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Ni isotopic analyses of meteorites using TIMS and MC-ICP-MS

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The isotope analysis of the meteorites can provide important information about the origin and evolution of our solar system. As for Ni, the isotopic anomalies on ^{60}Ni (decay product of ^{60}Fe), as well as ^{62}Ni and ^{64}Ni have been reported from both undifferentiated and differentiated meteorites (e.g. Shukolyukov et al. 1993, Steele et al. 2011). However, there have also been reports of disagreement between data obtained using different analytical approaches (e.g. Cook et al. 2008, Chen et al. 2009, Moynier et al. 2011), which need to be clarified in order to fully understand the cosmochemical implications of the isotope data. Here we report the results of Ni isotope analysis for carbonaceous chondrite Allende and iron meteorites Carbo, Toluca, and Buebaventura.

The Allende and iron meteorites were dissolved in HF-HNO_3 and HCl-HNO_3, respectively, and Ni was extracted using a method modified from Yamakawa et al. (2009). The chemical yield and the level of impurities in the Ni cut were monitored using ICP-MS. The high-precision Ni isotopic analyses were performed using TIMS (MAT262, TRITON) and MC-ICP-MS (NEPTUNE). The activator for the analysis using TIMS was prepared by modifying the Si-Al-B type activator of Yamakawa et al. (2009) to gain higher beam intensity for a longer period of time.

The data for the iron meteorites obtained using both TIMS and MC-ICP-MS clustered around epsilon ^{60}Ni = 0. They were broadly similar to the data reported by Chen et al. (2009), however, no obvious correlation between the ^{56}Fe/^{58}Ni and epsilon ^{60}Ni ratios was observed. Anomalies on ^{62}Ni and ^{64}Ni were also not detected in this study, but improvement in the analytical precision is necessary to further explore this issue. Bulk Allende also showed no anomaly on epsilon ^{60}Ni, implying the low abundance of ^{60}Fe in the early solar system and/or homogenization of Ni isotopes after the accretion of its parent body.

The data obtained so far in our laboratory is restricted to samples with relatively small variation in the ^{56}Fe/^{58}Ni ratio. Thus, additional analyses of samples from different meteorite classes, as well as phases with high Fe/Ni ratio (such as troilite) is required to shed light on the nature of the Ni isotope in meteorites.

Keywords: Ni isotope, Meteorite, TIMS, MC-ICP-MS