New Insights into Glacial Terminations from Mg-paleothermometry

LEA, D.W.[1]

[1]Department of Geological Sciences, University of California, Santa Barbara, CA 93106, USA (lea@geol.ucsb.edu)

The combination of oxygen isotopes and Mg paleothermometry in foraminifera has allowed, for the first time, the clear separation of temperature and ice volume signatures in marine sediment records. This advance makes it possible to ascertain both the magnitude of sea surface warming associated with glacial terminations and the timing of warming relative to ice volume changes. Our work in the tropical Pacific and Indian Oceans (with D. K Pak, H. J. Spero and B. N. Opdyke) reveals that deglacial warming clearly precedes the change in oxygen isotopes that marks the termination. Based on orbital scale records encompassing the last five glacial terminations (sedimentation rate <7 cm/ky), the lead of sea surface temperature (SST) is ~ 3 ky. In the best-dated records of glacial termination I, SST warms between 20 and 18 ky BP (calendar), close to the U-Th dated of initial sea-level rise, but preceding the oxygen isotope change by several thousand years. The lead of SST is especially clear at Termination II, possibly because of the larger value of orbital eccentricity and precessional amplitude.

A new Mg/Ca record from a high sedimentation rate (~35 cm/ky) core in the Cariaco Basin, tropical N. Atlantic, allows us to characterize the deglaciation with much higher resolution (with L. C. Peterson and K. A. Hughen). The Cariaco record reveals that SST changes at this site occurred in the distinct steps that are well known from Greenland ice core records: a rapid increase in SST from cool glacial levels (~24°C) to interglacial levels (27°C) at the transition into the Bølling/Allerød period, a cooling back to glacial levels during the Younger Dryas, and a rapid rise back to interglacial levels during the Pre-Boreal. A major question raised by the Cariaco record is why, given our tropical Pacific observations, the deglaciation there is synchronous with the characteristic Northern Hemisphere deglaciation. Three hypotheses are possible: 1) the increased resolution of the Cariaco record reveals relationships that cannot be distinguished in the orbital scale records; 2) Cariaco's unique coastal setting ties it to Northern Hemisphere processes (previously suggested by Kienast et al (2001) for the termination in the South China Sea); or, 3) the lead of SST is unique to the Southern Hemisphere. To test these hypotheses, we are analyzing Mg/Ca in several new Termination I sections, including a Tobago Basin (Caribbean) core previously cited as revealing warming during the Younger Dryas (with C. Ruehlemann) and a sub-tropical record from the Bay of Plenty, New Zealand (with W. Howard).

Benthic foraminiferal Mg/Ca paleothermometry and its application to Late Miocene changes in Atlantic circulation

C.H. LEAR[1], Y. ROSENTHAL[1] AND J.D. WRIGHT[2]

[1]Institute for Marine and Coastal Sciences, and Department of Geology, Rutgers University, 71 Dudley Road, New Brunswick, NJ, 08901, USA (lear@imcs.rutgers.edu, rosentha@imcs.rutgers.edu)

[2]Department of Geology, Rutgers University, Wright Laboratories, 610 Taylor Road, Piscataway, NJ, 08854, USA (jdwright@email.rci.rutgers.edu)

Core tops sediments from different ocean basins have been used to refine the benthic foraminiferal Mg/Ca – bottom water temperature (BWT) calibration. Three species of *Cibicidoides* appear to have similar temperature sensitivities. Considering both down-core Mg/Ca reproducibility and errors associated with the calibration, BWT may be estimated to within ±1°C.

The new calibrations are applied to Mg/Ca records of three species from an intermediate western equatorial Pacific site (ODP Site 806, ~2500 m) and a deep western equatorial Atlantic site (ODP Site 926, ~ 3500 m) covering the last 11 million years. Between 11 and 8 Ma, BWT of each site are similar (~6 °C). The Atlantic Mg/Ca record shows a decrease of around 0.7 mmol/mol at ~8 Ma, which corresponds to an increase in the flux of non-carbonate material at this site. Subsequently, the Atlantic Mg/Ca record increases between 7 and 5 Ma, corresponding to an overall decrease in the non-carbonate flux at this site. These changes in benthic foraminiferal Mg/Ca are not observed in the Pacific Mg/Ca record, arguing against global temperature or seawater Mg/Ca change as a cause. We interpret these signals as reflecting temperature changes resulting from variations in the flux of proto-North Atlantic Deep Water. The Pacific and the Atlantic Mg/Ca records show a parallel decrease through the Pliocene, probably reflecting a global cooling of the world's deep waters by ~ 3.5 °C.