Marine Os isotopic evidence for multiple submarine volcanic activities during Aptian, mid-Cretaceous

*松本 廣直[1]、黒田 潤一郎[1]、Coccioni Rodolfo[2]、Frontalini Fabrizio[2]
*Hironao Matsumoto[1], Junichiro Kuroda[1], Rodolfo Coccioni[2], Fabrizio Frontalini[2]

1. 東京大学理学系研究科地球惑星科学専攻、2. ウルビノ大学
1. Department of Earth and Planetary Science, The University of Tokyo, 2. DiSPeA, University of Urbino

The mid-Cretaceous is marked by repeated Oceanic Anoxic Events (OAEs) that are characterized by episodic burials of organic-rich sediments in various oceanographic settings. In the Aptian, several black shale horizons (e.g., Selli (OAE1a), Noir, and Fallot levels) have been reported from the Tethys, Atlantic, and Pacific sedimentary records. Since these black shale horizons are accompanied by the perturbations of the carbon cycle and biotic crises of marine organisms, the understanding of their triggers and influence on the marine ecosystem is important for the comprehension of the mid-Cretaceous marine environment. Radiometric ages of a major part of the Ontong Java Plateau (124.9-119.6 Ma) roughly correspond to the sedimentary ages of these black shale layers (124.55 to 117.84 Ma). However, large chronological uncertainties of radiometric ages of Ontong Java Plateau and sedimentary sequences have prevented the direct correlations of these events.

Marine Os isotope ratio ($^{187}Os/^{188}Os$) reflects the balance between the unradiogenic Os input from hydrothermal activities and radiogenic Os input from continental materials. The relatively short residence time (10-100 kyr) of Os makes it possible to constrain the precise duration of massive release of unradiogenic Os through hydrothermal activities using past marine $^{187}Os/^{188}Os$ ratios. Previous studies have revealed extremely unradiogenic marine $^{187}Os/^{188}Os$ values at the Selli level, suggesting active hydrothermal activity possibly at the Ontong Java Plateau during OAE1a. However, the Aptian Os isotopic record is limited to only OAE1a and no Os isotopic studies have focused on the aftermath of OAE1a. This study aims to reconstruct the continuous Os isotopic record during Aptian using pelagic Tethyan sediments deposited in the Umbria-Marche Basin to constrain the duration of massive volcanic activities related to the Ontong Java Plateau and its relationship with the Early Aptian black shale horizons (Selli, Noir, and Fallot levels).

Our new Os isotopic data reveal negative Os isotope excursions at the Noir and Fallot levels. These Os isotopic excursions can be explained by a massive input of unradiogenic Os isotopic through hydrothermal activities associated with submarine volcanism. Combining the Os isotopic record around the Selli level, which was reported in previous studies, there are four major submarine volcanic signals during the Early to mid-Aptian. Three of these volcanic pulses correspond to the deposition of black shales (e.g., Selli, Noir, and Fallot levels), which suggests the strong linkages between submarine volcanism and deposition of organic-rich sediments. The most probable candidate for these volcanic signals is submarine volcanic activities at the Ontong Java Plateau.

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