

LETTER

Hydration state and activity of aqueous silica in H₂O-CO₂ fluids at high pressure and temperature

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ABSTRACT

Quartz solubility in H₂O-CO₂ fluids was measured at 800 °C and 10 kbar. Mixed fluids were generated from hydrous oxalic acid, silver oxalate, silver carbonate, and liquid H₂O; solubility was determined by weight changes of the quartz crystals. Stringent blank tests and weighing procedures were used to establish the CO₂ and H₂O contents of experimental fluids. Using experimentally constrained models of H₂O activity and mixing of silica monomers and dimers, a logarithmic plot of monomer activity vs. H₂O activity yields a linear data array of constant slope n insignificantly different from 4 ($n = 4.024$, $R^2 = 0.997$), where n is the total monomer hydration number. Moreover, all high-quality quartz solubility data in H₂O-CO₂ fluids at lower temperature and pressure fall on the same line when SiO₂ and H₂O activities are calculated with this formulation. The same analysis for the dimer yields slope n of 7 ($n = 7.049$, $R^2 = 0.996$). Our results show that neutral silica monomers and dimers have fixed stoichiometry of Si(OH)₄·2H₂O and Si₂O(OH)₆·4H₂O (i.e., two solvating H₂O molecules per Si) in H₂O-CO₂ fluids for a large range of crustal metasomatic processes. This provides a simple basis for modeling H₂O-CO₂-SiO₂ fluids over a range of pressure, temperature, CO₂, and SiO₂ activity.

Keywords: Quartz solubility, crustal fluids, experimental petrology, thermodynamics