Transition of microbial communities and laminated structures in travertines: a case study in northern Sumatra, Indonesia

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Travertines, carbonate developed in calcareous and high pCO_2 hot spring. Because these often exhibit laminated structures similar with stromatolites that had been extensively developed in ocean in Archean and Proterozoic. Previous researches of the modern analogs of the ancient stromatolites have indicated that cyanobacteria played a central role to form the laminated structure in previous studies. However, this may contradict to very low oxygen concentration in Archean. To solve this paradox, we researched a travertine-bearing hot spring at Dolok Tinggi Raja in northern Sumatra, Indonesia. Here, the water of 62 degrees, high in H_2S and CO_2 discharged from the vent formed a travertine mound of ~50 m wide as a consequence of geochemical and microbial processed. The water rapidly degassed H_2S and CO_2 immediately after discharge, increased dissolved oxygen concentration and pH and $CaCO_3$ saturation index, and precipitated carbonate mineral (aragonite and calcite) along the flow passages. Responding to the change in the watery chemistry from upstream to downstream, the dominant microbes changed in order: chemical synthesis bacteria, purple sulfur bacteria, green non-sulfur bacteria, green sulfur bacteria. Although cyanobacteria were recognized in the downstream sites, they were subordinate. In the environment of high H_2S, anoxygenic photosynthesis (sulfur bacteria) can be more profitable than oxygenic photosynthesis (cyanobacteria), and takes first priority. In the places where microbial mat is developed, the travertines often form laminated structure. The travertines with sulfur bacterial mat appear the structures that resemble the daily lamination reported from Nagayu hot spring in Oita Prefecture and Pancuran Pitu in Java. Anoxygenic sulfur bacteria have a potential to form the stromatolitic lamination, and therefore, ancient stromatolites were not necessarily made by cyanobacteria.

Keywords: travertine, sulfur bacteria, stromatolite

