Metal-silicate paritioning of chlorine: Implications for terrestrial missing chlorine

H. KUWAHARA[1*], H. GOTOU[2], N. OGAWA[3], A. YAMAGUCHI[3], K. ISHIBASHI[4], T. YAGI[5] AND S. SUGITA[5]

[1]Graduate School of Frontier Sciences, The University of Tokyo, Japan
[2]Institute for Solid State Physics, The University of Tokyo, Japan
[3]Atmosphere and Ocean Research Institute, The University of Tokyo, Japan
[4]Planetary Exploration Research Center, Chiba Institute of Technology, Japan
[5]Graduate School of Science, The University of Tokyo, Japan

The chlorine abundance of the bulk silicate Earth may be greatly depleted relative to the prediction based on various types of primitive materials, such as chondrites [1]. There are two hypotheses for this depletion of terrestrial chlorine; Incorporation into the Earth's core and impact blow-off of primordial oceans. Here we experimentally examine the possibility of the former case. Specifically, metal-silicate partitioning of chlorine in a magma ocean is investigated.

In this study, we investigated the oxygen fugacity and sulfur content in metal dependencies for the partitioning coefficient of chlorine. Starting materials were prepared from a mixture of high-purity oxides (SiO_2, Al_2O_3, CaO, MgO, FeO) and metal (Fe, FeS). The relative abundances of each component in the mixture were assumed to be CI chondritic. Chlorine was added to the mixutre as $FeCl_2$. The starting materials were enclosed in graphite capsules. The experiments were performed at 4 GPa and 1900 K for 15 min using the multi-anvil high pressure apparatus. The elemental composition of recovered samples were analyzed by wavelength-dispersive electron microprobe.

The metal-silicate partitioning coefficient of chlorine in recovered samples was up to 0.15, suggesting that chlorine is a highly lithophile element. If such a highly lithophilic behavior of chlorine observed in our study does not depend significantly on pressure, terrestrial missing chlorine might require primordial ocean blow off during the main-accretion phase.

[1] Sahrp, Z.D. and D.S. Draper, (2013), *Earth Planet. Sci. Lett*. 369-370, 71-77.