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Early to Middle Toarcian (Jurassic) palaeoenvironmental perturbations and their repercussions on the Northern Gondwana margin carbonate platform (High Atlas, Morocco)

Stephane Bodin (1,3), Emanuela Mattioli (2), Sebastian Fröhlich (3), Jim Marshall (4), Lahcen Boutib (5), Salim Lahsini (5), and Jonathan Redfern (3)

(1) Ruhr-Universität, Bochum, Institute for Geology, Mineralogy and Geophysics, Germany (stefbodin@gmail.com), (2) UMR 5125 PEPS, Université Lyon 1, Campus de la Doua, Bâtiment Géode, 69622 Villeurbanne Cedex, France, (3) North Africa Research Group, Basin Studies and Petroleum Geosciences, School of Earth, Atmospheric and Environmental Sciences, University of Manchester, Williamson Building, Oxford Road, Manchester M13 9PL, United Kingdom, (4) Department of Earth and Ocean Sciences, University of Liverpool, Liverpool L69 3GP, United Kingdom, (5) Office National des Hydrocarbures et des Mines (ONHYM), 34 Avenue Al Fadila, 10050 Rabat, Morocco

The Early Toarcian is marked by a global perturbation of the carbon cycle and major marine biological changes, which coincide with a general decrease of calcium carbonate production and an increase of organic carbon burial, culminating in the so-called Toarcian Oceanic Anoxic Event. It is believed that the environmental crisis was triggered by the activity of the Karoo-Ferrar large igneous province. In order to further document the Early Toarcian palaeoenvironmental perturbations, we have investigated carbon isotope, total organic matter, calcareous nannofossils and phosphorus content of the Amellago section in the High Atlas rift basin of Morocco. This section offers the advantage to be extremely expanded compared to the well-studied European sections. Its position along the northern margin of the Gondwana continent is of critical importance to assess the change of continental river nutrient input into the western Tethyan realm. The carbon isotope curve shows two negative excursions of equal thickness and amplitude, at the Pliensbachian - Toarcian boundary and the Polymorphum - Levisoni ammonite Zone transition. This confirms the supra-regional nature of these shifts and highlights the possible condensation of the first "boundary" shift in European sections. Phosphorus content is used to trace palaeonutrient changes and shows that the two negative carbon isotope shifts are associated with increased nutrient level, confirming that these episodes are related to enhanced continental weathering, probably due to elevated greenhouse gases in the atmosphere. In the High Atlas Basin, the rise of nutrient level at the Pliensbachian - Toarcian boundary is moreover likely to be the main factor responsible for the coeval demise of the carbonate platform. Nutrient levels are thereafter decreasing during the Late Early Toarcian, permitting the reinstallation of carbonate platform growth. A Middle Toarcian event, centered on the Bifrons - Gradata Zones transition, characterized by a positive excursion of carbon isotope and nutrient level rise, is moreover documented in the Amellago section, and most likely accompanied by a second carbonate platform drowning event.