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Magnitudes, rates and periodicities of early Late Cretaceous sea-level changes: evidence from sedimentary basin in Europe, northern Africa and the Middle East

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Despite the mid-Cretaceous super-greenhouse with generally rising and high sea-level stands, the Cenomanian–Turonian interval (C–T, early Late Cretaceous, ∼100–90 ma) was repeatedly punctuated by large and rapid sea-level drops, the reasons of which are still poorly understood. In order to test the isochrony of those early Late Cretaceous sea-level changes, an interplate sequence stratigraphic study of selected Cenomanian–Turonian basins on different tectonic plates (Europe, northern Africa, Middle East) has been conducted. Well exposed shelf sections have stratigraphically been calibrated and correlated by means of integrated approaches, especially high-resolution ammonoid biostratigraphy, carbon stable isotopes and cyclostratigraphy. In combination with analyses of (bio-)facies and stratal architectures (such as on-/offlap geometries or incision at sequence boundaries), a precise correlation of unconformities and an assessment of the magnitudes of sea-level changes involved in their formation has been possible. High-resolution orbital time-scales provide the possibilities to elucidate the rates of sea-level change.

The study shows that C–T sea-level changes have in fact been strictly time-equivalent and iso-directional on different tectonic plates. Major sea-level falls, resulting in the development of depositional sequence (i.e. 3rd-order) bounding unconformities occurred in the latest Albian, the mid- and latest Early Cenomanian, the late Middle and mid-Late Cenomanian, the Lower–Middle Turonian boundary interval, the Middle Turonian as well as the early, mid-and late Late Turonian. Especially the sea-level falls were of high-magnitude and short duration (tens of metres in less than 100 kyr). The resulting rates of sea-level change are in the order of 150–1000 m/myr and can only be explained by glacio-eustasy (or a yet unknown process). The study also showed a regular temporal recurrence of unconformities and suggests that early Late Cretaceous 3rd-order sequences developed by low-frequency modulations of the Milankovitch oscillations, i.e. the nodes of obliquity cycle (ca. 1.2 myr), regularly amplified by the ca. 2.4 myr minima of Earth' eccentricity. High-frequency sequences, controlled by the ca. 400-kyr-long eccentricity cycle, are components of the depositional sequences. The study thus perfectly integrates the hitherto conflicting approaches of high-frequency and depositional sequence stratigraphy.