Micro-volume stable isotope measurement using IRMS and its application in high pressure research

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

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

Sulfur, oxygen, hydrogen and carbon are potential light elements candidates that might be present in the core in significant quantities to counter the density deficit of the metallic core. Based on geophysical consideration and high-pressure experiments, the core composition and its evolution have been focus of several previous studies. However, recent studies have predicted that there is a possibility of isotope fractionation at high temperature and high pressure conditions, especially in the 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 scales from high pressure experimental run products. At Niigata University, MAT-253 mass spectrometer (Thermo Fisher Science) was installed by the MEXT Grant-in-Aid for Scientific Research on Innovative Areas. The carbon and oxygen is measured using CO_2 and sulfur stable isotope measurement is carried out using SF_6 gas. We have completed the construction of vacuum inlet line for standard and sample gas, and evaluated the precision of carbon and oxygen isotope using CO_2 and for sulfur using SF_6 using the normal bellows sample reservoir. A new micro-volume inlet system was also installed and fundamental parameters such as pressure effect and capillary effect relating to micro-volume inlet system were tested. In the measurement using CO_2, standard gas in normal bellow showed a drift in both of carbon and oxygen isotopes were observed for six hours of continuous measurements ($\delta^{13}C$ = -0.172 ‰, $\delta^{18}O$ = -0.366 ‰) Therefore, we increased the volume of standard gas and obtained a better precession for the same sample duration. Internal carbon isotope standard sample of graphite (SP1 graphite powder), gave a precession of 0.045 ‰(n = 10). In the poster, we also present the details of the newly-constructed SF_6 gas preparation using curie point pyrolizer and gas purification system using gas chromatography. A new method for micro sampling using a femto-second laser ablation is also being tested for the analysis of small volume samples obtained using high-pressure experiments.

References:

Satish-Kumar et al., 2011, EPSL, 310, 340-34
Labidi et al., 2016, GCA, 175, 181-194

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