Iron isotopic signature of Fe-Ni metals in ordinary chondrites using LAL-MC-ICPMS technique

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Introduction

The ordinary chondrite is the most abundant and primitive meteorite in the solar system. It is widely believed that the formation sequence of the ordinary chondrites tell us details of the early solar system history. Among the various minerals or components found in the ordinary chondrites, the Fe-Ni metal is one of the characteristic materials of ordinary chondrite. Despite the major components, the formation processes of Fe-Ni metals have still been veiled. The Fe isotopic signature is one of the key information to derive the formation processes of Fe-Ni metals in the ordinary chondrites, because (a) Fe is ubiquitously distributed in various minerals or phases in the meteorites, and (b) Fe isotope composition can vary through the formation processes. In this study, the Fe isotopic ratios of Fe-Ni grains in ordinary chondrites were measured. In order to derive inherent and reliable Fe isotopic data from complex Fe-Ni phases, we have developed a new sampling technique described below.

Experimental

In this study, Fe-Ni metals in ordinary chondrites were collected using laser ablation in liquid (LAL) technique [1, 2]. The sample surface was polished and the metal phase was ablated in the deionized water using the femtosecond laser (λ=780 nm). Unlike with the conventional micro-drilling technique, the LAL technique can provide minimum risk of contamination of Fe from equipments. After the LAL sampling procedure, the resulting sample suspension was collected using micropipette and was then subsidized to acid digestion using conc. HCl and conc. H_2O_2. The sample solution was heated until dryness and the resulting sample cake was re-dissolved in 0.1% HCl, and then used for the isotopic analysis of Fe using MC-ICPMS connected to the desolvating nebulizer system.

Results and Conclusion

Total 15 ordinary chondrite metals were analyzed in this study. The $\delta^{56}Fe$ data for L chondrites did not vary with the $\delta^{56}Fe$ data for LL chondrites. In contrast, Fe in the H chondrites was isotopically lighter than those for L or LL chondrites. These Fe isotopic variations between H, L and LL chondrites are consistent with the data obtained by Theis et al. (2008) [3]. However, these Fe isotopic ratios within the metallic phase in the H, L and LL chondrites cannot be explained by the simple redox reaction suggested by Theis et al. (2008). Possible cause of the present variation of Fe isotopic ratios will be discussed in this presentation.

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[2] Douglas *et al.* (2011) *J. Anal. At. Spectrom.* **26**, 1294-11301.

[3] Theis *et al.* (2008) *Geochim. Cosmochim. Acta* **72**, 4440-4456.

Vertical distributions of ^{230}Th in the Pacific Ocean and their relation to advection and diffusion

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In the central Pacific Ocean, which is remote from all the continents, the distributions of trace elements expectedly show the typical vertical profiles of open oceans.

Vertical distributions of ^{230}Th in the Pacific Ocean have been well-described by the reversible scavenging model [1]-[5]. On the basis of the assumption of no lateral ^{230}Th transport in this model, in-situ produced ^{230}Th is scavenged within the basin. In contrast, the effect of lateral advection on Th distribution have been shown in the Southern Ocean and Atlantic Ocean[6]-[8] and using a model caluculation the effect of isopynal diffusion have been discussed [9].

We investigated the vertical distribution of total ^{230}Th in mid-latitudes of the Pacific Ocean. Because of low biogenic particle flux, high ^{230}Th activity in deep water is exhibited in the central gyre. The west–east section (20°N) of ^{230}Th shows a strong gradient in the deep waters around 170°E and 110°W. At depths of 2000–4000 m and 4000 m–bottom, within the time-scale of scavenging residence time of ^{230}Th, the horizontal eddy diffusion could reach 1100–1400 km and 400–700 km, respectively. The horizontal eddy diffusion transport is too weak to affect Th distribution in the deep layers between each station in this study area. We observed the depletion of total ^{230}Th compared with a reversible scavenging model prediction for the deep layers in the mid-latitudes of the North Pacific Ocean. The observed depletion is partly explained by lateral advection, adopting the scavenging-mixing model. Additionally, a bottom scavenging process above the seafloor and a diffusion process are considered to explain the ^{230}Th deficit.

In the Eastern Subtropical Pacific, advection and diffusion of low-^{230}Th water in the high particle flux region could affect the distributions of ^{230}Th. At the station on the East Pacific Rise, we observed exceptionaly depleted ^{230}Th in deep layers. The ^{230}Th depletion would be attributed to the active hydro-thermal activity in this area.

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