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Bottom water production variability in the Ross Sea slope during the Late Pleistocene-Holocene as revealed by benthic foraminifera and sediment geochemistry

Leonardo Langone (1), Alessandra Asioli (2), Fabio Tateo (2), Federico Giglio (1), Domenico Ridente (3), Vito Summa (4), Anna Carraro (5), Maria Luigia Giannossi (4), Andrea Piva (6), and Fabio Trincardi (1)

(1) Istituto Scienze Marine-CNR, Bologna, Italy (leonardo.langone@bo.ismar.cnr.it/390516398940), (2) Istituto di Geoscienze e Georisorse-CNR, Padova, Italy (alessandra.asioli@igg.cnr.it,/390498272010), (3) Istituto di Geologia Ambientale e Geoingegneria-CNR, Roma, Italy (domenico.ridente@cnr.it), (4) Istituto di Metodologie per l'Analisi Ambientale-CNR, Potenza, Italy (summa@imaa.cnr.it), (5) Dipartimento di Geoscienze, Università di Padova, Italy (a.carraro@unipd.it), (6) ENI E&P Division, Sedimentology, Petrography & Stratigraphy Dpt., S. Donato Milanese, Italy (Andrea.Piva@eni.it)

The Antarctic area produces bottom waters that ventilate the vast majority of the deep basins in the rest of the world ocean. The rate of formation in the source area and the strength of these cold bottom waters are key factors affecting the Global Thermohaline Circulation during modern and past climate conditions. The western Ross Sea is considered a formation site for a particularly salty variety of AABW as well as an important area of off-shelf transfer of water as plumes entraining in Lower CDW and as rapid downhill cascades. The results here presented were obtained within the frame of the PNRA project 4.8. Among the goals of the project, the main is to detect a qualitative signal of possible changes in the rate of bottom water production during the Late Pleistocene-Holocene by integrating data on foraminifera assemblages with sediment geochemistry (bulk mineralogy, Total Organic Carbon, biogenic silica, C and N stable isotopes) and IRD. A gravity core was collected at 2377m water depth off Drygalski Basin on the slope adjacent the western continental shelf of the Ross Sea, along the pathway of bottom water spreading. The chronology is based on the best fitting of twelve control points selected among twenty-two ^{14}C AMS datings performed on the bulk organic carbon and 210Pb excess data. The trend of the parameters allows the following observations:

1) two main intervals (15-10 and 7.5-6 cab kyr BP) mark a subsequent enhanced nutrient supply. Indeed, δ^{15}N variations depend on the utilization degree of nitrates, in turn reflecting productivity/nutrient supply changes. The concurrent increase of OC and biogenic silica suggests an increase of the nutrient availability. As the Upper CDW is a water mass rich in nutrients we interpret these intervals as characterized by a higher efficiency in the Upper CDW upwelling;

2) around 7.5-7kyr BP (part of the Middle Holocene Climatic Optimum) the IRD content drops, suggesting the reduction of iceberg production or a change of the iceberg path.

Within this general context, an oscillatory trend is present from 15 kyr BP to present time. Two hypotheses are proposed:

a) minima in foraminifera concentrations reflect relatively stronger dissolution, weaker bottom currents (minima in dry density) and lower nutrient supply (lighter values of δ^{15}N). These intervals may reflect a lower rate of bottom water formation; the intervals corresponding to maxima in foraminifers concentration should indicate better preservation, higher benthic productivity and/or better oxygenation at bottom, stronger bottom currents (maxima in dry density) and relatively higher nutrient supply reflecting a relatively higher rate of bottom water formation.

b) alternatively, minima in foraminifers, corresponding to minima in %OC and to reversal of ^{14}C (relative increase of older carbon), reflect dilution in the sediment because of rapid accumulation of fine sediment re-suspended at the shelf edge by the cascading currents. Therefore, the minima represent higher rate of bottom water formation.

The comparison of the D/H ratio in ice-cores from the Ross Sea sector with the core AS05-10 record indicates that

the foraminifers minima always correspond to colder condition. This scenario also correlates to the record reported in literature on the slope off Wilkes-Adelie Land.

At last, a condensed/hiatus interval at ca. 3.5-4 kyr BP does not seems to mark a major change in the general pattern of our variables, apart from biogenic silica and sheets silicates showing an increase of the oscillation amplitude. Nevertheless, this feature is coeval to the base of the Neoglacial and it is time-equivalent to the beginning of major changes in the Antarctic environment.