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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

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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 affect their flow toward the equator and are key factors affecting the Global Thermohaline Circulation during modern and past climate conditions. We present the results of a multidisciplinary study carried out on a core collected in 2377m of water depth on the slope off the Drygalski Basin (Ross Sea), along the modern path of the bottom waters. The goal of this research is to detect a qualitative signal of possible changes in the rate of bottom water production during the Late Pleistocene-Holocene by integrating micropaleontological and geochemical proxies. The micropaleontological signal is represented by the quantitative and qualitative variations of the agglutinated benthic foraminifera assemblages, while the amount of TOC, nitrogen, δ^{13}C, δ^{15}N, biogenic silica, $CaCO_3$ in the sediment, along with the bulk rock mineralogy, provide information on the paleoproductivity and allow reconstruction of changes in the paleocirculation. The chronology is supported by ^{14}C AMS datings on organic matter. Although this study is still in progress, the results obtained allow the following observations:

1) the Holocene sequence includes a major turnover around 8-8.5 calib kyr BP, leading to reduced nutrient utilization, probably reflecting an increased nutrient supply induced by an enhanced Upper Circumpolar Deep Water upwelling;

2) within this general context, the total concentration of benthic foraminifera preserved in the fossil component records millennial scale cycles of variable amplitude after 8.5 calib kyr BP and to present time. This oscillatory trend is paralleled by other parameters, such as the magnetic susceptibility, the dry density, the sheet silicates and the δ^{15}N;

3) minima in foraminifera concentration reflect relatively increased dissolution, weaker bottom currents (minima in dry density=higher amount of fine fraction), and lower nutrient supply; maxima in foraminifera concentration indicate better preservation, higher benthic productivity and/or better oxygenation at bottom, stronger bottom currents (maxima in dry density) and relatively higher nutrient supply;

4) these cycles are interpreted to reflect a relatively higher (maxima in forams concentration) or lower (minima in forams concentration) rate of bottom water formation;

5) between 8.5 and 6 kyr BP the amplitude of these cycles (and particularly those with increased rates of bottom water formation) is higher than the subsequent ones. We equate this interval with the early part of the Middle Holocene Climatic Optimum of the literature;

6) the condensed/hiatus interval centred at ca. 3.5-4 kyr BP does not seem to mark a major change in the general pattern. Nevertheless, this feature is time-equivalent to a major change in the circulation pattern in other Antarctic regions, such as the Antarctic Peninsula. This major change consists in oscillations between two contrasting circulation modes dominated respectively by: a) Upper Circumpolar Deep Water and b) shelf-water formation.

This major change can therefore be ascribed to the southward migration of the Intertropical Convergence Zone vs. ENSO prevalence, respectively.