REY compositions in hydrogenetic ferromanganese crusts of hadal zone

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Ferromanganese crusts, mainly composed of Iron and Manganese (oxhydro)oxide, occur regarding two kinds of their origins in submarine environment. One is hydrogenetic origin enriched in trace elements and rare earth elements (REE), the other is hydrothermal origin lacking those elements. The former is a useful tool to record oceanic paleo-environment, because they adsorb the elements from ambient seawater.
The relationships between chemical composition of ferromanganese crusts and water depth have already been studied to investigate the accumulation mechanism of elements. Most of ferromanganese crusts previously reported, however, have been only from shallower than 4 km depth of seamount. Here, the petit-spot volcanoes, monogenetic volcanoes occurred on bending oceanic plate, are possible to supply the ferromanganese crusts on abyssal plane covered with sediments of 5 to 6 km in water depth. The ferromanganese crusts from petit-spot volcanoes, therefore, are expected to record the chemical signatures of the deep-sea water in abyssal to hadal zones. We analyzed the samples off NE-Japan and Minamitorishima Island (5.2-6.0 km in depth), and those in Japan Trench (6.7-7.1 km in depth)
The data of them show low Mn/Fe ratios (0.63 to 1.5), high contents of Co, Ni, and REE and Y (REY), and positive Ce anomalies, all of which indicate hydrogenetic character. We used the ratios of two adjacent elements in REY to compare the compositions regardless of the contaminating detritus in ferromanganese crust. Shale-normalized REY patterns of the ferromanganese crusts shows characteristically lower La_{SN}/Pr_{SN} ratios than 1 although the typical crusts have La_{SN}/Pr_{SN} ratios systematically higher than 1. A strong correlation between the La_{SN}/Pr_{SN} ratios and water depths (correlation coefficient shows -0.9) suggests that the La_{SN}/Pr_{SN} in hydrogenetic crusts is a potential hydro-barometer of (paleo)ocean. Other hydrogenetic ferromanganese crusts from the Pacific Ocean also show the similar trend, but different from those in the Japan Trench. REY ratios of ferromanganese crusts from the Japan Trench (approximately 7km) are similar values to shallower crusts in this study. This would be due to remaining REY components on those of shallower portion prior to trench-oceanward slope on the plate motion (approximately 5.3 km in depth). The variations of REY ratios with water depth in ferromanganese crusts reflect REY compositions of ambient seawater.

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