Geophysical Research Abstracts, Vol. 8, 06225, 2006
SRef-ID: 1607-7962/gra/EGU06-A-06225

Sedimentary input flux in the Lesser Antilles arc system

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Geochemical variability of lavas from the Lesser Antilles arc is well established and is characterized by a chemical zoning from north to south along the arc. Lavas from the northern part of the arc have usually less radiogenic and less variable Sr and Pb isotopic compositions than those from the south. Possible explanations include a larger contribution from sediments in the source of the southern islands, and/or a north-south change in the chemical composition of the sediments that are subducted beneath the Lesser Antilles arc

We conducted a geochemical study (major and trace element contents and Sr, Nd, Hf and Pb isotopic compositions) of Atlantic sediments coming from two different latitudes, in front of the Lesser Antilles arc. We selected sediments drilled during DSDP Leg 78 site 543 (15.7˚N) in front of the island of Dominica, and sediments drilled further south during DSDP Leg 14 site 144 (9.5˚N, on the edge of the Demerara Rise).

At site 543, the sedimentary pile is dominated by Pleistocene to Campanian-Maestritchian mud, radiolarian clay and local ash layers. The ε_{Nd}values vary between -14.6 and -11 and ε_{Hf}between -10.6 and -1. When combined, Nd and Hf isotopes plot in the continental domain of the “terrestrial array”, but some of them are shifted toward the seawater array. ^{206}Pb/^{204}Pb ratios vary between 19.1 and 19.5. The sediment pile has an overall strong continental signature suggesting that their source is primarily detrital. This is in agreement with the interpretation of White et al. (1985) who suggested that the dominant source was the Archean Guiana Highland drained by the Orinoco River.

Further south, at site 144, the succession is more heterogeneous and consists of Oligocene to Maestrichian chalk ooze and marl, Santonian to Turonian organic-rich

black shale and Cenomanian to Aptian marl and clay. These samples also have very unradiogenic Nd and Hf isotopic compositions with ε_{Nd}between -18.4 and -10 and ε_{Hf}between -20.4 and -5.4. The Pb isotopic compositions are extremely variable. Chalk ooze, marl and clay have ^{206}Pb/^{204}Pb ratios between 18.8 and 20.0, while the black shales have extremely radiogenic compositions with ^{206}Pb/^{204}Pb between 21.6 and 27.7. These compositions reflect the radioactive decay of authigenic uranium concentrated in organic-rich layers characterized by elevated ^{238}U/^{204}Pb ratios (100 up to 600).

The isotopic compositions of sediments from both sites are largely influenced by continental input. However, the two sites are not similar: the southern Leg has more variable and extreme values than the northern site. In addition, the presence of black shales in the southern site leads, through diagenetic processes, to very radiogenic ^{206}Pb/^{204}Pb ratios.

When the composition of the sediments is compared to that of the volcanic arc, two main observations can be made: (a) the sediments correspond to the unradiogenic end-member of the Hf-Nd isotopic trend defined by the Lesser Antilles arc lavas. (b) the north-south Pb isotopic trend along the arc can be explained by the composition of the sediments present in front of the arc. Indeed, ^{206}Pb/^{204}Pb ratios of lavas from the northern part of the arc (St Martin to Dominica islands) do not vary much and never exceed 19.4. Incorporation of variable amounts of subducted sediments as drilled at site 543 can explain their Pb isotopic signatures. In contrast, the southern islands (Martinique, St Lucia, the Grenadines islands and Grenada) display a large range of ^{206}Pb/^{204}Pb with values up to 20.1. Subduction and involvement of sediments like those drilled at site 144 could explain their composition.

Ref: White et al., GCA. 49, 1875-1886, 1985.