Textual characteristics of laminated silica hot spring deposits in Kagoshima Prefecture

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The present oxygen-rich global environment was created by the interaction between ancient microorganisms and the environment. However, many mysteries remain in the evolution of microorganisms such as cyanobacteria that first generated oxygen in ancient atmosphere. The key for understanding the origin and evolution of Precambrian organisms is in banded iron formations and stromatolites, which contain components from seawater. As for the formation process of these two laminated sediments, the involvement of microorganisms has been pointed out from stable isotope ratios, biomarkers, or organic structures that are rarely preserved in chart-like parts (e.g., Konhauser et al. 2002). However, in many cases, evidence of microbial communities and activities has been erased by several billion years of metamorphism. Therefore, the origin and periodicity of lamination of stromatolite and banded iron formation are not yet clear. In this study, we focus on hot spring silica deposits, which have a slow deposition rate and have many similarities in ancient laminated sediments. Tamatebako hot spring in Ibusuki City, Kagoshima Prefecture, is a high temperature (about 90 degrees Celsius), neutral pH, and contains many Na^{+}, Ca^{2+}, Cl^{-}. A concentration of Si is about 190 mg/L. Amorphous silica is deposited along the flow path from the vent and have developed over about 170 m^2 due to the decrease in water temperature and evaporation from upstream to downstream. Silica sediment are very hard at upstream and become brittle at downstream. The surface of the sediment is pale pink, and the cross-section of the sediment can be observed with laminations in microns to millimeters of the white and colored layers. The sediments in the uppermost part have strongly colored layers that are alternated with porous white layers. The midstream sediments have clear laminations, and transparent filamentous microorganisms can be found in the pores of the white layers. The thickness of the sediments downstreams is thin, but as the midstream sediments, transparent filamentous microorganisms exist in the pores of the white layers. The elemental mapping showed that the white layers were more silica and the colored layers contained high iron and manganese. The white layer of silica deposits was porous and there were many microorganisms, and microorganisms probably work as the nucleus in silica precipitation. On the other hand, the colored layer was dense and contained a lot of heavy metals, and there were few microorganisms. The cycle of the laminations may reflect a cyclic change in the redox state of hot spring water and/or microbial metabolism, which is likely daily.

Konouser et al., (2002) Can bacteria have formed the Precambrian banded iron formations? Geology, 30(12), 1079-1082.

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