Geophysical Research Abstracts,
Vol. 11, EGU2009-11213-1, 2009
EGU General Assembly 2009

Bottom-water production and ice-sheet dynamics in the southeastern Weddell Sea during the Last Glacial Maximum – millennial to seasonal variability in sediment records and correlation to the EPICA-DML ice core

M. E. Weber (1), G. Kuhn (2), L. Reichelt (1), and W. Ricken (1)

(1) Institute of Geology and Mineralogy, University of Cologne, Germany (michael.weber@uni-koeln.de), (2) Alfred-Wegener-Institute for Polar and Marine Research, Bremerhaven, Germany

The Southern Ocean and the adjacent Weddell Sea are key areas for Earth's climate variability because they influence the global thermohaline circulation as major sites of bottom and intermediate water formation. With respect to suborbital climate change, Antarctica is becoming increasingly interesting, because the Southern Ocean and specifically the Weddell Sea, may have acted as a major supplier of deep water (Antarctic Bottom Water) during stadials, when production of North Atlantic Deep Water was sluggish or even terminated. Unfortunately, there is a lack of high-resolution Antarctic sediment cores that could provide detailed and continuous insight into Antarctic climate variability during the last glacial.

To fill in that gap, we re-examined AMS14C-dated gravity cores that were retrieved in the late eighties to early nineties with RV Polarstern in the southern to eastern Weddell Sea, using high-resolution non-destructive methods. The sites are mostly located on sediment ridges of the Antarctic continental margin north and east of Crary Fan and contain ultrahigh-resolution records of bottom-water production and glacial ice-sheet dynamics with sedimentation rates of up to 4 m/ka! during the last glacial maximum (LGM; 25-19 ka as deduced by AMS14C dating). The most intriguing characteristic is the abundant mm-scale lamination of relatively coarse (silty) and fine (muddy) layers of detrital composition.

In order to find out whether or not the lamination represents seasonal stratification and could hence be used as high-resolution chronology, we developed software-based tools to (i) extract gray values at pixel resolution (i.e., 12 values/mm) from x-ray radiographs, and (ii) to count layers semi-automatically. In core PS1789, for instance, we counted 2430 peaks over 2690 AMS-dated years. Accordingly, there is strong evidence that the lamination represents seasonal variability and therefore, the sites from the ridges contain an extremely valuable climate archive for ultrahigh-resolution studies of glacial climate variability in high southern latitudes.

Our preliminary interpretation is that a seasonally variable bottom-water production was induced by brine injection, which again, initiated density currents that were canalized within the channels. They overspilled the NW levee shoulder and deposited a coarser-grained (siltier) layer during glacial winter, when brine injection was probably enhanced, and a finer-grained (muddier) layer during glacial summer, when brine injection was likely reduced. Apparently, this mechanism operated consistently, producing intense bottom-water in the channels, and creating fine-scale lamination on the ridges over thousands of years during the LGM. Accordingly, we see evidence for a bipolar see-saw, i. e., the sluggish NADW production during the LGM in the North Atlantic might have been at least partially compensated by intense bottom-water production in the southern Weddell Sea.

However, bioturbated sections that dominate the post glacial record, are also scarcely intercalated into LGM sections with a 1 to 1.5 kyr spacing. Bioturbated sediment contains clear evidence of at least partly open water above the site and occasionally intensified iceberg calving and transport. Therefore, it represents warmer periods with likely enhanced paleoproductivity. As a working hypothesis we assume that these intervals correspond to Antarctic Isotopic Maxima (AIM) -like intervals, representing times of diminished bottom-water production in the Weddell Sea. Unfortunately, the currently available core material does not reach beyond the LGM so that the AIM of Marine Isotopic Stage 3 could not be analyzed.

Spectral analyses of laminae thickness, magnetic susceptibility, and Lab color indicate a novel finding: prominent cycles at periods of 80 – 90 years (Gleisberg cycle) and 200 – 220 years (de Vries cycle), revealing a dominant

linear response to solar forcing. Our multiproxy records will allow for detailed comparison to the neighboring EPICA-DML ice core at seasonal resolution over several millennia during the LGM. This will put our results into a larger-scale perspective, which includes the potential correlation of several (IRD-rich) marker horizons and the potentially asynchronous retreat of the East and West Antarctic Ice Sheets.