In situ determination of water-saturated solidus by electrical discontinuity

Xuan Guo and Huaiwei Ni

University of Science and Technology of China, School of Earth and Space Science, China (guoxuan@ustc.edu.cn)

Water plays an important role in lowering melting temperature of rocks. The water-saturated solidus of rock is critical for understanding the magma generation and the dynamics of the Earth. There have been a lot of water-saturated solidi of rocks constrained by traditional quench method in literature. However, since both of the hydrous silicate melt and aqueous fluid can be quenched to glasses at high pressure, it is difficult to discriminate whether the quenched glasses were from melt or not. As a result, the water-saturated solidi of rocks from different studies may show significant discrepancy. One way to solve this problem is to detect the characteristics change of the rock system in situ, and electrical conductivity measurement is one of the good options. It is known that hydrous melt has much higher electrical conductivity than solid rock, and temperature is much more effective in enhancing melt electrical conductivity than that for aqueous fluid. Once the partial melting is triggered, the electrical conductivity of the water-saturated rock system may have remarkable increase if the hydrous melt is interconnected in the system. Accordingly, the abrupt change of electrical conductivity may mark the solidus temperature. In this study, we performed electrical conductivity measurement for the determination of water-saturated solidus of albite. We adopted albite as the starting material because its water-saturated solidus is well known, which can help to verify the accuracy our method, and its quenched products are not so controversial. The electrical conductivity measurements were carried out at four different pressures ranging from 0.35 GPa to 1.7 GPa in a 3/4” piston cylinder apparatus with impedance spectroscopy. The obvious change of electrical conductivity was observed at solidus temperature within error, with increase of 1.8-0.18 log unit at 0.35-1.7 GPa. The results showed a stronger increase of conductivity at lower pressures, and fitted well with the water-saturated solidus of albite in literature. One defect of this method is the loss of water during experiment. The final water content in the system is about 1-2 wt%, comparing to the initial 10-15 wt% H2O. Nevertheless, the whole system is still water saturated, since water solubility in albite is fairly low. Therefore, if such a method can be improved to keep more water, it may be applied to other rocks to better constrain the water-saturated solidi in the future.