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Cyclostratigraphy of the Aptian-Albian transition in southern Tunisia (Southern Tethys): sequence stratigraphy and geochronologic implications

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The Aptian-Albian time interval (Early Cretaceous) was a period of dramatic global changes such as sea-level rise, oceanic anoxia, intensified carbon cycling, climatic warming, biotic events, significant evolutionary change in terrestrial life, and increased ocean crust production. However, a clear understanding of these events and their relationships is seriously hampered by a poorly defined Aptian-Albian chronology. Astrochronology is known to be a powerful tool in measuring time throughout deep Earth history. It provides a very high-resolution chronological framework and allows quantifying the rate of geologic events over a short timescale. So far, cyclostratigraphic studies through the Aptian and Albian stages mostly focused on the Northern Tethys margins (Italian sections and boreholes).

Many studies showed that shallow-water carbonates can carry evidences of orbital control on the sedimentation (carbonate platform strata). In southern Tunisia (southern Tethys), we focus on the Dkhilet Toujene record and we provide a sedimentological analysis, which places our record into a shallow carbonate platform domain (peritidal-supratidal to open lagoon). We generated high-resolution magnetic susceptibility and carbonate content records (~4 cm sampling interval) to track potential Milankovitch cycles across the Aptian-Albian boundary, through a collection of 1022 samples. Additional geochemical analysis (XRF analysis) allowed us to infer that the magnetic signal is likely related to terrigenous inputs.

First, we show that the vertical stacking of depositional strata makes it possible to visualize elementary cycles and grouping them into bundles and super bundles. This hierarchy of cycles is forced by high-frequency sea-level variations which are tied to the Earth's astronomical parameters. Such an orbital forcing is suggested by the hierarchic cyclic organization (4 to 6 elementary cycles (precession cycles) form a bundle (short eccentricity cycle), while 3 to 5 bundles form a super bundle (long eccentricity cycle).

Second, we combined different spectral analysis and statistical techniques on the MS and %$CaCO_3$ signals, such as the Continuous Wavelet Transform (CWT), Evolutive Harmonic Analysis (EHA), Multitaper method (MTM) to fit the optimal astronomical model. Modeling of the sediment accumulation rate (SAR) has been performed using multiple techniques such as the evolutionary Correlation Coefficient (eCOCO), Average Spectral Misfit (ASM), and evolutionary Time-Optimization (eTimeOpt). These analyses confirmed a pervasive expression of the long orbital eccentricity and the short orbital eccentricity cycles (E405-kyr and e100 kyr cycles respectively). The combination of these results allowed us to establish an astronomical timescale (ATS) for the studied interval at Dkhilet Toujene locality as follow: ~6 long eccentricity cycles (E405) were counted to provide a duration estimate of ~2.4 Myr and an average SAR of 1.87 cm/kyr. This enhanced chronostratigraphic setting permits to a global chronostratigraphic correlation of our inferred depositional cycles with the Tethyan 3rd order stratigraphic sequences of Haq et al. (2014).