



Experimental constraint on the dihedral angle in olivine-H₂O-CO₂ system in subduction zones

Yongsheng Huang (1), Takayuki Nakatani (1), Michihiko Nakamura (1), and Catherine Mccammon (2)

(1) Earth Science, Tohoku University, Sendai, Japan (huang.yongsheng.s8@dc.tohoku.ac.jp), (2) Bayerisches Geoinstitut, University of Bayreuth, Bayreuth, Germany

Fluid circulation in subduction zones is an important controlling factor of arc magma genesis and element cycling. The threshold dihedral angle of fluid interconnection is 60° in an isotropic system. Dihedral angles between olivine and H₂O have been extensively examined in a wide range of pressure (P) and temperature (T) to constrain the fluid connectivity in the mantle wedge. The dihedral angles in CO₂-bearing systems are, however, less constrained despite its importance as a component of subduction zone fluid. Exploration of the dihedral angles with CHO fluids in a broad P–T conditions is vital to fully understand the fluid connectivity in the mantle wedge.

We conducted the annealing experiments in the systems of olivine–H₂O and olivine–H₂O–CO₂ ($X(\text{CO}_2) = 0.33\sim 0.5$) at 1.0–3.0 GPa and 800–1100°C for 72–192 hours by using piston cylinder apparatus at Tohoku University and Bayerisches Geoinstitut, Bayreuth University. The run products were observed with FE-SEM and more than 200 olivine–olivine–fluid apparent dihedral angles were measured to obtain the true dihedral angle. In the H₂O system, the solid phase is only olivine at all the P–T conditions. On the other hand, in the H₂O–CO₂ systems, magnesite and orthopyroxene were present along with olivine at 2.0 GPa and 800–1000°C, and 3.0 GPa and 800–1100°C due to the reaction between olivine and CO₂. Dihedral angles in the pure H₂O system decreased with increasing P and T. In the H₂O–CO₂ systems, dihedral angles also decreased with increasing T at 1.0 GPa, but were always larger than those in the H₂O system. In addition, the angles increased with increasing CO₂ content in the aqueous fluid at 1.0 GPa, which suggested that nonpolar CO₂ molecules increase the interfacial energy between olivine and aqueous fluid. The dihedral angle at 2.0 GPa and 1100°C was also higher than that in the H₂O system. However, at the other P–T conditions where magnesite and orthopyroxene formed, dihedral angles were comparable to or smaller than those in the H₂O system. Since formation of magnesite reduces the CO₂ content in the aqueous fluid, it could decrease the dihedral angles close to the values in the pure H₂O system. However, this factor alone cannot explain the angles smaller than those in the pure H₂O system. The presence of magnesite and orthopyroxene could change the solute species and solute content in the aqueous fluid, which might reduce the interfacial energy between olivine and aqueous fluid and thus decrease the dihedral angle constrained by the olivine–magnesite–orthopyroxene equilibrium. Our results indicate that presence of CO₂ does not always increase the dihedral angle, i.e. it can reduce the angle even below 60° at relatively high pressure and low temperature conditions where olivine partly reacts with CO₂ to form magnesite and orthopyroxene. This work was supported by the JSPS Japanese-German Graduate Externship.