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Productivity, facies and stable-isotope records of OAE2 (Cenomanian - Turonian) in the NW European epicontinental sea: from the English Chalk to North Sea black shales

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The Late Cretaceous (100.5 – 66.0 Ma) provides perhaps the best example of how the Earth System may function under long-term extreme greenhouse conditions. Rapidly rising global temperatures indicate that we are heading 'back to the Cretaceous' within a few hundred years, so a better understanding of this time interval is essential. The beginning of the Late Cretaceous was characterized by a period of rapidly rising eustatic sea level, the Cenomanian transgression, which flooded continental margins and established large areas of new epicontinental sea that accumulated thick sequences of pelagic and hemipelagic carbonate (chalk). Highest global temperatures were reached during the early part of the Turonian Stage (93.9 – 89.8 Ma). This period of dramatic palaeoenvironmental change was accompanied by one the largest perturbations of the global carbon cycle in the Mesozoic: Oceanic Anoxic Event 2 (OAE2), which was characterized by a 500 kyr episode of oceanic anoxia, widespread black shale deposition, biotic turnover, and a large global positive carbon stable-isotope excursion (2 – 6 ‰ ∂13C) recorded in marine carbonates and both marine and terrestrial organic matter.

The Cenomanian-Turonian boundary interval exposed at Eastbourne, southern England, has become established as a European reference section for OAE2. Here, and elsewhere in Europe, the base of the ∂13C excursion is coincident with a marked facies change from rhythmically bedded grey chalks and marls, to a >8 m thick package of dark greenish-grey marl – the Plenus Marl. The termination of OAE2 occurs 6 m above, in a package of pale-yellow-weathering nodular chalks with prominent marl seams. Sediments are organic lean (<0.2 wt% TOC) and bioturbated throughout, and although a case can be made for periodic oxygen depletion in bottom waters, there is no evidence here of marine surface- or bottom-water anoxia. The Plenus Marl displays a distinctive succession of 8 beds that can be correlated throughout southern England and northern France, and the formation is widely developed in the North Sea Basin where it forms an important lithostratigraphic and geophysical marker. In contrast to southern England, the Plenus Marl of the North Sea (Blodøks Formation of the Norwegian sector) consists of a succession with laminated black shales yielding TOC >10 wt%. The onshore equivalent in eastern England (the Black Band) is similarly organic-rich, as are comparable sections in northern Germany (e.g. Wunstorf), indicating likely fully anoxic episodes within some NW European basins. The exact stratigraphic equivalence between the onshore Plenus Marl, North Sea black shales and the Black Band remains controversial.

Here, we compare the lithofacies, sedimentology, elemental and stable-isotope records, and palynology of Upper Cenomanian – Lower Turonian sections in southern England to those from a central North Sea cored reference well that includes a 6 m package with laminated black shales (Plenus Marl). Factors influencing carbonate and organic matter ∂13C trends in the records will be considered in the context of the palaeoceanographic and palaeoclimatic events that accompanied eustatic sea-level change, culminating in OAE2 and the subsequent global climatic optimum. The effects of diagenesis on the stable-isotope records will be discussed.