Oceanic Anoxic Event 1b (Aptian – Albian transition): A protracted multi-phased event at the dawn of the middle Cretaceous warmth

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Abstract

The Aptian-Albian transition encompasses the OAE 1b cluster event, an unusual Mesozoic OAE characterized by repeated carbon cycle perturbations and anoxic episodes, which extent (regional vs global) is currently not well-understood. The climax of OAE 1b is centered around the Kilian – Paquier interval, with this latter sub-event being the most geographically extended and pronounced stratigraphic interval. Nevertheless, numerous studies on OAE 1b have only focused on high-precision investigations of the Kilian and/or Paquier levels themselves, leaving vast uncertainties about the environmental changes and their drivers during the entire OAE 1b cluster. As such, it is unclear how the mechanisms leading to the formation of these sub-events differ from background environmental changes and if their occurrences are linked to unique or recurring perturbations. We have performed a high-resolution multi-proxy analysis of the Briers section, a well-exposed section in the Blue Marls Formation of the SE France Vocontian Basin, continuously covering the Kilian – Paquier interval. The Kilian and Paquier levels are characterized by higher total organic carbon (TOC) values and a substantial increase in the amount of marine organic matter compared to the background deposits, which are comprised of only continental organic matter. Hence, the transient increases in TOC values associated with the Kilian and Paquier levels are most likely the result of short-lived events of increased marine primary productivity and organic matter preservation. A high-resolution bulk carbonate and organic matter carbon isotope record shows that, apart from the Paquier level, all the fluctuations observed in the carbonate carbon isotope ratios are also mirrored in the organic matter record, although with higher amplitudes. This discrepancy in amplitude can be resolved by correcting the bulk organic matter carbon isotope record for fluctuations in the type of organic matter, demonstrating that both oceanic and atmospheric reservoirs were affected by similar carbon isotope fluctuations, which were hence of global extent. The abnormal bulk organic matter carbon isotope record of the Paquier level further confirms the large geographical expansion of unusual organic matter production and/or accumulation during this peculiar event. We suggest that Milankovitch-paced (long eccentricity) changes in monsoonal activity and their effect on the accumulation of organic matter in continental wetlands best explains the rhythmic change in the global carbon isotope record across the OAE 1b interval. Furthermore, thallium isotope analyses indicate that the Paquier level is the only OAE 1b sub-event that is associated with global

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deoxygenation, whereas, in agreement with previously published study, mercury content indicate that only the Kilian sub-event is associated with global volcanism. High-resolution strontium isotope data reveal that gradually enhanced continental weathering occurred under a warmer climate following this volcanism. Global deoxygenation during the Paquier event occurred therefore only under the combined influences of a long-term increase in weathering rates in a warmer climate and short-term orbital modulation.

Keywords: Aptian, Albian, Anoxia, Tethys, OAE 1b