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SiO_2 and LILE enrichment of the upper mantle via subduction components: insights from the Tallante mantle xenoliths (SE Spain)

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The incorporation of subducted oceanic lithosphere into the mantle is the most efficient and largely invoked mechanism to account for the development of different geochemical mantle reservoirs. Deep recycling of old oceanic crust and sediments is invoked to explain specific signatures of OIB, whereas contamination of the mantle wedge at arc settings by fluids and/or melts released by the subducting plate is inferred to account for the chemical and isotopic signature of arc lavas. In spite of a large literature on the geochemistry of arc basalts, studies on peridotite samples representative of the mantle wedge, aimed to document by direct observation the modal and chemical modifications induced in the mantle by subduction components, are still limited (e.g. [1], and quoted reference). Here we present the results of detailed microstructural and mineral major, trace element chemistry investigations on opx-enriched harzburgites, orthopyroxenites and gabbronoritic veins found in mantle xenoliths from Cabezo Tallante (SE Spain), an eroded cinder cone of Pliocene age [2]. These xenoliths pertain to a complex geodynamic setting, the Alboran Region, featured by Neogene extension and opening of the Alboran Sea, concomitant to progressive westward retreating and roll-back of a subducting slab. In response to such geodynamic evolution, the region was affected by widespread magmatic activity involving tholeiitic to calc-alkaline magmas followed by Late Neogene alkaline basalts (e.g. the Cabezo Tallante). Recent work [3] have documented that the Tallante xenoliths exceptionally record a multi-stage history of melt-rock interaction and melt intrusion tracking an extension-related 30 km uplift, consistent with the transition from subduction-related to alkaline magmatism. Microstructural and geochemical studies on the opx-rich peridotites and opx-rich veins were aimed to define their origin and significance in the context of the geodynamic evolution of the Alboran Region. Different types of opx-rich lithologies, reflecting multiple melt inputs and/or different styles of melt migration, have been found: i) coarse opx-rich peridotite pockets and opx-rich veins, mostly consisting of large (mm-sized) orthopyroxene grains showing clear replacive contacts against mantle olivine; ii) later thin fine-grained cross-cutting gabbronoritic veins, constituted by opx, plagioclase (often including Cl-apatite micro-crystals) and subordinate cpx, showing a fine-grained opx reaction rim against the host peridotite. The investigated rocks display different styles of trace element enrichment. In coarse opx-rich peridotite, clino- and ortho- pyroxenes have convex-upward M-REE enriched spectra (up to 100 xPM), coupled to high Th, U contents and strong Th/U fractionation (Th_N/U_N=2-3.8). In the gabbronoritic veins, all minerals are significantly enriched in Th, U, LREE (apatite up to 30000-80000 xPM). Overall, microstructural and geochemical features of studied opx-rich lithologies point that the Tallante mantle record multi-stage interaction with Si-saturated, LILE and volatile (Cl) enriched components, consistent with subduction-related melt/fluid agents of crustal (either continental crust or terrigenous sediment) origin, acting at different lithospheric depths. This likely occurred during uplift and concomitant migration of the Tallante peridotites from an inner part of the mantle wedge towards a position above a slab edge or slab detachment zone.

[1] Ionov D.A., 2010, J.Petrology 51, 327-361. [2] Duggen et al. 2005, J.Petrology 46, 1155-1201. [3] Rampone et al., 2010, J.Petrology 51, 295-325