

TEMPERATURE AND PRODUCTIVITY CHANGE ASSOCIATED WITH THE CLOSURE OF THE CENTAL AMERICAN SEAWAY

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The Earth's climate experienced a dramatic transition during the Neogene from a "hothouse" climate significantly warmer than today, with smaller ice volume and higher sea levels, to the current "icehouse" climate with massive ice sheets (Zachos et al., 2001). A key stage in this transition is the development of Northern Hemisphere Glaciation. The closure of the Central American Seaway (CAS) and its influence on ocean heat and moisture transport have been suggested to be the major forcing factor for continental ice growth, particularly in the Northern Hemisphere (Driscoll and Haug, 1998). However, the impact of the Panama Isthmus formation on climate change still remains uncertain, partly due to insufficient constraints on the timing of the restriction of the CAS. In this study, we measure geochemical tracers in three sediment cores taken from Caribbean Sea [Ocean Drilling Program (ODP) Sites 999 and 1000] and from the Guatemala Basin, East Equatorial Pacific (EEP) (ODP Site 1241). Today, these two basins have distinctly different temperatures and pH values. Therefore, comparing these records will allow us to clarify the timing of the separation of these two Ocean Basins and the closure of the CAS.

Fig. 1 displays alkenone based sea surface temperatures (SST) and C₃₇ alkenone concentrations in ODP Sites 999 + 1000 and 1241 for the last 10 Myr. Alkenone SSTs range from 24.9 to 28.3 °C in Caribbean Sea samples and from 25.6 to 27.7 °C in EEP samples. The SSTs in the Caribbean Sea exceed the upper limit of the U^K₃₇ calibration of 28.9 °C prior to 6 Ma, but from 5 Ma, SSTs in both regions document a long-term cooling from ~28.3 °C in the Late Miocene/Early Pliocene to ~25.5 °C in the late Pleistocene (Fig. 1A). This suggests that the two regions responded similarly and dramatically to Plio-Pleistocene global climate change. In contrast, and unexpectedly, the proposal closure of the CAS for surface water in the Pliocene (Driscoll and Haug, 1998) is not evident in the development of a SST gradient (Fig. 1C). This would suggest that the changes in foraminiferal δ¹⁸O records can not be attributed to temperature change. Therefore, these changes reflect mainly changes in salinity as a result of a change in moisture transport related to the build-up of the Panama Isthmus and hence a significant change in the hydrological cycle.

The concentration of alkenones in sediments can be used to trace the paleoproductivity of haptophyte algae. C_{37} alkenone concentrations in dry sediment vary between 0.12 to 2.44 $\mu\text{g/g}$ in Caribbean Sea samples and between 0.20 and 4.14 $\mu\text{g/g}$ in EEP samples (Fig. 1B). The concentration records from Pacific samples are relatively higher prior to 5 Ma and during the period between 3 and 1.5 Ma but low the Pliocene warm period (5-3 Ma). This is in marked contrast to the Caribbean Sea, where alkenone abundances are generally high from 5 to 4 Ma. The long-term variability of EEP productivity is probably caused by either change in upwelling intensity or nutrient status of source waters, probably associated with changes in the reorganization of global ocean circulation. Thus, although the closure led to a different surface current system in the Caribbean Sea and EEP, this tectonic change did not induce a SST anomaly between the two sites.

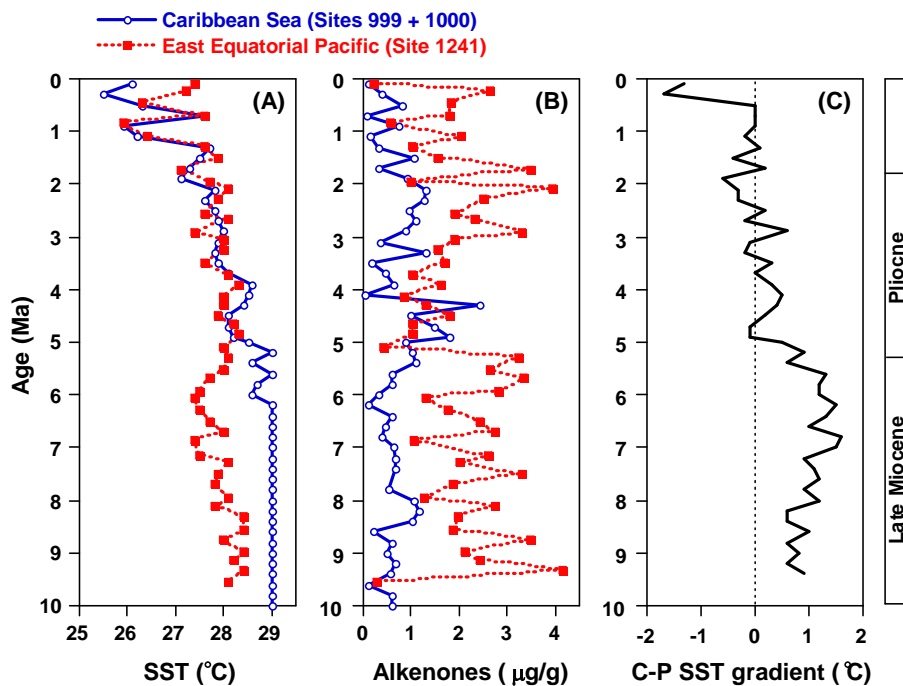


Figure 1. Alkenone records from ODP Sites 999 + 1000 (Caribbean Sea) and 1241 (East Equatorial Pacific) over the last 10 Myrs. A: U_{37}^K derived sea surface temperatures (SST). B: Concentrations of C_{37} alkenones. C: Caribbean-Pacific (C-P) SST gradient. U_{37}^K values were converted into temperature by using the global core-top calibration of Müller et al. (1998).

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