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Biogeochemical responses to global warming during the Paleocene–Eocene Thermal Maximum in the eastern Tethys

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The Paleocene–Eocene Thermal Maximum (PETM; ~56 Ma) represents a rapid and sustained climatic perturbation that lasted for ~170 kyr and coincided with the emplacement of the North Atlantic Igneous Province (NAIP). Global average temperature increased by 5 to 9 °C, which was likely triggered by a rapid emission of ^{13}C–depleted CO_2. Numerous sites from the deep oceans have been studied for the PETM, but subtropical shallow–water eastern Tethys remains poorly understood despite its importance in regulating heat and moisture transport. Prior studies on calcareous nannofossil biostratigraphy and stable isotopes of marine carbonates confirmed the occurrence of the PETM in the Tarim Basin of the eastern Tethys in northwestern China. Here we present new, high–resolution major, trace and rare earth element geochemical data, and clay mineral records at the Kuzigongsu section in the Tarim Basin to assess the biogeochemical responses of the eastern Tethys to climatic forcings across the PETM. Chemical weathering proxies (chemical index of alteration [CIA], chemical index of weathering [CIW], plagioclase index of alteration [PIA], and Rb/Sr) support an enhanced terrestrial input shortly after the PETM onset, possibly due to intensified chemical weathering. Furthermore, clay mineral assemblage is dominated by illite and illite/smectite during the PETM, implying increased physical weathering. The PETM is also characterized by an increase in nutrient–sensitive elements such as P, Ni, and Cu and higher abundance of nutrient–sensitive calcareous nannofossils, suggesting an intensification of marine primary productivity. Meanwhile, the Tarim Basin may have encountered episodic bottom water deoxygenation supported by an increase in the enrichment factor of redox–sensitive elements such as U and V. The integrated geochemical proxy records suggest that the eastern Tethys has encountered profound ecosystem stress imposed by elevated nutrient fluxes and ocean deoxygenation, which may have been amplified by simultaneously intensified chemical and physical weathering during the PETM.