

Iron-nickel alloy–water reaction under high pressure and high temperature

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Since the discovery of the high solubility of hydrogen in iron at high pressure (Antonov et al., 1980; Fukai et al., 1982), various studies on the iron-hydrogen and iron-water systems have been carried out as a major candidate for light elements in the Earth's core (e.g. Fukai and Akimoto, 1983; Badding et al., 1991; Yagi and Hishinuma, 1995; Okuchi, 1997). Recently, Saxena et al. (2002) conducted the experiments for the iron-water system up to 85 GPa and to 2000 K, and showed that iron hydride stability extended to 85 GPa and 1800 K and iron hydride could not exist without wustite. The Earth's core, however, might contain significant (5-15 %) amount of nickel, based on cosmochemistry arguments. Therefore, we performed high pressure and high temperature experiments on the iron-nickel–water system to simulate more realistic condition of the Earth's core.

In this study, the reaction of iron-nickel alloy, Fe₉₀Ni₁₀, and water was investigated at high pressure and high temperature up to 36 GPa and nearly 1200 K with laser-heated diamond anvil cell (LHDAC). In situ high-pressure X-ray diffraction experiments were performed at Photon Factory, KEK, Japan. At 5 GPa and ~1000 K, we observed iron-nickel alloy and iron-nickel hydroxide. At 36 GPa and ~1000 K, we confirmed the further production of iron-nickel hydride adding to these phases. In the iron-water system, hydroxide was produced at 9 GPa, while no hydroxide was observed above 11 GPa. The stability field of iron-nickel hydroxide might extend to high pressure region by nickel component.

References

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Isotopic Fractionation of Fe through Biochemical Processes

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Introduction

Many pioneering studies have demonstrated the potential of multiplecollector-ICPMS technique for precise isotopic analysis for various elements including transition metals. An extension of the capability of the ICPMS method is to accept dry sample aerosols generated by laser ablation. The LA-MC-ICPMS technique can provide in-situ precise isotopic data (e.g., Hirata and Ohno, 2001). Analytical precision could be improved significantly by a correction of slow response of the Faraday amplifiers.

⁵⁶Fe/⁵⁴Fe Ratio for Iron Deposits

In-situ ⁵⁶Fe/⁵⁴Fe ratio for Quaternary sedimentary iron deposits has been measured by the LA-MC-ICPMS technique. We analyzed the isotopic ratios of Fe in goethite-rich ore with numerous well-preserved algae-like fossils and in highly crystalline jarosite-rich ore devoid of such microfossils (Shiikawa, 1960, Akai et al., 1999). These two types of material selected for our measurements essentially lack volcanic fragments, and thus they give an excellent constraint on the iron isotopes of iron precipitates mediated by biochemical or pure-chemical processes. The ⁵⁶Fe/⁵⁴Fe ratio for jarosite-rich ore did not vary measurably (<1‰). This indicates that the Fe in the source spring water precipitating the iron deposit was not isotopically fractionated, and moreover that the jarosite precipitation from the water did not fractionate Fe isotopes. In contrast, those of goethite-rich ores are fractionated 3‰ higher than that for jarosite-rich ore. It should be noted that the goethite-rich samples analysed here are from the same hand specimen of the jarosite-rich samples, and thus a large difference in ⁵⁶Fe/⁵⁴Fe ratio exists within only a few centimeters. This indicates that the isotopic fractionation of Fe must have occurred by local reactions, rather than a large-scale isotopic fractionation of source materials.

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