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Mg/Si ratios of aqueous fluids coexisting with forsterite and enstatite based on the phase relations in the Mg_2SiO_4-SiO_2-H_2O system

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ABSTRACT

Direct observation of aqueous fluids coexisting with $MgSiO_3$ (enstatite) and/or Mg_2SiO_4 (forsterite) was performed at 0.5–5.8 GPa and 800–1000 °C with an externally heated diamond-anvil cell and synchrotron X-rays. At 1000 °C in the $MgSiO_3$–H_2O system, forsterite crystallizes below 3 GPa but not above that pressure. At 1000 °C in the Mg_2SiO_4–H_2O system, forsterite congruently dissolves into the aqueous fluids up to 5 GPa. These observations suggest that the aqueous fluids coexisting with enstatite and forsterite have Mg/Si < 1 below 3 GPa and 1 < Mg/Si < 2 above that pressure.

Comparison with the previous studies reporting Mg/Si ratios of the aqueous fluid coexisting with enstatite and forsterite indicates that the Mg/Si ratios change rapidly from SiO_2-rich to MgO-rich at around 3 GPa and 1000 °C. This change can be related to possible structural changes of liquid water under these conditions. The aqueous fluids coexisting with enstatite and forsterite do have Mg/Si ratios similar to those found in the partial melts of H_2O-saturated peridotite. Somewhere within the upper mantle, these two fluids unite to form a single regime and cannot be distinguished from each other.