Spatiotemporal distribution of independent components constituting deep-sea sediments

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Deep-sea sediments have recently attracted our attention as a new resource for rare-earth elements and yttrium (REY). To elucidate the REY-enrichment mechanism in deep-sea sediments, we applied Independent Component Analysis (ICA) to a multi-elemental data set of 3,968 bulk sediment samples from 101 sites in the Pacific [1] and the Indian Oceans [2, 3]. The result of ICA indicates that the 11-dimensional chemical compositions of bulk sediment samples can be successfully expressed by seven statistically independent components (ICs) that collectively account for 97.9% of the total sample variance.

Combined with sedimentary age that is mainly inferred from available biostratigraphic information and paleogeographic reconstruction, we visualized the spatiotemporal distributions of the geochemical ICs during the past 65 million years. The synthetic pictures of IC signal intensities during the Cenozoic era provide us insights on the genesis of deep-sea mineral resources. For example, the distribution of IC that can be interpreted as a contribution of hydrogeneous component exhibits relatively strong signals in the central and the eastern North Pacific throughout the Cenozoic, which broadly overlaps on the distribution of REY-rich mud with moderate REY concentrations (400–1,000 ppm of total REY) near the seafloor surface [1] and the zones of greatest economic interest regarding ferromanganese crusts and nodules [4]. Such a relationship implies a latent but important genetic linkage among the different types of seafloor mineral resources.

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