

Enstatite-forsterite-water equilibria at elevated temperatures and pressures

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ABSTRACT

The compositions of aqueous fluids in equilibrium with enstatite + forsterite were investigated at temperatures from 900 to 1200 °C and pressures from 1.0 to 2.0 GPa. Experiments, performed in a piston-cylinder apparatus, involved the location of phase boundaries between the stability fields of enstatite and enstatite + forsterite, and enstatite + forsterite and forsterite. The intersection of these two phase-boundaries near the H₂O apex was used to define the fluid composition. The results indicated a systematic increase in the concentration of silica in the fluid phase with increasing temperature. The experiments indicated that the concentration of dissolved MgO was below 0.3 mol% and not resolvable using our techniques. This finding was corroborated by microprobe analyses of quench precipitates from the fluid phase, which gave on average 0.2 mol% MgO. Because of the low MgO concentrations, the mean values of the intercepts with SiO₂-H₂O binary of the fitted lines representing, respectively, the phase boundaries between the enstatite and enstatite + forsterite and between the enstatite + forsterite and forsterite stability fields were taken to represent the concentrations of dissolved silica at the various temperatures and pressures of the present study. The concentrations increased from 0.6 mol% at 900 °C to 3.9 mol% at 1200 °C at 1.0 GPa. The pressure effect from 1.0 to 2.0 GPa at 1000 °C appeared to be minor and not resolvable using our techniques. At 1.0 GPa, the base 10 logarithm of the molal concentration of dissolved silica in equilibrium with enstatite + forsterite was obtained combining data from the present study with those from Nakamura and Kushiro (1978) and Manning and Boettcher (1994):

$$\log m_{\text{SiO}_2(\text{aq})}^{\text{En-Fo}} = 6.869 - 1.335 \times 10^4 / T(\text{K}) + 5.544 \times 10^6 / T(\text{K})^2.$$

Comparison with studies of the solubility of quartz (Manning 1994) indicated that thermodynamic properties of aqueous silica derived from silica-saturated systems may not be applicable to calculations in silica-deficient systems at high pressure.