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Mesozoic-Cenozoic Carbon Isotope Stratigraphy: Links Among the Carbon Cycle, Phytoplankton Evolution, Sea-Level Change, and Geologic Proxies

Tracing the carbon cycle through the world's oceans and atmosphere links many Earth systems. We construct a composite bulk sediment $\delta^{13}C$ curve for the Mesozoic and Cenozoic from open ocean locations. Comparison with shorter-duration published records shows that the $\delta^{13}C$ composite can be used as a correlation tool. Widespread $\delta^{13}C$ increases indicate times of excess carbon burial that are often associated with source rock deposition; these occurred in the Pliensbachian-early Toarcian (an OAE), Bajocian, Callovian-Oxfordian, mid-Valanginian, early Aptian (OAE1a), late Aptian, Albian (smaller $\delta^{13}C$ increases of OAE 1b, 1c, 1d), and Cenomanian/Turonian (OAE2). Rapid, transient $\delta^{13}C$ decreases occurred in the Toarcian, Oxfordian, Tithonian, and PETM.

We integrate our $\delta^{13}C$ composite with datasets and proxy records from micropaleontology, biogeochemistry, and modelling studies. This provides the opportunity to examine the complex interactions among multiple paleoenvironmental factors that affected the evolutionary trends of Mesozoic phytoplankton, ultimately favoring the three orders of eucaryotes that dominate today's oceans (coccolithophores, diatoms, and dinoflagellates). There is a first-order correlation between long-term (10^7-10^8 my) sea-level rise and increased diversity of the eucaryotes at the genus and family level; in contrast, shorter-term (10^6 my) sea-level change shows little correlation with evolutionary trends. This indicates that major phytoplankton radiations were related to expanded ecological niches and ocean chemistry changes that accompanied long-term continental shelf flooding and increased sea-floor spreading rates. Superimposed on these long-term trends are times of rapid faunal turnover at the species level that often correspond to rapid changes in isotope and proxy records.