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Long-term variation of barium stable isotope ratio as a proxy for paleo-productivity during the Paleogene "Hothouse" world

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The early Paleogene (late Paleocene–early Eocene) is characterized as the warmest "Hothouse" environment in the long-term (~10^6 yr) climatic trend of the Cenozoic. The long-term warming culminated during the early Eocene (~53 Ma), and then the climate turned to long-term cooling.

During the long-term global warming in the early Paleogene, marine productivity could have been profoundly affected due to oceanographic environmental changes. Because marine productivity plays great roles in the Earth's carbon cycle, reconstructing paleo-productivity during the early Paleogene is essential for elucidating biogeochemical cycles in the Hothouse world.

However, definitive proxies of paleo-productivity have not been established yet. Traditionally, the barite accumulation rate (BAR) in marine sediments has been employed as a proxy of paleo-productivity because barite precipitates following the decay of biogenic organic matter in the water column[1]. Nevertheless, difficulty in the precise estimation of the BAR prevents it from becoming a robust paleo-productivity proxy[2].

To this end, we employed the barium isotope ratio ($\delta^{138/134}$Ba) of pelagic carbonate sediments as an effective proxy for paleo-productivity. The $\delta^{138/134}$Ba of bulk sediments is likely to be controlled by that of barite in the sediments, which expected to reflect variations of seawater $\delta^{138/134}$Ba. During barite precipitation, isotopically light Ba is preferentially incorporated into barite particulates from ambient seawater with a constant fractionation factor. Therefore, the rise of barite $\delta^{138/134}$Ba indicates the rise of seawater $\delta^{138/134}$Ba, resulting from a high barite precipitation rate (i.e., high productivity) and vice versa[2]. By using this isotopic systematics, reconstructing the paleo-$\delta^{138/134}$Ba record is expected to illuminate the change in marine productivity in the Earth's history.

In this presentation, we report $\delta^{138/134}$Ba of early Paleogene carbonate sediments from the Pacific and Indian Oceans obtained by TIMS analyses [3][4]. Then, by using isotopic mass-balance calculation, we discuss the potential cause of the $\delta^{138/134}$Ba variation and implications for the oceanic paleo-productivity during the early Paleogene climatic trend.

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