

Late Paleocene eastern Tethys paleoenvironmental reconstruction using calcareous nannofossils in the Patala Formation, Salt Range, Pakistan

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The Paleocene/Eocene (P/E) boundary, which correlates with the thermal maximum event, is one of the most important transitions in the Cenozoic. In some studies, the P/E boundary is marked by an unconformity in the Kohat-Potwar Basin, whereas others put it within the Patala Formation. In this study, calcareous nannofossil assemblages from the Patala Formation in the Trans-Indus Range allowed identification of the P/E boundary and reconstruction of the paleoenvironmental thermal conditions. The Patala Formation is placed in Zone NP9 based on the first occurrence of *Discoaster multiradiatus* and the consistent occurrence of *Calciosolenia aperta* and *Fasciculithus richardii*. The co-occurrence of Paleocene, Eocene, and Cretaceous species in the Patala Formation is due to unconformities both at the formation's upper and lower boundaries in the Trans-Indus Range. The P/E boundary corresponds to the unconformity between the Patala Formation and the overlying Nammal Formation, which is likely the result of the India–Asia collision at 56–55 Ma. Malformed assemblages of the *Discoaster araneus* group and *Rhomboaster* spp., which characterize the Paleocene–Eocene Thermal Maximum (PETM) event, were identified in the Patala Formation, whereas the pre-PETM phase could be identified by decreasing diversity and abundance of the genus *Fasciculithus*. The neritic PETM event found in the Tethys Sea is characterized by low salinity and increasing productivity due to terrestrial input. The Patala Formation also contains an increase in low-salinity species and higher productivity. Moreover, the synchronous increased productivity could be the result of higher temperatures due to the onset of the thermal maximum event. Abundant calcareous nannofossils indicate a stable sea level in the Trans-Indus Range, which might be deeper than inner neritic environments.