The 513th Geodynamics Seminar

Metal-silicate partitioning of carbon in a magma ocean: Implications for the distribution of carbon in the Earth

Dr. Hideharu Kuwahara (JSPS postdoctoral fellow, GRC)

EHIME UNIVERSITY GRC GEODYNAMICS RESEARCH CENTER

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Elucidating the distribution of carbon in the Earth during core formation is important for understanding early Earth's atmosphere mass and composition, and perhaps the composition of the Earth's core. However, the distribution of carbon in the Earth during core-mantle differentiation has not been understood well. Previous studies have conducted high-pressure experiments on liquid metal-silicate partitioning of carbon and found that carbon is highly siderophile (iron loving) (i.e., Metal-silicate partition coefficients > 500) (e.g., Dasgupta et al., 2013, *GCA*; Chi et al., 2014, *GCA*). However, carbon abundance in the current Earth's mantle (i.e., 35-115 ppm) (Rosenthal et al., 2015, *EPSL*) is much more abundant than prediction based on experiments (i.e., < 1 ppm) (e.g., Li et al., 2016, *Nat. Geosci.*). In order to explain this discrepancy, the late accretion of sulfur-rich planetesimals has been proposed because carbon is thought to be expelled to mantle if planetesimals had sulfur-rich core (Li et al., 2016, *Nat. Geosci.*; Grewal et al., 2019, *Sci. Adv.*). However, this hypothesis is based on experiments using a graphite capsule. Because the activity of carbon in both metal and silicate phases would depend on its concentration, the solubility ratio of carbon between metal and silicate may not be equal to metal-silicate partition coefficient of carbon. Given that bulk Earth is not saturated with carbon, it is necessary to perform experiments at undersaturated conditions. In this study, we conducted high-pressure experiments on liquid metal-silicate partitioning of carbon at 2500-5000 ppm carbon concentration and pressures of 4-12 GPa (Kuwahara et al., *in review*). We found that carbon in a magma ocean is saturated even at such low carbon concentrations. Our experimental results also suggest that the solubility of carbon in a magma ocean is mainly controlled by silicate composition. The predicted abundance of carbon in chondritic magma ocean is well consistent with the current abundance of carbon in the Earth's mantle. Thus, the late accretion of sulfur-rich planetesimals, such as a Mercury-like impactor, may not be necessary to explain the abundance of carbon in the Earth's mantle.

Contact : Masayuki Nishi, Ph.D. (e-mail: nishi@sci.ehime-u.ac.jp)