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Palaeoevironmental change during the Cenomanian (100 – 94 Ma): new insights from organic-walled dinoflagellate cysts, isotopic and elemental geochemistry, Wunstorf, northern Germany

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A unique and expanded Cenomanian – Turonian boundary succession was cored at Wunstorf, Germany, in February 2006, in order to develop a high-resolution chemo- and biostratigraphy for the Cenomanian / Turonian (C/T) boundary interval which will serve as an international standard. The Wunstorf section includes one of the world's most expanded (25 m thick), accessible C/T sections with thick black shales. The extensive burial of organic carbon in these black shales and a large positive δ^{13}C excursion in both marine carbonate and organic matter, are characteristic of the Cenomanian – Turonian boundary event (CTBE), and represent a global oceanic anoxic event (OAE) known as OAE2. Stratigraphic coverage of the Wunstorf study has been extended down to the Lower Cenomanian by sampling an adjacent quarry. The additional 39 m of section includes a well-developed mid-Cenomanian positive carbon isotope excursion (MCEI), and an expanded Lower Cenomanian succession.

The long-term response of organic-walled phytoplankton to the major environmental changes accompanying the two major Cretaceous carbon stable-isotope events is being studied based on the analysis of dinoflagellate cyst (dinocyst) assemblages and abundances in samples collected at metre intervals through the Wunstorf core and quarry (104 m). Dinocyst assemblage and geochemical data from Wunstorf indicate that considerable water-depth fluctuations occurred during the Cenomanian. These changes are inferred to have been both local and eustatic, the latter reflected by significant variations in the carbon isotope profile, which are interpreted to reflect global sea-level change (Jarvis et al., 2001, 2002, 2006).

Relatively stable open-ocean conditions during the Early and Late Cenomanian are inferred from dinocyst assemblages dominated by *Spiniferites ramosus ramosus* and *Palaeohystrichophora infusorioides*. Major variations from these assemblages are associated with the positive carbon isotope excursions marking MCEI and OAE2. During the later stages of MCEI, within the *Acanthoceras rhotomagense* ammonite Zone, an unusual assemblage dominated by *Oligosphaeridium complex* is recorded. The C/T black shale interval yields an abundant palynomorph assemblage characterised by a significant increase in numbers of *Cyclonephelium membraniphorum*, and a decrease in numbers of *P. infusorioides*.

Typical Cenomanian dinocyst absolute abundances are recorded through the lower part of the section (1000 – 2000 dinocysts per gram, dpg), with elevated levels averaging 3000 dpg associated with rising carbon isotope values at the onset of the MCEI. Reduced dinocyst abundances of 500 dpg are recorded with maximum carbon isotope values of MCEI, and dinocyst numbers continue to decline to a low abundance zone within the “Poor rhotomagense Limestones” of the Upper Cenomanian. Unusually high dinocyst abundances averaging 2000 dpg (peaks of $>$7000 dpg recorded) are associated with the black shales of the uppermost Cenomanian and Lower Turonian at Wunstorf.

Despite the presence of black shales, elevated manganese contents through the Cenomanian–Turonian interval of the Wunstorf core suggest that bottom waters remained oxygenated. Low molybdenum values throughout the succession point to an absence of sulphidic bottom waters. High dinoflagellate cyst abundance values, and an increase in both phosphorus and manganese suggest that black shale deposition accompanied increased surface-water fertility.

It is proposed that black shale deposition was a product of increased surface-water organic productivity and decreased carbonate fluxes, rather than bottom-water anoxia. Rapidly rising global sea-levels following a eustatic lowstand, inferred from the carbon stable-isotope profile and sequence stratigraphic interpretations, would have released shoreface and land-locked nutrients, promoting an increase in surface productivity and initiating black shale deposition. Black shales at Wunstorf extend into the Lower Turonian, above the level of the positive carbon isotope excursion. This indicates that the high productivity event was more prolonged in the Wunstorf basin than the episode of organic carbon burial that generated the global δ^{13}C excursion. The palaeoceanographic and palaeoclimatic causes and consequences of the productivity events are currently being investigated.

References

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