The effect of faceting on olivine wetting properties

*Yongsheng HUANG[1], Takayuki Nakatani[1], Sando Sawa[1], Michihiko Nakamura[1], Catherine McCammon[2]

1. Graduate School of Science, Tohoku University, 2. Bayerisches Geoinstitut, University of Bayreuth

Grain-scale pore geometry exerts a primary control on the fluid distribution in rocks, affecting the element cycling and geophysical response. The dihedral angle in the olivine-fluid system is a key parameter to determine the fluid pore geometry in mantle wedges. Both curved and faceted olivine-fluid interfaces define the dihedral angle in the system generating the faceted-faceted (FF), faceted-curved (FC), and curved-curved (CC) angles, but the effect of faceting on the dihedral angle is poorly constrained and its mineralogical understanding is still lacking. Here we evaluated the facet-bearing dihedral angles and their proportions in olivine-fluid systems. The results show that 1/3 olivine-fluid dihedral angles are facet-bearing angles irrelative to the P–T conditions and fluid compositions. The values of facet-bearing angle are comparable to or larger than the CC angle. The Electron Back-Scattered Diffraction (EBSD) analysis show that the run products have not intense crystallographic preferred orientation (CPO) corresponding to static compression conditions. Strikingly, the grain boundary plane distribution (GBPD) reveals that grain boundary planes of faceted and curved interface at triple junctions were subjected to low (e.g., (010), (001), (100)) and high (e.g., (015), (152), (203), (320)) Miller Index faces, respectively. Moreover, the calculation of angle values between two adjacent crystal planes shown the results similar to the measured values of FF angles. Therefore, our study suggests that the crystallographic orientation is a key to explain the appearance of faceting. The presence of faceting increases the dihedral angle and critical fluid fraction, thus decreases the permeability. In the mantle wedge and oceanic mantle where olivine CPO is expected, the presence of FF angle with associated changes in fluid pore morphology will lead to the permeability anisotropy and its geophysical anomalies. This study was supported by the JSPS Japanese-German Graduate Externship and International Joint Graduate Program in Earth and Environmental Sciences, Tohoku University (GP-EES).

Keywords: dihedral angle, faceted plane, Miller Index, grain boundary energy, fluid connectivity, permeability anisotropy

