Geophysical Research Abstracts,
Vol. 11, EGU2009-2690, 2009
EGU General Assembly 2009

Constraining the carbon and hydrological cycles of North American continental margins across the Paleocene-Eocene thermal maximum

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The impacts of the Paleocene-Eocene Thermal Maximum (PETM, ca 55 Ma), one of the most rapid and extreme warming events in Earth history, are well characterized in open marine and terrestrial environments but less so on continental margins, a major carbon sink. Continental margins are also ideally located to record changes in sediment fluxes, for instance in response to a change in the degree of continental weathering. Here we present results from an interdisciplinary study based on outcrop sections in California and ODP cores drilled on the New Jersey margin. Our goal is to characterize the PETM interval on continental margin locations, with an emphasis on the duration and magnitude of the Carbon Isotope Excursion. We also explore potential changes in sedimentation rates as a mean to assess sediment flux and associated changes in the hydrological cycle and continental weathering rates. For this, we generated stable isotope, carbonate content, organic matter content, C:N ratio and mineralogy data. Stable isotope data was measured on carbonate material, organic matter, and the siliciclastic clay-sized fraction.

Foraminifer oxygen isotope data suggest that mid-latitude shelves warmed by a similar magnitude as the open ocean (5-8°C), while the Carbon Isotope Excursion (CIE), recorded both in carbonate and organic carbon isotope records, is slightly larger (3.3-4.5 per mil) than documented in open ocean records. Sediment accumulation rates increase dramatically during the CIE in marked contrast to the open ocean sites. In parallel, mass accumulation rates of both organic and inorganic carbon also increased by an order of magnitude. The estimated total mass of accumulated carbon in excess of pre-CIE rates suggests that continental margins, at least along North America, became carbon sinks during the CIE, mainly due to weathering feedbacks and rising sea-level. This result is significant, because it implies that the negative feedback role of carbon burial on continental margins was greater than previously recognized. Furthermore, preliminary oxygen isotope results on the siliciclastic clay-sized fraction show a marked excursion during the PETM. This could suggest important changes in the amount of precipitation during the PETM, but the stable isotope composition of individual clay species needs to be measured before a conclusive interpretation can be reached.