【Grant-in-Aid for Scientific Research(S)】

Science and Engineering (Mathematical and physical sciences)

Title of Project: Molecular Geochemistry: Analyses of Evolution of Earth and Life based on Speciation from atomic scale

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Research Area : Geochemistry

Keyword : Geochemical cycle

【Purpose and Background of the Research】

In this study, we will investigate local structures of elements at solid-water interfaces using X-ray absorption fine structure spectroscopy (XAFS) and other methods. Based on the information, mechanism of isotopic fractionation during sorption on solid phase can be elucidated, which enables us to estimate paleoredox condition in ancient seawater.

We will also investigate factors controlling solubilities of elements in seawater, in particular by examining the sorption reactions which regulate solubilities of trace elements in water. Such solid-water distributions under oxic and anoxic conditions will be studied in details, based on which we can discuss the change of solubilities of elements through the history of the earth. Such information is important in considering the change of essential elements to organisms possibly due to the change of their concentrations in seawater during the evolution of the earth from anoxic to oxic conditions.

【Research Methods】

In this study, isotopic fractionation of various elements especially under marine environment (to be measured by ICP Mass Spectrometry) will be studied based on the chemical speciation at solid-water interface mainly obtained by X-ray absorption fine structure (XAFS). The main targeted elements are Mo, W, Se, and Te. In addition, their solubilities at different redox conditions will be also studied.

【Expected Research Achievements and Scientific Significance】

The relationship between surface complexes and isotopic fractionation of Mo and W will be established. In particular, difference in the structure of surface complexes at the solid-water interfaces for various Fe (hydr)oxides and Mn oxides will be examined. Based on the difference considering that Mn oxides is precipitated under more oxic condition, it is expected that these isotopes can be used to estimate more quantitatively the redox conditions in paleoseawater.

Speciation of elements at solid-water interface can be also important to understand the solubilities of the trace elements. In particular, physic-chemical factors controlling solubilties of trace elements in anoxic and oxic seawater will be examined and its possible relation to their concentrations in paleoseawater and history of essential elements (Fig. 1).

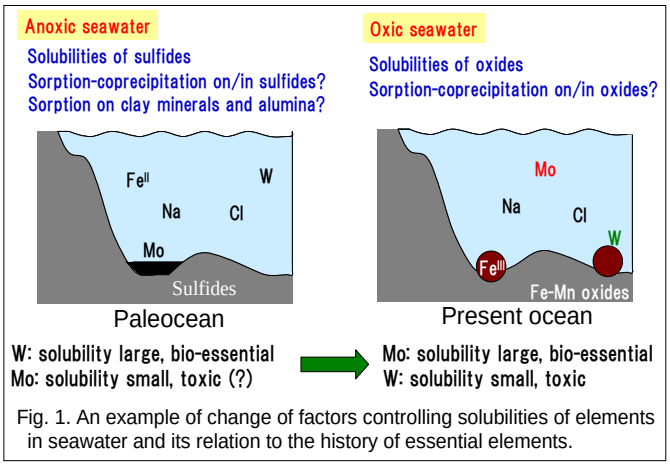

Fig. 1. An example of change of factors controlling solubilities of elements in seawater and its relation to the history of essential elements.

【Publications Relevant to the Project】

- T. Kashiwabara, Y. Takahashi, and M. Tanimizu, A XAFS study on the mechanisms of isotopic fractionation of molybdenum during its adsorption on ferromanganese oxides. Geochem. J., 43 (2009) e31-e36.
- T. Harada and Y. Takahashi, Origin of the difference in the distribution behavior of tellurium and selenium in a soil-water system, Geochim. Cosmochim. Acta, 72 (2008) 1281-1294.

【Term of Project】 FY2010-2014

【Budget Allocation】 54,500 Thousand Yen

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