PALEOPRODUCTIVITY, PALEOTEMPERATURE AND TERRIGENOUS INPUT IN THE MID-PLEISTOCENE SOUTHERN SOUTH ATLANTIC: IMPLICATIONS FROM BIOMARKER RECORDS (ODP-SITE 1089)

Petra Weller, Jens Hefter, and Ruediger Stein

Alfred Wegener Institute for Polar and Marine Research Bremerhaven, Germany

In order to reconstruct changes in paleoproductivity, paleocean-surface temperatures, and terrigeneous/marine organic carbon input and their relationship to climate change, specific biomarkers [n-alkanes, fatty acids, alkenones, sterols], Rock-Eval pyrolysis data, and stable carbon isotopes of the organic fractions (total Corg and biomarkers), as well as accumulation rates of organic carbon were determined in sediment samples from ODP Site 1089 (Atlantic sector of the Southern Ocean; Gesand et al., 1999). The investigated samples represent the time interval from Marine Oxygen Isotope Stages (MIS) 12 to 5e (i.e., about 450 to 100 ka). Based on the biomarker data, marine organic carbon was significantly enriched during glacial stages. Estimated paleoproductivity, corrected for the amount of refractory ("dead") organic matter as obtained from Rock-Eval pyrolysis (Fig. 2), reaches values of about 50 gC m$^{-2}$ y$^{-1}$ during peak interglacials (e.g., MIS 5e and lowermost MIS 11), which is close to the modern productivity measured in the study area (Fig. 3). During glacial intervals, the productivity was increased reaching values of about 100-150 gC m$^{-2}$ y$^{-1}$. These glacial interglacial changes are explained by a northward shift of the high-productivity zone during glacials. During peak-interglacials, akerolines, sea ice temperatures were about 4°C warmer than during glacials. Stable carbon isotopic analyses of the terigeneous n-alkanes identified a mixed origin of C3 and C4-plants, with a variability in relative proportions constrained to proxies of ocean circulation (Fig. 4).

The biomarker records display a distinct periodic variability which is related to Milankovitch and super-Milankovitch climate cycles (Fig. 5). Furthermore, a correlation with the Vostok temperature curve (Petit et al., 1999) and the SPECMAP climate record (Jouzel et al., 1984) is obvious. The same type of works in progress for ODP Site 1093, located further to the south.

Fig. 1: Study area showing the position of ODP Site 1089 and cited core locations in the southeastern South Atlantic. Arrows indicate independent surface and bottom ocean circulation patterns (adapted from Kuhn & Diekmann, 2002). Coloured regions of South Africa indicate simplified distribution of terrestrial plant-type. Background image shows satellite derived gravity field (Smith & Sandwell, 1997).

Fig. 2: Correlation of total organic carbon (Kuhn & Diekmann, 2002) and D2-values from Rock-Eval pyrolysis (R = 0.844, n = 198). The intercept of the regression line (not shown) determines an amount of ca. 0.13% "dead" (i.e., refractory) organic carbon. HI hydrogen index (Sx100/TOC), calculated after subtraction of "dead" carbon.

Fig. 3: Total organic carbon (Kuhn & Diekmann, 2002), amount of brassicaster tie (a plant-derived organic compound), estimated paleoproductivity (according to the terrestrial Steib, 1986), and akerolines-derived sea-surface temperature (SST) for the time interval 100 to 450ka at ODP Site 1089. The records are correlated with the Vostok atmospheric temperature difference (Petit et al., 1999) and the benthic and SPECMAP stack (Jouzel et al., 1984). "Modern" values (top of the figure) derive from munc-samples taken at the location of Site 1089.

Fig. 4: Amount of landplant-derived n-alkanes (C18-C20-C22)4), carbon isotop composition of n-C18 alkane, and %-contribution of C4-plants from binary mixing calculations, assuming literature-derived C4 (45.9‰) and C3 (20.5‰) n-alkane endmembers (Collister et al., 1994; Chikaraishi & Naraska, 2003). The proportions of C4-derived n-alkanes correlates with proxies for the variability of ocean circulation (Kuhn & Diekmann, 2002), suggesting an origin from different continents for the terigeneous n-alkanes and thus obscuring the n-alkane record in terms of absolute amounts.