Decoding geochemical signals: Independent components constituting deep-sea sediments

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Rare-earth elements and yttrium (hereafter referred to as REY) play essential roles in various modern high-tech products. Recently, wide distribution of REY-rich mud, deep-sea sediments containing high concentrations of REY, was confirmed in the Pacific Ocean [1]. Because of their potential economic value as a new resource for REY, it is becoming an important issue to understand the origin of REY-rich mud.

To elucidate the REY-enrichment mechanism in deep-sea sediments, an effective approach is to separate geochemical signatures of genetic processes that could be preserved as characteristic chemical compositions of the sediments. In order to decode the geochemical signals in various types of deep-sea sediments that are originated from mixing of multiple source materials and/or processes, multivariate statistical analyses that can treat multi-elemental information are very useful.

In the present work, we newly constructed a huge data set composed of chemical compositions of 3,968 bulk sediment samples from the 82 sites in the Pacific Ocean [1] and 19 sites in the Indian Ocean [2]. Then we applied Independent Component Analysis (ICA) to the data matrix, which can extract original independent source signals from observed multivariate signals (i.e., chemical compositions of deep-sea sediments) on the basis of intrinsic non-Gaussian data structures attributable to each geochemical process.

The result of ICA indicates that the chemical compositions of bulk sediment samples can be successfully expressed by independent components, including biogenic carbonate and silica components, hydrothermal component, and REY-controlling components.

[1] Kato, Y. et al. (2011) *Nat. Geosci.* **4**, 535-539.
[2] Yasukawa, K. et al. (2015) *Geochem. J.* in press.