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Solubility of quartz in water vapor at 400-800°C and 25-300 bar

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Low-density hydrothermal fluids play a fundamental role in the chemical evolution of the Earth's crust, spanning from volcanic to low-temperature environments. These aqueous fluids resemble gas-like vapor and may contain a variety of elements, yet their solubility and molecular chemistry are not well understood. In this study, we present the results of solubility measurements of quartz at temperatures of 400-800°C and pressures of 50-300 bar. The experiments were conducted using state-of-the-art U-tube reactor systems that enable fast and reliable solubility measurements across a wide range of temperatures and pressures. The experimental results were analyzed assuming complete ion-pairing of the molecular species in the vapor phase followed by hydration (H_2O addition) of such neutral gas moieties with increasing water pressure. As pressure increases, the hydration number was fond to increase, while the stability of smaller solute-water clusters increases with increasing temperature. Based on the experimental results and data processing, thermodynamic values (ΔG_r, ΔH_r, ΔS_r, $\Delta C_{p,r}$) have been obtained for the solubility of quartz to form hydrated neutral silica gas compounds as a function of temperature and pressure. These values are subsequently utilized to model silica transport behavior in upper crustal environment. The project has received funding from the European Union’s Horizon 2020 under Grant Agreement #818169 (GeoPro).