Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 765

Spatial and Temporal Distribution of Biomarkers in Sediments of the California Current System: Clues to Paleoecology and Paleoclimate

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During ODP Leg 167 sediments from 13 locations within the California Current system in the Northeast Pacific have been recovered. The drilling sites represent different environments that encompass subtropical deep sea sediments, anoxic basins in the California borderlands and temperate to subarctic shelf and deep sea sediments. Samples of interglacial and glacial age from each location have been analysed with regard to the molecular and stable nitrogen isotopic composition of their organic matter. Biomarker analyses focussed on the following compound classes: Sterols, fatty acids and alcohols, long-chain ketones, long-chain alkyl diols and keto-ols, loliolides, chlorins and selected compounds indicative for land-plant input or redox conditions in the lowermost water column. The calibration of the Holocene samples with the nowadays situation revealed characteristic biomarker associations for e.g. the permanent upwelling cells off California or the restricted basins in the borderlands. Some biomarkers enabled to trace the distribution of single producer groups within the plankton associations (e.g. alkenones for haptophytes) in a south-north transact. Others accurately described the relative intensity of primary production in the photic zone and the degree of degradation within the water column (loliolides, pyrrols). By comparison of deep sea, shelf, and anoxic basin sediments several parameters could be tested with regard to their reliability to indicate different diagenetic settings. The distribution and variability of the nitrogen isotopic composition of the sediments revealed clear signals of the areas underlain by oxygen minimum zones, i.e. the stratified subtropical North Pacific and the upwelling cells north of Point Conception. On the background of the spatial variability of biomarker distributions and nitrogen isotopic compositions one dedicated core was investigated in detail to elucidate the course of the last deglaciation since 25 ka in the Northeast Pacific. The temporal resolution varied between 125 to 500 years. The last glacial surface waters were characterized by temperatures varying between 10 an 12 C (according to the degree of unsaturation of the alkenones) and reduced or even no upwelling at Point Conception. The chain-length distribution of land-plant derived long-chain alkanes (>C25) reveals an cooler and moister climate than today. The haptophytes were greatly reduced in importance compared to nowadays. The percentage of terrestrial organic matter within the sediment was elevated. At the beginning of the Boelling/Alleroed warm period the above land temperatures warmed rapidly, whilst the warming of the sea surface was delayed by an sudden increase in upwelling intensity, concomitant with an increase of the percentage of marine organic material in the sediments and slight modifications of the plankton association. The changed productivity and circulation patterns led to oxygen depleted conditions at the sediment water-interface. During the following Younger Dryas cold period which is evidenced by declining upwelling intensity, reduced above land temperatures and lowered marine productivity the primary producers adapted to cooler water shifted southwards again. In the preboreal the warming trend of the sea surface to early Holocene maximum temperatures of 17 C lagged again the rise of above land temperatures by the renewed onset of strong upwelling. After the establishment of slightly warmer than today but relatively stable conditions before 6 ka the haptophytes migrated northward and became a persistent component of the primary producer association. Short term climatic fluctuations in sea surface temperatures throughout the last 6 ka contrast with relatively stable above land conditions. During the past 3 ka the haptophytes gained additional importance and - if this is not a diagenetic trend - overall productivity increased.