Experimental confirmation of a spineloid transitional olivine polymorph using ultrafine-grained aggregates of Mg_2GeO_4

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Ultrafine-grained aggreagtes of Mg_2GeO_4 were synthetized using spark plasma sintering and deformed using an 1-atm deformation rig between 950˚C and 1200˚C. Observations with SEM, EBSD, XRD and Raman together confirm that the samples consist of α-olivine with minor enstatite, with a grain size of 1-10 microns. Deformation data indicate an extreme softening of the material around 100 MPa in samples deformed at temperatures of 1000˚C or above. This softening is followed by a sharp hardening, suggesting that the fast deformation process ended.
The olivine-spinel transition in Mg_2GeO_4 occurs around 810˚C, and all experiments were done in the stability field of olivine. The deformation curves, supported by Raman and XRD data, suggest that ω-olivine, expected by Poirier in 1981, and observed in Mg_2GeO_4 within a meteorite in 2017, transiently forms during the deformation. ω-olivine is a spineloid metastable olivine, which does not have any stability field in a P-T diagram, but it might have one in a P-T-σ diagram. It was reproduced in the stability fields of β-olivine (Guyot et al., 1991) of γ-olivine (Reynard et al., 1994). Here I show that it can also form in the stability of α-olivine.
It seems that the transition occurs only between 1000˚C and 1150˚C when the stress approaches 100 MPa, as a result of a competition between diffusional and displacive processes.
The existence of ω-olivine in stressed mantle regardless of stability fields could have major consequences on how we understand the solid-state olivine-spinel transition and related earthquakes triggering. Below 1200˚C, if ω-olivine does not form then α-olivine is metastable.

Keywords: olivine-spinel transition, ω-olivine, mantle, laboratory, metastable, martensitic