Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

MIS27-11 Room:101B Time:May 24 14:00-14:15

Variations in SST and primary production revealed from long-chain diols in the Neogene equatorial Pacific sediments

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The eastern equatorial Pacific Ocean today sustains significant amounts of global marine productivity, and the region is one of the largest marine sources of carbon dioxide to the atmosphere. Nevertheless, geological time-scale variations of marine productivity and ecological / biogeochemical systems in the equatorial Pacific have been still unclear. It was obtained rough knowledge that marine productivity in the region was characterized by abundant diatoms since the late Oligocene to early Miocene. In this study, we reconstruct more detailed variations of primary productions by new diatom biomarker (long-chain diols) proxies from 'Pacific Equatorial Age Transect (PEAT)' sediments, and discuss evolution of the diatom-dominant ecosystem and the related paleoceanographic and paleoclimatic systems during the Neogene. In addition, we reconstruct variations in sea surface temperarture (SST) by long chain alkenone and the newest long-chain diol thermometers in these sediments.

Integrated Ocean Drilling Program (IODP) Expeditions 320/321, 'PEAT', recovered a Cenozoic sediment record from the equatorial Pacific by coring above the palaeoposition of the Equator at successive crustal ages on the Pacific plate. We used the cores U1335, U1336, U1337 and U1338 of the Neogene 'PEAT' sediments. The long-chain diols in marine sediments are mainly derived from diatom, and 28 carbon numbers (C_{28}) and C_{30} 1,14-diols are peculiar biomarkers of specific diatom genus Proboscia. These long-chain diols are used as upwelling indicator, diol index, which is the ratio of C_{28} and C_{30} 1, 14-diols to C_{30} 1,15-diols (Rampen et al., 2008, Earth Planet. Sci. Lett. 276, 207). Furthermore, Eustigmatophyceae are also known to have C_{28} and C_{30} 1, 13-diols, and more recently, these biomarkers are proposed as paleothermometer, which is the ratios of C_{30} 1, 15-diols to C_{28} and C_{30} 1,13-diols, called 'diol isomer index (DIX)' (Rampen et al., 2011, IMOG abstract).

We identify saturated C_{28} and C_{30} 1,13-diols, C_{28} and C_{30} 1,14-diols, and C_{30} 1,15-diol from almost all the early Miocene to Pleistocene PEAT sediments (23-0.23 Ma; cores U1335, U1336, U1337 and U1338). This indicates that diatom and eustigmatophyte algae productions were consistently significant in the equatorial Pacific throughout the Neogene. In particular, the diatom productions recorded by total diol concentrations increased at paleolatitude 2 ^{o}N-4 ^{o}N during 6 and 5-3 Ma, and at paleolatitude 2 ^{o}S-2 ^{o}N during 10-7 and 5-4 Ma. The diol (1,14/1,15) indices also varied, and higher diol index values suggest that upwelling more efficiently occurred in sea surface layers at paleolatitude 2 ^{o}S-4 ^{o}N since 16 Ma. However, their decreasing spikes appeared at 2 ^{o}S-2 ^{o}N during 8 Ma and 4 Ma and at 2 ^{o}N-4 ^{o}N during 4-3 Ma. The horizons of higher diol concentrations do not correspond to those of higher diol indices. Therefore, the increase of diatom production cannot be explained by only more efficient occurrence of upwelling in the equatorial zone. Diatom is known to need silica (Si) for its production, and Si is thought to be transported from land to ocean. Thus, the increase of diatom production in this study might be caused by increasing amount of terrigenous matter transported via atmosphere from land to the pelagic areas of the equatorial Pacific. From these insights, we suggest that variations of diatom productions are presumably attributed to changes in efficiency of upwelling and terrigenous input by aeolian transport in the equatorial Pacific during the Neogene.

The diol thermometer, DIX, values varied in the Neogene PEAT sediments. Variations in DIX-based SSTs were quite different from those in alkenone-based SSTs, which were nearly constant over the 15 Ma. The DIX-based temperatures might vary controlling by occurrence of cooler upwelling in the equatorial Pacific areas. These trends are concordant with that of the Neogene global paleoclimatic variation.

Keywords: Pacific Equatorial Age Transect (PEAT), marine primary production, sea surface temperature, diol paleothermometer, diatom production, Neogene paleoceanography