【Grant-in-Aid for Scientific Research (S)】

Broad Section D

Title of Project： Creation of a unified theory of global environmental changes and resource generation

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Keyword：Resource exploration, seafloor mineral deposits, global geochemical cycles

【Purpose and Background of the Research】

The field of resource investigation has shifted from land to ocean; however, the aims of previous studies of seafloor mineral resources were limited to clarifying the ore genesis of individual resources, hindering attainment of a unified picture of the Earth system and ore genesis. Generation of resources in the oceans and associated environmental changes can be regarded as aspects of the global cycles of various elements and materials. The question “how did these resources form?” can be answered only through a quantitative analysis of global geochemical cycles (Fig. 1), including input of elements from the mantle to the ocean via volcanic and hydrothermal activities and output to the mantle through precipitation and deposition of elements to the seafloor and their subsequent subduction into the trenches. Pelagic clay is the key material for elucidating these global cycles. We will apply newly developed “chemostratigraphic probes” to pelagic clay cores collected from various oceanic regions, to map time-series information recorded in pelagic clays worldwide, and to elucidate the dynamics of global geochemical cycles.

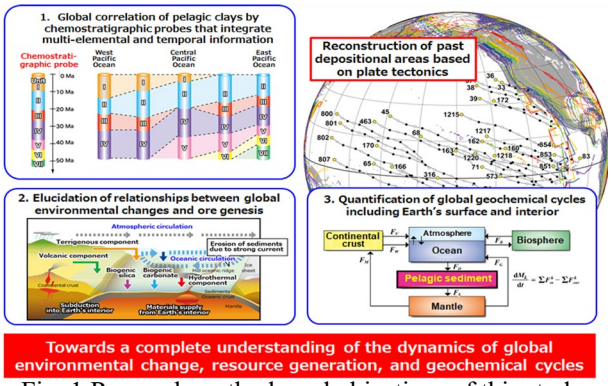

Fig. 1 Research methods and objectives of this study

【Research Methods】

“Chemostratigraphic probes”, which integrate multi-elemental and chronological information, will be used to correlate pelagic clays over a wide area of several oceans. First, we will perform high-precision chemical analyses on International Ocean Discovery Program core samples to construct a large-scale, multi-elemental dataset of pelagic clays. In addition, we will combine Os isotopic ratios and ichthyolith biostratigraphy to precisely determine depositional ages. Then, we will analyze the high-dimensional data covering global oceans by multivariate analyses (e.g., independent component analysis). The results will provide a comprehensive picture of temporal variations in pelagic-clay geochemistry, as well as their causes and a record of erosion of sedimentary layers. We will also construct a global geochemical cycle model incorporating all the geochemical and temporal information on pelagic clays to quantify the mass balance and flux variations between the atmosphere–ocean and solid earth systems. As part of this modeling, we will focus on the cycles of critical elements to elucidate the entire picture of ore genesis in the ocean.

【Expected Research Achievements and Scientific Significance】

Quantitative analysis of the mass balances of various elements on the Earth's surface, as well as the factors and processes controlling them, will provide a unified picture of the causal relationships between environmental changes and resource generation. This unified picture will facilitate novel, systematic exploration for promising resources. Furthermore, pelagic clays are the most important interface between the solid earth and the atmosphere–ocean systems, serving as a bridge between the disciplines of environmental and solid earth sciences. By obtaining a precise picture of this interface for the first time, we will create a theory to explain various phenomena on the Earth in a unified framework, from a panoramic view of global geochemical cycles.

【Publications Relevant to the Project】

- Kato, Y. et al. “Deep-sea mud in the Pacific Ocean as a potential resource for rare-earth elements.” *Nature Geoscience* **4**, 535-539 (2011).
- Takaya, Y. et al. “The tremendous potential of deep-sea mud as a source of rare-earth elements.” *Scientific Reports* **8**, 5763 (2018).
- Ohta. J. et al. “Fish proliferation and rare-earth deposition by topographically induced upwelling at the late Eocene cooling event.” *Scientific Reports* **10**, 9896 (2020).

【Term of Project】 FY2020- 2024

【Budget Allocation】 156,900 Thousand Yen

【Homepage Address and Other Contact Information】

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