Propagation of Deglacial Changes in Water Mass Sourcing and Deep Ocean Carbon Storage in the Southern Indian Ocean During the Last Glacial Termination

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Abstract
Changes in deep ocean circulation are hypothesized to have played a role in the release of carbon dioxide (CO_2) to the atmosphere during the last glacial termination. One mechanism for reducing the oceanic carbon reservoir is to increase air-sea exchange when deep water masses upwell to the surface; another mechanism is to change the proportions of newly-formed versus recirculated deep waters, such as by increasing the total volume of the ocean ventilated by North Atlantic Deep Water (NADW). Here, we use $\delta^{13}C$ and ε_{Nd} to assess the relative role of these processes in the deep waters of the Indian Ocean. While $\delta^{13}C$ is sensitive to air-sea exchange and biological processes, ε_{Nd} is sensitive to changes in water-mass mixing without being influenced by carbon chemistry. We present data from a depth transect of cores that capture modern-day Upper and Lower Circumpolar Deep Water (UCDW and LCDW), water masses that represent a combination of Pacific and Atlantic sources that have been mixed in the Southern Ocean. Consistent with previous studies, we find more radiogenic ε_{Nd} during the last glacial period (ε_{Nd} ~-6.5), interpreted as an increase in the relative proportion of Pacific waters contributing to the sites compared to today. During the glacial termination, the ε_{Nd} records show increasingly nonradiogenic values (down to ~-8.5) corresponding to the increasing contribution of Atlantic waters to the Indian Ocean. The $\delta^{13}C$ records are consistent with a decrease in the amount of carbon storage in the deep Indian Ocean across the deglaciation, but an examination of the millennial-scale changes in $\delta^{13}C$ compared to ε_{Nd} shows that, while these proxies are often linked, there are times when their changes are decoupled, indicating that they were affected by different processes. Importantly, the full glacial-Holocene $\delta^{13}C$ change was completed by ~16 kyr BP for the sites at ~2600 m and ~2800 m depth, prior to any significant changes in ε_{Nd}, suggesting that at least part of Southern Ocean ventilation increased before any major changes in the structure of global ocean circulation. This depth transect of ε_{Nd} records in the under-studied southern Indian Ocean reveals how deglacial change propagated between ocean basins in different layers of the deep ocean on millennial timescales during the last glacial termination.

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