Geophysical Research Abstracts
Vol. 14, EGU2012-7108, 2012
EGU General Assembly 2012

What does the Lesser Antilles arc tell us about the fate of subducted slabs?

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Island arc volcanics have geochemical characteristics that differ significantly from those of mid-ocean ridge basalts and ocean island basalts, a feature that is usually explained by the involvement of subducted materials in their source. These materials are added to the mantle wedge either through dehydration or melting of the subducted pile. These processes fractionate chemical elements in very different ways: while dehydration enriches fluid-mobile elements relative to others, melting of the slab enriches the mantle wedge in all elements.
Here we present a compilation of geochemical features along the Lesser Antilles arc, which is famous for having the most “continental crust-like” geochemical characteristics of all island arcs. We show that beneath the southern part of the Lesser Antilles arc, where vast amounts of sedimentary material are subducted, sediments melt to produce island arc magmas with elevated La/Yb and low Ba/Th, U/Th, Sr/Th and Pb/Th. Associated with these trace element characteristics are isotopic signatures typical of continental crust: low 143Nd/144Nd and 176Hf/177Hf and high 87Sr/86Sr and Pb isotopic ratios. In contrast, in the northern part of the arc, where less sediment enters the trench, La/Yb is low and associated to high Ba/Th, U/Th, Sr/Th and Pb/Th in all lavas, and radiogenic isotope ratios are near those of MORB. In this part of the island arc, dehydration of altered basalt seems to be responsible for the enrichment in fluid-mobile elements (Ba, U, Sr, Pb etc..) and the subducted sediments are barely involved. On Martinique in the middle of the arc, both types of lavas exist but not in the same location. On the west side of the island, sediment melting dominates while in the east, closer to the trench, dehydration of basalt controls the volcanism. This geographical dichotomy between sediment melting and slab dehydration suggests strongly that the means of transport of chemical elements is related to the depth of the slab and that the mechanism changes within a distance of less than 50 km. Even more interestingly, it shows that fluids that most probably originate from subducted basalts find their way through the sedimentary pile without interaction since volcanics with elevated Sr/Th have unradiogenic Sr isotopes on the eastern side of the island while lavas with low Sr/Th have radiogenic Sr isotopes on the western side.
Extending this observation to numerous other oceanic arcs in which fluid transport has led to very high Sr/Th ratios associated to near-constant and low 87Sr/86Sr (0.7030 - 0.7035) suggests that fluid is transported untouched through the sedimentary pile in many other arcs. The amount of subducted sediments recycled into the deep mantle could therefore be much larger than previously estimated.