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Recurrent global carbon cycle disturbances during the Aalenian: Evidence from France and Chile

Alicia Fantasia^{1,2}, Thierry Adatte³, Jorge E. Spangenberg⁴, Emanuela Mattioli^{1,5}, Enrique Bernárdez⁶, Nicolas Thibault⁷, François-Nicolas Krencker², and Stéphane Bodin²

¹Université Lyon 1, Laboratoire de géologie de Lyon - Terre Planètes Environnement, F-69622 Villeurbanne Cedex, France

²Aarhus University, Department of Geoscience, 8000 Aarhus C, Denmark

³University of Lausanne, Institute of Earth Sciences, 1015 Lausanne, Switzerland

⁴University of Lausanne, Institute of Earth Surface Dynamics, 1015 Lausanne, Switzerland

⁵Institut Universitaire de France, Paris Cedex 05, France

⁶INSUGEO, San Miguel de Tucumán, Argentina

⁷University of Copenhagen, Department of Geosciences and Natural Resource Management, 1350 Copenhagen K, Denmark

The Jurassic was punctuated by several episodes of abrupt environmental changes associated with climatic instabilities, severe biotic crisis, and perturbations of the global carbon cycle. Over the last decades, the Toarcian Oceanic Anoxic Event (Early Jurassic, ~183 Ma) and the early Bajocian Event (Middle Jurassic, ~170–168 Ma) have attracted much attention because they represent such episodes of global and severe environmental change. Bracketed in between the Toarcian and the Bajocian, the Aalenian stage (Middle Jurassic, ~174–170 Ma) has received less attention, although there is some evidence from Tethyan and Boreal records that it was a time of environmental changes marked by marine biotic turnovers. The lack of knowledge about the Aalenian palaeoenvironments leaves a gap in our understanding of the wider context of the Toarcian and Bajocian events and hence of environmental feedback mechanisms surrounding Mesozoic carbon cycle perturbations. In this study, we provide a high-resolution, biostratigraphically well-defined carbon isotope records ($\delta^{13}\text{C}_{\text{org}}$ and $\delta^{13}\text{C}_{\text{carb}}$) combined to Rock-Eval data for the upper Toarcian–lower Bajocian interval from two expanded marl/limestone alternation successions from France (French Subalpine Basin) and Chile (Andean Basin). The comparison with available records from the Tethyan and Boreal domains highlights that medium-term $\delta^{13}\text{C}$ fluctuations are reproducible across different palaeoceanographic settings from both hemispheres and between different carbon substrates. The new high-resolution dataset highlights the complexity of the Aalenian $\delta^{13}\text{C}$ record, including previously identified $\delta^{13}\text{C}$ shifts and hitherto undescribed fluctuations. This study provides one of the most expanded high-resolution chemostratigraphic reference records for the entire Aalenian stage, and shows compelling evidence from both hemispheres that it was a time marked by recurrent perturbations to the global carbon cycle and environmental changes.

