Weakening of the biological pump induced by a nannoplankton crisis during the early Toarcian Oceanic Anoxic Event

Wolfgang Ruebsam

Department of Organic and Isotope Geochemistry, Institute of Geoscience, University of Kiel, Germany

Emanuela Mattioli*

Univ Lyon, UCBL, ENSL, UJM, CNRS, UMR 5276 LGL-TPE, F-69622 Villeurbanne, France, also at Institut Universitaire de France, Paris, France. emanuela.mattioli@univ-lyon1.fr

Lorenz Schwark

Department of Organic and Isotope Geochemistry, Institute of Geoscience, University of Kiel, Germany.
WA-OIGC, Curtin University, Perth, Australia

Severe environmental changes occurred during the early Toarcian (Early Jurassic, ~183 Ma) related to rising atmospheric CO_2 concentration and associated changes in ocean alkalinity and sea water temperatures. Such perturbations directly or indirectly (i.e., via ocean water stratification and nutrient delivery to surface waters) impacted on marine primary producers. Changes in the phytoplankton community structure in turn affected the marine food web, the biological pump and thereby the entire marine ecosystem and carbon cycling. Recently, this scenario has been challenged thanks to the recovery in sediments of imprints of coccoliths on organic materials, originated because of dissolution of $CaCO_3$ due to high amounts of organic matter leading to acidic pore waters during diagenesis.

We show here new data from the core FR-210-078 (Lorraine Basin), where rather low organic carbon accumulation rates are estimated. This observation is substantiated by a reduced export efficiency of organic carbon to the sediment, caused by a drastic decline in the abundance of mineral ballast (i.e. nannoplankton-derived calcite), due to a major decrease in calcification potential of coccolithophores, and in calcareous nannofossil fluxes. Besides this decline in primary carbonate production, a drop in both abundance and size is documented for fæcal pellets. A net reduction of mineral (i.e. calcite) ballast led to weakening of the sinking speed of particulate organic matter that became more prone to biodegradation. The reduced organic carbon accumulation rates are here interpreted to reflect a weakening of the biological pump. These new data substantiate the role of organic matter preservation as major factor controlling the formation of black shales during the early Toarcian, as well as the key role played by calcareous nannoplankton in the C cycle during past dramatic climatic events.