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Evidence for silica-saturated melts in the Tallante mantle xenoliths (SE Spain): Inferences on their origin and geodynamic significance

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Gabbronoritic - dioritic veins and opx-enriched harzburgites with high amounts of LILE and volatile elements are rarely documented in peridotites from mantle wedge environments, and are considered the product of silica-saturated melt/fluid agents of slab origin percolating and interacting with the overlying mantle [1,2,3,4]. Mantle xenoliths from Cabezo Tallante (SE Spain), an eroded cinder cone of Pliocene age (2.93-2.29 Ma, [5]), constitute one of these unique geologic occurrences. 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, this region has been affected by widespread magmatic activity involving tholeiitic to calc-alkaline magmas followed by Late Neogene alkaline basalts (e.g. the Cabezo Tallante).

Recent work [6] 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 observed transition from subduction-related to alkaline magmatism. Textural relationships observed in xenoliths indicate that tholeiitic melt percolation at spinel- and plag-facies mantle depths was followed by the intrusion of opx-rich veins, in turn followed by the intrusion of alkaline amphibole pyroxenites; this constrains the gabbronoritic veining at 0.7-1 GPa. In this paper, we present the results of ongoing microstructural and geochemical studies on the opx-rich veins, aimed to define their origin and discuss the significance of this magmatic event in the context of the geodynamic evolution of the Alboran Region.

Different types of opx-bearing veins, likely reflecting multiple melt inputs, have been observed in the xenoliths: i) coarse opx-rich veins, mostly consisting of large (mm-sized) orthopyroxene grains showing clear replacive contacts against mantle olivine; similar texture is also observed in some opx-enriched harzburgite xenoliths, ii) thin fine-grained cross-cutting gabbronoritic veins, constituted by opx, plagioclase and subordinate cpx, showing a fine-grained opx reaction rim against the host peridotite. Remarkably, plag and opx in these latter veins host Cl-apatite micro-crystals. Minerals in the veins are all significantly and selectively enriched in Th, U, LREE (apatite up to 30000-80000 xPM). These features indicate that parental melts to the gabbronoritic veins were Si-saturated, enriched in LILE and volatile (Cl) components and depleted in Nb, Ta, consistent with subduction-related melts reflecting either a continental crust or terrigenous sediment source. In situ U-Pb dating on zircons in the veins [7] have yielded 2.2 - 4.4 Ma ages, thus indicating a close temporal relation of this magmatic event with the Late Miocene slab detachment and the host alkaline Tallante volcanism. According to recent models [5], we propose that Neogene lithosphere extension led to uplift and migration of lithospheric mantle sectors (as the mantle presently sampled at Tallante) from an inner part of the mantle wedge towards a position above a slab edge or slab detachment zone. This allowed upwelling of hot asthenosphere which generated the alkaline magmatism, and possibly induced melting of the subducting slab [8], that originated the observed SiO2-rich melts.

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