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The Paleocene–Eocene thermal maximum: New data on microfossil turnover at the Zumaia Section, Spain

Laia Alegret,[1]* Silvia Ortiz,[1,2] Xabier Orue-Etxebarria,[3] Gilen Bernaola,[3,4] Juan I. Baceta,[3] Simonetta Monechi,[5] Estibaliz Apellaniz,[3] and Victoriano Pujalte[3]

[1]Universidad de Zaragoza, Departamento de Ciencias de la Tierra, Facultad de Ciencias, 50009 Zaragoza, Spain; [2]University College London, Department of Earth Sciences, WC1E 6BT London, UK; [3]Universidad del País Vasco, Departamento de Estratigrafía y Paleontología, Facultad de Ciencia y Tecnología, 48080 Bilbao, Spain; [4]Universidad del País Vasco, Departamento de Ingeniería Minera y Metalúrgica y CC de los Materiales, Escuela Universitaria de Ingeniería Técnica de Minas y de Obras Públicas, 48901 Barakaldo, Spain; [5]Università degli Studi di Firenze, Dipàrtimento di Scienze della Terra, Via La Pira, 4, 50121 Florence, Italy
e-mail: laia@unizar.es
**Corresponding author.*

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ABSTRACT

The benthic foraminiferal turnover and extinction event (BEE) associated with the negative carbon isotope excursion (CIE) across the Paleocene–Eocene Thermal Maximum (PETM) is analyzed in the Zumaia section (Spain), one of the most complete and expanded deep-water sequences known worldwide. New biostratigraphic, paleoecologic, and paleoenvironmental data on benthic foraminifera are correlated to information on planktic foraminiferal and calcareous nannofossil turnover in order to evaluate possible causes and consequences of the PETM. Gradual but rapid extinction of 18% of the benthic foraminiferal species starts at the onset of the CIE, after the initial ocean warming (as inferred from calcareous nannofossils) recorded in the last 46 kyr of the Paleocene. This gradual extinction event culminated ~10.5 kyr after the onset of the CIE and led to the main BEE, affecting 37% of the species. Therefore, extinctions across the PETM affected a total of 55% of the benthic foraminiferal species at Zumaia. The gradual extinction occurred under inferred oxic conditions without evidence for carbonate dissolution, indicating that carbonate corrosivity and oxygenation of the ocean bottom waters were not the main cause of the event. An interval characterized by dissolution occurs above the main BEE, indicating that bottom waters became corrosive after the main extinction. Carbonate is progressively better preserved through the overlying deposits, indicating a gradual return of carbon isotope values to background levels, consistent with a slow deepening of the carbonate compensation depth after its initial rise owing to abrupt acidification of the oceans. Microfossil data support a rapid onset of the PETM, followed by long-term effects on calcareous plankton and benthic foraminifera.