Controls on La and Ce enrichment in marine ferromanganese crusts

X. REN[1*], J. R. HEIN[2], A. ZHU[1], X. SHI[1], K. MIZELL[2]

[1] First Institute of Oceanography, State Oceanic Administration, 6 Xianxialing Rd., Qingdao, Shandong 266061, China (*correspondance: renxiangwen@163.com)

[2] Pacific Coastal and Marine Science Center, USGS, 400 Natural Bridges Dr., Santa Cruz, CA 95060, USA

In order to decipher the controls on rare earth elements in ferromanganese crusts, we construct a conceptual model composed of five stages to describe the enrichment process of La and Ce: (1) Diffusion in seawater and sorption; (2) Equilibrium between sorption and desorption; (3) Diffusion in pore water of crusts; (4) Phosphatization, the incorporation of phosphate; and (5) Diffusion in the phosphatized crust layers. Based on a systematic analysis, we suggest that **seven factors control the La** concentration in Fe-Mn crusts including mineral concentration (MnO_2+$FeOOH$), element ratios (Mn/Fe), distribution coefficient of REY between seawater and ferromanganese oxides ($_iK_S$), concentration of free hydrated REY ions in seawater [M^{3+}], temperature (T) and pH (pH) both of which are capable of changing the $_iK_S$, and the incorporation of phosphate during phosphatization. The **seven controls on Ce** concentration in Fe-Mn crusts include mineral concentration (MnO_2+$FeOOH$), diffusivity of REY in seawater (D_{sw}), temperature (T) which is capable of changing the D_{sw}, concentration gradient of free hydrated Ce ions in seawater ($d\varrho/dx$), growth rate of ferromanganese crusts (GR), specific surface area (S_{sp}), and the incorporation of phosphate. Our analyses on the ferromanganese crusts from the Magellan seamounts suggest that the La^{3+} concentration in seawater is a major control of the concentration of La in Fe-Mn crusts in this area. Our analyses further indicate that variations of paleoseawater T, GR, S_{sp}, and subsidence and migration of the host seamounts cannot fully explain the temporal variation of Ce concentrations in Fe-Mn crusts from the Magellan seamounts, and that seawater Ce^{3+} concentration is the key controlling factor.