The effect of spin crossover in lower mantle silicate perovskite (Pv) and ferropericlase (Fp) on the iron-partitioning between these two phases remains uncertain, mainly due to the lack of *in situ* experiments under the relevant pressure and temperature conditions. Combining *in situ* synchrotron X-ray absorption and diffraction measurements of natural $(Mg_{0.88}Fe_{0.12})_2SiO_4$ San Carlos olivine and synthetic ringwoodite at pressures between 22 GPa and 115 GPa treated at temperatures 1950 K to 2300 K, we found that temperature promotes iron partitioning into silicate perovskite, while pressure acts oppositely. There is a limited but clear effect of spin crossover in co-existing Pv and Fp on iron partitioning which, in turn, promotes chemical homogeneity within the Earth's spin transition zone.

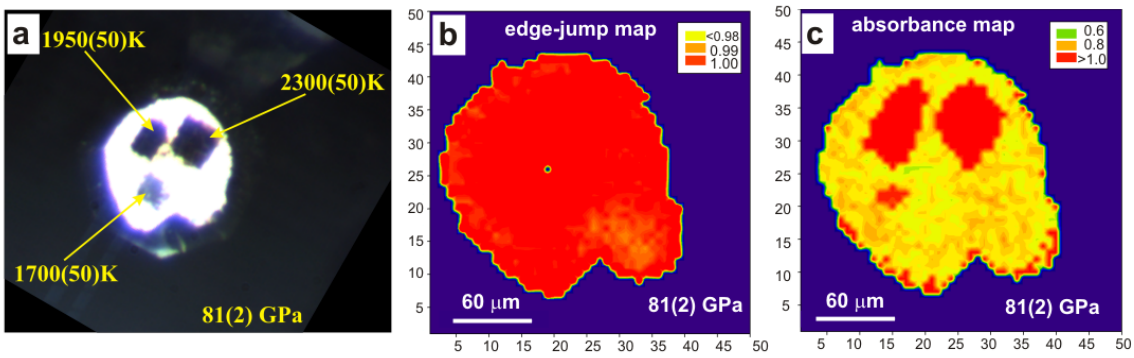

Fig. 1. (**a**) Photograph of the starting ringwoodite material compressed in a LiF pressure medium in a diamond anvil cells, where different parts of the sample were laser heated at 1700(50) K, 1950(50)K and 2300(50) K at 81(2) GPa. Pre-normalised XANES edge-jump map (**b**) and normalised absorbance map, plotted at 7132 eV (**c**), collected after laser heating at 81(2) GPa.

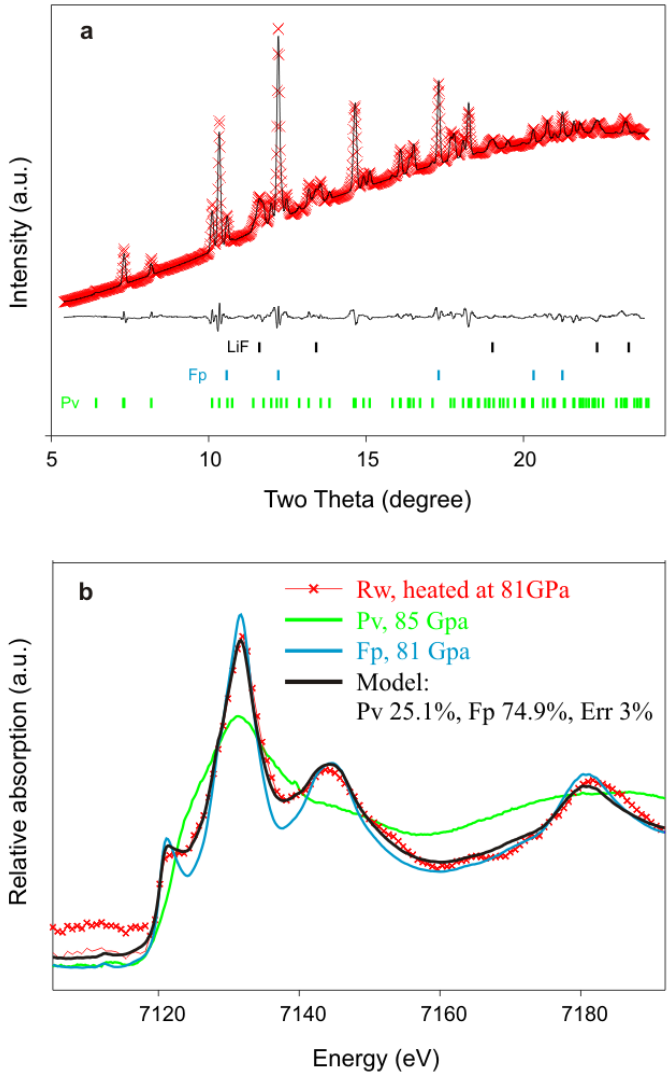

Fig. 2. (**a**) X-ray diffraction pattern (wavelength 0.4141 Å) from the $(Mg_{0.88}Fe_{0.12})_2SiO_4$ ringwoodite laser heated at 2300(50) K and 88(2) GPa. Apart from LiF only diffraction peaks from silicate perovskite and ferropericlase are observed which confirms the complete decomposition of the ringwoodite to perovskite and ferropericlase in the proportion 1:1 via the breakdown reaction. (**b**) Deconvolution of the XANES spectrum, collected from the area that was laser-heated at 81(2)GPa and 2300(50) K, to the "perovskite" (25.1 ± 5%) and "ferropericlase" (74.9 ± 5%) XANES components (Muñoz et al., 2008; Aquilanti et al., 2009; Narygina et al., 2009), collected at the same pressure.

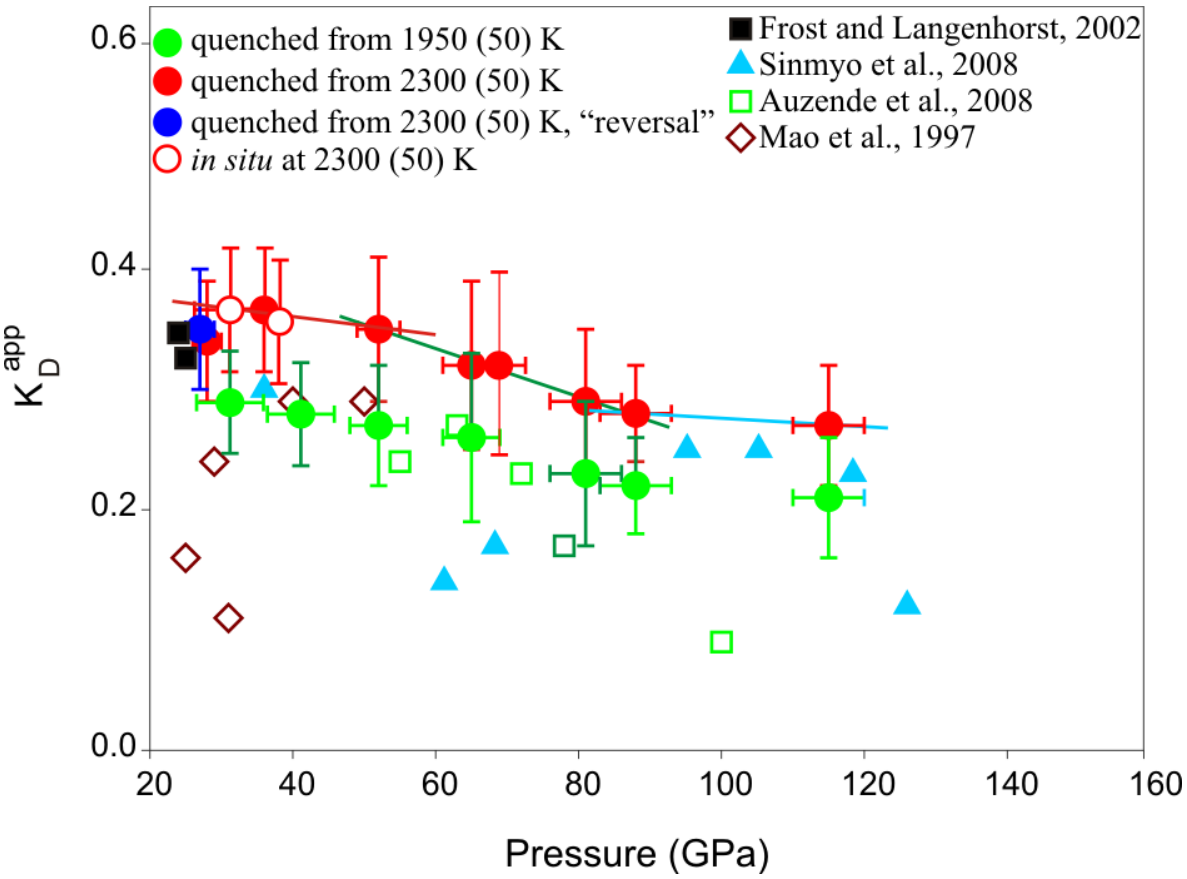

Fig. 3. Apparent Fe-Mg partition coefficient between $(Mg,Fe)SiO_3$ perovskite and (Mg,Fe)O ferropericlase (defined in Eq. 2) as a function of pressure at 1950(50) K (green closed circles) and 2300(50) K (open red and closed red and blue circles), obtained in this study. Open red circles represent K_D values obtained from the data collected *in situ* at high pressure and high temperature. The blue point was obtained on decompression from the part of the ringwoodite sample that was initially laser heated at 81(2) GPa to 2300(50) K. Red, blue and green solid lines represent fit of the experimental data to Eq. S3 with the following parameters: ΔH = 24.2 kJ/mol, ΔS = 3.29 J/mol K, ΔV = 0.066 cm^3/mol (red line), ΔH = 14.64 kJ/mol, ΔS = 0.513 J/mol K, ΔV = 0.127 cm^3/mol (green line) and finally ΔH = 23.4 kJ/mol, ΔS = 0.59 J/mol K and ΔV = 0.026 cm^3/mol (dark blue line). For comparison, some previously published results are shown.