



Experimental determination of forsterite, enstatite and magnesite solubilities in graphite-saturated and redox-buffered high-pressure COH fluids (invited)

Carla Tiraboschi (1), Simone Tumiati (1), Dimitri Sverjensky (2), Thomas Pettke (3), Peter Ulmer (4), and Stefano Poli (1)

(1) University of Milan, Dipartimento di Scienze della Terra, Milan, Italy (tiraboschi.carla@gmail.com), (2) Johns Hopkins University, Department of Earth & Planetary Sciences, Baltimore, USA, (3) University of Bern, Institute of Geological Sciences, Bern, Switzerland, (4) ETH Zürich, Institute of Geochemistry and Petrology, Zürich, Switzerland

Subduction zone fluids are able to mobilize and transport significant amounts of dissolved species resulting from fluid-rock interactions at high pressure. Experimental data, thermodynamic models and natural samples provide evidence for silicate solutes and dissolved carbon species in deep fluids, although the effect of carbon on mantle minerals solubility is still poorly constrained.

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 $f\text{O}_2$ 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 ($m\text{SiO}_2 = 1.24 \text{ mol/kg}_{\text{H}_2\text{O}}$ vs. $m\text{SiO}_2 = 0.22 \text{ mol/kg}_{\text{H}_2\text{O}}$ at $P = 1 \text{ GPa}$, $T = 800 \text{ °C}$) and magnesia ($m\text{MgO} = 1.08 \text{ mol/kg}_{\text{H}_2\text{O}}$ vs. $m\text{MgO} = 0.28 \text{ mol/kg}_{\text{H}_2\text{O}}$) 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 shallowest level of the upper mantle.