Cyanobacterial extracellular polymeric substances (EPS) control stromatolite and thrombolite formations

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Stromatolite and thrombolite are the major components of microbialite. Stromatolite is abundant in Meso- to Neoproteozoic successions, while it declined in the early Paleozoic and thrombolite became dominant alternatively. The cause of this transition was previously considered to be due to the bioturbation of evolved metazoans, but recently most of thrombolites are considered to be the primary structure. Therefore, the reconsideration is necessary for the cause of microbialite transition in the early Paleozoic. However, stromatolite and thrombolite are rare in the modern environments, and moreover, there had been no report for the site where they both are formed together. Nonetheless, such example has been found recently from the tufa site in Okayama Prefecture. The present study therefore examined this site for revealing the factors controlling microbialite fabrics.

Water chemistry at the depositional sites of stromatolite and thrombolite are similar, and microelectrode measurement revealed that they both are mainly formed by photosynthesis-induced $CaCO_3$ precipitation. Confocal laser scanning microscopy observation and DNA analysis indicated that cyanobacteria colonizing the stromatolite are mostly *Phormidium* sp., and their extracellular polymeric substances possess acidic group to provide mineral nucleation sites, and resulted in the stromatolite formation. On the other hand, cyanobacteria colonizing the thrombolite are mostly *Leptolyngbya* sp., and their extracellular polymeric substances does not possess acidic group to be unsuitable for the mineral nucleation sites, and resulted in the thrombolite formation. These results indicate that chemical characteristics of extracellular polymeric substances are crucial for the formation of microbialite fabrics.

By simply applying the results above, we can hypothesize that the evolution of cyanobacteria lacking acidic extracellular polymeric substances caused the microbialite transition in the early Paleozoic. Nonetheless, further investigation is necessary for validating this hypothesis.

