Extreme Heterotrophy after Snowball Earth

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The Neoproterozoic Snowball Earth events (0.72–0.64 Ga) represent the most severe climatic pertubations in all of Earth's history. The termination of these global glaciations is marked in the rock record by several meters of carbonates that overlay the glacial diamictites and which were deposited as a consequence of strongly elevated pCO_2. Yet their dolostone lithology remains enigmatic since dolomite precipitation is kinetically inhibited at normal marine temperatures and salinities. Over the last decades, lab and field experiments have revealed that certain microbes, in particular heterotrophs can play a role in nucleating Mg-rich carbonates on their cell walls and induce the precipitation of dolomite (Sánchez-Román et al. [2] and references therein).

We here report on a newly characterized pentacyclic terpenoid biomarker observed in exceptional abundances in a Marinoan cap dolostone, whose concentrations dwindle at the dolostone-limestone boundary. The molecule occurs sporadically throughout the last 800 Myr of Earth history independent of lithology (271 samples), with a prevalence in warm periods and environments. A statistically relevant correlation between this biomarker and the ordering of compound-specific stable carbon isotopes in alkanes and phytyl-derived hydrocarbons reveals a mechanistic connection to severe heterotrophic reworking of biomass. Our results provide a new tool to indentify heterotrophic reworking in ancient depositional basins and highlight the role of biology in the exceptionally rapid deposition (estimated at $\leq 10^4$ years [3]) of post-glacial cap dolostones.

[1] Van Tuyl, F. M., (1914) Iowa Geol. Surv. Annu. Rep., 25–251
[2] Sánchez-Román, M. et al., (2011) Chem. Geol. 281, 143–150
[3] Shields, G. A., (2005) Terra Nov. 17, 299–310