Marine Osmium isotope record across the Aptian/Albian boundary to elucidate the relationship between the Oceanic Anoxic Event 1b and massive volcanic activities at the Southern Kerguelen Plateau

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Several organic-rich sediments (black shales) were deposited in the Tethys and the Atlantic Oceans from the uppermost Aptian to the lower Albian. In particular, four prominent black shale layers have been identified (i.e., Jacob, Kilian, Urbino/Paquier, and Leenhardt levels in stratigraphic order) as the sedimentary expression of Oceanic Anoxic Event (OAE) 1b. The OAE1b is characterized by a major planktic foraminiferal turnover in the Cretaceous period and its exceptionally long duration. In spite of its significant impact on the marine biological evolution, the OAE1b is one of the least studied Cretaceous OAEs. Massive volcanic activities associated with the emplacement of Southern Kerguelen Plateau were ascribed as the trigger mechanisms for the OAE1b. However, the large uncertainties in the radiometric age of Southern Kerguelen Plateau and the sedimentary sequence of OAE1b have however hampered the definition of their causal relationship. Paleo-seawater osmium isotopic record ($^{187}Os/^{188}Os$) is a powerful tool to detect the timing of volcanic pulse. Marine $^{187}Os/^{188}Os$ value mainly reflects the balance between radiogenic osmium flux from the continental crust ($^{187}Os/^{188}Os$ ~1.0-1.5) and unradiogenic osmium flux through hydrothermal activities ($^{187}Os/^{188}Os$ ~0.12). Thus, the relative contribution of hydrothermal activities (or the submarine volcanic activities) can be reconstructed from the paleo-seawater $^{187}Os/^{188}Os$ variation recorded in the sedimentary rocks. In this study, we present a new record of marine Os isotopic record from the Late Aptian to Early Albian to reveal the timing of massive volcanic activities and its relationship with OAE1b.

Pelagic sedimentary rock samples were collected from two sites; 1) Poggio le Guaine (PLG) section (Italy) that was deposited in the central-western Tethys Ocean, and 2) Deep Sea Drilling Project (DSDP) Site 463 drilled at the western Mid-Pacific Mountains in the Pacific Ocean. Based on the micropaleontological study on planktonic foraminifera and carbon isotopic analysis of bulk inorganic carbon, the stratigraphy of these two sections was precisely correlated. Indeed, the stratigraphic interval equivalent to the Jacob and Kilian levels were identified for the first time in the Pacific region. Variations of initial $^{187}Os/^{188}Os$ values were consistent between PLG section and DSDP Site 463 and summarized as follows; 1) relatively stable $^{187}Os/^{188}Os$ values in the pre-OAE1b interval, 2) decline of $^{187}Os/^{188}Os$ values at the onset of OAE1b, (3) a first sharp drop of $^{187}Os/^{188}Os$ at the extinction level, (4) a second sharp drop followed by an abrupt increase in the $^{187}Os/^{188}Os$ values at the Kilian level, and (5) fluctuation of $^{187}Os/^{188}Os$ values above the Kilian level. Combining $^{187}Os/^{188}Os$ data and other geochemical data, we interpreted that the drops of $^{187}Os/^{188}Os$ values at the extinction and Kilian levels were induced by pulses of hydrothermal activities. Massive volcanic eruptions at the Southern Kerguelen Plateau is one of the most likely candidates to have caused the decreases in isotopic composition of osmium of seawater recorded at PLG section and DSDP Site 463. The close correspondence of osmium spikes to the extinction events within the OAE1b would support a causal link between the volcanic eruptions at the Southern Kerguelen Plateau and the biotic turnover recorded across Aptian/Albian boundary.

Keywords: Oceanic Anoxic Event 1b, Osmium isotope ratio, large igneous province

