INTENSE HETEROTROPHY BOOSTED THE DEPOSITION OF POST-SNOWBALL EARTH CAP DOLOSTONES

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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 (Hofmann *et al.* 1998). The termination of these global glaciations is marked in the rock record by several meters of dolomitic carbonates (i.e. cap dolostones) that drape the glacial diamictites and which were deposited as a consequence of strongly elevated pCO_2. Yet their mineralogy remains enigmatic since dolomite precipitation is kinetically inhibited at normal marine temperatures and salinities. The 'dolomite problem' has occupied geologists already well over a century (Van Tuyl 1914)—e.g. despite Mg^{2+} super-saturation, dolomite does not form in the modern ocean. 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 (Vasconcelos *et al.* 1995; Van Lith *et al.* 2003; Sánchez-Román *et al.* 2011).

We here report on a newly characterized (by MS and NMR: see abstract by Wolkenstein *et al.* 2017; this abstract volume) pentacyclic terpenoid biomarker observed in exceptional abundances in Marinoan cap dolostones, whose concentrations dwindle at the dolostone-limestone boundary. The component occurs throughout the last 800 Myr of Earth history independent of lithology (271 samples), with a prevalence in warm periods and environments. Statistically relevant parallels to compound-specific stable carbon isotope systematics reveal a mechanistic connection to severe heterotrophic reworking of biomass. Our results highlight the role of biology in precipitating Mg-carbonates, and provide a new biological explanation for both the mineralogy and the exceptionally rapid deposition (estimated at $\leq 10^4$ years (Shields 2005) of post-glacial cap dolostones.

Hoffman, P.F. *et al.,* (1998) A Neoproterozoic Snowball Earth. *Science*. 281, 1342–1346
Sánchez-Román, M. *et al.*, (2011) Aerobic biomineralization of Mg-rich carbonates: Implications for natural environments. *Chem. Geol.* 281, 143–150
Shields, G. A., (2005) Neoproterozoic cap carbonates: A critical appraisal of existing models and the plumeworld hypothesis. *Terra Nov.* 17, 299–310
Van Lith, Y. *et al.,*(2003) Microbial fossilization in carbonate sediments: a result of the bacterial surface involvement in dolomite precipitation. *Sedimentology*. 50, 237–245
Van Tuyl, F. M., (1914) The origin of dolomite. *Iowa Geol. Surv. Annu. Rep.*, 25–251
Vasconcelos, C. *et al.*, (1995) Microbial mediation as a possible mechanism for natural dolomite formation at low temperatures. *Nature*. 377, pp. 220–222

Wolkenstein, K. *et al.,* (2017) Structural elucidation of a novel triterpane from the Neoproterozoic era using microcryoprobe NMR. *IMOG book of abstracts*