

## Repeated anoxia-extinction episodes progressing from slope to shelf during the latest Cenomanian

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Oceanic Anoxic Event 2 (OAE 2) during the Cenomanian?Turonian (C/T) transition caused stepwise marine extinctions. Using organic compounds, stable carbon and oxygen isotopes, and foraminifera from three depth-transect sections in northern Spain, this study revealed repeated anoxic/euxinic events coinciding with warming and stepwise extinctions of planktonic and/or benthic foraminifera within intermediate to surface waters in the proto-North Atlantic during the C/T transition. Those short-duration euxinic events occurred four times: at 93.95 Ma, marked by the extinction of *Rotalipora greenhornensis*; at 93.90 Ma, marked by the extinction of *Rotalipora cushmani*; at the mid-time maximum of the plateau of the  $\delta^{13}C$  of carbonates (93.70 Ma); and at the time of the C/T boundary (93.55 Ma). Furthermore, the main benthic foraminiferal extinctions occurred during the first and second euxinic events in the upper slope, during the second and third euxinic events in the outer to middle shelf, and during the third and fourth events in the middle shelf. The main euxinic events in each section also showed a progression to the shallow shelf. The main anoxia-extinction events occurred in the upper slope and outer shelf then moved to the middle shelf. The shallowest section had relatively weak anoxia and a proportionally low extinction rate. These new findings indicate that foraminiferal extinctions started from the intermediate water and the continental slope and then moved to the continental shelf. This was the result of the repeated progression of euxinic-anoxic water from the upper slope to the middle shelf on the eastern continental margin of the proto-North Atlantic four times during a 400 kyr period, to the end of the Cenomanian.

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