# From OAE 2 anoxia to oxic CORBs – rapid environmental changes in the Late Cretaceous

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CORBs - Cretaceous Oceanic Red Beds - are red to pink to brown, fine-grained sedimentary rocks of Cretaceous age deposited in pelagic marine environments, including red carbonates, shales, and radiolarian cherts. CORBs are an important facies of deep-water pelagic deposits and pelagic/hemipelagic sedimentary systems. The two major global events of of CORB deposition in the Cretaceous are the event at nannofossil zone CC7 just shortly after the OAE1a and the second in CC11 after the OAE2. Three general facies types were recognized with the end members clay, carbonate, and chert. The depositional environments are fairly deep oceanic basins, generally far from a shoreline. Significant controlling factors of CORB formation were slow sediment accumulation rates at great paleo-water depths.

The transition from OAE 2 black shales to CORBs was studied in three ultrahelvetic sections in the Eastern Alps that were deposited at the distal European continental margin of the (Alpine) Tethys (Neuhuber et al., 2007).

The first section at Rehkogelgraben comprises a 5 m thick succession of Upper Cenomanian marl-limestone cycles overlain by a black shale interval composed of three black, organic-rich (ca. 5% TOC, kerogen type II) layers and carbonate-free claystones, followed by Lower Turonian white to light grey marly limestones with thin marl layers. Carbon isotope values of bulk rock carbonates display the well documented positive shift around the OAE2 black shale interval therefore the Rehkogelgraben section can be correlated to other sections. Except for the OAE2 event the content of organic carbon is low in the entire section.

Early Turonian sediments of similar facies are exposed in the second section at Buchberg that contains white to light grey marly upper- to middle bathyal carbonates. In this section red-colored carbonatic CORBs develop within a time span of about 1.5 my in the Middle Turonian. The total organic carbon content is very low throughout the section, similar to the Rehkogelgraben section. However, benthic foraminifera associations indicate repeated phases of enhanced organic matter flux and less aerated bottom waters during the transitional interval from white to red carbonatic marl deposition. Sedimentation of red layers was controlled by periods of well oxygenated bottom waters, reduced sedimentation rates, and degradation of organic matter in the underlying sediments. Principal component analysis of carbonate chemical data showed that the development of red coloured pelagic sediments is accompanied by a shift towards highly oligotrophic conditions in the surface ocean as well as a decrease in hydrothermal activity. The general formation of red beds is most likely associated with a shift towards more oxic conditions.

Above the Cenomanian-Turonian interval, red limestone-marl cycles of Coniacian-Santonian age are present. Mineralogical data suggest a constant source area over the investigated interval. The relatively higher content of organic carbon in the Upper Santonian may indicate a regressive event in accordance with the global sea-level curve. Plagioclase and organic carbon correlate positively and might indicate enhanced input of nutrient- like trace metals during episodes of higher volcanic activity. Terrigeneous elements (Al, Li, Rb, Be) decrease upwards. Iron speciation data for marl and limestone layers attest to oxic early diagenesis during marl deposition compared to limestone episodes.

Low sediment accumulation rates (2.5 mm/ka) are reconstructed. On the whole, geochemistry (Ba) and stable carbon isotope data indicate a highly oligotrophic environment with efficient recycling of organic matter and nutrients in the upper water column. The investigated Santonian CORBs were deposited above the Upper Cretaceous CCD and show that nutrient availability varied and resulted in periods of higher primary production.

Neuhuber, S., Wagreich, M., Wendler, I. & Spötl, C. (2007): Turonian Oceanic Red Beds in the Eastern Alps: Concepts for palaeoceanographic changes in the Mediterranean Tethys. Palaeogeography, Palaeoclimatology, Palaeoecology, 251, 222–238.