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The Cenomanian–Turonian boundary event and OAE2: marine productivity and climate interactions

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OAE2, spanning the Cenomanian – Turonian (Upper Cretaceous) boundary at around 93.6 Ma, is one of very few truly global oceanic anoxic events. The widespread synchronous deposition of black shales in basinal and oceanic areas generated one of the World's most important petroleum source rock intervals. Moreover, the boundary interval is characterized globally by a large positive excursion of delta13C in marine carbonates, and both marine and terrestrial organic matter, indicating a dramatic change in the dynamics of the global carbon cycle lasting around 450 kyr. The time interval is remarkable for having both the highest eustatic highstand of sea level and the warmest global climate of the Mesozoic – Cenozoic. The dramatic palaeoenvironmental change of Cenomanian–Turonian boundary times was additionally associated with an episode of significant biotic turnover, including the extinctions of many key marine microbiota. It is widely believed that increased primary productivity and sluggish oceanic circulation caused widespread oxygen depletion in oceanic water columns which led directly to OAE2. However, the oceanic and other environmental conditions that drove the event remain poorly understood. Organic-walled dinoflagellate cyst (dinocyst) and geochemical records across the Cenomanian–Turonian boundary (CTB) are compared between NW European Boreal Chalk sections in southern England, and North Tethyan hemipelagic black shale-bearing successions in the Vocontian Basin, SE France. High-resolution correlation between the sections has been achieved using planktonic foraminifera, calcareous nannofossil, and dinocyst biostratigraphy, integrated with carbon-isotope and elemental chemostratigraphy. The sections show remarkably similar stratigraphic trends despite representing different palaeolatitudes and different biotic provinces (Boreal versus Tethyan), and contrasting lithofacies associations (pelagic chalks and marls versus organic-rich shales and limestones).

Dinocyst fertility indexes indicate that an upwelling-driven productivity pulse accompanied a eustatic sea-level fall that preceded the rise in delta13C values that marks the onset of OAE2. A marine productivity collapse in the Chalk Sea and Tethyan marginal basins during the latest Cenomanian is indicated by the falling absolute and relative abundance of peridinioid dinocysts, believed to be the product of heterotrophic dinoflagellates. This biotic change accompanied transgression and sharply rising sea-surface temperatures, following an Atlantic-wide episode of short-lived cooling. Differences between the magnitudes of changes in the organic-carbon and carbonate-carbon stable isotope (delta-delta13C) records provide evidence of episodes of falling atmospheric pCO2 driven by organic-matter burial in oceanic areas. CTB biotic turnover in epicontinental and marginal seas was driven largely by watermass changes rather than oxygen depletion.