

Early Pleistocene shelf seep activities were controlled by glacio-eustacy

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The Upper Pliocene and Lower Pleistocene Ofuna (shelf edge to slope facies) and Koshiha Formations (shelf facies) of the Kazusa Group, are exposed at Segami, Yokohama City, northern part of the Miura Peninsula, Pacific coast side of central Japan. These formations yield a cold-seep assemblage consisting exclusively of chemoautotrophic bivalves, *Lucinoma*, *Conchocele*, and *Acharax*, in association with authigenic carbonates greatly depleted in ^{13}C . Seven cores (cores A to E, K, L) are recovered from the outcrop where the cold-seep assemblage occurs. Core observations clarify that the aggregation of chemoautotrophic bivalves are stacked normal to the bedding in association with massively developed authigenic carbonates which precipitated between the upper part of the Ofuna Formation to the lower part of the Koshiha Formation, and seven seep stages are determined based on the occurrence of chemoautotrophic bivalves.

To understand the relationship between the seep stages and the Glacio-eustacy, we measured stable oxygen isotope ($\delta^{18}\text{O}$) of a planktonic foraminifer *Globorotalia inflata* extracted from the core J that was recovered 180 m away from the outcrop where cold-seep assemblage occur. Foraminifer specimens measured are sampled with 50 cm intervals in the core. For comparison of $\delta^{18}\text{O}$ (Glacio-eustatic) fluctuation with the seep stages that are recognized in the cores at the seep site, tephra beds intercalated in the Koshiha Formation were faithfully described and traced in the cores and outcrops around the seep. Based on these stratigraphical correlations, the horizons of five seep stages 3 to 7 are recognized in the cores B to E, L and K and correlated accurately with those in the core J.

We identified the marine isotope stages (MIS) in the core J: MIS 49 (core depth 5.5-6.5 m), 50 (7.5-9.8 m), 51 (10.0-11.5 m), 52 (14.5-16.5 m), and 53(17.5-18.5 m), with the aid of calcareous nannofossil stratigraphy. Our seep stages 5 (19.3-23.0m), 6 (12.2-17.3m) and 7 (6.8-9.4m) occurred in the cold periods of MIS 54, 52 and 50, respectively. These results evidently suggest that the cold-seep activities on the shelf environments were synchronized with the global glacio-eustacy.