

CHEMISTRY AND MINERALOGY OF EARTH'S MANTLE

Formation of SiH₄ and H₂O by the dissolution of quartz in H₂ fluid under high pressure and temperature‡

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ABSTRACT

Species dissolved in H₂ fluid were investigated in a SiO₂–H₂ system. Raman and infrared (IR) spectra were measured at high pressure and room temperature after heating experiments were conducted at two pressure and temperature conditions: 2.0 GPa, 1700 K and 3.0 GPa, 1500 K. With the dissolution of quartz, a SiH vibration mode assignable to SiH₄ was detected from Raman spectra of the fluid phase. Furthermore, an OH vibration mode was observed at 3260 cm⁻¹ from the IR spectra at 3.0 GPa. With decreasing pressure, the OH vibration frequencies observed between 3.0 and 2.1 GPa correspond to that of ice VII, and those observed at 1.4 and 1.1 GPa correspond to that of ice VI. These results indicate that the chemical reaction between dissolved SiO₂ components and H₂ fluid caused the formation of H₂O and SiH₄, which was contrastive to that observed in SiO₂–H₂O fluid. Results imply that a part of H₂ is oxidized to form H₂O when SiO₂ components of mantle minerals dissolve in H₂ fluid, even in an iron-free system.

Keywords: H₂–H₂O fluid; dissolution; Raman; IR; laser-heated diamond-anvil cell