Mechanical anisotropy of olivine polycrystals: a comparision between laboratory data and viscoplastic self-consistent models

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Textured olivine aggregates are mechanically anisotropic. Laboratory data [1,2] show that aggregates first deformed in torsion and then in extension have tensional strengths up to 1.9 times higher than the torsional ones. The mechanical anisotropy increases with texture (crystal preferred orientation or CPO) intensity. Yet these experiments only tested the contrast in mechanical behavior between simple shear and axial tension; this is not sufficient to fully characterize the mechanical anisotropy of olivine polycrystals. Numerical models allow the prediction of the viscoplastic behaviour of a polycrystal as a function of the full range of orientation relations between the mechanical solicitation and the texture. Viscoplastic self-consistent (VPSC) models predict mechanical anisotropy similar to that observed in experiments: polycrystals in which the CPO is oriented oblique to extensional stresses deform faster than those where the CPO is parallel or normal to the imposed extension [3]. Low strengths also characterize polycrystals sheared parallel or normal to the main orientation of the dominant olivine glide plane (010). Here we present a direct comparison between the mechanical predictions of VPSC models and the experimental data [1,2], which shows that the models predict higher anisotropy magnitudes than observed in the laboratory. VPSC models reproduce the strengths measured in torsion. However, for tension the stresses predicted by the models are on average 2.5 times higher than the experimental ones, leading to tensional strengths up to 4.5 times higher than in torsional ones. The difference in model predictions and experimental results is consistent with activation, in the fine-grained experimental polycrystals, of other deformation mechanisms in addition to dislocation creep. VPSC models including additional isotropic deformation processes do reproduce the experimental data.

[1] Hansen *et al*. (2012) *Nature*, **492**, 415-418. [2] Hansen et al. (2016) EPSL **445**, 92-103. [3] Knoll *et al*. (2009), *G-Cubed*, **10**: Q08009. This project has received funding from the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie grant agreement No 642029 - ITN CREEP