玄武岩質マグマとFe-FeS融体間の硫黄分配
Sulfur distribution between basaltic magma and Fe-FeS melt

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Earth is consist of crust, mantle, and core. The crust and mantle are made of silicates and oxides. The core is mainly composed of iron with light elements such as H, C, O, S, and Si. This is because the density of the core is smaller than that of pure iron under the core conditions. The Earth’s structure was considered to have formed during the differentiation of magma ocean in the early stages of formation of Earth. During the magma ocean, the metallic liquid reacted with the magma at the bottom of the magma ocean.
Since sulfur is depleted in the mantle compared to CI chondrites (e.g., Murthy and Hall, 1970) and sulfides are found in meteorites, sulfur is one of the most plausible candidate elements in the Earth’s core. Therefore, the study on Fe-S system provides us some significant information about magma ocean and core formation. In magma ocean, metallic melts sank to the bottom of the magma ocean because of gravitational separation. At the same time, a partitioning between liquid silicate and liquid metal occurred under very high temperature and pressure conditions. Sulfur distribution and isotope fractionation are affected by these parameter (T, P, f_{O2} etc.). Therefore, research on sulfur distribution leads to understanding the process of the differentiation between core and mantle in early Earth.
In this study, partitioning experiments between silicate (basaltic composition) and metal (Fe-14 wt%S alloy) were performed using Kawai-type 3000 ton multi-anvil press at Tohoku University. The experiments were carried out at pressures ranging from 1 to 7 GPa and heated to temperatures of 1400 ˚C to 1800 ˚C. Chemical composition of the sample were analyzed using SEM-EDS.
Experimental results show that correlations between distribution coefficients of sulfur and temperature changed by pressure. Distribution coefficients of sulfur at 3 GPa decreased with increasing temperature while those at 5 GPa increased with increasing temperature. Also, correlations between distribution coefficient of sulfur and pressure were changed by temperature. Distribution coefficients of sulfur at 1650 ˚C increased with increasing pressure, on the other hand, those at 1800 ˚C decreased with increasing pressure. As a whole, it was observed that they had a negative relation between distribution coefficient and temperature, and a positive relation between distribution coefficient and pressure.
The average distribution coefficients in this study was 76±36. McDonough (2003) reported that the total abundance of sulfur in Earth was 6530 ppm. Using the average and the abundance, we estimated that the amount of sulfur in Earth’s mantle was 82±7 ppm. This abundance is less than expected previously (e.g., Palme and O’Neill, 2001; McDonough, 2003). However, it is actually expected to be higher content of sulfur in Earth’s mantle because magma ocean experienced higher temperature condition than this study, with higher lithophile nature. Oxygen fugacity is also an important parameter that influence element partitioning. Under reducing condition, sulfur tends to be distribute to silicate phase than in oxidizing condition. The present ΔIW (oxygen fugacity to Iron-Wüstite buffer) of the experiments were in the range of -1.16 and -1.44. Assuming more reductive condition than the present ΔIW in magma ocean, the content of sulfur in Earth’s mantle might increase and match the geological estimate.

