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Astrochronology of the Valanginian Stage (Early Cretaceous) : implications for the origin of the Weissert Event

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Due to the scarcity of available radioisotopic ages in the Lower Cretaceous, the Geologic Time Scale presents uncertainties that impact palaeoceanographic and palaeoclimatic reconstructions. Particularly, the chronological relationship between the Mid-Valanginian carbon-isotope excursion (namely the 'Weissert Event') and the activity of the Paraná-Etendeka Large Igneous Province is debated. To better constrain this relationship, an astrochronology of the Valanginian Stage is proposed based on high-resolution gamma-ray spectrometry measurements performed on five biostratigraphically well-constrained sections throughout the Vocontian Basin (SE France).

The Valanginian sediments of the Vocontian Basin are composed of decimetric hemipelagic marl-limestone alternations. These lithologic cycles are attributed to orbital forcing because marls and limestones display significant differences within clay mineralogy, geochemistry and faunal assemblages and these marl-limestone alternations are correlated throughout the Western Tethys and the Atlantic Ocean. Among the analyzed sections, Vergol (GSSP candidate for the Berriasian-Valanginian boundary), La Charce (GSSP candidate for the Valanginian-Hauterivian boundary) and Angles (Valanginian Hypostratotype) are standard sections for the Valanginian Stage since all ammonite zones and subzones are precisely identified and bounded.

Spectral analyses were performed using the multi-taper method and amplitude spectrograms on the gamma-ray signals. The comparison between sedimentary frequency ratios derived from the spectral analyses and orbital frequency ratios calculated from astronomical solutions allows the identification of a pervasive dominance of the precession and the 405 kyr-eccentricity cycles throughout the Valanginian Stage. A duration of 5.1 myr is proposed for the Valanginian Stage on the base of the recognition of the 405 kyr-eccentricity cycles. This duration is in agreement with the orbital calibration proposed from δ^{13}C measurements in the Maiolica Formation (Central Italy).

By anchoring this proposed astrochronology with available radioisotopic ages for the Berriasian-Hauterivian interval, it appears that the Paraná-Etendeka activity started $\sim$2 myr after the onset of the Weissert Event and therefore can not have induced the carbon-isotope excursion. Instead, following Westermann et al. (2010), we propose that continental carbon organic storage accompanied by carbonate-platform drownings are responsible for the first major carbon-isotope shift of the Cretaceous.

Bibliography :

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