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On the tectonic emplacement of the Ronda subcontinental mantle peridotites (western Betic Cordillera)

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Composite tectonic emplacement of the Ronda peridotites – the largest outcropping body of subcontinental mantle rocks on Earth —- occurred as a result of a series of geodynamic events including: (i) Mesozoic break-up of Pangaea and opening of the Tethyan Ocean, (ii) Oligocene back-arc lithospheric extension, and (iii) Early Miocene continental subduction associated with oblique plate convergence. Top-to-the-hinterland shear along the upper contact of the peridotites during stage (iii) above is consistent with the kinematics expected for an extrusion wedge consisting of subcontinental mantle rocks. On the other hand, coeval strike-parallel extension and thinning of the crustal rocks overlying the peridotites confirms that, similarly to further Alpine-Mediterranean examples, partitioned transpression resulted in the development of a complex deformation pattern, with kinematically linked shear zones aiding exhumation. Partitioning of transpressional deformation between coeval orogen-parallel wrenching and orogen-perpendicular, pure thrusting components is recorded by shear zone kinematics and dynamothermal metamorphism in the footwall to the ultramafic rocks. Left-lateral shear, characterizing the deeper, high-pressure (eclogitic) portions of the continental subduction system, propagated through the mantle into the overlying continental crust of the overriding plate, while top-to-the foreland frontal thrusting dominated at the leading edge of the hot peridotite body. In this latter area, strongly heterogeneous deformation and extreme metamorphic gradients characterize the dominantly carbonate Nieves Unit in the footwall to the peridotites. A well-developed foliation and mineral lineation, together with isoclinal intrafolial folds, occur in silicate-bearing, calcite/dolomite marbles within a c. 1.5 km-thick metamorphic aureole underlying the peridotites. For the inferred maximum pressure of 300 MPa, petrological investigations allow to define temperature ranges for the main zones of the metamorphic aureole: forsterite zone (> 510 ºC; probably c. 700 ºC), diopside zone (510–430 ºC), tremolite zone (430–360 ºC), and phlogopite zone (360–330 ºC). Field structural analysis integrated with petrological, microstructural and EBSD textural data document large finite strains consistent with general shear within the metamorphic aureole, associated with NW-ward thrusting of the peridotites. On the other hand, post-kinematic silicate growth suggests that heat diffusion from the high-temperature peridotites continued after the final emplacement of the Ronda mantle extrusion wedge, leading to final zoning of the metamorphic aureole and to local partial annealing of calcite marble textures, particularly in the highest-temperature zone of the thermally softened footwall carbonates. Following substantial cooling, renewed crustal shortening affected the whole Nieves Unit, resulting in widespread development of NE-trending meso-scale folds.