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Global patterns in Late Cretaceous Nd data and their relationship to climate changes

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The geographic and stratigraphic coverage of published Late Cretaceous Nd isotopic data, a paleocirculation proxy, has increased dramatically in the past five years. Sites have now been studied in the Pacific, North Atlantic, South Atlantic, Southern, and Indian oceans. Pacific samples consistently yield the highest ratios ($\varepsilon_{Nd(t)}$ values of -6 to -3) throughout the Late Cretaceous. These values are similar to Cenozoic and modern values in the region suggesting a signal dominated by input from young volcanic material. In contrast, Cenomanian-Campanian samples from Demerara Rise in the tropical western Atlantic exhibit values that are generally very low (-17 to -14) both relative to other Late Cretaceous samples and to the modern record. However, Demerara Rise values rise to -8 during Oceanic Anoxic Event 2 (OAE2) and to -12 during the Maastrichtian. The low values suggest input from old continental sources and formation of a warm saline intermediate water mass in the western equatorial Atlantic whereas the excursions indicate that that downwelling was interrupted during OAE2 and terminated during the Maastrichtian.

At other sites, most $\varepsilon_{Nd(t)}$ values fall between -5 and -12 with significant temporal shifts within and differences among sites. Unique interpretations of these patterns is not yet possible, but they suggest Late Cretaceous oceans were characterized by patterns of circulation and mixing more complicated than traditionally discussed. Further and provocatively, apparent changes in circulation inferred from ε_{Nd} data often are correlated with intervals of climate change or ecological perturbations. Cooling during the Campanian and Maastrichtian correlates with a widespread decline in ε_{Nd} values, perhaps signaling increased importance of high latitude source regions. Inferred circulation changes during OAE2 could have influenced the efficiency of nutrient trapping in the North Atlantic promoting enhanced productivity and organic carbon burial. Discriminating among alternative paleoceanographic hypotheses requires additional data. Better ε_{Nd} data for terrigenous material in the samples studied could help separate the contributions of weathering inputs and any boundary exchange from seawater signatures inherited from source regions. Better geographic coverage and bathymetric resolution, particularly in the region of possible gateways to circulation, could help address the cause of changes seen within basins. Finally, parallel study of faunal distributions, lithologic changes, elemental ratios, and stable isotopic ratios as well as more novel measurements (e.g., Os, Mo, and Fe isotopes) can be used to test the relationship between circulation and environmental change/perturbations.