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Mass extinction and demise of carbonate factory in the aftermath of the Toarcian oceanic anoxic event

Francois-Nicolas Krencker (1), Stéphane Bodin (1), René Hoffmann (1), Guillaume Suan (2), Emanuela Mattioli (2), Lahcen Kabiri (3), and Adrian Immenhauser (1)

(1) Ruhr-Universität Bochum, Institut für Geologie, Mineralogie und Geophysik, D-44870 Bochum, Germany, (2) Université Lyon 1, Campus de la Doua, Bâtiment Géode, F-69622 Villeurbanne Cedex, France, (3) Moulay Ismail University (UMI), Faculty of Sciences and Techniques, Errachidia (FSTE), Department of Geology, PO Box 52 000 509 Boutalamine Errachidia Morocco

The Pliensbachian – Toarcian interval is characterized by several events of relatively short-lived carbon cycle perturbation, climate change and faunal turnover. The cause(s) of these biotic and abiotic disturbances remains unclear but probably involves increased magmatic activity in the Karoo-Ferrar flood basalt province. The Toarcian ocean anoxic event (T-OAE) might represent the most extreme of these events, and as such, is becoming increasingly well documented worldwide. As a consequence other critical time periods of the Pliensbachian – Toarcian interval have received considerably less attention. For instance, a second order faunal crisis is recognised near the transition between the Bifrons-Variabilis ammonite zones, but really few is known about this event. Here, the impact of this Bifrons-Variabilis event on the shallow marine realm is investigated using three well-exposed and extended stratigraphic sections in the Central High Atlas, Morocco. The carbon and oxygen isotopic composition, calcium carbonate contents and phosphorus concentrations of micritic mudstones and marls of 132 samples were determined to assess temporal changes in climate, C and P-cycling and carbonate production. The sections, forming a proximal to distal transect extending over 10 km in north-south direction, were correlated using sequence stratigraphy, isotope geochemistry and biostratigraphy. In all studied sections, a major change from carbonate-dominated deposition to siliclastic-dominated deposition is recorded at the Middle-Upper Toarcian transition, pointing to a first-order carbonate production crisis. Our results reveal that these major changes in sedimentology coincide with a marked decrease of carbon and oxygen isotope values and an increase of phosphorous contents. These geochemical perturbations suggest that much like the T-OAE, the Middle-Late Toarcian carbonate-platform crisis was related to an enhanced hydrological cycling. Consequently, the nutrient input increased possibly associated with the release of isotopically light carbon to exchangeable reservoirs. Our data thus provide the first evidence for coupled changes in carbon cycling, continental weathering and neritic systems in the aftermath of the T-OAE.