Distributions of Rare Earth Elements between Seawater and Fe-Mn Crust Surface at the Takyo Daigo Seamount, Northwestern Pacific

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Since the Late Paleocene, ferromanganese crusts (Fe-Mn crusts) have been deposited extensively on the surface of seamounts or plateaus at 400 to 6000 meters below sea level (mbsl) with a thickness range of 1 to 20 cm. Owing to the exceedingly slow growth rates (1 to 10 mm/Myr) and the nm-scale constituents of Fe and Mn oxides/oxyhydroxides, rare earth elements (REEs) are highly concentrated in Fe-Mn crusts from ambient seawater. Over the past two decades, the speciation across the solid-water interface has been intensively studied for many REEs. In terms of the distributions of REEs between seawater and Fe-Mn crusts, apparent distribution coefficients of REEs have been estimated between reference seawater and Fe-Mn crusts with variable locations, depths and ages. Although this compilation provides fundamental insights into the selective enrichment pattern of REEs, it might be deviated from the intrinsic values by taking the heterogeneity of vertical profiles of REE concentrations in seawater adjacent to Fe-Mn crusts and the progressive transformation from metastable Fe and Mn oxides/oxyhydroxides to their stable states in Fe-Mn crusts. For accurate estimation of the apparent distribution coefficients, it is necessary to clarify equilibrium solute and sorbate concentrations in seawater and Fe-Mn crusts, because in situ physicochemical conditions represented by high hydraulic pressure, partial pressures of CO₂ and O_2 and constant fluxes of low solute concentrations are difficult to be reproduced experimentally. In addition, the complex nm-scale mineral assemblages of Fe-Mn crusts are impossible to be synthesized. As for sorbate concentrations in Fe-Mn crusts, it is critical to sample from the surface layer in Fe-Mn crusts, which is equilibrated with ambient seawater. To collect ambient seawater adjacent to the outcrop of Fe-Mn crusts, seawater sampling by a submersible is of technical advance in comparison to the deployment of a water sampler such as the rosette from a research vessel. Furthermore, seawater sampling needs to be optimized by developing a sampling device to minimize the levels of contamination and loss of trace elements. In this study, it is aimed to obtain the apparent distribution coefficients of REEs between seawater and Fe-Mn crusts by using vertical profiles of REE concentrations of the surface layer of Fe-Mn crusts and the corresponding ambient seawater from one of the largest deposits of Fe-Mn crusts in the northwestern Pacific. As for Ce, anomalously low concentrations in ambient seawater and high apparent coefficients were evident at depths. We will discuss the potential causes of the Ce anomaly as well as the distribution patterns of the other REEs.