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Constructing a biological productivity index using Ba stable isotope ratio in paleo-seawater: Toward understanding Earth system's response to transient global warming - *Geochemical Society of Japan Award Lecture*

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During the Early Paleogene, several short-term global warming events, known as hyperthermal events, occurred. At their onset, isotopically lighter ^{12}C-rich greenhouse gases were instantaneously supplied in substantial amounts to the atmosphere–ocean system. The biological pump, which is associated with an increase in oceanic biological productivity, plays a crucial role in terminating global warming by efficiently removing excess carbon from the atmosphere and fixing it into sedimentary layers (e.g., [1]). Ba is primarily transported in the water column as a constituent of barite, a mineral formed in microenvironments associated with organic matter decomposition. The Ba stable isotope ratio of barite reflects the Ba stable isotope ratios of upper ocean water; hence, Ba stable isotope ratios can provide key insights into the biological processes underlying Ba export. Three negative $\delta^{138/134}Ba$ shifts were detected by analyzing the $\delta^{138/134}Ba$ values of bulk sediment samples from ODP Site 738C in the southern part of the Kerguelen–Heard Plateau [2]. These shifts correspond to the Paleocene–Eocene Thermal Maximum, a global super-warming event at 56 Ma, and two hyperthermal events, ETM2 and I1. Bulk sediment samples primarily consisted of carbonates, clastic components such as quartz and feldspar, and biogenic barite. Clastic, carbonate, and other source components were removed from the bulk sediment samples to estimate the Ba stable isotope ratios in paleo-seawater using those of barite. To calculate the Ba stable isotope ratio of paleo-seawater from bulk samples instead of using the sequential leaching method, three factors must be determined: (1) Ba content and stable Ba isotope ratio in clastic components; (2) Ba content in carbonate components and isotopic fractionation between seawater and carbonate; and (3) Ba content in barite and isotopic fractionation between seawater and barite. By accurately and precisely determining these factors, the Ba stable isotope ratio of paleo-seawater can be used as an index of paleo-productivity.

[1] Yasukawa, Nakamura, Fujinaga, Ikehara & Kato (2017), *Sci. Rep.* 7, 11304.

[2] Miyazaki, Yasukawa, Tanaka, Vaglarov & Yoshida (2023), *Geochemical J.* 57, e1-e8.