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High-resolution iridium, $\delta^{13}C$, $\delta^{18}O$, foraminifera and nannofossil profiles across the latest Paleocene benthic extinction event at Zumaya, Spain

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Abstract

In the expanded upper Paleocene–lower Eocene section (≈30 m of Zone P5 sediments) at Zumaya, northern Spain, the highest occurrence of many late Paleocene deep-sea benthic foraminifera species (≈40% extinction), coincides with a transition from marl to calcite-free clay. Our high-resolution studies (chemical elements, $\delta^{13}C$, $\delta^{18}O$, calcareous nannofossils, planktic and benthic foraminifera) show that below the marl–clay transition there is a 40–50 cm thick interval (corresponding to 10–20 kyr) containing a detailed record of a gradual succession of faunal and geochemical events culminating in the benthic extinctions. Planktic foraminiferal and nannofossil changes (e.g., the onset of demise in *Fasciculithus* genus) occur a few meters below the marl–clay transition. In the limestone 50 cm below the base of the clay, a prominent glauconite maximum indicates that sea-floor oxygenation suddenly decreased. Glauconite continues to be common until the onset of clay deposition. A whole-rock negative $\delta^{13}C$ shift (1.6‰), most likely reflecting an original sea-water trend, is gradually developed over the 40 cm of greenish brown marls immediately below the clay. At the base of these marls there is a small, significant iridium anomaly of 133 ppt Ir compared with an average background of 38 ppt. In the marls the demise of the *Fasciculithus* species accelerates, *Gavelinella beccariiformis* becomes extinct, and the abundance of *Acarinina* species begins to increase. The superjacent 4 m of clay is devoid of original calcite in its lower part and has a low calcareous content higher up. At calcareous levels in the clay an unusual planktic foraminifera fauna occurs, dominated by *Acarinina* species. When marl deposition returns, $\delta^{13}C$ gradually increases and then stabilizes at values about 0.5‰ lower than before the isotopic excursion. The $\delta^{13}C$ excursion spans in total 5 m, probably corresponding to 200–400 kyr. The fasciculiths disappear shortly after the stabilization of $\delta^{13}C$.

Here we also present a whole-rock $\delta^{13}C$ profile through the entire Paleocene section at Zumaya. The profile is very similar to previous profiles registered in well preserved deep-sea material, suggesting that whole-rock $\delta^{13}C$ at Zumaya can be used for correlation.

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