CO_2 storage in the Glacial deep Southeastern Indian Ocean and CO_2 outgassing across the last deglaciation tracked with Benthic foraminiferal $\delta^{13}C$

Sikes, E.L., Umling, N.E., Glaubke, R., Starr, A., Stirpe, C.R., and Martin, E.E.

Abstract

The Southern Ocean (SO) is an important area for ocean-atmosphere CO_2 equilibration, as the principal location where the wind driven component of thermohaline overturning circulation brings deep water to the surface releasing its accumulated load of "excess" respired CO_2. The stable isotopic composition ($\delta^{13}C$) of this dissolved inorganic carbon (DIC) recorded in benthic foraminifera reflects the addition of respired DIC with low $\delta^{13}C$ values to subsurface water masses isolated from the atmosphere. Transfer of this DIC to the surface in polar reaches of the SO and its subsequent loss through atmospheric exchange results in a gradient of decreasing $\delta^{13}C$ with water depth today. We have developed a depth transect (1.1 km to 3.2 km) of 6 sediment cores from the Southeast Indian and Southern Ocean (32° to 42° S) spanning the last 50 ka. We have determined the $\delta^{13}C$ on single species analyses of benthic foraminifera from the genus *Cibicides* (primarily *wuellerstorfi, kullenbergi* and *lobatulus*) to examine the $\delta^{13}C$ evolution of the several deep and shallow subsurface water masses present in the SO in the last glacial and across the last deglaciation. Glacial $\delta^{13}C$ values are ~1‰ more depleted than Holocene values in our deepest sites, ~0.5‰ more depleted in the 2.5 km core site, and show little or no change in sites at or above 1.8 km. Values at our shallowest 1.1 km site are nearly 1.0‰ more enriched than all other depths in the Holocene and as much as 2.5‰ more enriched in the glaciation. Lowest values of about -0.8‰ in our deepest core are ~0.3‰ lower than similar depths in the South Atlantic and the Southwest Pacific. The initial deglacial shift to more enriched $\delta^{13}C$ occurs earlier in cores above 2600 m and becomes progressively later with depth. The beginning of the deglacial shift seen in our deeper sites precedes the shift seen in previous studies in the South Atlantic. The $\delta^{13}C$ enrichment reflect the loss of a ^{12}C-rich respired DIC pool from the deep SO. These differences in the relative timing in the different basins suggests that deglacial CO_2 loss was initiated by SO dynamics in the Indian and Pacific basins rather than the reinvigoration of Atlantic Meridional Overturning Circulation.