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How dynamic recrystallization affects olivine crystal preferred orientations

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Spinel peridotite mantle xenoliths from Persani Mountains, Romania, derived from about a 20 km depth-transect of the shallow subcontinental lithosphere display deformation by dislocation creep accompanied by dynamic recrystallization at continuously varying temperature, strain rate and stress conditions. The continuous variation in deformation conditions allowed us to characterize the effect of dynamic recrystallization on olivine fabric strength, which is the main parameter controlling the anisotropy of physical properties, such as electrical conductivity, seismic wave propagation and thermal diffusivity in the upper mantle.

We have defined a dimensionless dispersion factor, which describes the randomization of crystallographic orientations of recrystallized grains with respect to the parental porphyroclasts. This dispersion factor is largely independent of the number of grains analyzed, of the recrystallized grain size, which directly relates to the deviatoric stress, and of the overall fabric strength. This suggests that, for a large range of stress, strain rate and temperature conditions, recrystallization could result in similar dispersion in the orientation of recrystallized grains with respect to the orientation of the parental grains. Consequently, the olivine fabric strength seems to be dominantly controlled by the volume of recrystallized grains, which depends mainly on finite strain, whereas strain rate and temperature conditions act only via grain growth, that tends to counteract the effect of subgrain rotation and strengthen the CPO.