Stability of low-spin phase D in the lowermost mantle

J. P. S. Walsh, S. M. Clarke, E. Greenberg, V. B. Prakapenka, D. E. Freedman, and S. D. Jacobsen

The Earth's mantle constitutes half of the planet's mass and may contain several times the amount of water as the combined surface reservoirs, dispersed within high-pressure silicates and melts. Water is cycled between the crust and mantle *via* plate tectonics, but there is also evidence for primordial reservoirs in the deeper mantle (Hallis *et al.*, 2016). Evidence for H_2O-bearing phases trapped as inclusions in diamond emanating from the transition zone (410–660 km depth), and deeper still from the top of the lower mantle (~700-800 km depth), suggest that hydrous melts and minerals are present throughout most of the Earth's mantle (Pearson *et al.*, 2014; Palot *et al.*, 2016). A major question is: what are the dominant host minerals for water in the lower mantle, *i.e.* at depths of around 660–2900 km? Among all of the known dense hydrous magnesium silicates, phase D ($MgSi_2O_4(OH)_2$) and phase H ($MgSiO_4H_2$) are expected to have the highest stability in the lowermost mantle. Ohtani *et al.* (2014) found phase H stable in the peridotite system from 35–65 GPa at elevated temperatures, with a possibly expanded stability upon dissolution of the isostructural δ-AlOOH component. The magnesium end-member of phase D breaks down at 20–30 GPa at temperatures above ~1300–1400 °C, and at around 50 GPa below 1000 °C (Frost and Fei, 1998). However, a spin transition was recently observed in iron bearing phase D at around 40–65 GPa (Chang *et al.*, 2013), and the stability of the low spin phase may be stable to much lower depths. We are investigating the high *P*–*T* stability of Fe- and Al-bearing phase D at deeper mantle conditions using the laser-heating setup at GSECARS. Our results place new constraints on the stability of this family of hydrous minerals, with implications for which hosts carry water into the deep Earth.