Integrated stratigraphy of the Paleocene-Eocene thermal maximum in the New Jersey Coastal Plain: Toward understanding the effects of global warming in a shelf environment

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[1] In the New Jersey Coastal Plain, a silty to clayey sedimentary unit (the Marlboro Formation) represents deposition during the Paleocene-Eocene thermal maximum (PETM). This interval is remarkably different from the glauconitic sands and silts of the underlying Paleocene Vincentown and overlying Eocene Manasquan Formation. We integrate new and published stable isotope, biostratigraphic, lithostratigraphic and ecostratigraphic records, constructing a detailed time frame for the PETM along a depth gradient at core sites Clayton, Wilson Lake, Ancora and Bass River (updip to downdip). The onset of the PETM, marked by the base of the carbon isotope excursion (CIE), is within the gradual transition from glauconitic silty sands to silty clay, and represented fully at the updip sites (Wilson Lake and Clayton). The CIE "core" interval is expanded at the updip sites, but truncated. The CIE "core" is complete at the Bass River and Ancora sites, where the early part of the recovery is present (most complete at Ancora). The extent to which the PETM is expressed in the sediments is highly variable between sites, with a significant unconformity at the base of the overlying lower Eocene sediments. Our regional correlation framework provides an improved age model, allowing better understanding of the progression of environmental changes during the PETM. High-resolution benthic foraminiferal data document the change from a sediment-starved shelf setting to a tropical, river-dominated mud-belt system during the PETM, probably due to intensification of the hydrologic cycle. The excellent preservation of foraminifera during the PETM and the lack of severe benthic extinction suggest there was no extreme ocean acidification in shelf settings.

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1. Introduction

[2] The early Paleogene was a climatically dynamic period, during which relatively short intervals of rapid global warming (hyperthermals) were superimposed on a warm background climate [*Sluijs et al.*, 2007a; *Zachos et al.*, 2008]. The Paleocene-Eocene thermal maximum (PETM), directly after the Paleocene-Eocene boundary, is the most extreme and best studied hyperthermal, with reconstructions of global temperature anomalies available from the deep-sea to terrestrial environments [e.g., *McInerney and Wing*, 2011]. The ~170- kyr-long PETM [*Röhl et al.*, 2007] is linked to a perturbation of the global carbon cycle, as seen in a several per mille negative carbon isotope excursion (CIE) recorded globally, in marine and terrestrial settings [e.g., *Kennett and Stott*, 1991; *Koch et al.*, 1992; *Thomas and Shackleton*, 1996]. The CIE is caused by the rapid release of a large amount of ^{13}C-depleted carbon compounds into the atmosphere-ocean system, causing a rise in concentration of greenhouse gases and global warming. The approximate volume of released carbon compounds is still under debate, but has been commonly estimated between 2000 and 4500 gigaton [*Dickens et al.*, 1997; *Zachos et al.*, 2005; *Dickens*, 2011]. The rate of emission is also debated [*Sluijs et al.*, 2012], ranging from a few thousand years [*Zachos et al.*, 2007] to about 20 kyr [*Cui et al.*, 2011]. There is no agreement on source and method of emission of carbon compounds, hypotheses ranging from dissociation of submarine methane hydrates [e.g., *Dickens et al.*, 1997; *Dickens*, 2011] to burning of peat deposits [*Kurtz et al.*, 2003], to oxidation of marine organic matter due to igneous intrusion [*Svensen et al.*, 2004], or oxidation of

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