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Isotopic constraints on the origin of high-alumina and high-magnesia basalts in the southern Lesser Antilles arc

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The South of the Lesser Antilles volcanic arc presents large chemical and isotopic heterogeneities. This wide range of composition is explained by the nature of the sources which are generated by mixing of a mantle component and variable amounts of subducted sediments [1]. The specificity of Grenada, the southernmost island of the arc, has been studied [2] but the Grenadine archipelago's characteristics (some fifty islands representing the emerged part of a ridge that includes Grenada) are still poorly known.

Two basaltic magma series can be distinguished in this region: high-alumina basalts ($Al_2O_3 > 17\%$) and high-magnesia basalts ($MgO > 8\%$) [3]. Both types of magma occur in the same location, suggesting that either they derive from the same source but changes occur through time, or that their respective sources are vertically separated. A chemical and isotopic study of 14 basalts from islands of the southern part of the Lesser Antilles volcanic arc was therefore performed. We measured trace elements contents and Pb, Sr, Nd and Hf isotopic compositions of basaltic rocks from the Grenadine archipelago, St Vincent, Ste Lucie and Martinique and our results were combined to published data to constrain the sources in the region.

The Grenadine archipelago presents $^{87}Sr/^{86}Sr$ ranging from 0.7042 to 0.7054, $^{143}Nd/^{144}Nd$ from 0.51272 to 0.51289 and $^{176}Hf/^{177}Hf$ from 0.28298 to 0.28315. On the other hand, the islands of St Vincent, Ste Lucie and Martinique have lower $^{87}Sr/^{86}Sr$ from 0.7037 to 0.7042, and higher $^{143}Nd/^{144}Nd$ from 0.51290 to 0.51304 and $^{176}Hf/^{177}Hf$ from 0.28310 to 0.28317. Our isotopic data also show that the Grenadine archipelago defines a trend in $^{207}Pb/^{204}Pb$ versus $^{206}Pb/^{204}Pb$ space that is

distinct from that defined by the group of islands St Vincent, Ste Lucia and Martinique. Trace elements ratios such as La/Yb are also different in the Grenadine basalts (La/Yb$>$5) and in the other islands (La/Yb$\approx$2) showing a difference in the magma genesis processes.

The Grenadine basalts can be generated by a simple mixture of an enriched mantle wedge ($^{87}Sr/^{86}Sr \approx 0.705$) and variable amounts of sediments with elevated Pb and Sr isotopic compositions. Similarly, the basalts from St Vincent, St Lucie and Martinique also result from a mixture of enriched mantle ($^{87}Sr/^{86}Sr \approx 0.704$) and variable amounts of sediments with radiogenic Pb and Sr isotopes, but the end-members are different from those sampled in the Grenadine archipelago. In terms of the origin of high-alumina basalts versus high-magnesia basalts, our data show that no systematic distinction can be made. The proportion of sediment involved in the genesis of the high-alumina basalts is not systematically higher than for the high-magnesia basalts.

References:

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