Origin of REY-rich mud based on bulk geochemistry of deep-sea sediment cores in the western North Pacific Ocean

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REY-rich mud, a deep-sea sediment containing high concentrations of rare-earth elements and yttrium (REY), is expected to be a new resource for the critical elements due to its multiple advantages such as huge resource potential and paucity of radioactive elements [1]. It has been confirmed that the REY-rich mud also exists in the Japanese exclusive economic zone (EEZ) around Minamitorishima Island [2], followed by the discovery of “extremely REY-rich mud” that contains more than 5,000 ppm of total REY from the Minamitorishima EEZ [3].

For the future development of the REY-rich mud, clarifying the stratigraphy and lateral extent of the extremely REY-rich mud is critically needed. In this respect, continuous cores of deep-sea sediments obtained by deep-sea drilling can provide important information. In the western North Pacific Ocean, only two drilling cores, Ocean Drilling Program (ODP) Sites 1149 and 1179, were almost continuously recovered from the seafloor surface to basement rock (chert). Chemical analyses of these two cores could provide the entire picture of common stratigraphy of deep-sea sediments including the extremely REY-rich mud in the western North Pacific Ocean. The analysis of the Site 1149 has already been implemented by Mimura (2016) [4], which demonstrated that the site has essentially common stratigraphy with the Minamitorishima EEZ. In the present study, we newly analyzed sediment samples of the Site 1179 and determined their bulk chemical compositions.

The sediments in the Site 1179 has been classified into five units: clay- and radiolarian-bearing diatom ooze of Unit I (from the core top to 221.52 mbsf), clay-rich and diatom-bearing radiolarioan ooze of Unit II (221.52 to 246.0 mbsf), pelagic clay of Unit III (246.0 to 283.53 mbsf), chert layer of Unit IV (283.53 to 377.15 mbsf) and basaltic crust layer of Unit V [5]. Analytical results of 173 bulk sediment samples from Unit I, Unit II, and Unit III, show that the REY-rich mud occurs only in the Unit III lower than ~260 mbsf. Moreover, whereas the extremely REY-rich mud containing 7,500 ppm of total REY has been discovered at Site 1149, the total REY content at Site 1179 was at most 1,675 ppm. In addition, we clarified the geochemical end-members constituting the deep-sea sediments in the Site 1179: terrigenous, hydrogenous, hydrothermal, and biogenic calcium phosphate components. Based on the results, we further quantified the relative contributions of each component. By comparing the new data from the Site 1179 with previous data from the Site 1149, we found out both a common chemostratigraphy of deep-sea sediments in the western North Pacific Ocean as well as local characteristics overlapping the common features.

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