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Was the Latest Danian Event a precursor of the PETM? – A comparison of both events at Gebel Qreiya, Egypt

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Qualitative, high-resolution observations showed remarkable similarities in lithological and paleoecological disruptions between event deposits found at the D/S transition (“Latest Danian event; LDE”) and the Paleocene-Eocene thermal maximum (PETM) in the Nile Basin, Egypt. This points to similar processes operating in the Nile Basin and suggests the presence of additional hyperthermal events preceding the PETM. At the Gebel Qreiya section, both levels are exposed approximately 30 m above each other. Quantitative microfaunal analysis of benthic foraminifera, ostracoda and nannofossils provided paleo-environmental information on productivity, circulation, stratification and oxygenation of the water column. Stable isotopes, clay minerals and trace elements provide further data on depositional conditions.

The LDE and PETM event beds are brown-pinkish, organic-rich marls with abundant coprolites and fish-remains. Benthic foraminifera turnover and anomalous planktic foraminiferal assemblages indicate transient environmental anomalies perturbing the ecosystems of the entire water column. d13Corg chemostratigraphy reveals the well-known 3 per mil negative excursion at the PETM, whereas the LDE shows a 1 per mil negative excursion, followed by a short-lived 3 per mil positive excursion. This positive excursion at the LDE may reflect water stratification under high productivity. At both events, however, the paleoecological and geochemical proxy data suggest a distinct sedimentary sequence: (i) the absence of carbonate (as low as <2wt%) below the basal part of the event bed may indicate severe dissolution, probably related to upwelling of CO2-saturated water. A sharp short-lived increase in siliciclastic detritus (LDE and PETM) as well as a strong increase of chlorite and illite (PETM) suggest deposition during low sea-level and increased weathering rates. (ii) Subsequently, at the onset of the PETM and the LDE a period of anoxic sedimentary conditions is indicated by the absence of benthic live, elevated TOC, high trace metal enrichment factors (e.g., Ni up to 30 ppm), and lowered siliciclastic input. This period may be associated with rapidly rising sea level and high organic C sinking flux. Post-event there is an extended period of increased phosphate and high organic C deposition. In this aftermath the faunas display a benthic shift towards more infaunal species e.g. Buliminids.

In summary, the local paleoenvironmental changes during both events were very similar and related to changes in the upwelling regime, productivity, sea level, as well as hydrological changes (increased weathering) on the adjacent continent. Notably, sea-level dropped just prior to the events and rose during the events, but the amplitude of sea-level fall at the LDE appears to have been much greater (about 75 m vs. 25 m at the PETM). We conclude from these similarities that the LDE may have been a precursor of the PETM, albeit of much lower environmental impact. Whether the LDE had any global significance is currently under investigation in deep-sea sequences.