Strength of (Mg,Fe)O ferropericlase at high-pressures and high-temperatures and slab stagnation in the shallow lower mantle

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The Earth's lower mantle constitutes more than 50% of Earth's volume and is the largest geochemical reservoir for many elements. Material transport from Earth's surface into the deep mantle occurs by subduction of oceanic lithosphere. Seismic observations indicate stagnation and broadening of subducting slabs in the shallow lower mantle, but the underyling principle is unclear.

Ferropericlase (Mg,Fe)O is thought to be the second most abundant mineral in Earth's lower mantle. Due to its potentially weak rheological behavior it may play a key role in controlling rheology, particularly in high strain areas in the Earth's mantle such as around subducting slabs.

Here, we present new results from synchrotron radial x-ray diffraction measurements on the deformation behavior of (Mg,Fe)O at high-pressures and high-temperatures. One set of experiments was performed on $(Mg_{0.8}F_{0.2})O$ at the Advanced Light Source (Lawrence Berkeley National Laboratory) up to 96 GPa at 300 K. A second suite of data were collected at the Extreme Conditions Beamline of PETRA III (DESY) to 70 GPa at 850 K and 40 GPa at 1150 K.

From our data, we calculate the flow strength of ferropericlase, which we find to increase by a factor of 3 at pressures from 20 to 65 GPa at 300 K. Modelling based on our experimental data indicates a 2.3 orders of magnitude increase of viscosity around subducting slabs in the upper 900 km of the lower mantle [1]. Such a strong viscosity increase can lead to stagnation of sinking slabs in the shallow lower mantle as observed by seismic tomography.

[1] Marquardt & Miyagi (2015) *Nature Geoscience* **8**, 311-314, doi:10.1038/ngeo2393.