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The Paleocene-Eocene Thermal Maximum (PETM) in the Dababiya Quarry Section, Egypt: New evidence for environmental changes from mineralogical and geochemical data

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In the Dababiya Quarry section, the Paleocene-Eocene Thermal Maximum (PETM) consists of a succession of five characteristic beds that can be traced throughout eastern Egypt. The base of these beds defines the Global boundary Stratotype Section and and Point (GSSP) of the Eocene. Previous studies of mineralogical and geochemical proxies have suggested a period of euxinic conditions from the onset of the PETM up to the beginning of the recovery phase (Aubry et al., 2007). Dupuis et al. (2003) described prominent mineralogical changes (increase of illite and chlorite-smectite mixed layers) that occurred contemporaneous to the maximum negative carbon isotope values. A sea-level fall immediately preceding the onset of the PETM, followed by a sea-level rise and enhanced upwelling during the PETM is postulated in Egypt (Speijer and Wagner, 2002). However, a detailed study of the Dababiya Quarry beds, and specifically their element geochemistry, is currently lacking. Therefore, we investigated the Dababiya Quarry section by X-ray diffractometry (XRD; bulk rock and clay mineralogy) as well as by X-ray fluorescence analysis (XRF; major and trace elements and rare earth elements, REE) to detail the succession of environmental events during the PETM.

(i) The absence of carbonate (as low as <2 wt%) in the basal event bed 1 indicates severe carbonate dissolution. A sharp short-lived increase in siliciclastic detritus (PETM) as well as an increase of chlorite and illite as well as well-crystallized smectite suggest deposition during low sea-level and increased weathering rates. Event bed 1 is also strongly deprived in REEs and shows high Zr/Rb ratios, indicative for input of coarse siliciclastic detritus.
(ii) Subsequently, during the peak phase of the PETM, i.e. during the maximum negative shift of the Carbon Isotope Excursion ("CIE"), a short-lived period of pronounced anoxic sedimentary conditions is indicated by sediment lamination, absence of benthic life, elevated TOC, trace metal enrichment, and lowered siliciclastic input. The enrichment of the trace metals at the base of bed 2 relative to the Esna shale is Mo ≈ V » Zn > Ni > Cr > Co > Cu. Notably, Pb shows no particular enrichment in the event beds and Mn is depleted within bed 2. This period may be associated with rapidly rising sea level and high organic C sinking flux, similar to transgressive black shales. Nevertheless, the interval of dysoxic to anoxic conditions at the transition of bed 1 to 2 shows only a moderate increase of organic matter to about 1 wt%.
(iii) During the subsequent recovery phase of the PETM, encompassing the beds 3 to 5, there is an extended period of increased phosphate and high organic C deposition (up to 25 wt% carbonate-fluorapatite and 5 wt% Corg) within bed 3 and 4. The trace element enrichment decreases gradually, indicating that oxygen-deprivation is restricted to the base of bed 3 and recovers immediately during the upper part of the PETM.
(iv) The event bed 5 is associated with the recovery of the d13Corg excursion to background values (Dupuis et al., 2003), very high carbonate contents, and shows no particular trace metal or phosphate enrichment.

In conclusion, the element chemostratigraphy as well the mineralogy of the PETM in the Dababiya Quarry beds reveals a more complex depositional sequence than previously assumed. We suggest that the base of the PETM in the Dababiya Quarry records deposition during a low sea-level in combination with carbonate dissolution, probably related to upwelling of CO2-saturated water (bed 1). The trace element enrichment reflect

a prominent change in the detritus composition that occurs at the base of event bed 1 as well as a short phase of dysoxic to anoxic. Lowstand deposition was followed by rapid flooding combined with high productivity in the water column and/or impinging of O2-deprived water on the shelf led. These settings led to a short-lived period of dysoxic-anoxic, but not euxinic conditions on the sea floor with associated trace metal enrichment (bed 1 to 2 transition). Subsequently, productivity in the water column increased extremely (beds 2-4) though no particular dysoxic conditions occurred. High productivity during the peak phase of the PETM supports current views that shelf areas acted as large carbon sinks due to increased weathering and sea level rise (John et al., 2008). During the subsequent recovery phase of the PETM, the high productivity and upwelling regime ceased and was replaced by normal marine shelf deposition.

References

Aubry, M.-P. et al. (2007): Episodes, v. 30(4), p. 271-286.
Dupuis, C. et al. (2003): Micropaleontology, v. 49(s1), p. 41-59.
Speijer, R.P. and Wagner, T. (2002): GSA Special Paper, v. 356, p. 533-549.
John, C.M. et al. (2008): Paleoceanography. v. 23, PA2217.