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A Late Oligocene supra-subduction setting for the Westernmost Mediterranean revealed by andesite-derived mantle pyroxenite in the Ronda peridotite (S Spain)

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The Betic-Rif orogenic belt in the westernmost Mediterranean region was assembled in the Late Cretaceous-Early Tertiary during compressional events followed by Early Miocene post-orogenic extension. Lithospheric thinning resulted in the formation of the Alborán marine basin, the exhumation of large bodies of subcontinental lithospheric mantle (the Ronda and Beni Bousera peridotite massifs) and the extrusion of Neogene-Quaternary volcanic rocks. Slab roll-back, slab detachment, mantle lithosphere delamination, and convective thinning of the thickened lithospheric root are some of the diverse geodynamic scenarios proposed for the genesis of the Betic–Rif orogen and the associated post-orogenic volcanism.

Here we present new trace element and Sr-Nd-Pb isotopic data on Cr-rich mantle pyroxenites from the Ronda peridotite (S Spain). Previous studies have shown that they were formed after andesite-derived melts in the mantle lithosphere before the early Miocene intracrustal emplacement of the Ronda peridotite. Clinopyroxene from Cr-rich pyroxenites displays diverse trace element and Sr-Nd-Pb isotopic compositions depending on their structural occurrence in the massif. In Cr-rich layers parallel to the foliation of tectonites, clinopyroxene is LREE-depleted and has Sr-Nd-Pb isotopic compositions that overlap those of mantle peridotites and pyroxenites from orogenic massifs. In Cr-rich cross-cutting dykes intrusive into late Oligocene Grt-Sp mylonites, clinopyroxene is strongly enriched in LREE and Pb, depleted in Nb-Ta, and is in trace element exchange equilibrium with Neogene calc-alkaline lavas erupted in the western and central Mediterranean. Sr-Nd-Pb radiogenic isotopic ratios show that the mantle source of intrusive Cr-rich dykes was contaminated by a subduction component issued from continental-derived and Atlantic pelagic sediments similar to those involved in the Neogene calc-alkaline volcanism of the Alborán realm. These observations require a supra-subduction setting for the Ronda peridotite in the Late Oligocene. Rather than convective [U+2010]removal or delamination of the lithospheric root, our data provide conclusive evidence for Alborán geodynamic models invoking the role of subduction and exclude genetic models invoking exclusively a supra-mantle lithospheric origin for the geochemical signature of the Alborán arc-like magmatism and andesitic magmatism overall. The onset of subduction-related magmatism occurred shortly before the final emplacement of the massif into the crust, most likely in a back-arc continental basin formed by slab roll-back of westward receding subduction zone in the westernmost Mediterranean.