Oscillating redox conditions in the Vocontian basin (SE France) during OAE 2: Paleoenvironmental implications

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The Oceanic Anoxic Event 2 (OAE 2) spanning the Cenomanian-Turonian boundary (~94 Ma) represents an interval of worldwide enhanced organic carbon burial in marine sediments, triggered by widespread O2 deficiency in water column and/or an increased primary production in seasurface. In epicontinental basins, anoxia establishment modalities are still debated and is probably due to complex interactions between global vs. local forcing factors.

In the Vocontian Basin (SE France), the OAE 2 is evidenced by a positive δ13C excursion (+2.5‰) within the so-called “niveau Thomel”. This level is particularly well exposed at the Pont d’Issole section as a ~22m succession of calcareous dark shale (with TOC up to 2.5 wt.%), disrupted by bioturbated limestone intervals. Iron speciation measurements (FeHR/FeT and FePy/FeHR) indicate suboxic to euxinic conditions during the deposition of the organic-rich intervals and widespread oxic conditions associated with limestone intervals. Redox sensitive trace elements (e.g. Mo, V, U, Cr) also show strong oscillations with only small and brief enrichments in the shale intervals, suggesting sensible post-depositional reoxygenation within the OAE. A high degree of pyritisation linked to bacterial sulfate reduction is, however, recognized with high-amplitude negative excursion (~40‰) in the δ34S record starting with the OAE onset. Previous studies in different basins, including the Vocontian, supported the idea that OAE 2 was triggered by massive sulfate input, in a low-SO4 Cretaceous ocean, associated with intensified volcanism and/or enhanced continental weathering. Fe-Mn-P coupled variations, negatively correlated to TOC and pyrite burial, indicate that bottom waters was dominated by Fe and Mn redox cycles in the Vocontian basin. P release from sediments to water column in anoxic environment may have contributed to fertilize the photic zone and enhance primary production maintaining anoxia during the OAE. Within the OAE 2 record, a major reoxygenation phase, previously pointed out in European and Atlantic sites, is associated with a regional atmospheric pCO2 drawdown highlighted by a Δ13C (δ13Corg-δ13Ccarb) decrease. This, resulting in an episode of regional cooling known as the Plenus Cold Event, is suggested to bring oxygenated cold waters from boreal realms.