The radiocarbon age glacial deep water

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Constraining the ventilation rate of the glacial ocean is important not only to climate studies but also to the understanding of temporal changes in the ^{14}C to C ratio of atmospheric and upper ocean inorganic carbon. We are exploring one of the ways by which this might be accomplished; namely, by obtaining radiocarbon ages on coexisting benthic and planktic foraminifera shells. This approach is plagued by biases introduced by bioturbation, dissolution, and secondary radiocarbon addition. In order to avoid these biases, the measurements must be conducted on high deposition rate sediments and on more than one species of planktics. We will report a number of new results from cores in the western equatorial Pacific.

Paired Mg/Ca and $\delta^{18}O$ records reveal mid Miocene paleoceanography

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Foraminiferal $\delta^{18}O$ values are a function of temperature and the oxygen isotopic composition of seawater ($\delta^{18}O_{sw}$), which reflects global changes in the amount of freshwater frozen at the poles and regional precipitation versus evaporation patterns. Using foraminiferal Mg/Ca ratios as an independent temperature constrain in conjunction with $\delta^{18}O$ values affords to opportunity to derive the $\delta^{18}O_{sw}$ from which changes in global ice volume can be inferred assuming that regional changes in $\delta^{18}O_{sw}$ are minor.

In this study we set out to apply this approach to constrain the magnitude of the second major ice expansion event on Antarctica between about 15-13 Ma. We measured Mg/Ca ratios and $\delta^{18}O$ values on benthic foraminifera from western subtropical Pacific Deep Sea Drilling Program Hole 588A spanning 11-16 Ma with a temporal resolution of 30 kyr.

Our results show unexpectedly large Mg/Ca variations of between ~2 and 4 mmol/mol. The ratios are too high to be a function of intermediate water temperatures. Mg/Ca maxima and minima follow the same long term trend making it unlikely that the data are entirely artificial (e.g., diagenetic overprints or clay contamination). The long-term temperature and corresponding $\delta^{18}O_{sw}$ trends parallel the long-term trend in the Southern Ocean record of *Shevenell et al*. [2004]. At both sites, there is a pronounced temperature maximum ~14.5-14.4 Ma postdating minimum foraminferal $\delta^{18}O$ values by ~0.5 myr. The corresponding $\delta^{18}O_{sw}$ values exhibit a maximum concurrent with this temperature maximum, but predate the foraminferal $\delta^{18}O$ maximum at 13.8 Ma by ~0.6 myr. We do not believe that the $\delta^{18}O_{sw}$ maximum reflects ice extent. It would imply maximum glaciation during the time of warmest surface and intermediate water temperatures. Rather, the coincidence of a temperature maximum in surface and intermediate depth waters and high water mass $^{18}O/^{16}O$ ratios points to a change in the isotopic composition of high latitude surface and intermediate water during a climatically warm interval. These observations demonstrate the importance of regional water mass effects on the oxygen isotopic composition of foraminifera.

Reference

Shevenell, A. E., Kennett, J. P. and Lea D. W. (2004), *Science*, **305**, 1766-1770.