Mechanism/s of deformation and strength of experimentally deformed hornblende-rich amphibolite with a strong pre-existing texture

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Amphibole is an important mineral in rocks of the lower crust and in subduction zones, forming as the product of metamorphic reactions and hydration of mafic rocks. As such, the textural and rheological properties of amphibole are of relevance for assessing the physical properties of these tectonic provinces. Aggregates containing amphibole grains often exhibit a strong texture, i.e., a crystallographic preferred orientation (CPO). Since amphibole possesses inherent anisotropic properties, the CPO will affect the bulk strength and elastic properties. However, amphibole's rheological behavior is not well understood as its capability to deform purely via plastic deformation remains unresolved, previous studies suggesting numerous deformation mechanisms such as semi-brittle and cataclastic flow, dissolution precipitation, dislocation creep, recrystallization, micro-twinning, and diffusion assisted creep. Here, we use pre-textured natural samples cored at 60° to the foliation and lineation to investigate the deformation mechanism/s activated in a polycrystalline aggregate/rock of well-oriented amphibolite-rich hornblende. Samples from the Mamonia complex (Cyprus) with hornblende as the dominant mineral (> 70 % modal fraction) and strong initial alignment of the [001] axis were deformed using a Griggs-type solid-medium apparatus. Experiments were run at 1 GPa confining pressure, temperatures of 400 to 800 °C, and a strain rate of ~10⁻⁵ 1/s. Samples show temperature-dependent differential stress that falls below the Goetze criteria (i.e., below the confining pressure, 1 GPa) - ~700, 500, and 200 MPa for samples deformed at 400, 600, and 800 °C, respectively. Microstructural analysis using Electron backscatter diffraction (EBSD) reveals folding and kink bands, accommodated by both plastic mechanisms, via dislocation glide on the hornblende easy slip system, and brittle mechanisms, via micro-fracturing along the crystal cleavage (110). We discuss the implications of the interplay and contribution of different deformation mechanisms for our ability to translate laboratory experiments to flow laws for the lower mantle and subduction zone interfaces.