Throw out the Binary and Keep the Multiple Working Hypotheses for Microbial Influences on Stromatolites

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A spectrum of physical and microbial influences

Aragonite crystals growing upward to form domes

Complicated columns with multiple growth directions and textures

Complicated structures composed of calcite cements and organics

Rolled up laminae composed of organic inclusions in calcite

"Is this structure a stromatolite influenced by biology?" should have a binary answer. Either it was or was not. However, in this case, the question sets the expectation of a binary answer, not the nature of biological influences on stromatolite morphology and texture. In reality, stromatolites (as morphological structures) have a continuum of biological influences from none to being fully templated by microbial processes. I propose that the questions we ask influence the answers we find, and some questions are poorly framed for the processes influencing stromatolites. In other words, the possible extent and preservation styles of biological influences should shape the questions we ask about stromatolites as biosignatures. When we ask about possible influences and how they may or may not be preserved, we end up with multiple working hypotheses that can be compared to observations to provide a landscape of reasonable interpretations, including both biotic and abiotic processes. Sometimes the interpretation landscape requires a biological influence, for example organic laminae with complex geometries captured in carbonate cements (lower right image). Other times, even if biology was present, the landscape allows entirely abiotic interpretations, for example the growth of aragonite crystals upward from the seafloor coated by detrital sediment (upper image). Many stromatolites reflect both abiotic and microbial influences, for example, aragonite crystal growth, organic laminae, and physical erosion (lower left image). When we are interpreting ancient structures, we will arrive at more appropriate answers if we consider landscapes of possible interpretations than if we try to force a binary decision on whether a particular structures was or was not influenced by biology.