Barremian to early Aptian environmental changes in the North Sea: new results from high-resolution carbon and oxygen stable isotopes, major and trace elements, and calcareous nannofossils

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The Barremian to lower Aptian Tuxen and Sola Formations have been investigated in the North Jens-1 well (Danish Central Graben, North Sea) for environmental changes based on a revised calcareous nannofossil biostratigraphy, on geochemical analysis of 316 samples (stable isotopes, hand-held XRF element analysis) and quantitative nannofossil abundance counts of 75 samples. Our results delineate the well-established Barremian rise in carbon isotopes as well as the typical excursions across the early Aptian Oceanic Anoxic Event (OAE) 1a characterized by two short and prominent negative excursions right below and at the base of the Fischschiefer laminated black shale horizon, followed by the long-lasting positive carbon isotope excursion of the lower to upper Aptian. Our new results also show significant cyclic changes in the Barremian carbon cycle with a number of new possible negative and positive excursions that could be defined and used for refinement of the stratigraphy of this stage. Oxygen isotopes and calcareous nannofossil assemblages highlight the coupling of significantly warm episodes associated to eutrophic conditions during deposition of the lower Barremian Munk marl and early Aptian Fischschiefer laminated horizons whereas a significant cooling associated to oligotrophy triggered the deposition of nannoconid chalk in the upper Barremian. Major and trace elements suggest rather similar environmental contexts for the deposition of the Munk marl and Fischschiefer and advocate for these levels being deposited in association with maximum flooding, in accordance with results of the Lower Saxony Basin in North Germany.