

# SYNCHRONISING THE TIMING OF CARBON CYCLE, VOLCANISM AND PACING OF THE EARTH'S ORBIT DURING THE EARLY CRETACEOUS

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The Weissert Event (mid-Valanginian), the Faraoni Event (latest Hauterivian), the mid-Barremian and Taxy events in the Barremian are referred to as Episodes of Environmental Change (EECs) (Föllmi 2012). These episodes are associated with accelerated hydrolysis cycles, increased levels of continental weathering and temperature-triggered fertilization of water masses. Other events were recognized in the Berriasian to Barremian, suggesting that these events punctuated the Early Cretaceous (Kujau et al. 2013; Charbonnier et al. 2016; Martinez 2018; Martinez et al. 2020). Uncertainties in the geological time scales, however, preclude the full understanding of the onset, unfolding and termination of EECs. Here, we analyze the amplitude modulation of precession cycles recorded in two Hauterivian sedimentary series in France and Spain to provide a comprehensive and accurate time scale of the Valanginian–Barremian interval based on the stable

405-kyr eccentricity cycle. The new time scale proposed here significantly differs from the Geologic Time Scale 2020 (GTS 2020) (Gradstein et al. 2021). According to our astrochronological framework, the Weissert Event started at  $134.56 \pm 0.18$  Ma, in perfect synchronicity with the peak of volcanic activity of the Paraná-Etendeka Large Igneous Province. The above-mentioned EECs are within a pacing of 2.40 myr of the detrital supply and carbon isotope variations recorded in bulk rock and belemnite rostra. Hence, long eccentricity cycles were key parameters in the regulation of climate and carbon cycles during the Early Cretaceous through changes in the detrital and nutrient supply, oceanic fertilization, organic carbon storage and global sea level. We also demonstrate that the humid peak related to the Weissert Event is driven by the pacing of the long orbital cycles, in spite of the emplacement of the Paraná-Etendeka province. Nevertheless, in comparison to other EECs of the Valanginian–Barremian, the Weissert Event appears to be a singularly long event with profound impact on climate and marine ecosystems. 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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