Sources, sinks and cycling of seawater ^{232}Th in the north and south Atlantic basins.

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This study examines the distribution of the long-lived thorium isotopes ^{232}Th and ^{230}Th in the Atlantic Ocean. ^{232}Th in the ocean is derived from the partial dissolution of lithogenic minerals. ^{230}Th is produced at a predictable rate by the decay of uranium, and its subsequent removal by efficient reversible scavenging onto settling particles provides a method to quantify ^{232}Th fluxes to the ocean, and eventually to the seafloor. As such, combining analysis of these two isotopes in seawater has the potential to improve our ability to calculate present and past detrital fluxes to the ocean. Challenges to using this approach are both analytical, for example ^{232}Th contamination issues encountered by many labs during the international GEOTRACES intercalibration, and the lack of systematically collected sample sets. The GEOTRACES program is helping to overcome these issues, giving deeper insights into the processes controlling the sources, sinks and cycling of thorium isotopes in the ocean.

In this study we analyze ^{232}Th and ^{230}Th in two zonal Atlantic transects, crossing a range of oceanographic settings. The first is the U. S. GEOTRACES North Atlantic Zonal Transect, between 17N and 40N, for which six stations have been analysed thus far. The second consists of three stations from the CoFeMUG cruise across the South Atlantic at about 30S. All profiles are full depth and were analyzed together with GEOTRACES intercalibration standards. The CoFeMUG sites have ^{232}Th concentrations that range from 15 to 60 pg/kg, are similar across the basin, particularly in the upper 1000m and show no surface enrichment. Station 13 in the east has the highest ^{232}Th values at depth, but this small difference between sites is overwhelmed by the difference from the concentrations in the North Atlantic. The GEOTRACES samples in the eastern basin (stations 1 to 12) range from 25 to 191 pg/kg. The highest values both at the surface and at depth are from stations 9 and 10 which are the closest to the African coast. These high values likely reflect the input of Saharan dust. We discuss the controls on the ^{232}Th distributions in the context of local and basin scale processes.

Widespread expansion of intermediate water suboxia at 2 Ma

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ABSTRACT

The transition from the warm Pliocene to the cool Pleistocene appears to accompany a decrease in intermediate water oxygenation. The Plio-Pleistocene cooling begins with the onset of major Northern Hemisphere glaciation, around 3.0-2.7 million years ago (Ma). High latitude cooling and extension of the polar ice caps led to cooling of the deep ocean and shoaling of the thermocline. Cooling of the whole surface ocean and establishment of strong zonal and meridional atmospheric circulation occurred around 2.0 Ma. A compilation of high-resolution nitrogen isotope records from the eastern tropical Pacific, North Pacific, and the Arabian Sea and a global multi-site survey, indicates that regional intensification of oxygen minimum zones (OMZs) and expansion of water column denitrification accompanied the surface cooling and circulation changes at ~2.0 Ma. Large-scale open ocean suboxia intensified with the inception of a modern polar frontal system, despite lower temperatures and thus higher initial oxygen contents of the mode waters themselves. This likely reflects the increased importance of aged mode waters as the principle conduit of nutrients and oxygen to the OMZs and stresses the importance of ocean circulation in regulating oxygenation.