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Past temperature and nutrient conditions in the namibian upwelling system over the last 3.5 Ma, ODP Site 1082

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Since the beginning of the closure of the Panama Gateway at about 4.5 Ma BP, global climatic conditions underwent fundamental changes marked by the onset of the North Hemispheric Glaciation (NHG). From the early Pliocene warm period, to the colder Pleistocene, all oceans passed through profound reorganizations in circulation and productivity. The latter is particularly observed in the center areas of marine productivity, the upwelling systems which may have been important for the atmosphere-ocean carbon cycle through biological pumping and dumping of CO_2 and therefore also important for global Plio-Pleistocene climatic variability.

In our study, we focused on sediment cores from ODP Site 1082 (21˚5.6S, 11˚49.2E, 1280 m water depth), located in the Namibian upwelling system and we here report the first entire 4 Ma record at 3 to 5 ka resolution for alkenone-based Sea Surface Temperature (SST) variations and for variations in bulk organic carbon δ^{15}N values.

From 3.5 Ma to 0.41 Ma BP, SST reconstructions show a gradual cooling about 3-4˚C/My. Concomitant with the final closure of the Central American Seaway at 2.7 Ma BP more pronounced cooling steps occurred, shifting the SST variability into a mode of higher-amplitude variations, while the period between 2.0 and 1.45 Ma BP was again characterized by relatively SST conditions. After a major cold excursion at 1.45 Ma BP, consistent with a strong glacial event in global ice volume record, the SST further declined following the intensification of the NHG and shows variations of large amplitude (about 4 to 6˚C) at Glacial-Interglacial cycles. In the course of the Mid-

Pleistocene Transition at about 0.9 Ma BP, the temperature signal is still dominated by the obliquity period in a world that became progressively bipolar with continental ice sheets. SST reached minimum values at 0.41 Ma before increasing about 2˚C over the last 0.4 Ma.

The δ^{15}N of bulk organic matter, serving as nutrient utilization proxy, show low values during the early warm Pliocene associated with weak upwelling conditions. The lowest values reach 0-1‰ close to atmospheric values between 2.7 and 2.6 Ma BP corresponding to the initiation of the NHG. At that time, the Namibian upwelling system probably was weaker then during the Pleistocene, as can be inferred from generally high SST values. We assume that upwelled waters did not carry enough nitrates to forster very high productivity. The very low nitrogen isotope values could be then interpretated as evidence for intensive activity bacterian nitrogen-fixating bacteria. However, further evidence is needed to support this assumption. With the intensification of the upwelling system from the early to mid Pleistocene, the nutrient supply seemed to increase due to the strengthening of the trade wind and upwelling of nutrient-enriched subsurface water masses of subantarctic origin (δ^{15}N values about 4-5‰). With a greater nutrient supply, the local productivity increased, reaching an optimum period at the MPT (1.2 to 0.85 Ma), as implied by the alkenones concentration levels relative to the carbon content and the C/N ratio.

These paleoclimatic reconstructions are in agreement with other studies in different oceanic and continental settings: they imply that the Atlantic Ocean experienced profound hydrographic perturbations after the closure of Panama Seaway which had also strong impact on the SST and nutrient conditions in the Namibian upwelling area, one of the most important eastern boundary currents systems that probably acted as a major negative or positive climatic feedback system in the low–latitudes for the marine and atmospheric carbon cycle and the ocean´s nutrient inventory on long time scales.