Synchrony of carbon cycle fluctuations, volcanism and orbital forcing during the Early Cretaceous

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Abstract

Episodes of Environmental Change (EECs) were times of accelerated hydrological cycle that punctuated the Early Cretaceous. Uncertainties in the geologic time scales however preclude full understanding of the onset, unfolding, and termination of EECs. Here, we reanalyze the hemipelagic sedimentary series from France and Spain from the Valanginian to the Barremian to provide a comprehensive and accurate time scale of the Valanginian–Barremian interval based on the stable 405-kyr eccentricity cycle. According to our astrochonologic framework, the Weissert Event started 134.56 ± 0.19 Ma, in perfect synchronicity with the peak of volcanic activity of the Paraná-Etendeka Large Igneous Province. On average, EECs show a pacing of 2.40 Myr from the Valanginian to the Barremian, in phase with detrital supply and carbon isotope variations from marine carbonates. Long eccentricity cycles were hence key parameters in the regulation of climate and carbon cycles in the Early Cretaceous through changes in the detrital and nutrient supply, oceanic fertilization, organic carbon storage and global sea level. A long obliquity forcing, at 1.2 Myr, is also observed through the studied interval in both the detrital and carbon-isotope ratios series, allowing the identification of long isotopic stages in the Early Cretaceous. Our study highlights a positive correlation between continental runoff and sea-level change, suggesting that glacio-eustasy was the main driver of global-sea level fluctuations during the Early Cretaceous. We also demonstrate that the humid peak related to the Weissert Event is driven by the pacing of the long orbital cycles despite the emplacement of the Paraná-Etendeka province. Nevertheless, in comparison to other EECs of the Valanginian–Barremian, the Weissert Event appears as

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a singularly long event with stronger impact on climate and marine ecosystems compared to other EECs. We posit that this is a consequence of the concomitant effect of the emplacement of the Paraná-Etendeka province and the long orbital cycles.

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