Black shales from the Latest Danian Event and the Paleocene-Eocene thermal maximum in central Egypt: Two of a kind?

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The Latest Danian event (LDE) at ~61.7 Ma is considered to be one of the earliest of a series of Early Paleogene transient warming events ("hyperthermals") that peaked later in the Paleocene-Eocene thermal maximum (PETM; ~55.5 Ma). However, environmental changes during the earlier transient warming events and their magnitude compared to the PETM are still poorly constrained. We present high-resolution micropaleontological, geochemical, and mineralogical data of the LDE and PETM in one continuous section from the southern Tethyan margin [1]. There, both hyperthermals are characterized by a distinct set of event beds overlying an erosional unconformity. Both events are associated with intense carbonate dissolution and substantial changes in the benthic foraminifera fauna. Both events show an abrupt drop of siliciclastic input (sediment starvation) correlative the onset of black shale formation as well as a strong enrichment in redox-sensitive trace elements. The evidence for a longer recovery phase with enhanced P-sedimentation during the PETM attests to the significantly stronger environmental impact of this event compared to the LDE. According to Rock-Eval and elemental analysis, the LDE as well as the PETM event beds have up to 4% organic carbon, low amounts of volatile hydrocarbons, but high amounts of highly weathered and inert organic matter ("black carbon"). Extreme high temperatures for the maximum release of hydrocarbons of the PETM and LDE samples correspond to thermal heating of >170°C, which is incompatible with the sediment burial history. Therefore, we suggest that the organic matter in both event deposits does not reflect well-preserved marine biomass but predominantly represents a mixture of heavily weathered autochthonous marine material and allochthonous combustion residues. Differences in preservation are also likely to account for the divergent stable isotope anomalies of organic carbon: the well-known negative carbon isotope anomaly at the PETM and a positive anomaly at the LDE. Although warming, water column stratification, and enhanced nutrient input during the hyperthermal events may have promoted anoxic conditions on the shelf, our results support rapid sea level rise and clastic starvation as one additional important mechanism for black shale formation and carbon sequestration during the LDE and PETM.

References:

[1] Schulte, P., et al., 2011, EPSL, (in review)