

Volcanically induced warming and sea-level rise as triggers of exceptional vertebrate preservation in Toarcian shales of southern France (Hérault)

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Over the past three years, paleontological excavations realized in lower Toarcian (Lower Jurassic) strata around Lodève, Hérault (France) have yielded several specimens of marine vertebrates. The newly discovered specimens are partly or entirely preserved in anatomical connection and include a partial ichthyosaur skeleton with soft tissues as well as a complete, >4 m-long longirostrine marine crocodile. We have developed a multi-proxy approach (XRD-bulk and clay mineralogy, Rock-Eval pyrolysis, phosphorus and mercury contents) to replace these findings in a well-defined temporal and paleoenvironmental context, and hence constrain the factors that led to their remarkable preservation. The fossiliferous succession exposes a 3 m-thick upper Pliensbachian interval of marl and nodular carbonate beds, overlain by a 3 m-thick interval of lower Toarcian laminated shales and limestone beds. Our high-resolution ammonite biostratigraphy, combined with inorganic and organic carbon isotope chemostratigraphy, shows that the fossiliferous Toarcian strata were deposited at a time of global warming and major carbon cycle perturbation known as the Toarcian Oceanic Anoxic Event (T-OAE). The studied succession shows several similarities with the classical coeval fossiliferous Posidonia Shale in SW Germany, including high organic matter and hydrocarbon contents as well as extremely reduced sedimentation rates. These results indicate that the unusual richness in exceptionally preserved vertebrates of the studied site can be explained by a combination of warming-induced, prolonged seafloor anoxia and reduced dilution by low carbonate and terrigenous input due to rapid sea-level rise. Our preliminary results also reveal a significant peak in mercury at the base of the T-OAE interval, consistent with that recorded in several coeval sections (e.g. Portugal, Morocco, Argentina, Chile). This mercury anomaly, most likely resulting from intense volcanic activity of the/in the Karoo-Ferrar large igneous province, suggests that widespread exceptional vertebrate preservation during the T-OAE was induced by a suite of severe environmental perturbation ultimately triggered by intense volcanic emissions.

Mots-Clés : Pliensbachian, Toarcian, T-OAE, crocodile, biostratigraphy, paleoenvironment, volcanism