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Isotopes and the Lesser Antilles arc system

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Subduction zones are key areas on Earth where material once exposed at the surface is processed: part of the material almost instantaneously finds its way back to the surface in the island arcs but most of it is recycled into the mantle. Elements are not all transferred in the same way from the subducted material to the island arc. Most fluid-mobile elements such as B, Li or U escape the subducted slab in arc magmas while others such as Hf and the heavy REE are mainly recycled into the mantle.

Here I present a compilation of published data on the Lesser Antilles arc system with special attention to elements such as HFSE, REE, Pb and Sr because their isotopic compositions constrain their origin. Most arcs around the globe acquire their arc signature either through fluid transfer of mobile elements or through melt transfer from the subducted slab. In the case of the Lesser Antilles arc, both processes operate with the northern islands dominated by fluid transfer and the southern islands dominated by sediment melt transfer.

The origin of some of the transferred elements can be further traced using isotopic compositions because the isotopic compositions of subducted sediment and subducted basalt differ significantly. Nd and Hf isotopes can be used to quantify the proportion of involved sediment but the situation is more complex for Sr and Pb. While Sr and Pb are highly enriched in lavas produced in fluid-dominated environments, their average Sr and Pb isotopic compositions are quite low and close to average depleted mantle values. This indicates that the fluids come mainly from the basaltic portion of the subducted slab with little contribution from the subducted sediments. This in turns indicates that the fluid-mobile elements present in the subducted sediments are quantitatively sent back into the mantle. Non-traditional stable isotopes provide complementary information and demonstrate that deep fluids/melts originating in the subducted slab can transfer signatures of the subducted material to the arc magmas, making these systems excellent tools to trace processes in subduction zones.