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Periodicity of stromatolite lamination revealed by high-resolution ^{14}C stratigraphy

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Stromatolites are laminated organo-sedimentary structures that have been preserved in sedimentary records since at least 3.4 Ga and serve as significant paleoenvironmental archives [1]. These structures demonstrate considerable diversity in their morphology, internal structure, composition, and depositional environments, both in the present and in the fossil record. The distinctive lamination of stromatolites is assumed to be controlled by the combined influence of biotic factors (e.g., microbial activity) and abiotic factors (e.g., climate), and, on longer time scales, tectonic factors such as sediment supply, diagenetic overprinting, or subsidence [2]. Nevertheless, the exact timescales and drivers of stromatolite growth remain poorly constrained, particularly the relative influence of biotic and abiotic factors on their biomineralization. Can stromatolite lamination serve as a reliable archive for tracing periodic phenomena and reconstructing past environmental conditions? In this study, we present the first high-resolution ^{14}C-based chronostratigraphies for three Holocene stromatolites from contrasting environments. Our data reveal not only constant and exceptionally low accretion rates but also remarkable lamination periodicity, which is independent of depositional conditions. Frequency analysis of laminar records suggests that orbital climate control of laminae formation is attributable to either the 22-year solar Hale cycle or the 18.6-year lunar node cycle. It is well established that both of these phenomena influence global climate [3], [4]. This work demonstrates that the lamination of stromatolites, despite exhibiting local variations in the context of diagenetic alteration, may provide a robust signature for high-resolution chronostratigraphy and orbital forcing of climate, offering a unique opportunity to trace past environmental conditions in response to periodic phenomena and to reconstruct Earth's geochemical cycles.

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