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The Eocene and Oligocene Pacific Equatorial Region from ODP Leg 199 Drilling

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ODP Leg 199 drilled a latitudinal transect of sites across the position of the early Eocene equator, designed to study the evolution of the equatorial Pacific current and wind system as the Earth went from maximum Cenozoic warmth to initial Antarctic glaciations. The cruise recovered a biogenic sedimentary record of equatorial processes from the early Miocene to the late Paleocene, roughly from 18 to 56 Ma. Above the biogenic sediments are 10 m or more of nonfossiliferous clay, representing most of the Neogene interval. We found that equatorial deposition patterns were stable for the Eocene but very different from those of the Neogene. The Eocene is marked by a very shallow carbonate compensation depth (CCD) and radiolarian ooze sediments. In contrast, Pleistocene equatorial sediments are carbonate and diatom rich. The Eocene equatorial sedimentation regime was also much wider than modern, expanding in the middle Eocene to about 10 degrees north of the paleoequator. We interpret the Eocene sedimentary environment to indicate significantly more diffuse upwelling than is found in the modern ocean and a deeper-than-modern eastern Pacific thermocline. Eocene deep waters appear to have been well-oxygenated despite being much warmer than modern deep waters. There is an abrupt sedimentological transition from the Eocene equatorial state to proto-modern conditions coincident with the first major glaciation of Antarctica in the early Oligocene. Over a time period of about 120 kyr the CCD dropped by more than 1.3 km and sedimentation focused into a narrow equatorial band similar to equatorial sedimentation in the Holocene equatorial Pacific. We interpret the change to mark the first Cenozoic appearance of the modern Pacific equatorial upwelling system. We also recovered examples of the Paleocene-Eocene boundary at 3 different drillsites from about 1 degree south of the 55 Ma paleoequator to 11 degrees north of it. The P-E boundary event, one of the largest carbon-isotope excursions of the Cenozoic, is represented by a carbonate-poor multi-colored sediment interval. Consistent banding between two sites more than 200 km apart suggest significant changes in deep ocean chemistry during this time interval.

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