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Effect of temperature and Al content on water solubility in periclase

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The presence of water in the Earth's mantle is underlined by the degassing via volcanism and the observation of mantle minerals raised by xenoliths in magmas. Because thermal conditions in the mantle are too hot for hydrous minerals to be stable, traces of water are likely to be dissolved as hydroxyl point defects in nominally anhydrous minerals (NAMS). Such water is going to have large effects on transport properties of the mantle which depend on the concentration and nature of point defects. In the lower mantle (670-2900 km) water is likely to be stored in ferropericlase (Mg,Fe)O. The effect of iron has been shown to be minimal (Bolfan-Casanova et al, 2006) but the effect of aluminum is unknown.

Multi-anvil press experiments were conducted at 10 GPa and 1400˚C on Al-doped periclase (MgO) to constrain the effect of incorporation of aluminum on its water solubility. Results show that incorporation of Al^{3+} in pure periclase favors incorporation of hydrogen, and the water contents measured by FTIR increase non-linearly with increasing Al content, indicating more complex behavior than $2Mg^{2+} = Al^{3+} + H^{+}$.

Experiments are also being conducted at 10 GPa as a function of temperature on pure periclase. These results will help us to understand the temperature dependence of water solubility in pure periclase, at high pressures where water is not a pure fluid. The results will constrain the incorporation mechanism of H linked to trivalent cations in periclase, which are likely to control, with temperature, the water content of ferropericlase and hence the water content of the lower mantle since perovskite is likely to be very dry.