

Shelf ecosystem response to the Eocene-Oligocene Transition

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The Eocene-Oligocene transition (EOT) is one of the most dramatic climate shifts of the Cenozoic with severe consequences for reef ecosystems. The onset of continental Antarctic glaciation is associated with widespread environmental change, resulting in a global peak in biotic turnover. Whilst numerous studies of the biotic response to the changes at the EOT have been carried out, most high-resolution studies consist of open ocean records of foraminifera and nannofossils. However, this is not representative of the ocean system as a whole. The shelf seas and reefs are some of the most diverse and fundamentally important ecosystems of the oceans. Long-term diversity loss across the EOT has been shown in several macrofossil studies, but mainly at low resolution, and recovery is not well understood. Larger benthic foraminiferal records provide a higher resolution insight to this event, both in terms of biodiversity, physiology and shallow water geochemical records. Additionally when integrated with records of other shelf organisms (e.g. molluscs, algae, bryozoa) this provides a powerful overview of whole ecosystem response. Many shelf species are ecosystem engineers whose loss and recovery have profound implications for the entire ecosystem. Understanding these interactions will provide insights into shallow marine ecosystems and their response to major climate perturbations.

The Tanzanian Drilling Project EOT record (TDP 11, 12, 17) is recognised globally for its completeness and exceptionally preserved calcareous microfossils. It is most importantly, though, a rare record of both shallow water organisms and open ocean plankton. Here we draw together a unique dataset of high-resolution larger benthic foraminifera, planktonic foraminifera, mollusc, Dasycladaceae, bryozoan, coral, shallow water trace element and isotope records from the EOT. The response and recovery of these species is compared with known, modern physiology of each group to provide a complete picture of the shallow marine ecosystem response. Following rapid extinctions in the larger foraminifera at the Eocene/Oligocene boundary, molluscs, Dasycladaceae and bryozoans all show increases in abundance, indicating a major shift in shelf ecosystem composition. These assemblage changes are coincident with a period of more positive values in $\delta^{13}\text{C}$ of planktonic foraminifera and changes in trace element values. Comparison with the open ocean record of planktonic foraminiferal, pteropod, and nannofossils confirm fossil increases are a biological, rather than sedimentological response and additionally support a transition to more eutrophic conditions during the transition. The interaction of these groups, within an environmental framework of traditional and novel geochemistry indicate that increased nutrient fluxes, rather than the temperature change directly, played a pivotal role in restructuring shelf ecosystem dynamics, and offer new insights into our understanding of the EOT.