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# Effect of hydrogen on properties of minerals and magmas: in situ X-ray observations using synchrotron light source and future works using neutrons

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Hydrogen is the most abundant element in universe, and it can provide significant effects on physical properties of minerals and magmas even by addition of small amount of the element. It controls the global geodynamics and evolution of the Earth, although its abundance is very low in the Earth. I will review our recent studies on the effect of hydrogen in stability of minerals, and its reaction with metallic iron, silicate, and oxides with geophysical interests, such as Fe-H system, Fe-$H_2O$ system, $Al_2O_3$-$H_2O$ and MgO-$SiO_2$-$H_2O$ systems at high pressure and high temperature. We have used the Kawai multianvil press (MAX-III and SPEED1500) and the laser heated diamond anvil cell (LH-DAC) combined with the synchrotron X-ray radiation at PF and Spring-8. Incorporation of hydrogen in minerals provides an important mechanism for transport and deep circulation of water into the transition zone and lower mantle.

We also made in situ X-ray viscometry for the dry and wet basaltic magmas. We measured the velocity of the falling sphere of platinum or rhenium in the melts by using in situ X-ray radiography. The experiments were conducted by using Kawai multianvil press (SPEED1500) at Spring-8. Our measurements revealed that hydrogen provides a significant effect on viscosity of the melts. We have determined the viscosity of dry basaltic magma up to 5 GPa and found a viscosity minimum at around 2$\sim$3 GPa. We also determined viscosity of hydrous magma containing water of 8.0 wt.% up to 5 GPa. We found that the viscosity of the wet basaltic magma is significantly lower than that of the dry magma, and it increases with increasing pressure without viscosity minimum suggesting change in the melt structure by addition of water at high pressure and temperature.

Future studies by the neutron diffraction of minerals and melts at high pressure and temperature are indispensable to understand the roles of hydrogen in structures of minerals and melts accounting for the change of these properties.