Cenomanian-Turonian boundary diachroneity unraveled by highly resolved carbon-isotope cyclostratigraphy from the Paris Basin Chalk

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The Oceanic Anoxic Event 2 (OAE2, ca. 94.6 Ma) is one of the major perturbations in the global carbon cycle during the Phanerozoic. Stable carbon isotopes ($\delta^{13}C$) from marine and continental sedimentary environments document this carbon cycle perturbation with a pronounced (> 2‰) positive carbon isotope excursion (CIE). Although the OAE2 stratigraphic interval has been intensively studied in terms of paleoceanography and paleoclimatology, several biotic, climatic and carbon-cycle aspects are not yet well-understood. In particular, cyclic short-term $\delta^{13}C$ variations within the OAE2 and their potential implications for the global carbon cycle have been rarely addressed.

Here, we present high-resolution (5 cm, ~2 kyr) $\delta^{13}C$ data spanning the OAE2 from the Paris Basin Chalk (Poigny Craie-701 drill-core) to show high amplitude short-term δ13C oscillations, superimposed on the major CIE. Time-series analysis indicates that short-term oscillations are astronomically paced, with eccentricity cycles being the most prominent. We suggest that orbitally paced carbon cycle oscillations were amplified by considerable emission of greenhouse gases from volcanism that caused the overall CIE.

Cyclostratigraphic correlations among several OAE2 key records indicate that the entry of *W. devonense* ammonite, which defines the Cenomanian-Turonian boundary (CTB), was at least 200 kyr later in the Western Interior Basin (WIB, USA) than in Europe (Anglo-Paris and Lower Saxony basins). Key calcareous nannofossil biohorizons (e.g., *Quadrum gartneri*) are also stratigraphically upshifted in the WIB with respect to the European sections, hence further supporting a younger CTB in the WIB. We ascribe such significant temporal offset to diachroneity of the CTB, which is likely the result of different, regional biotic responses to the global OAE2 paleoenvironmental perturbation.

Keywords: OAE2, Cenomanian-Turonian boundary, diachroneity, carbon cycle, volcanically amplified eccentricity record, Anglo-Paris Basin.

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