Multiple sulfur isotope analytical system using IRMS MAT-253 for high pressure experimental run products

*Madhusoodhan Satish-Kumar[1], Shinnosuke Aoyama[1], Miyako Abe[2]

1. Department of Geology, Faculty of Science, Niigata University, Japan, 2. Graduate School of Science and Technology, Niigata University, Japan

The candidates for major light elements in the core are carbon, sulfur, oxygen and hydrogen. Based on geophysical studies and high pressure experimental results, the core composition and its evolution have been the focus of several previous studies. However, recent studies have suggested the presence of isotope fractionation at high temperature and high pressure conditions, especially in magma ocean environment and core segregation (e.g. Satish-Kumar et al., 2011; Labidi et al., 2016). In order to understand the light element isotope fractionation processes in the deep earth, it is necessary to measure isotope composition accurately in micro to nano mole scales, because of the small volume run products from high pressure experiments.

At Niigata University, MAT-253 mass spectrometer (Thermo Fisher Scientific) was installed through the MEXT Grant-in-Aid for Scientific Research on Innovative Areas. Carbon and oxygen isotopic composition are measured using CO_2 and sulfur isotopic composition are measured using SF_6 gas. A new micro-volume inlet system was installed and fundamental parameters such as pressure effect and capillary flow effect were tested. Using the micro-volume inlet system the minimum volume required for each analysis is 1 micro mole sample gas, and the precession of carbon isotopic composition is better than 0.1 ‰.

Multiple sulfur isotope measurement system consists of; 1) curie point pyrolyzer for rapid conversion of small volume samples to SF_6 gas (Ueno et al., 2015), 2) gas chromatograph for purifying the SF_6 gas and 3) micro-volume inlet system for introduction of sample gas to ionization chamber. Initial measurements on small volume samples gave precession better that 0.1‰ for both $d^{34}S$ and $d^{33}S$. However, $d^{36}S$ has large errors due to possible contamination by hydrocarbons. Experiments are now being carried out with better vacuum conditions and higher purity carrier gas for refining the precision of $d^{36}S$. Sulfur-bearing samples from experimental run products as well as natural samples will be measured for multiple sulfur isotopes for understanding the presence of mass independent fractionation in mantle reservoirs and possible isotope exchange during core-mantle interaction.

References

Satish-Kumar, M., So, H., Yoshino, T., Kato, M. Hiroi, Y. 2011. Earth and Planetary Science Letters, 310, 340-348.

Labidi, J., Shahar, A., Le Losq, C., Hillgren, V.J., Mysen, B. O., Farquhar, J., 2016. Geochimica et Cosmochimica Acta, 175, 181-194.

Ueno, Y., Aoyama, S., Endo, Y., Matsu’ ura, F., Foriel, J., 2015. Chemical Geology, 419, 29–35.

Keywords: sulfur isotopes, fractionation, light elements in core

