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Tungsten isotope analysis of meteorite samples using ETV-MC-ICPMS technique

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Hf-W chronometer is based on the decay of ^{182}Hf to ^{182}W with a half-life of 8.9 Myr. Hf is strongly lithophile elements, whereas W is moderately siderophile elements. Thus, the Hf-W age can provide critical information about the timing of metal-silicate differentiation (core formation) processes at the early stage of the planetary formation. Moreover, both the Hf and W is strongly refractory elements, the Hf-W age can reflect the timing of condensation or segregation of the metallic nuggets from chondritic reservoir at the early sequence of the solar system.

The thermal ionization mass spectrometry (TIMS) is widely used for W isotope analysis. However, a micro-gram amount of W is desired for Hf-W chronological studies in this technique. The ICP-MS technique coupled with the conventional nebulization technique is also used for W isotope measurement. With this technique, total amount of W required for the isotopic ratio measurements could be 50 - 100 ng. On the other hand, typical ion transmission efficiency from sample to ion collector would be $<$0.1% under the sample introduction using the nebulizer. This suggests that the sample introduction efficiency (i.e., high transmission efficiency) can be dramatically improved when the loss of sample mist could be minimized. To achieve this, we have developed a sample introduction technique using the electrothermal vaporization (ETV) technique for W isotope analysis.

In this study, W sample in 2% HNO_3 solution is loaded on the Re filament located in a small volume ETV chamber to achieve minimum loss of W vapor and also to reduce the memory of W within the chamber. Temperature of the Re filament is controlled by the incident current (0 - 4 A). The W evaporation is carried out under the two different ambient gasses, Ar or He. We found that W signal intensity profile obtained under the Ar carrier gas is spiky and unstable, and this is not suitable for the precise isotopic analysis. In strike contrast, the signal intensity profile obtained under the He carrier gas is very smooth and stable. Moreover, with the He carrier gas, total number of W atoms was about 1.7 times higher than that achieved by the Ar carrier gas. Taking these points into account, He carrier gas was used throughout the W isotope measurements.

The isotope analysis was carried out using various amount of W solution sample. As a result, we found that $<$25 ng of W can reveal the precise W isotope ratio. The W isotope ratios of some meteorite samples were also measured using the ETV-MC-ICPMS technique. The results will be discussed in this presentation.

Keywords: MC-ICP-MS, isotope, ETV, meteorite