Late Pliocene paleoenvironmental changes from the Ananai Formation drilled core: evidence for stable isotope ratio

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INTRODUCTION

The Ananai Formation is one of the Pliocene Tonohama Group, which is distributed in west coast of the Muroto Peninsula, Kochi. Kondo *et al*. (1997) reported that there are several sedimentary cycles in the Tonohama Group. It was inferred that the sedimentary cycles were formed by sea-level change due to glacial-interglacial climate change. It was also considered that a maximum paleo-water depth of the Ananai Formation deposition was estimated to about 100m, therefore these sediments were deposited on the continental shelf in the paleo-Tosa Bay off Kochi. However, the paleoenvironmental changes recorded in the formation were remained poorly understood. In this study, we evaluate the late Pliocene sea-level changes from sedimentary cycles and oxygen isotope records. We discuss about contribution of terrestrial matter and changes of water mass in paleo-Tosa Bay during the late Pliocene.

SAMPLE AND METHOD

The continental drilled core ANA (ANA1 and ANA2: total length 70m and 100m) was recovered from the Ananai Formation in Tonohama, Kochi, at early 2006. Seventeen sedimentary cycles were recognized in the core, some of which can be correlated to those identified in the Ananai Formation outcrops. According to bio- and magnetostratigraphic studies, the age of ANA core was restricted between 2.3 and 3.54Ma (Iwai *et al*., 2008). Oxygen and carbon isotope ratio (delta^{18}O and delta^{13}C) of benthic foraminifer *Hanzawaia nipponica* ASANO was analysed using the stable isotope mass spectrometer (IsoPrime). Mg/Ca ratio of *H. nipponica* was also measured using ICP-OES (Optima 4300 DV). In addition, the dried sediment samples were analyzed in elemental analyzer on-line mass spectrometer (DeltaPlus Advantage) to measure the total organic carbon (TOC) contents, total nitrogen (TN) contents, and carbon isotope ratio of organic matter (delta^{13}Corg).

RESULTS AND DISCUSSION

The delta^{18}O records of benthic foraminifer *H. nipponica* show the periodical variation with amplitude of about 0.5-0.7 per mill. At least, the delta^{18}O variation at the sedimentary cycles 9-17 (7-48m) is corresponded to the estimated water depth changes, which are inferred from sedimentary facies and fossil mollusks of outcrops. Therefore, it is considered that the periodic delta^{18}O change of *H. nipponica* show glacio-eustatic sea-level changes by continental ice volume effect. Thus, the delta^{18}O records of ANA were compared with oxygen isotope standard curve LR04 (Lisiecki and Raymo, 2005) to establish the oxygen isotope stratigraphy. Based on biostratigraphy, magnetostratigraphy, and oxgen isotope stratigraphy, the age model of ANA core was constructed. As a result, the age of ANA is from 2.42 to 3.14Ma and an averaged sedimentation rate is about 9.5 cm/kyr.

Before 3Ma, *H. nipponica* delta^{13}C was relatively higher, and productively of ANA was relatively lower. Therefore, it is imply that the effect of Kuroshio Current was strong in paleo-Tosa Bay. At 3 Ma, Mg/Ca of ANA was apparently high, suggesting that paleotemperature of bottom water was probably very warm. This could be corresponded to global warm event called as mid-Pliocene warmth (Raymo *et al*., 1996) around 3Ma. During 2.95˜2.78Ma, *H. nipponica* delta^{13}C show gradual degrease by about 0.5 per mill. This maybe resulted from intensified effect of water mass, which have enrich nutrient with low delta$^{13}C_{DIC}$, due to development of coastal water or shallowing of seasonal thermocline. After 2.8Ma, it is occurred increasing of the amplitude of *H. nipponica* delta^{18}O and increasing-decreasing of contribution of terrestrial organic matter. The sedimentary basin of paleo-Tosa Bay could be affected by larger eustatic sea-level changes due to intensification of Northern Hemisphere glaciation about 2.8Ma (Bartoli *et al*., 2008).