



## Two-phase deformation in peridotite: recrystallization and phase-mixing

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Solid-state interaction of phases may give rise to the formation of mixed, fine-grained interconnected layers in the ductile portion of the lithosphere. Strength reduction via this mechanism is a distinct possibility, facilitating plate tectonics. In this study, we explore the microstructural evolution in a representative olivine (75%)–orthopyroxene (25%) mixture deformed to large strains at different temperatures. We used a Griggs deformation apparatus to deform the pre-sintered, coarse-grained aggregates in simple shear geometry at 1.5–2.0 GPa and 1173 to 1543 K at a strain rate of  $\sim$ 10–4 s<sup>-1</sup>. The water content in these samples was moderate (about 100 wt. ppm H<sub>2</sub>O after deformation). Our results show that the addition of orthopyroxene causes substantial reduction of the bulk strength following an initial higher stress, within a certain temperature window (> 1273–1523 K). Microstructural analysis shows extensive dynamic recrystallization of parent grains and phase-mixing of recrystallized grains. We observe a possible correlation between highly-strained and recrystallizing orthopyroxene grains and their orientation towards favourable slip, suggesting dislocation processes actively contributed to grain size reduction. In mixed regions, second-phase grain-boundary pinning follows a possible Zener relationship. We interpret the present results using a model where the influence of both grain-size sensitive rheology and of grain-growth is considered. The addition of orthopyroxene substantially expands the conditions for weakening in the grain-size-sensitive creep regime by reduction of grain-growth kinetics. On the contrary, preliminary experiments on water-saturated samples using the 6-ram press at BGI show a lack of phase-mixing in the same temperature range, owing to water-enhanced grain growth kinetics of olivine in particular. However, at larger strains ( $\gamma = 1.7$  at 1273 K) small orthopyroxene grains tend to align on olivine grain boundaries. Evolution of grain size and lattice preferred orientation of both phases in these wet deformed samples will also be briefly discussed.