Changes in carbon cycling across the OAE 1b cluster (Aptian-Albian transition): New insights from the Vocontian Basin

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The Aptian-Albian transition is marked by the unfolding of the Oceanic Anoxic Event (OAE) 1b, a protracted environmental perturbation characterized by occurrence of several sub-events out of which the Kilian and Paquier events are the most well-known ones. So far, the conditions leading to the unfolding of the OAE 1b cluster and its sub-events, as well as their consequences, remain elusive as most of the studies have focussed on the Paquier level, thereby precluding a broader perspective on this event. In this study, we focus on an extended stratigraphic interval from the Brier section (Vocontian Basin, SE France) spanning the Kilian to Paquier levels interval. Our goal is to better understand the processes having led to organic matter (OM) accumulation across this stratigraphic interval as well as to constrain the exogenic carbon cycle framework in which these changes are inscribed. For this purpose, we have performed high-resolution bulk-rock pyrolysis analyses, paired stable carbon isotope measurements on both bulk carbonate and organic matter, and handheld XRF analyses.

Measured total organic contents (TOC) average 1.5% with peaks reaching 3% in the Paquier level. Apart for the Kilian, Paquier and HN 12 levels, which are characterized by the dominance of marine organic matter, the remainder of the studied interval is characterized by the accumulation of continental organic matter. Moreover, there is a good correlation between changes in the long-term TOC content and detrital input as inferred from changes in element concentration such as aluminium and thorium. A preservation model therefore best explains the long-term OM accumulation across the studied interval. Sporadic episodes of enhanced marine OM productivity account only for the deposition of the Kilian, Paquier and HN 12 levels.

Carbon isotope analyses shows that the Kilian and Paquier levels are both associated with a 0.5 – 1‰ negative excursion in the bulk carbonate record. In the bulk OM record, the C-isotope signal is however different. The Kilian level is hence characterized by a 3‰ negative excursion whereas the Paquier level is characterized by a 4‰ positive excursion. This discrepancy is due to the fact that the bulk OM C-isotope record is strongly influenced by the mixing of different types of organic matter. By applying a correction factor tacking into account the type of organic matter, as characterized by the pyrolysis analyses, both OM and carbonate C-isotope records can be reconciled.

Importantly, our paired C-isotope record shows that in between the Kilian and Paquier levels, two
others episodes of similar negative C-isotope excursion occur, with an abrupt onset and a total amplitude of 1‰. These episodes likely correspond to the Monte Nerone level observed in Italy. The unfolding of OAE 1b cluster is thus tightly tied to a very dynamic exogenic carbon cycling, characterized by repeated injections into the oceans-atmosphere of light isotopic carbon, potentially similar to the Early Eocene scenario.