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U04-19 Room:303 Time:May 25 12:00-12:15

Stromatolitic travertines formed by cyanobacterium, *Microcoleus* sp.

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Precambrian stromatolites have been investigated over one century as important records of the early biosphere, however the detailed processes have not been specified because the initial structures and chemical features were obscured due to recrystallization, deformation, and scarcity of microfossils. Investigation of physicochemical and biological processes of modern analogs for ancient stromatolites is a potential approach for interpreting such ancient stromatolite formation. Travertines, carbonate precipitates from hot spring, have common fabrics to the ancient stromatolites in terms of sub-mm order lamination and scarcity of detrital particles and preserved microbes. This study describes texture, microbial composition, and hydrodynamic settings on microbial-rich travertines at Anraku hot spring in Kagoshima Prefecture and Nagayu hot spring in Oita Prefecture.

16S rRNA phylotype analysis of both two samples revealed dominance of a filamentous cyanobacterium closely related to *Microcoleus* sp. that has a high gliding ability. Despite of similar microbial composition, the two samples differ in outer shapes and internal texture, likely depending of the difference in hydrodynamics. A microbial travertine at Anraku hot spring exhibits a conical shape of 5-30 mm in diameter and 10-50 mm in high, which was formed at sidewall of the water discharge where the 55-degree Celsius water was splashing. All peaks of the coniforms inclined 30 degrees to the south corresponding to the direction of mid-day sun light. The surface is dark-green, while the lighter-colored inner part exhibits lamination consisting of alternation of 50 to 200-micron-thick crystal layer and filamentous cyanobacterial layer. The lamination was not daily because this microbe-rich travertine grew only 5 mm during 3 months. SEM image of the surface showed that cyanobacterial filaments were randomly tangled. On the other hand, the microbial travertine at Nagayu hot spring was in a planner form developed slowly flowing (5 cm/sec) water of 35-40 degrees Celsius. Similar to the Anraku one, the surface of the mat was dark-green, but internal texture clearly showed a clear lamination consisting crystalline layers and microbe-rich layers, equally of 250 microns. Sampling throughout a day confirmed that this lamination was daily; crystalline layer was formed during nighttime and microbe-rich layer was formed during the daytime. SEM image of the surface showed extension of the filaments aligned parallel to the flow direction.

Culture experiments in a static water showed that randomly-directed gliding of cyanobacteria formed a tangle of the filaments that generated the starting points of the conical projection (Shepard and Sumner, 2010). On the other hand, such tangles were hardly formed in flowing water that aligned filaments parallel to the flow direction. For the Anraku microbial mat developed under unstable water supply, gliding of cyanobacteria was controlled by their phototactic behavior, and overall directed to the mid-day sunlight. In the Nagayu microbial travertine, the directed filaments formed biofilm during daytime and were covered with precipitated aragonite during nighttime. Thus, regular daily lamina formation resulted from competition between daytime cyanobacterial growth and nighttime inorganic precipitation. Such lamination cannot be formed in the Anraku microbial mat where the water was occasionally splashing.

Conical shaped stromatolites were abundant in Precambrian stromatolites and called *Conophyton*. This study showed that one phylotype of cyanobacteria could make different outer shapes and inner textures of the microbial travertines by reflecting from flow conditions. Building up the geomicrobiological investigation of the modern analogs may lead a new possible interpretation for the stromatolite microbiology and early biosphere.

References

Shepard, R.N. and Sumner, D.Y. (2010) Geobiology, 8, 179-190.

Keywords: stromatolite, cyanobacteria, travertine, microbial mat