Magmatic response to early aseismic ridge subduction: the Ecuadorian margin case (South America)

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Abstract

A geochemical and isotopic study of lavas from Pichincha, Antisana and Sumaco volcanoes in the Northern Volcanic Zone (NVZ) in Ecuador shows their magma genesis to be strongly influenced by slab melts. Pichincha lavas (in fore arc position) display all the characteristics of adakites (or slab melts) and were found in association with magnesian andesites. In the main arc, adakite-like lavas from Antisana volcano could be produced by the destabilization of pargasite in a garnet-rich mantle. In the back arc, high-niobium basalts found at Sumaco volcano could be produced in a phlogopite-rich mantle. The strikingly homogeneous isotopic signatures of all the lavas suggest that continental crust assimilation is limited and confirm that magmas from the three volcanic centers are closely related. The following magma genesis model is proposed in the NVZ in Ecuador: in fore arc position beneath Pichincha volcano, oceanic crust is able to melt and produces adakites. En route to the surface, part of these magmas metasomatize the mantle wedge inducing the crystallization of pargasite, phlogopite and garnet. In counterpart, they are enriched in magnesium and are placed at the surface as magnesian andesites. Dragged down by convection, the modified mantle undergoes a first partial melting event by the destabilization of pargasite and produces the adakite-like lavas from Antisana volcano. Lastly, dragged down deeper beneath the Sumaco volcano, the mantle melts a second time by the destabilization of phlogopite and produces high-niobium basalts. The obvious variation in spatial distribution (and geochemical characteristics) of the volcanism in the NVZ between Colombia and Ecuador clearly indicates that the subduction of the Carnegie Ridge beneath the Ecuadorian margin strongly influences the subduction-related volcanism. It is proposed that the flattening of the subducted slab induced by the recent subduction (<5 Ma?) of the Carnegie Ridge has permitted the progressive warming of the oceanic crust and its partial melting since ca. 1.5 Ma. Since then, the production of adakites in fore arc position has deeply transformed the magma genesis in the overall arc changing from 'typical' calc-alkaline magmatism induced by hydrous fluid metasomatism, to the space- and time-associated lithology adakite/high-Mg andesite/adakite-like andesite/high-Nb basalts characteristic of slab melt metasomatism.

Available in:

Earth and Planetary Science Letters, 2003, vol. 205 (3-4), p. 123-138.

DOI: https://doi.org/10.1016/S0012-821X(02)01024-5

http://www.sciencedirect.com/science/article/pii/S0012821X02010245