use existing and new (57 samples from 36 volcanoes of the whole Ecuadorian arc) major-trace element and Sr-Nd-Pb isotope data to resolve precisely magma compositional changes occurring across and along the volcanic arc and to precise the role of the heterogeneous crust underlying this arc segment.

In the 207Pb/204Pb vs. 206Pb/204Pb diagram, most of Western Cordillera volcanic centres and Back arc volcanoes display a flat trend characterized by a large variation in 206Pb/204Pb (18.5 – 19.15), with little variation in 207Pb/204Pb (15.54-15.62). Along this trend, back arc volcanoes tend towards unradiogenic compositions with Reventador as end-member whereas western cordilleras volcanoes generally show more radiogenic compositions (Pilavo, Imbabura). In contrast, the Eastern cordillera volcanoes display more radiogenic 207Pb/204Pb (15.60 - 15.70) or 208Pb/204Pb (38.7 - 39) at a given 206Pb/204Pb compared to the Western cordillera with similar variation in 206Pb/204Pb (18.85 – 19.05). Extreme compositions are observed at Tungurahua and Antisana volcanoes. Several volcanoes of the 2 cordilleras and of the inter-andean valley plot at the junction of the two trends. These new data confirm previous observations made with the trace element and Sr-Nd systematics that suggested marked differences between the two cordilleras ([1], [3], [4]), and allow us to go forward distinguishing the back-arc. In addition, we are able to test the influence of Carnegie ridge on magma geochemistry, which is still debated.

Altogether, Sr-Nd-Pb isotope variations require three different magmatic sources: (1) an unradiogenic component, represented by back-arc magmas, which may correspond to the mantle source; (2) an upper crustal radiogenic component, expressed in Eastern cordillera magmas and (3) a third component (low 87Sr/86Sr, radiogenic Nd-Pb isotopes), represented by some Western Cordillera magmas, which could either be an unradiogenic, immature oceanic basement or a slab influence.

[1] Hidalgo et al., Lithos 132-133 (2012), 180-192
[2] Samaniego et al., Contrib. Mineral. Petrol. 160 (2010), 239-260
[3] Chiaradia et al., Contrib. Mineral. Petrol. 158 (2009), 563-588
[4] Schiano et al., Contrib. Mineral. Petrol. 160 (2010), 297-312