

## Multiple early Eocene hyperthermals reconstructed from the Indian Ocean deep-sea sediments

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From the late Paleocene to the early Eocene (ca. 56 Ma), an extreme global warming by 5-8 °C occurred within several thousand years, which is termed as the Paleocene-Eocene Thermal Maximum (PETM). The PETM is known to accompany severe ocean acidification and a prominent negative carbon isotope excursion in both marine and terrestrial environments, which indicate a massive and rapid injection of isotopically light (<sup>12</sup>C-enriched) greenhouse gas into the ocean-atmosphere system. Recently, additional PETM-like global warming events (called as "hyperthermals") have also been identified during the early Eocene period of ca. 56-52 Ma [2]. As is the case with the PETM, the early Eocene hyperthermals also accompanied rapid and pronounced negative carbon isotope excursions. Besides, the hyperthermals appear to be in phase with the oscillations in the eccentricity of Earth's orbit [2, 3], which suggests that the orbital forcing affected to earth's climate and global carbon cycle even in the warmer Earth without large continental ice sheet during this period.

Geologic records of the hyperthermals have so far been reported from all over the world (e.g., the Pacific, the Atlantic, the Arctic, Europe and North America). The Indian Ocean, however, is the exception where only few published data are available for reconstruction of the hyperthermals and thus, the global extent of the hyperthermals remains uncertain. Here, we analyzed  $\delta^{13}\text{C}$ ,  $\delta^{18}\text{O}$  and  $\text{CaCO}_3$  contents of 376 bulk sediment samples taken from four DSDP/ODP cores (DSDP Site 213, DSDP Site 259, ODP Site 738C, ODP Site 752). The analytical results show that sediments from Site 738C and Site 752 contain multiple negative carbon and oxygen isotope excursions and reductions of carbonate contents, which appear to corresponding to the PETM and the early Eocene hyperthermals. Observed hyperthermals from the both sites are inferred to be H1 (Eocene Thermal maximum 2; ETM2)/H2 and I1/I2 events [3]. The observed carbon isotope excursions of ETM2 event ( $\sim -1\text{‰}$  at Site 752 and  $\sim -0.5\text{‰}$  at Site 738C) and I1 event ( $\sim -0.6\text{‰}$  at both sites) are comparable with those reported from the other regions, such as the Pacific and the Atlantic Oceans. Our results strongly suggest that the hyperthermals in the early Eocene period were a global event including the Indian Ocean.

### – References –

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