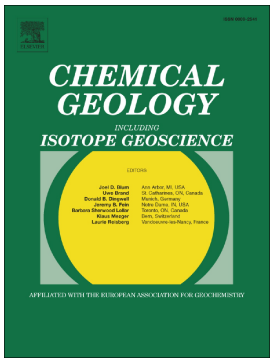

Ancient depleted and enriched mantle lithosphere domains in northern Madagascar: Geochemical and isotopic evidence from spinel-to-plagioclase-bearing ultramafic xenoliths

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ANCIENT DEPLETED AND ENRICHED MANTLE LITHOSPHERE DOMAINS IN NORTHERN MADAGASCAR: GEOCHEMICAL AND ISOTOPIC EVIDENCE FROM SPINEL-TO-PLAGIOCLASE-BEARING ULTRAMAFIC XENOLITHS

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Abstract

Mantle xenoliths hosted in Cenozoic alkaline rocks of northern Madagascar (Massif d'Ambre and Bobaomby volcanic fields) are spinel lherzolites, harzburgites and rare websterites. Petrography, electron microprobe, LA-ICP-MS and thermal ionization mass spectrometry techniques allowed to recognize domains characterized by variable degree of partial melting and extent of re-enrichment processes: 1) refractory spinel-to-spinel+plagioclase-lherzolites, with clinopyroxenes having marked LREE (Light Rare Earth Elements) depletion ($(La/Yb)_N \sim 0.2$) and very high $^{143}Nd/^{144}Nd$ (0.513594), which represent a limited and shallow portion of old mantle that suffered low degree partial melting (2-3%) and was later accreted to the lithosphere. These lherzolites acted as a low-porosity region, being, in places, percolated by small volumes of melts shortly before eruption; 2) lherzolites and harzburgites that suffered variable degrees of partial melt extraction (up to 15%), assisted and/or followed by pervasive, porous flow infiltration of alkaline melts in a relatively large porosity region, leading to the creation of a wide area rich in secondary mineral phases (i.e. olivine, clinopyroxene and pargasitic amphibole), enriched in incompatible elements (e.g., La_N/Yb_N in clinopyroxene up to 15) and having radiogenic Sr and unradiogenic Nd; 3) websterites and wehrlite-bearing samples that record differentiation processes of alkaline melts highly enriched in Th, U and LREE, not yet documented in the erupted volcanics of northern Madagascar. The mantle xenoliths of northern Madagascar show a regional decrease of the equilibration temperature from to SW (up to 1180 °C, Nosy Be Archipelago) to the NE (up to 900 °C, Bobaomby district). A significant lithologic and geochemical variation of the shallow lithospheric mantle beneath northern Madagascar is noted, in contrast with the relatively uniform geochemical and isotopic composition of the host alkali basalt and basanite lavas.

Introduction