Productivity and dissolved oxygen controls on the Southern Ocean deep-sea benthos during the Antarctic Cold Reversal

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The Antarctic Cold Reversal (ACR; 13 to 14.7 ka) marked a distinct phase in the deglacial transition to the Holocene – representing a pause in the rise of atmospheric CO_2 and Southern Hemisphere temperature, contrasted with warming in the North. Mechanisms associated with interhemispheric heat and nutrient transfer have been called upon to explain features of this event but the controls on the carbon cycle and marine biotic response are debated. Given the central role of the Southern Ocean in the climate system, it is important to understand the sequence of events during this period, including nutrient cycling, circulation and productivity. Here we present a new perspective into the deglacial biogeochemistry, circulation and productivity of the Southern Ocean coupled with multi-faunal assemblage data from the Drake Passage during the ACR. The most distinctive features of the combined record occur at ~14 ka. At this time of decreasing temperature, benthic fauna exhibited marked turnover with an abundance of thick-walled benthic foraminifera and deep-sea corals at shallow depths in the sub-Antarctic (~300 m), but an almost complete absence of coral occurrence at greater depths or further South. Geochemical proxy data indicate that this ecological change was associated with high primary productivity in the sub-Antarctic, a more stratified water column, and poorly oxygenated bottom water. This result is consistent with a northward shift in primary production in response to Antarctic cooling and widespread change across multiple ecological niches. We suggest that expanding sea ice, suppressed ventilation the deep ocean, shifting centres of upwelling, and the impacts on planktonic and benthic ecology were instrumental in halting CO_2 rise in the mid-deglaciation.