

Astrochronology and heterogeneous oceanic oxygenation in the Ediacaran Period

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The Ediacaran Period is currently constrained by discontinuous and low-resolution temporal frameworks, generating ongoing controversies regarding the tempo for oceanic oxygenation and organism evolution. This study highlights Milanković cycles and carbon isotopic profile throughout the Doushantuo Formation in South China and establishes a continuous astrochronology from 635.11 ± 0.57 Ma to 568.34 ± 0.57 Ma. The EN3/DOUNCE of South China exhibits a pronounced temporal heterogeneity contrasting with the Shuram excursion recorded elsewhere, marked by its earlier onset (no later than 584.21 ± 0.57 Ma), prolonged duration (exceeding 12.2 Myr), and a more gradual triggering process (reaching the nadir form 0‰ around 4.23 Myr). This distinction likely reflects the temporally heterogeneous oxygenation process of the Ediacaran ocean. Future research on the trigger mechanisms and biogeochemical perturbations of the EN3/DOUNCE/Shuram excursion should account for the spatiotemporal heterogeneity in δ13C variations. Moreover, the quantitative reconstruction of sea level changes in South China, based on the lag-1 autocorrelation coefficient model, and significant lithological changes throughout the EN3/DOUNCE interval suggest that the δ13Ccarb profile in South China during the EN3/DOUNCE interval correlates with a "M-shaped" second-order sea-level oscillation. In conclusion, the established ~66.8-Myr high-resolution astrochronology contributes to the understanding of the evolutionary tempo of Ediacaran macroscopic organisms and oceanic environment. The global oceanic environment throughout the Ediacaran Period was probably influenced by the global/local sea-level oscillations and differential diffusion of oxidants in water bodies, appear more intricate than previously recognized.

