



Solubility of magnesium silicates and carbonates in high-pressure COH fluids

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High-pressure aqueous fluids are able to transport significant amounts of dissolved species derived from interaction with rock-forming minerals. Experimental constraints on the extent of mineral dissolution are therefore crucial to understand metasomatic processes closely related to the mass transport of elements by high-pressure fluids. We experimentally investigated the dissolution of forsterite, enstatite and magnesite in graphite-saturated COH fluids, synthesized using a rocking piston cylinder apparatus at pressures from 1.0 to 2.1 GPa and temperatures from 700 to 1200 °C. Synthetic forsterite, enstatite, and nearly pure natural magnesite were used as starting materials. Redox conditions were buffered by Ni–NiO–H₂O ($\Delta\text{FMQ} = -0.21$ to -1.01), employing a double-capsule setting. Fluids, binary H₂O–CO₂ mixtures at the P, T, and fO₂ conditions investigated, were generated from graphite, oxalic acid anhydrous (H₂C₂O₄) and water. Their dissolved solute loads were analyzed through an improved version of the cryogenic technique, which takes into account the complexities associated with the presence of CO₂-bearing fluids. The experimental data show that forsterite + enstatite solubility in H₂O–CO₂ fluids is higher compared to pure water, both in terms of dissolved silica ($m\text{SiO}_2 = 1.24$ mol/kgH₂O versus $m\text{SiO}_2 = 0.22$ mol/kgH₂O at P = 1 GPa, T = 800 °C) and magnesia ($m\text{MgO} = 1.08$ mol/kgH₂O versus $m\text{MgO} = 0.28$ mol/kgH₂O) probably due to the formation of organic C–Mg–Si complexes. Our experimental results show that at low temperature conditions, a graphite-saturated H₂O–CO₂ fluid interacting with a simplified model mantle composition, characterized by low MgO/SiO₂ ratios, would lead to the formation of significant amounts of enstatite if solute concentrations are equal, while at higher temperatures these fluid, characterized by MgO/SiO₂ ratios comparable with that of olivine, would be less effective in metasomatizing the surrounding rocks. However, the molality of COH fluids increases with pressure and temperature, and quintuplicates with respect to the carbon-free aqueous fluids. Therefore, the amount of fluid required to metasomatize the mantle decreases in the presence of carbon at high P–T conditions. COH fluids are thus effective carriers of C, Mg and Si in the mantle wedge up to the shallowest level of the upper mantle.