PATTERNS OF ICE-RAFTED DETRITUS IN THE GLACIAL NORTH ATLANTIC (40-55°)

F. Grousset (Dépt. of Géologie & Océanographie, Univ. Bordeaux, Talence, France), L. Laberyie, J. Sinko, G. Bond, J. Duprat, M. Cremer, and S. Huon

A study by Heinrich (1988) rekindled interest in the timing of the influx of ice-rafted detritus in North Atlantic sediments. In a set of cores of the Northeast Atlantic Basin (≈47°N, 20°W), we have resolved six well-defined, ice-rafted detritus layers over the last 70 ky at approximately 11 ky intervals. Broecker et al. (1992) described these events in a high-resolution study of a neighboring core (ODP-609), demonstrating that these "Heinrich Layers" were not an exceptional feature; moreover, they reported AMS radiocarbon dates for the three most recent events (13.4-14.5ka, 18.9-21.4ka, 25.6-29.2ka).

In this paper, we present a rapid method to study the distribution of these events (both in space and time) using whole core low-field magnetic susceptibility. We report on approximately 30 cores covering the last 150 to 250 ka. Well-defined patterns of ice-rafted detritus appear during periods of large continental ice sheet extent, although not always within their maxima. Most of the events may be traced across the North Atlantic Ocean. For the six more recent Heinrich layers (HL), two distinct patterns exist: HL1, HL2, HL4 and HL5 are distributed along the northern boundary of the Glacial Polar Front, over most of the North Atlantic between ≈40° and 50°N; the 3 and HL6 are more restricted to the central and eastern part of the northern Atlantic. The Nd-Sr isotopic composition of the material constituting different Heinrich events indicates the different provenance of the two patterns: HL3 and HL6 have a typical north Europe-Arctic-Icelandic "young crust" signature, and the others have a large component of northern Quebec and northern West-Greenland "old crust" material. These isotopic results, obtained on core SU-9008 from the North American basin, are in agreement with the study by Huon and Jantschik (1992), who used K-Ar dating of silt-and clay-size fractions of an eastern basin core (Me-6889), and confirmed the large spatial scale of these events and the enormous amount of ice-rafted detritus they represent.

BIOGEOGRAPHIC DISTRIBUTION OF *BOLBOFORMA* IN UPPER EOCENE/OLIGOCENE MARINE SEDIMENTS IN THE SOUTHERN HEMISPHERE

U.J. Grützmacher (GEOMAR, Kiel, Germany)

The members of the genus *Bolboforma* (Daniels and Spiegler, 1974) are marine microfossils (probably protophytic algae) which are mainly limited to middle and high latitudes in both hemispheres. *Bolboforma* have been observed in lower Eocene to lower Pliocene sediments and yield a useful biostratigraphic tool, mainly in high latitudes, where the biostratigraphic value of other biozonations is restricted.

The object of this study is to demonstrate the biogeographic distribution changes of *Bolboforma* in upper Eocene to Oligocene marine sediments in the southern hemisphere. Therefore, *Bolboforma* data of ODP Leg 113 (Kennett and Kennett, 1991), ODP Leg 114 (Spiegler, 1991), and of ODP Leg 120 (Mackensen and Spiegler, 1992) are compared and correlated with the evaluated data of DSDP Legs 29, 36, 71 and 90 and represented in palinspastic maps in time spans of about 6 My.

In the lower-most Oligocene, a formation of a continental ice sheet on Antarctica is postulated, which is mainly derived from a rapid, positive shift of the oxygen isotope values in tests of marine calcareous microfossils. The distribution of *Bolboforma* reacts upon this well-known climatic deterioration in the southern hemisphere at about 35.9 Ma in dependent of latitudes.

In late Eocene (40 Ma) *Bolboforma* shows a wide-spread extension in latitude. A successive, south to north disappearance of *Bolboforma* in the sites just after the oxygen isotopic shift at 35.9 Ma can be recognized. At about 34 Ma the biogeographic distribution of *Bolboforma* is only restricted to a small belt in middle southern latitudes. This characteristic distribution can be explained as a reaction of *Bolboforma* to a progressive cooling northward in the southern hemisphere.

$\delta^{18}O$-VARIATIONS IN DIAGENETIC SEQUENCES FROM ATLANTIC SEDIMENTARY BASINS

J. Grützner (GEOMAR, Kiel, Germany) and J. Mienert

Stable isotope analyses on DSDP/ODP-samples from Atlantic Ocean basins have been carried out to reconstruct the formation temperatures of calcite and chert at various burial depth levels. The effect of geothermal anomalies on authigenic mineralization.is of special interest in this context.

The carbon isotopic composition of concretionary calcite ($\delta^{13}C$=0.4 to 2.9‰) suggests dissolved primary marine carbonate to be the source for the diagenetic calcite. Using the calcite/water equilibrium, the oxygen isotopic composition of the calcite indicates maximum formation temperature of 50°C. It can be seen that the diagenetic carbonate formation gives no hints on unusually high heat flow in North Atlantic ocean basins. This is also obvious from the thermal gradients. Values of 3 to 6°C/100m derived from the formation temperatures are similar to the geothermal gradient.

On the other hand the oxygen isotopic composition of concretionary chert samples could reflect the influence of heat flow on silica precipitation. The $\delta^{18}O$ values range from 35.6‰ to 20.9‰. This accords to a temperature range from 11°C (24°C) to 86°C (102°C) depending on published equations. The calculated thermal gradients vary from 2.8 (3.9)°C/100m to 9.1 (14.5)°C/100m. In shallow subbottom-depths, far away from the basement temperatures, temperature gradients are in good agreement with those derived from the calcites. However, near the sediment/basement interface hydrothermally altered quartz reveal high mineral formation temperatures and steep thermal gradients possibly caused by unusual high heat flow during "hot times" of Atlantic Ocean basin formation.

FEATURES AND ORIGIN OF JURASSIC TO TERTIARY RADIOLARIAN CHERTS ASSOCIATED WITH OPHIOLITES IN SOUTHERN CENTRAL AMERICA

H.-J. Gursky (Institut für Geologie und Paläontologie, Philipps-Universität, Marburg/Lahn, Germany)

The Nicoya Ophiolite Complex in southern Central America consists of tholeiitic basalts and volcanoclastic breccias formed during the Jurassic to Early Tertiary. The Lower Nicoya Complex is interpreted as oceanic crust accreted in a spreading ridge; the Upper Nicoya Complex consists of an oceanic intraplate