Can you reconstruct paleoclimate in carbonate rocks before the advent of biomineralization?

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Paleo-temperature estimates utilizing clumped isotopic (Δ_{47}) analyses of ancient rocks are different than analyses of ancient fossils because of the multitude of processes required to lithify carbonate sediment into a rock. Both fossils and rocks can be subjected to the same physical and chemical microanalyses to evaluate preservation and the role of dissolution and reprecipitation. Both suites can be selected from shallowly buried sites with independent constraints on burial and thermal history. Yet, shell materials will always provide an additional constraint from the physical preservation and lack of porosity to be filled in by later cements. The question becomes whether carbonate rocks are a useful tool to reconstruct paleoclimate when there is no other option, before the advent of biomineralization. Does diagenesis, lithification or even solid state reordering completely erase differences in the primary signal? We will present three case studies from the Cambro-Ordovician period, the Ediacaran of Oman and the Cryogenian of Svalbard than interrogate a range of materials to assess carbonate rocks as a tool to reconstruct paleoclimate before there were fossils. In the Cambro-Ordovician, we find the least cemented carbonate muds and finest mudstones are both closest in temperature to the co-occurring fossil temperatures. Mudstones also show less scatter than heterogeneous carbonate rocks in more ancient successions. Importantly, even among carbonate mudstones, we find no evidence for long-term evolution of the $\delta^{18}O$ of seawater from its ice-free Cenozoic mean of -1.4‰.