Inferring the structure of greenhouse oceans from the distribution of inoceramid bivalves

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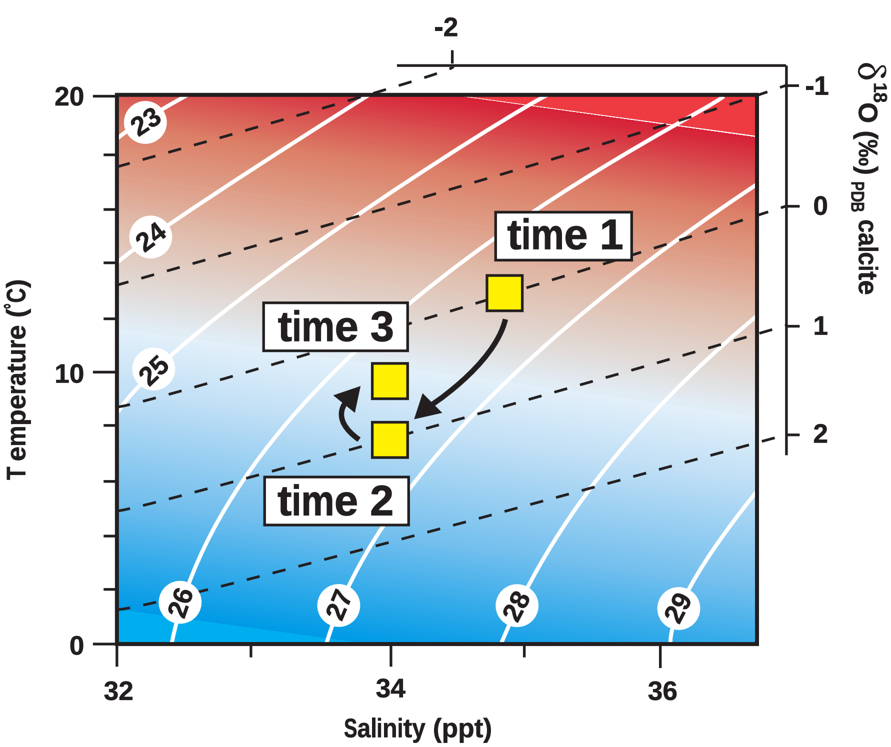
Circulation in the deep ocean may be a critical variable in the global climate equation. For intervals of global warmth, poleward heat transport by warm, saline water masses is widely discussed as a potential mechanism to reconcile differences between computer models and empirical data. However, ocean structure during greenhouse times remains poorly constrained especially on a global scale. The distribution of fossil organisms provides one way to map the distribution of paleoecological conditions. Inoceramid bivalves reached the acme of their 200 million year range during the Late Cretaceous and then virtually disappeared ~67 million years ago in an episode of global change associated with the deterioration of the Cretaceous greenhouse climate [*e.g.*, MacLeod *et al.*, 1996]. In ~1500 samples (73 sites) representing bathyal paleodepths across the last ~35 million years of the Cretaceous, inoceramid abundance is remarkably constant in time (extinction interval excluded) but not in space. In general, inoceramids were common to abundant throughout the Atlantic and Indian Oceans but rare in the Pacific [MacLeod *et al.*, in review]. Parallel geochemical studies in two Indian Ocean sites revealed changes in the rank order of $\delta^{18}O$ in benthic and deep dwelling planktic foraminifera suggesting that bottom waters became cooler and less salty at the time of inoceramid extinction (see figure, [*MacLeod and Huber,* 1996]). The correlation between this switch and Late Cretaceous cooling supports the proposition that warm, saline water masses have a role in creating and/or maintaining greenhouse climate conditions. Further, the global distribution of inoceramids suggests that these water masses were most prevalent in the Atlantic and Indian Oceans. Results from new multilayered, ocean circulation models will include implicit predictions regarding regional and bathymetric differences in water mass properties. Independent constraints on conditions in the deep ocean (*e.g.*, the distribution of inoceramid bivalves through the Late Cretaceous) provides important tests of these predictions and increases the likelihood that improved agreement between model results and proxy data will reflect improved understanding of the climate system.



Relative changes in Maastrichtian bottom waters at ODP Site 750A inferred from $\delta^{18}O_{PDB}$ (dashed lines) of foraminifera (only benthic are data shown) and seawater density (solid white lines) plotted in temperature/salinity space appropriate for the Late Cretaceous (after MacLeod and Huber, 1996).

References:

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