Statistical characterization of organic-rich sediments in the modern ocean by Independent Component Analysis

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In the Phanerozoic eon, reducing ocean depleting dissolved oxygen had emerged repeatedly (Wignall and Twitchett, 1996; Jenkyns, 2010). As a record of such a reducing ocean environment, sedimentary rocks called black shale with high organic carbon contents and laminations had been formed due to suppression of both decomposition of organic matter and activities of benthic organisms. It is well known that these black shales are rich in redox-sensitive elements such as V, Mo and Re that are stable as insoluble solid phases in reductive conditions (Brumsack, 2006; Cohen et al., 1999)

In contrast to large-scale anoxic events in geological past, the modern ocean is enriched in oxygen from the surface to the deep owing to a vigorous overturning circulation (Broecker and Peng, 1982). However, anoxic water mass develops in a limited number of sea areas such as restricted basins and high productivity zones. Organic-rich sediments distributed in such areas also show high concentrations of redox-sensitive elements (Hirst, 1974; Ravizza et al., 1991). Geochemical characterization of such organic-rich sediments can provide a key to understand physicochemical processes in reducing oceans of deep past including the Cretaceous OAEs and the Permo-Triassic boundary.

In this study, we collected organic-rich sediments from core samples drilled by the Deep Sea Drilling Project/Ocean Drilling Program/Integrated Ocean Drilling Program in multiple sea areas where anoxic water mass develops, and analyzed their bulk chemical composition (major- and trace-element, total organic carbon, and total sulfur contents). In addition, we performed independent component analysis (ICA) on the obtained multi-elemental data set. ICA is one of the relatively new multivariate statistical techniques developed in the fields of information science and neuroscience. In recent years, ICA has also been applied to the field of geochemistry (Iwamori and Albarède, 2008), and is also exerting its power on chemical composition data of sediments (Yasukawa et al., 2016).

We will present geochemical characteristics of the organic-rich sediments and discuss their relationship to sedimentary environments based on the extracted independent components.

Keywords: organic-rich sediments, redox-sensitive elements, independent component analysis