

# Early Eocene hyperthermals in northern Bulgaria (SE Europe): New nannofossil and stable isotope data

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<https://doi.org/10.58998/jnr3286>

We present new calcareous nannofossil and benthic carbon and oxygen stable isotope records for a marl-rich, shallow-water succession of the Paleocene–Eocene transition that is exposed at three neighboring sections in central northern Bulgaria (Pleven District). The presence of nannofossil Zones NP9, NP10, and NP11 is confirmed with high-resolution nannofossil biostratigraphy. The carbon dissolution interval is marked by the abrupt drop of  $\text{CaCO}_3$  content and deposition of a clay interval at the onset of the Paleocene–Eocene Thermal Maximum (PETM). Stable isotope analyses of  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  were performed on benthic foraminiferal tests. The stepped carbon isotope excursion (CIE) profile consists of three discrete intervals of decreasing carbon isotope values. An unusual two-fold CIE in the PETM interval is documented with a total negative shift of 2.89‰. Moreover, three paired negative excursions are identified: two in the uppermost Thanetian (upper Zone NP9 within the PETM interval) and one within the lower Eocene (Zone NP11). The presence of a carbon dissolution interval in the uppermost part of the Paleocene is unequivocally supported by the sedimentological study.

The most prominent negative carbon isotope excursion (4.90‰ negative shift) is observed within Zone NP11. It is related to the Eocene Thermal Maximum 3 (ETM 3) event (or “X” event), dated at 52.84 Ma ago. This hyperthermal event preceded the Early Eocene Climatic Optimum (EECO), the interval with the hottest climate in Earth's Cenozoic history. The paleotemperature data for the seawater, derived from  $\delta^{18}\text{O}$  values in benthic foraminiferal shells, ranged between 23.18°C and 35.73°C during the PETM and reached a maximum of 38.43°C during the ETM 3 event. In addition, during the ETM 3 event the deposition of the mineral aragonite, characteristic of coastal settings with high evaporation and high seawater temperature, was recorded.

## **Acknowledgements:**

This work has been carried out in the framework of the National Science Program "Environmental Protection and Reduction of Risks of Adverse Events and Natural Disasters" and supported by the Ministry of Education and Science (MES) of Bulgaria (Agreement № Д01-27/06.02.2024).