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 CO_2
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.