Two isotopic mixing lines in Martinique Island: The effect of ridge subduction

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The Lesser Antilles arc presents an unusually wide range of chemical and isotopic compositions compared to other arcs. Due to the subduction of a buoyant ridge the northern part of the arc displays two branches with distinct ages. In contrast, both periods of volcanic activity are superimposed in the southern part. With its central position, Martinique, where both northern branches merge, is the island with the most complete history of the arc. Old and recent arc volcanics, together with intermediate arc products, outcrop in this Island. In addition, Martinique lavas cover most of the isotopic variability of the arc. The aim of this study is (1) to constrain the source of volcanics in Martinique, (2) to explain the large chemical and isotopic variability in the island itself and along the arc.

We measured major and trace elements on ~ 100 dated samples carefully chosen to cover all volcanic phases of Martinique, and Pb and Sr isotopic ratios on a selection of 30 samples. Our isotopic results cover most of the range of Lesser Antilles volcanics from fairly unradiogenic rocks (^{206}Pb/^{204}Pb ~ 19 and ^{87}Sr/^{86}Sr ~ 0.7037) to highly radiogenic rocks with ^{206}Pb/^{204}Pb ~ 20 or ^{87}Sr/^{86}Sr over 0.710.

Samples define two mixing lines in Pb and Sr isotopic spaces: one for the old and intermediate arcs (25Ma to 7Ma) and the other for the recent arc volcanics (5.5Ma to present). The two lines have different unradiogenic (mantle) and enriched (subducted sediments) end-members.

The old arc results of the contamination of a mantle with high ^{87}Sr/^{86}Sr (~ 0.7037) and relatively low ^{208}Pb/^{204}Pb (37.95) by less than 0.1% of sediments (^{208}Pb/^{204}Pb > 39.87). The intermediate arc is produced by the same end-members but with a sediment contribution of 0.1 to 6%. In contrast, the recent arc is produced by contamination of a different mantle (higher ^{208}Pb/^{204}Pb $\approx$ 38.1 but ^{87}Sr/^{86}Sr similar to the older volcanics) by 0.1 to 5% sediments with less radiogenic Pb isotopic compositions (^{208}Pb/^{204}Pb ~ 39.52).

The origin of the isotopic range in lavas can be found in variable sediment input but more importantly in a sudden switch in the composition of both the mantle source and the subducted sediments. We suggest that the switch is related to the ridge subduction event that shifted the northern part of the arc to the west and changed the slab dip.

Coupled cation and O isotope exchange in alkali feldspar

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Of the many processes that occur during hydrothermal alteration, two that track the composition and flux of fluid are cation and isotope exchange in alkali feldspar. We have conducted experiments of short duration to determine the scales of diffusion and recrystallization during hydrothermal alteration. The starting materials were single crystals of adularia and sanidine, which were sealed in gold capsules with a 2 M NaCl solution having ^{18}O/(^{18}O + ^{16}O) $\cong$ 0.9. The capsules were heated to 600 °C at 200 MPa for a period of 1 and 2 d. After experimentation, the crystals were analyzed with a Cameca 7f ion probe in Cs^{+} mode for O and O^{-} mode for H, Na, and K. The sanidine showed evidence for an equilibrated replacement rim, even after only 1 d; whereas, the adularia had an apparently continuous change in composition with depth (Figure 1). The sanidine is apparently less stable than adularia at the conditions of the experiments. While there could be an exchanged rim within ~100 nm of the surface of the adularia, there is a continuous change in ^{18}O/(^{18}O + ^{16}O) and Na/(Na + K) with depth that appears to be a result of diffusion or some other mass transfer process. The ratios are strongly correlated, although in detail there are some fine differences in the slopes of the curves. Cation and isotope exchange appear to be coupled, perhaps both taking advantage of defects or fast pathways near the surface. Although recrystallization is a major replacement process, diffusive transport is significant at short times and small distances from the replacement boundary.