CYCLOSTRATIGRAPHIC ANALYSIS OF THE LOWER CRETACEOUS TERRESTRIAL SONGLIAO BASIN, NORTHEAST CHINA

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Recent exploration of the Songliao Basin, NE China, which is one of the largest and longlived Cretaceous continental basins in the world with a continuous 10-km-thick sequence of strata, provides new opportunities to study terrestrial climate change and to improve the Early Cretaceous time scale. Understanding the evolution of the basin, including the climatic and environmental changes that affected sediment deposition, is key to identifying the forces that led to enhanced carbon burial and preservation, leading to today's oil and gas reserves in the basin. In this study, we conduct cyclostratigraphic analysis on natural gamma-ray logs from extended boreholes in the Songliao Basin. The target is the Lower Cretaceous Shahezi Formation (K1S), a 836-m-thick succession with black and dark grey mudstone, siltstone, fine grained sandstone, gravel-bearing sandstone and conglomerate, together with meter-scale black coal units distributed throughout the upper part of the formation. The mudstones have the highest gamma-ray values and the conglomerates the lowest gamma-ray values. Time series analysis of the gamma-ray logs from selected boreholes reveals power spectra that are consistent with Earth's astronomical frequencies of precession, obliquity and orbital eccentricity, providing strong evidence for astronomically driven climate change. The results also indicate that black coal coincides with short eccentricity minima that exceed a threshold. We conclude that the age of K1S is from early Valanginian to late Hauterivian with a duration of approximately 11 million years by calculating cycle number and matching with the La2004 theoretical astronomical model. The formation may also reflect the well-known transient cooling Weissert Event in the mid-Valanginian as evidenced by marine glendonites at Svalbard Island. The cyclic evolution of the formation's lithology indicates a paleo-lake and surrounding environment that expanded and contracted repeatedly. Astronomical forcing influenced paleo-lake level: climate was warm and humid with high orbital eccentricity, and cold and dry with low orbital eccentricity. Sedimentation rates significantly decreased from lower to upper K1S as the basin evolved from synrift to post-rift conditions.