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Strain localization in the subcontinental lithospheric mantle during the final exhumation of the Ronda Peridotite (Betic Cordillera, S-Spain)

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The Ronda massif (S-Spain) is the largest (ca. 300km2) of several orogenic peridotite massifs exposed in the Betic and Rif (northern Morocco) mountain belts in the westernmost part of the Alpine orogen that was tectonically emplaced during early Miocene times. Its latest evolutionary stages and mechanisms of exhumation and crustal emplacement are suggested to be controlled by km-scale folding and shearing along mylonitic-ultramylonitic shear zones at the base of the subcontinental lithospheric mantle section. Here we report microstructural study of strain localization in mylonitic peridotite shear zones that have been formed during the latest ductile history of the massif. The shear zones first occur as thin (<10 cm) and discontinuous bands at the base of the granular spinel peridotite domain but they get progressively wider (up to 5-10 m width) downwards in the plagioclase tectonite domain at the base of the mantle section. In the study area high-T tectonite foliation of the host plagioclase peridotite and the lower-T mylonitic shear zone foliation are subparallel and show a fairly uniform dip of 30-50° to the NNE with stretching lineation trending NE-SW in the foliation plane. Microstructures imply top-to-the-SW sense of shear.

Similarly to those observed in the overlying older spinel tectonite domain, olivine CPO in the study area show N-directed [100]-axes, subhorizontal NW-SE aligned [010]-axes, and S-SW directed [001]-axes distribution with moderate point-like maxima. However, unlike the overlying units where mostly the common high-T and low stress (010)[100] olivine slip system was described, our field observations and olivine CPO can only be correlated to each other if the unusual (001)[100] olivine slip system becomes dominant in the deformation of the plagioclase tectonite domain. The gradually increasing fabric strength from the plagioclase tectonite ground rock (J-indices of 2.8-3.5) to the mylonitic peridotite of the shear zone (J-indices of 5.7-6.8) also supports that this unusual slip system has become progressively active during the latest ductile deformation of the massif. We propose that the switch of dominant slip systems is the result of preferential reutilization of favorably oriented slip planes of earlier deformation events. Overprinting of pre-existing structures can be achieved by a rapid change in the kinematic regime, such as the back-arc basin inversion proposed to be responsible for large scale folding at the base of the Ronda mantle section.