The Palaeocene/Eocene boundary section at Zumaia (Basque-Cantabric Basin) revisited: new insights from high-resolution magnetic susceptibility and carbon isotope chemostratigraphy on organic matter ($\delta^{13}C_{org}$)

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The Palaeocene–Eocene Thermal Maximum (PETM at 55.8 Ma) was a short-lived episode of extreme global temperatures, often regarded as a past analogue of the ongoing global warming. The PETM is defined chemostratigraphically by a carbon isotope excursion (CIE) recognized globally in both marine and terrestrial sections. The onset of this ca. 150-200 ka event marks the Palaeocene/Eocene (P/E) boundary. Zumaia is the most complete and representative section of the early Palaeogene (hemi)-pelagic succession of the Pyrenees, recognised as a key reference section for the Cretaceous-Palaeogene and Palaeocene–Eocene boundaries, and recently ratified as the Global Stratotype Boundary Sections and Points (GSSP) for the bases of the Selandian and Thanetian Stages. Concerning the P-E Boundary, Schmitz *et al.* (1997) provided the unique $\delta^{13}C_{carb}$ curve based on bulk carbonate samples. However, conclusions of this pioneering isotopic study were partially problematic due to dissolution processes just above the P/E, leading to chemostratigraphic uncertainties of several key levels of the section. Here, we refine the position of the P/E in the Zumaia section by using carbon isotope chemostratigraphy on organic matter ($\delta^{13}C_{org}$), to avoid effects of carbonate dissolution. New high-resolution $\delta^{13}C_{org}$ of the Zumaia section (-23.8 to -28.8‰) confirms the position of the Carbon Isotope Excursion and enhances the distinction between the different steps of the CIE/PETM event. Moreover, based on a detailed study of palynofacies and high-resolution magnetic susceptibility profile in which several cycles of susceptibility variations can be identified, we discuss the duration of the CIE and speculate about the palaeoenvironmental and sea-level changes that took place across the P/E boundary. According to new magnetic susceptibility data and detailed cycle counting, the entire duration of the CIE/PETM in Zumaia is estimated in ~168 ± 16 ka. Moreover, the investigation of palynofacies and low-field magnetic susceptibility reveal significant detrital influx during the interval. Several magnetic susceptibility phases and trends are recognised and are interpreted in terms of sea-level fluctuations before, during and after the PETM. Coupled with results from other sections, our data reveal the presence of an unconformity followed by an eustatic sea-level rise (TST) in the latest Palaeocene.