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Fluid-assisted strain localization in peridotites during emplacement of the shallow subcontinental lithospheric mantle

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Here we report a microstructural study of fluid-assisted ductile strain localization in a mylonitic-ultramylonitic peridotite shear zone in the shallow subcontinental lithospheric mantle (Ronda massif, Southern Spain). The studied shear zone localized in a highly attenuated mantle lithosphere associated with kilometer-scale folding recorded in the base of the Ronda massif. For the formation of the such structures, geodynamic models suggest backarc basin inversion during late Oligocene southward collision of the Alborán Domain with the paleo-Maghrebian passive margin leading to the intracrustal emplacement of the Ronda peridotites in the earliest Miocene (21-23 Ma). Strain localization occurred at low pressure (<0.8 GPa) in the temperature range of 750-1000°C. It started under relatively dry conditions, resulting in formation of mylonites. Focusing of aqueous fluids favored the activation of dissolution-precipitation creep, resulting in further strain localization in two generation of ultramylonitic bands, which are composed of fine-grained nearly homogeneous olivine-orthopyroxene aggregates. Microstructural observations suggest alternating dissolution and precipitation of olivine and orthopyroxene, which may be explained by changes in Si molality of the percolating fluid due to pressure fluctuations. Olivine CPO indicate high activity of (001)[100] glide, probably due to the presence of interstitial fluids during deformation. CPO is well developed in the mylonites, but weak to very weak in the ultramylonite bands, consistent with the increasing contribution of dissolution-precipitation to deformation in the latter. Orthopyroxene CPO in the shear zone cannot be explained by dislocation glide in any known slip system for enstatite. It mimics that of olivine, suggesting topotaxial growth.