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Redox Shifts in Ediacaran Lacustrine Basins Revealed by Biomarkers and Carbon Isotopes

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The Ediacaran Period (635–539 Ma) was marked by profound reorganizations of aquatic redox conditions and microbial ecosystems, driven by changes in basin connectivity, climate, and nutrient availability, yet lacustrine systems remain comparatively understudied relative to marine basins (Lyons et al., 2014). Here, we integrate bulk geochemistry (TOC, TN, $\delta^{13}C_{org}$), *n*-alkane distributions, and GDGT-based lipid proxies (isoprenoidal and branched GDGTs) to reconstruct redox dynamics and microbial ecosystem evolution in two late Ediacaran lacustrine basins developed under contrasting paleogeographic and climatic regimes: subtropical, stromatolite-rich lake systems in Morocco (Tifernine), and glacially influenced lakes from the Avalon Zone of Newfoundland (Bonavista Peninsula and northern Fortune Bay), Canada.

The Tifernine succession is characterized by very low TOC and TN (<0.05 wt%) and δ^{13}Corg values between –24.4‰ and –28.2‰. These values are consistent with biologically derived organic matter dominated by aquatic microbial sources and limited preservation in shallow lacustrine carbonates (Meyers, 1997). *n*-Alkane distributions are consistent with predominantly aquatic microbial and benthic photoautotrophic microorganisms. The absence of branched GDGTs suggests minimal terrestrial soil input. Aquatic isoprenoid GDGT are low, and they show no methanogenesis or methanotrophy-related signatures, indicating weak water-column stratification, low nutrient availability, and largely oxygenated lake waters.

In contrast, glacial lacustrine deposits of the Bonavista Peninsula display extremely low TOC (0.02–0.04 wt%) and TN, with δ^{13}Corg values around –28.5 to –29.3‰, consistent with low organic matter accumulation in cold, glacially influenced lake environments. In younger lacustrine successions from northern Fortune Bay, modest TOC increases and relatively higher isoprenoidal GDGT abundances point to increasing marine influence and evolving depositional conditions. Together, these records reveal that late Ediacaran lacustrine basins exhibited highly variable redox states controlled by climate, basin connectivity, and nutrient supply.

References:

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