Subduction controls on the compositions of lavas from the Ecuadorian Andes

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Abstract

Three volcanoes of the Ecuadorian Andes, Atacazo, Antisana, and Sumaco, lie in a transect perpendicular to the trench and the main trend of the Andean arc. Each of the volcanoes lies on crust of substantially different age, composition, and thickness. Few compositional or isotopic features correspond in a straightforward way to the type of the crust through which the magmas have passed. Isotopic data limit assimilation to <15% at each of the volcanoes. Instead, a systematic relationship exists between the compositions of the lavas and the depth to the Benioff zone, suggesting that subduction imparts the principal control on the compositions of the magmas. Atacazo's lavas have low concentrations of the incompatible trace elements and very large LIL/HFS ratios. Sumaco's lavas are strongly enriched in the incompatible trace elements and have small LIL/HFS ratios. Antisana's lavas are intermediate in almost every respect. These features are consistent with devolatilization of the subducted slab controlling the extent of partial melting of a depleted mantle source. A mixing and melting model suggests the volcanic front magmas are made by large extent of partial melting (~15%) and include a large slab input (1.1% added to the depleted mantle). The magmas of the middle belt of volcanoes are made by smaller extent of partial melting (3%), induced by moderate amounts of slab-derived fluid (0.06%). The back arc magmas result from small degrees of melting (2%) and small slab input.

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