Enhanced fossil whale bone preservation by abiotic ferromanganese stromatolite and frutexite growth in the hadal Diamantina Trench

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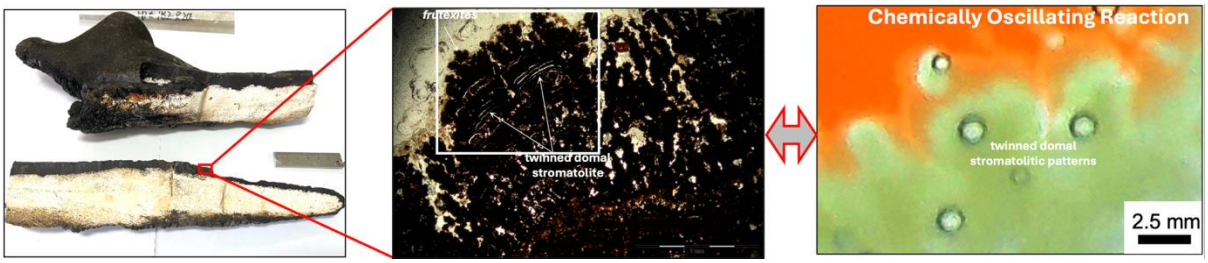
Abstract

In the geological record, stromatolites are usually presumed to be biological in origin, whereas the origin of frutexites remains debated as possibly biological or abiotic. However, as some stromatolites in underground botryoidal cavities or in abyssal ferromanganese nodules form in the absence of visible light, phototrophy may not be required for stromatolites to grow. Here we show that stromatolites and frutexites in ferromanganese crust occur in the deepest abyssal zone and in the hadal zone of the Diamantina Trench, Indian Ocean. The studied ferromanganese crusts grow onto decayed whale bones collected from the recently discovered Diamantina whale necropolis and may help to preserve the bones. They have an irregular botryoidal habit at their surface, while in cross-section, stromatolitic ferromanganese oxide morphologies are displayed as domal, turbinate, columnar, anastomosed, multifurcate, and columnar-branching patterns (see figure). These patterns are self-similar with those of ferromanganese nodules and also akin to those produced by new chemically oscillating reactions using manganese compounds with variable oxidation states (see figure). First-order comparisons of chemical compositions between hadal ferromanganese crusts with ferromanganese nodules and chemically oscillating reactions also reveal striking similarities. Based on similarities across the patterns and substances of these objects, an abiotic reaction-diffusion model is considered plausible for the formation of hadal ferromanganese crusts. If correct, this model also predicts that biomass from the deceased whale and/or opportunistic microbial decomposers provided

key fuel for the underlying chemical oscillations. Hence, this work provides a new basis towards understanding the origin of stromatolites and frutexites in the geological record and help to understand the mechanism of bone preservation in the deep-sea.