Heavy element-stable isotope systematics for metallomics induced by the MC-ICPMS technique

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Continuous developments in inorganic mass spectrometry techniques, including a combination of an ICP ion source and a magnetic sector-based mass spectrometer equipped with a multiple-collector array (MC-ICPMS), have revolutionized the precision of the isotopic ratio measurements. Although the magnitude of many analytical problems is clearly exacerbated, the analytical community is actively solving problems, such as spectral interference, mass discrimination drift, high-yield chemical separation and purification processes, or reduction of the contamination of analytes, and the applications of the heavy element-stable isotope geochemistry are beginning to appear over the horizon [1, 2]. The variations in isotopic ratios of the heavy elements, such as Fe, Zn, Cu, Sr, Ce-Nd, W, or U can provide new insights into past and present geochemical and biochemical processes [2]. Among the heavy elements, mass-dependent isotopic fractionation of the bioessential metals (e.g., Ca, Fe, Zn or Cu) was extensively applied to investigate the nutritional status of elements or to evaluate the elemental metabolism for plant and animals [e.g., 1,3,4]. This is well demonstrated by the diagnosis for specific diseases through the changes in isotope ratios of the elements [5,6]. To take a full advantage of the heavy element-isotope systematics, we are currently trying to obtain *in situ* isotope ratio data of the elements using MC-ICPMS technique coupled with a femtosecond-laser ablation sample introduction technique (fLA-MC-ICPMS). Analytical advantages achieved by the fLA-MC-ICPMS technique or by the LAL-MC-ICPMS technique [7] will be presented in this presentation.

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Crystal structure in Earth's inner core

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Composition and state of the core remain uncertain to a large extent [1], in part because static experiments performed on candidate compositions at such extreme conditions have been difficult until recently. Nevertheless, ultrahigh-pressure experimental techniques using laser-heated diamond-anvil cell (DAC) combined with synchrotron x-rays have greatly advanced in recent years. Now static experiments are being performed at the core ultrahigh pressure and temperature conditions, even beyond those at the center of the Earth [2]. Recent experimental and theoretical studies indicated that hexagonal-close-packed (hcp) structure is a stable form of iron in the Earth's inner core. Earlier calculations suggested that body-centered-cubic (bcc) Fe is stable above ~5500 K at 330 GPa [4]. However, the temperature at the inner core boundary may be as low as 5200 K, inferred from recent estimates of core-mantle boundary temperature of ~3800 K. The nature of stable crystalline phases and physical properties are strongly affected by impurity elements in the core. We have performed x-ray diffraction measurements so far up to 412 GPa and 5900 K and examined stable crystal structures of iron-compounds including Fe-10wt%Ni, FeO, Fe-9wt%Si, and Fe-S alloys under the core conditions. Considering a small density deficit, our data so far suggest that hcp is a plausible crystal structure in the inner core.

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