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The role of preservation bias in the sparsity of the Precambrian thrombolite record

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Microbialite research is overwhelmingly focused on stromatolites, and thrombolites are poorly understood in comparison. This discrepancy is partly due to the relatively sparse geological record of thrombolites. Here we present the first comprehensive record of thrombolite occurrences from the Archaean to the Holocene based on published literature. We provide quantitative evidence demonstrating that thrombolites are most abundant from the Middle Cambrian to Early Ordovician, and we also document a relative increase in documented cases from the Middle Mississippian, earliest Triassic and Upper Jurassic. One of the most notable features of the record is the vanishingly small number of thrombolite case studies before the late Ediacaran. In this study, we investigate the hypothesis that the sparsity of this record is affected by poor preservation of thrombolites, using a case study of a middle Tonian reef from the Yukon, Canada. The Reefal assemblage is a progradational platformal reef built by stromatolites and thrombolites at variable stages of preservation, with mineralogy defined by primary microcrystalline calcite, texture-retentive microcrystalline replacement dolomite, and texture-destructive planar to sub-planar replacement dolomite. We find that poorly-preserved stromatolites and thrombolites have large crystal size distributions, high proportions of authigenic quartz, and wide ranges of $\delta^{13}C$, $\delta^{18}O$ and trace element concentrations. However, despite their similar mineralogical and geochemical profiles, they have different textural characteristics. In stromatolites, zones of planar-euhedral replacement dolomite and authigenic silica are less extensive and follow the overall textural grain, meaning that the rock remains recognizably laminated at the mesoscale. By contrast, in thrombolites the replacement phases overprint the primary texture, resulting in a rock that is unrecognizable as biogenic in outcrop without stratigraphic context and a complete preservational sequence. We therefore conclude that under similar diagenetic and burial conditions, there is a preservational bias against thrombolites in the Reefal assemblage. More broadly, the sparse geological record of ancient thrombolites may be at least partially explained by textural obliteration due to recrystallization and silicification, resulting in under-recognition in the field.