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Exploring Mechanisms of Microbialite Texture Formation through mapping in situ $CaCO_3$ precipitation and Microbial Cell Position

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Microbialites—macroscopic organosedimentary structures (rocks) formed by interaction between microbial communities and detrital or chemical sediments— represent the oldest evidence of life on Earth and are the most conspicuous fossils during the Precambrian. Microbialites are recognizable as macroscopic manifestations of microbial activity because of their sedimentary textures, which consist of visible remnants of primary mineralogy and cemented channel architecture (which presumably hosted a microbial community). Despite the importance of texture in interpretation of these trace fossils, little is known about origins of texture, its evolution, and its dependence on local biofabrics and microbial processes. Previous work in our group addressed this issue by characterizing texture within incipient $CaCO_3$ microbialites from Little Hot Creek (LHC), a hot spring system in eastern California, where actively lithifying microbial mats have a shrub-like texture strikingly similar to certain Precambrian microbialites, providing a unique opportunity to examine modern mat lithification in-situ with relevance to ancient equivalents. We used fluorescently labelled embedded coring (FLEC) to preserve minerals, microbial biofabrics, and channel architecture in life position on sub-mm scales. This addressed a methodological gap —allowing creation of thin sections of partially lithified material comparable to thin sections of their ancient counterparts—and established the technical foundation for the experiment described here. We aim to map loci of $CaCO_3$ precipitation within incipient LCH microbialites over a 24 hour $H^{13}CO_3$ spike incubation experiment. LHC microbialite cores were incubated with $H^{13}CO_3$ spike for 24 hours in sunlit and dark conditions, and thin sections created using FLEC. We used Raman spectroscopy to map ^{13}C incorporated into $CaCO_3$ crystal lattices, and epifluorescence microscopy was used to correlate $Ca^{13}CO_3$ with biofabrics found at crystal surfaces. This experiment tests whether different spatial relationships between biofabric and crystal surfaces produces heterogeneous calcite crystal morphologies. By combining epifluorescence and petrographic microscopy with $H^{13}CO_3$ spike incubation, we characterize relationships between minerals, microbes, and fluid-filled channels with the highest possible detail while mapping micron-scale loci of $CaCO_3$ precipitation. This study helps us better understand origin of similar microbialite textures preserved in the sedimentary record, and for the first time, clarifies mechanisms leading to formation of specific microbialite textures.