Oscillating redox state in Vocontian Basin (SE France) during the Cenomanian–Turonian Oceanic Anoxic Event (OAE 2)

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The Oceanic Anoxic Event 2 (OAE 2) spanning the Cenomanian-Turonian boundary (CTB) represents a global interval of enhanced organic carbon burial triggered by widespread oxygen deficiency in water column and/or an increased primary production. In the epicontinental Vocontian Basin (SE France) the CTB is characterized by the so-called “niveau Thomel”. This level is well exposed at the Pont d’Issole section as a ~22 m succession of calcareous shale and black shale, disrupted by bioturbated limestone intervals. Those lithological variations, highlighted by fluctuations in total organic concentration (TOC) along the CTB, are in favor of a non-permanent anoxia in the Vocontian Basin with important migration of the chemocline inside the sediments and the water column. The aims, here, is to precisely determined the conditions of bottom-water oxygenation and further to decipher which environmental parameters are at the origin of anoxia establishment and disappearance.

Iron speciation measurements indicate anoxic to euxinic conditions during the deposition in the shaley intervals and widespread oxic conditions associated with limestone intervals. This observation is consistent with high variations in the sedimentary degree of sediment pyritisation. Water column or sedimentary pore fluids bacterial sulfate reduction (BSR) is suggested by extremely negative values ($\delta^{34}S$ ~-40‰). Such $\delta^{34}S_{py}$ negative excursion was previously observed in other OAE 2 sites associated with an anti-correlated positive excursion in the marine sulfur isotope sulfate measures as carbonate associated sulfate ($\delta^{34}S_{CAS}$)[a,b]. These signals associated with massive pyrite burial suggest important external S flux (intensified volcanism[a] and/or enhanced weathering[c]) in a pre-OAE low-sulfate ocean which may have triggered anoxia. Fe-P coupling in those sediments indicates, otherwise, that bottom water was dominantly non-sulfidic and was dominated by redox cycling of iron and manganese. P release from sediments to water column in anoxic environment may have contribute to fertilized the photic zone and enhance primary production maintaining anoxia. On the other side, P enrichment peaks in low TOC and low S intervals suggest intense phases of reoxygenation. While presence of anoxia is evident in shale, redox sensitive Trace Element (e.g. Mo, V, U) display only small enrichments, probably reflecting post-depositional reoxygenation. Interval of reoxygenation inside the OAE 2 record was previously pointed out in other European and Atlantic sites and was associated with a regional atmospheric pCO_2 drawdown highlighted by a $\Delta^{13}C$ ($\delta^{13}C_{org}$ - $\delta^{13}C_{carb}$) decrease resulting in an episode of cooling, known as the Plenus Cold Event.

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