

High Mg-basalts in the Western Cordillera of Ecuador: Evidence of plateau root melting during Late Cretaceous arc-magmatism

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Introduction

The eastern part of the Western Cordillera of Ecuador comprises of oceanic terranes accreted to the continental margin of Ecuador from late Cretaceous to Eocene times (Kerr et al. 2002). Recent geochemical data (Lebras et al., 1987, Kerr et al., 2002, Mamberti et al., 2003) indicates that these terranes include thick buoyant oceanic plateaus, island arc-tholeiites and subduction related calc-alkaline series.

Two oceanic plateau sequences have been identified: the San Juan oceanic plateau dated to 123 Ma and the Guaranda oceanic plateau dated to 90-86 Ma (a remnant of the Cretaceous Caribbean Oceanic Province: CCOP). Mamberti et al. (2003) suggest that this plateau is radiogenically enriched in ²⁰⁶Pb and ²⁰⁷Pb and contains a HIMU component similar to that observed in the case of the Gorgona basalts (Kerr et al. 1997). Guaranda plateau Pb isotope data plots in a restricted field overlapping the radiogenic end of Pacific MORB (Thompson et al. 2003). High Sr ratios in Curaçao oceanic plateau basalts could result from the assimilation of altered high ⁸⁷Sr/⁸⁶Sr basalt (Kerr et al., 1996).

Geochemical data

Samples studied here were taken from two arc-sequences of Upper Cretaceous (Otavalo) and Eocene (Macuchi) throughout the northern part of the Western cordillera (fig. 1).

Otavalo samples consist predominantly of clinopyroxene-bearing basalts and andesites. The complete petrological and geochemical study of these cpx-rich rocks reveals that they have a primitive island arc nature; indeed MgO values range from 8 to 12%. Their arc-affinity is shown by the Nb and Ta negative anomalies (fig. 2), La/Nb is of approximately 6. These rocks are LREE-enriched and their bearing cpx (fig. 3) have a tholeiitic affinity (FeO₁-TiO₂ enrichment and CaO depletion from core to rim of a single crystal and within the whole sample, not shown). This LREE-enrichment despite the high MgO contents (high partial melting of primitive source) could be explained by the interaction with an enriched component.

Initial Nd, Sr and Pb isotope ratios are very homogeneous between whole rock and clinopyroxene separates. εNdi values range between +4 and +5 and suggest that these samples result from mixing of two sources. Chiaradia & Fontboté (2002) suggested mixing of the E-Pacific DMM source with an enriched mantle component to explain Ecuadorian isotope chemistry. Initial Sr isotope ratios for clinopyroxene plot in the mantle array suggesting that Rb and Sr have not been mobilized. Thus clinopyroxene isotope data can be used along with whole rock data to identify source composition. Once again as shown in figs 4 and 5, sample chemistry can be explained by mixing processes involving a DMM reservoir and an EM2 component. This is confirmed by the radiogenic Pb isotope ratios that plot between a DMM and EM2 type source in figure 6.

Characterising the EM2 component is important. The subduction zone that generated the arc-lavas occurred far from the continental margin (Jaillard et al., 1995); no terrigenous detrital sediments could have interacted with the source at this period. Thus, the EM2 component can only result from the melting of the arc substratum or of the underlying mantle.

In Peru, no plateau sequences exist but partial melting of assumed underplated crustal material (Atherton et al., 1983 and Petford et al., 1995). Peru isotope chemistry is similar to but less radiogenic than Otavalo and Ecuadorian samples. This reveals that Otavalo rock chemistry cannot be explained solely by the melting of crustal components (similar to those found in the Raspas metamorphic complex) but also from the interaction of the arc parental magmas with their oceanic plateau basement.

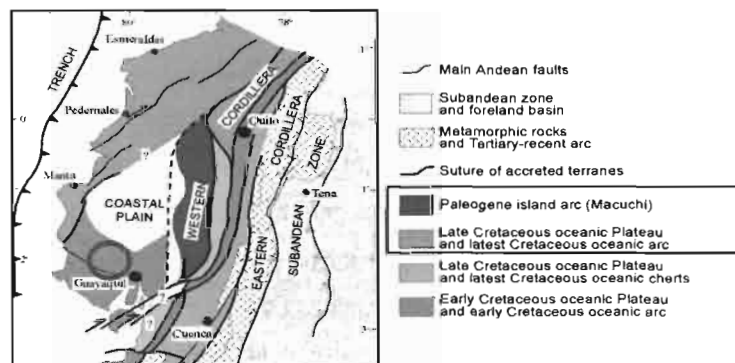


Fig. 1: Geological map of W Ecuador. (modified from Mamberti et al 2003).

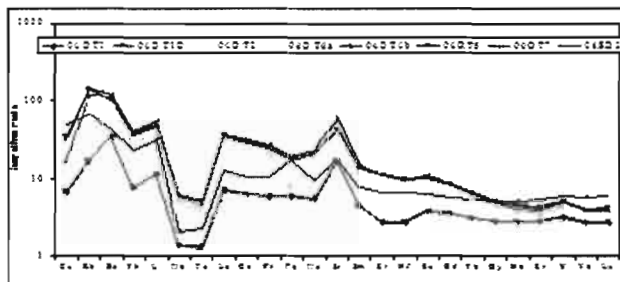


Fig. 2: Whole rock multielement primitive mantle normalised spidergrams, Sun&McDonough (1989).

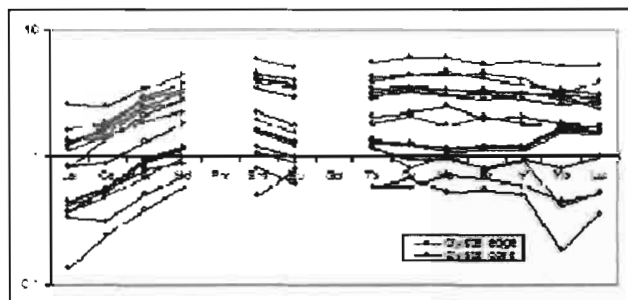


Fig. 3: Clinopyroxene trace element chondrite normalised spidergrams, Sun&McDonough (1989).

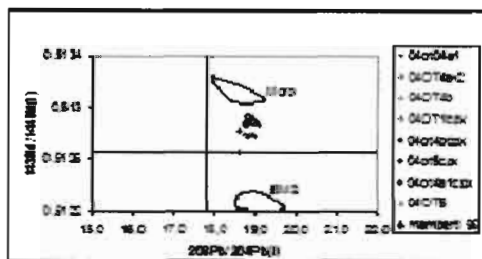


Fig. 4: $^{143}\text{Nd}/^{144}\text{Nd}(i)$ vs $^{206}\text{Pb}/^{204}\text{Pb}(i)$ isotope correlation diagram showing the main oceanic reservoirs of Zindler et Hart (1968).

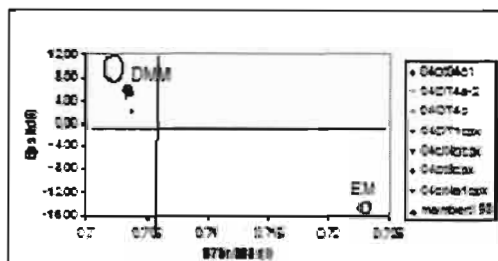


Fig. 5: $\epsilon\text{Nd}(i)$ vs $^{87}\text{Sr}/^{86}\text{Sr}(i)$ correlation diagrams showing the main oceanic reservoirs of Zindler et Hart (1968).

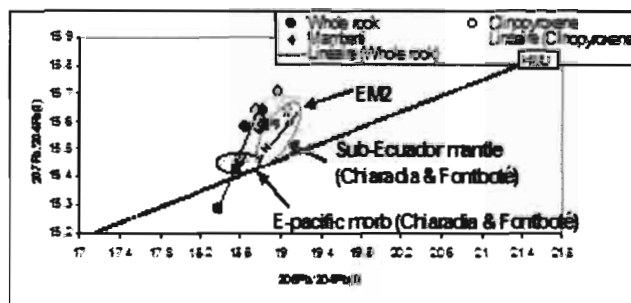


Fig. 6: $^{207}\text{Pb}/^{204}\text{Pb}(i)$ vs $^{206}\text{Pb}/^{204}\text{Pb}(i)$ isotope correlation diagram.

Conclusion

Otavaló samples chemistry shows that these arc basalts resting on the CCOP have a primitive nature despite the LREE and Th enrichment that can be explained by the interaction of a primary melt with an enriched source. Isotope chemistry suggests that whole rock and clinopyroxene chemistry may be due to the melting of the underlying mantle or possibly to the melting of the plateau root and crustal under-plating caused by the subducted slab dehydration under the CCOP.

References

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