

Intensified silicate weathering and erosion in the semi-arid Southern Pyrenees during the PETM: Lithium isotope record in clays and carbonate nodules

ROCIO JAIMES GUTIERREZ¹, MARINE PRIEUR¹, DR. DAVID J WILSON², EMMANUELLE PUCÉAT³, THIERRY ADATTE⁴, PROF. PHILIP POGGE VON STRANDMANN⁵ AND SÉBASTIEN CASTELLTORT¹

¹University of Geneva

²University College London

³Université Bourgogne

⁴ISTE, bâtiment GEOPOLIS

⁵JGU Mainz

The Paleocene-Eocene Thermal Maximum (PETM), the strongest hyperthermal event during the Cenozoic (~56 Ma ago), records rapid global warming due to the release of light carbon into the atmosphere. Recent investigations link the PETM with a negative lithium isotope ($\delta^7\text{Li}$) excursion, interpreted as an increase in continental silicate weathering, which can regulate Earth's surface temperature over geological timescales. However, the silicate weathering response under different climatic regimes has yet to be constrained. Here, we investigate how chemical weathering in the semi-arid Southern Pyrenees responded to the PETM and how different geochemical archives (clays and carbonate nodules) recorded this response.

We analyzed two terrestrial sections in the Southern Pyrenees. In the well-characterized Esplugafreda section, we measured $\delta^7\text{Li}$ in clay minerals as a silicate weathering proxy and neodymium isotopes (ϵNd) to track sediment provenance. In the Rin section, we identified the PETM locally using carbon isotopes ($\delta^{13}\text{C}$) in organic matter and examined paleosol clay mineralogy; additionally, we measured $\delta^7\text{Li}$ in both clays and carbonate nodules.

At Esplugafreda, ϵNd values remain stable, indicating no significant shift in sediment provenance. The $\delta^7\text{Li}$ record reveals two positive excursions: one during the Pre-Onset excursion and another during the main PETM body (~0.8 ‰ and up to 1.1 ‰). At Rin, a $\delta^{13}\text{C}$ negative excursion (~2.4‰) marks the PETM body. Paleosols are rich in smectite and illite/smectite, with minor illite, kaolinite, and chlorite, reflecting a seasonal climate. We find a positive $\delta^7\text{Li}$ excursion in the clays (~0.8‰ and up to 1.6‰), while $\delta^7\text{Li}$ signal in carbonate nodules is less well resolved, likely due to clay contamination. We interpret the positive $\delta^7\text{Li}$ excursions as evidence of increased silicate weathering fluxes. Given the reworked, carbonate-rich bedrock and seasonal precipitation, initial low weathering rates evolved into a moderate regime during the PETM, with intensified erosion driving regional denudation.