Partitioning of water between iron and ringwoodite:Implications for water transport into the Martian core

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Recent astronomical surveys suggest that large amount of water may have existed on the ancient Martian surface based on an existence of andesite which is supposed to have been formed by a reaction between basalt and water. Plate tectonics on the ancient Mars has been proposed based on a pattern of quasi-parallel bands of uniformly magnetized crust with alternating positive and negative polarity by Mars Global Surveyor spacecraft (for example, Conneny et al.,2005). Hence, the subducting slab may had transported water to the Martian mantle.

At the Martian core-mantle boundary condition of 20-25 GPa, the base of the mantle mainly consists either of Ringwoodite or Perovskite. Ringwoodite can contain 2-3 wt.% of water. If the Martian mantle (ringwoodite) contains water, water may react with the Martian core (Fe-metal) and form iron hydride around the core-mantle boundary. The melting temperature of iron hydride is much lower than of iron and its density is lower than of iron. Therefore, partitioning behavior of water between iron and ringwoodite is important to investigate physical properties of Martian core.

In this study, we determined the partitioning behavior of water between iron and ringwoodite at 16-20 GPa and 1273 K. Experiments were carried out using a kawai-type multianvil apparatus (SPEED 1500) together with a synchrotron X-ray radiation at BL04B1 beamline in SPring-8. Amount of hydrogen dissolved in iron hydride was estimated based on the volume expansion of iron by interstitial hydrogen atoms. The result shows that water (hydrogen) tends to partition strongly into iron compared to ringwoodite. Therefore, Martian core may contain significant amount of hydrogen, which was supplied from the ancient ocean of Mars by the slab subduction.