

Evidence of mantle metasomatism beneath São Tomé Island (Cameroon Volcanic Line)

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The occurrence of CO₂ rich and carbonatitic metasomatic fluids as fertilizing agents of sub-continental mantle sources of the Cameroon Volcanic Line has been frequently referred. This report provides evidence for metasomatic processes in the mantle beneath São Tomé Island (oceanic sector of the CVL) based on mineralogical and geochemical data from primitive lavas and ultramafic xenoliths.

São Tomé primitive basalts (Mg# > 57; Ni > 170 ppm) geochemistry reveals a non-primordial, heterogeneous, oxidized, amphibole bearing source, characteristic of metasomatic activity in the magma sources. Incompatible trace element patterns show an overall enrichment (e.g., Ce/La = 0.55 ± 0.02) implying a non-primordial character of their mantle sources. Observed variations on trace element contents and ratios (e.g. ΔYb = 88%, ΔZr/Y = 120%, ΔLa/Sm = 49%) suggest mantle heterogeneities sampled by low, but variable, partial melting degrees (< 17%), whereas K negative anomalies and D_K > D_{Rb} and D_{Sr} > D_{Ba} indicate amphibole as the predominant K-rich residual phase. High Δlog(*f*O₂)_{FMQ} values [= 1.0 to 3.4] estimated for São Tomé primitive magmas reflect the oxidized nature of their asthenospheric magma sources. These features, together with sub-chondritic Ti/Eu ratios (5669 ± 706), uncorrelated with Mg# and negatively correlated with Zr/Hf, La/Sm, and Th contents, suggest that mantle metasomatism was induced by interaction with carbonatitic melts.

Lack of correlation between silicate mineral Mg# values and modal compositions in spinel peridotite xenoliths enclosed by São Tomé basaltic lavas indicate that these xenoliths are not simple residues, suggesting the occurrence of metasomatic activity within the regional lithospheric mantle. Abundant carbonate and CO₂ rich fluid inclusions (T_m ≈ -56.6°C), development of low-Al₂O₃ secondary clinopyroxene, and high *f*O₂ [Δlog(*f*O₂)_{FMQ} ~ 1] in peridotitic xenoliths are consistent with the inferences on geochemical processes operating at their host magma sources, providing further support for carbonate (fluid/melt) related metasomatism in the mantle beneath São Tomé Island.

Nickel stable isotopes as biogeochemical tracers

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Nickel (Ni), a bioessential trace metal, is functionally important to predominantly prokaryotic microorganisms (*Archaea* & *Bacteria*) in which, for example, Ni-containing enzymes act as catalysts in very specific metabolisms such as methanogenesis. Only one known enzyme, urease, in higher-order organisms (e.g. fungi & plants) requires Ni. Thus, from a biological point of view, it seems that the importance of Ni is relegated to more primitive and probably, ancient metabolisms that existed before the appearance of oxygen (Frausto da Silva and Williams, 2001).

We undertook an exploratory study of the Ni stable isotope system in an effort to determine natural variability for geochemical and particularly, biological applications. With the exception of extraterrestrial materials, Ni isotope studies have not previously been carried out. Additionally, as an astrobiological tool, Ni stable isotopes may potentially be utilized as biosignatures in characterizing and understanding microbial metabolisms and trace metal acquisition. A proven Ni isotope biomarker could be a useful tracer for microbial processes in which the geologic record of Ni isotopic composition might be employed in evaluating the evolutionary history of certain metabolisms, such as methanogenesis. Similarly, Ni isotopic compositions may be useful for assessing the metabolic characteristics of modern microbial ecosystems.

Method development and isotopic measurements were carried out at the University of Bristol. Initial experiments were of a biological nature and results will be presented.

References

Frausto da Silva, J. J. R. & Williams, R. J. P. 2001. *The biological chemistry of the elements*. 2nd ed. New York: Oxford University Press.