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Dislocation mobility in ringwoodite as a function of temperature and water content

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Ringwoodite is the dominant mineral in the lower part of the Earth's mantle transition zone from 520 to 670 km depth. Understanding the creep properties of ringwoodite is thus essential to know the geodynamical process at this depth. Dislocation creep, which could cause seismic anisotropy and non-Newtonian viscosity, is an important creep mechanism for high temperature plastic deformation of minerals. Since the dislocation creep rate is controlled by the mobility of dislocations, we measured the dislocation mobility in ringwoodite single crystals as a function of temperature and water content under the mantle transition zone conditions.

The ringwoodite single crystals were synthesized from natural olivine at 1800 K and 22 GPa in a multi-anvil apparatus. The crystals were deformed after synthesization by increasing the load to create high density dislocations. The deformed crystals were surrounded by CsCl and annealed at 22 GPa, 1600-2000 K for dislocation recovery. The water contents in the crystals were measured by Fourier transform infrared, the dislocation densities before and after recovery were determined by transmission electron microscopy, and the dislocation mobility were calculated from the dislocation densities and annealing durations.

The activation enthalpy for dislocation mobility is 360 ± 90 kJ/mol. This value is much lower than that for Si diffusion (480 ± 90 kJ/mol), but similar to that for O diffusion (370 ± 80 kJ/mol) (Shimojuku et al., 2009). It is probably because the dislocation movement in ringwoodite is controlled by both Si and O due to their similar diffusion rates (less than 0.5 orders of magnitude difference, Shimojuku et al., 2009). Temporary results suggest that the water content exponent for the dislocation mobility in ringwoodite is about $1.1(\pm0.9)$. Namely, in contrast with olivine (Fei et al., 2013; 2014), water may have large effect on ringwoodite rheology. But more experimental data are required for precise determination of the water content exponent.

Shimojuku et al. (2009), *EPSL* **284**, 103-112.
Fei et al. (2013), *Nature* **498**, 213-215.
Fei et al. (2014), *JGR* **119**, 7598-7606.

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