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Controlling factors of microbialite textures inferred by a tufa deposit

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Microbialite is organosedimentary deposits that are formed by the interaction between life, water and mineral. It has accreted as a result of a benthic microbial community trapping and binding detrital sediment and/or forming the locus of mineral precipitation. Typical examples of microbialite are laminated stromatolite, and clotted thrombolite. In the Earth history, stromatolite appeared from about 3500 Ma, followed by its peak at 1300 Ma. At about 500 Ma, stromatolite rapidly declined, and thrombolite appeared. Although this transition is considered to reflect evolution of life and Earth environment, its detail is still not well understood. To understand the basic mechanisms forming microbialites, the geomicrobiological studies of recent samples are essential. While microbialite in modern marine environment is scarce, it is relatively common at freshwater environment as a tufa. The present study focuses on tufa for investigating the relationship between depositional structure and microbial composition. Tufa deposit usually has laminated structure resembling stromatolite. However, tufa deposit developed in Takahashi city (Okayama prefecture) exhibits both stromatolitic and thrombolitic structures by reflecting the difference of hydrodynamic condition. The chemical compositions of creek water at the sites where stromatolitic and thrombolitic tufa are depositing are almost the same, and similar to that of common tufa-depositing creek. Extracellular polymeric substances (EPS) staining observation applied for deposits surface by Conforcal Laser Scanning Microscope (CLSM) showed that the distribution patterns of phototrophs and EPS were different between stromatolitic and thrombolitic tufa. At the surface of thrombolitic tufa, coccoid cyanobacteria densely colonized to form small mounds (500 μm in diameter) and EPS located inner and marginal part of the mounds. On the other hand, at the surface of stromatolitic tufa, filamentous cyanobacteria distributed sparsely with EPS, and calcite was widely exposed. Vertical thin section observation revealed that there were large calcite crystals (500 μm in diameter) at the surface of thrombolitic tufa, and filamentous one colonized around them. Stromatolitic tufa, on the other hand, was consisted of fine grained calcite (10 μm in diameter) with filamentous cyanobacteria colonized perpendicular to the lamination. Microbial composition of both deposits was examined by 16S rRNA gene analysis. The result indicated that cyanobacteria were abundant and some strains were common between thrombolitic and stromatolitic tufa. However, the diversity of microbial population microbial population was higher in thrombolitic tufa than stromatolitic ones.

From the results above, it is inferred that the transition from stromatolite to thrombolite in $\sim$500 Ma was caused by microbial diversification and resultant EPS composition change.

Keywords: microbialite, stromatolite, thrombolite, tufa, carbonate rock