From the continent to the ocean: A basin-wide perspective on the Early Toarcian mass extinction

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Abstract

The Central High Atlas Basin offers a rare opportunity to study the paleoenvironmental, sedimentological, and biological evolution associated with the Early Toarcian mass extinction on a basin-scale. Thanks to outstanding exposure quality and high accumulation rates, numerous detailed sections can be studied across this basin, which encompasses terrestrial, transitional, and open ocean paleo-domains. This unique setting allows us to study the interaction between climate change, siliciclastic sediment supply, sea-level fluctuations, and neritic carbonate production during an interval characterized by two major environmental perturbations; the Pliensbachian/Toarcian boundary event (Pl/To) and the Toarcian oceanic anoxic event (T-OAE). A major change in sediment supply coincides with the Pl/To event, characterized by a neritic carbonate factory collapse coeval to a considerable input of coarse siliciclastic materials accompanying a switch from dry to humid climatic conditions. This event also marks a major change in shallow-marine carbonate-producing ecosystem and one of the most dramatic coral extinction events of the Phanerozoic. The onset of the T-OAE is also characterized by a change in sediment supply and a carbonate factory collapse, but this later is short-lived as neritic carbonate production resumes already during the T-OAE. Moreover, differences in terms of sea-level fluctuations are observed between the two events; the Pl/To carbonate factory collapse is coeval with a 40 m sea-level fall while the T-OAE corresponds to an 50 m sea-level rise (minimum). One major overarching result from the Central High Atlas Basin is that chronostratigraphically complete sections are never encountered in this continental shelf setting due to the combination of highly fluctuating sea-level and sediment supply during the early Toarcian as a consequence of severe and repeated environmental/climatic perturbations. The most critical aspect is that hiatus surfaces are often cryptic (lacking clear physical evidence and/or of a duration lower than the highest possible biostratigraphic resolution) and can only be firmly recognized by the high-resolution sequence stratigraphic and chemostratigraphic framework developed here. This raises concerns about the completeness of numerous classical sections situated in similar continental shelf settings but which lack a robust basin-scale depositional architecture control.

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