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New palaeoceanographic constraints on the Eocene-Oligocene Transition in the Pacific

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The Eocene-Oligocene (E/O) transition represents perhaps the most pivotal phase in the shift from Cenozoic greenhouse to icehouse and is marked by the most pronounced shift in the calcite compensation depth (CCD) over the last 100 Myr. Yet detailed palaeoceanographic records for these important events are rare because of the lack of well-dated, expanded deep-sea sedimentary sections containing well-preserved calcareous microfossils. Recently, during Ocean Drilling Program Leg 199, we recovered a series of high-quality E/O sections across a latitudinal and depth transect in the central tropical Pacific Ocean. These sections provide an excellent opportunity to improve our understanding of the palaeoceanographic chain of events that took place across this important interval in the region of the world where the CCD perturbation is believed to be most extreme and in the largest ocean basin. Here, we report new high-resolution records of bulk sediment carbon and oxygen isotopes and percent carbonate from ODP Sites 1217 through 1220. Our results show the following: (i) Bulk records from the central tropical Pacific have the potential to provide a remarkably clean and detailed chemostratigraphy for the E/O transition. (ii) CCD deepening occurred remarkably rapidly (initial depression ≤ 50 ka) and, in the most expanded section, at the shallowest end of the transect (Site 1218), as a two-step shift. (iii) The form of this two-step shift is strikingly similar to the bulk oxygen isotope record on the build up to Oi-1. (iv) The intermediate plateau that occurs between the two steps in the oxygen isotope series fits very well with the main ~ 100 -120 ky eccentricity cycles observed in multi-sensor track data and their amplitude modulation (plateau = one cycle). (v) The interval of maximum CCD as defined by high carbonate sediment content (more than 60 percent carbonate) at the deeper end of the transect (Site 1220) correlates with the onset of Oi-1 and lasts for ~ 250 ka. (vi) Hitherto unrecorded extreme perturbations to low oxygen and carbon isotope values occur in the uppermost Eocene at Site 1218. (vii) Stable isotope records from this site show significantly more structure within Oi-1 than published records (characteristic features of obliquity control, with a small imprint of precession).

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