Biogeochemistry of Silicious Biofilms in Geothermal Ecosystems

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Streamer-forming biofilm microbial communities (SBCs) are common in alkaline-chloride geothermal environments. Examples of SBCs have been reported in Yellowstone National Park (YNP), Iceland, Japan, New Zealand, and the Azores [1]. Silicification of SBCs, typical in these ecosystems, has led to investigations of potential biological mediation [2], but the in situ physiochemical parameters of SBCs are unknown [3]. Regardless, the association of microbe and mineral is likely advantageous in these extreme environments, and may be preserved in the rock record.

Based on several years of geochemical analysis, "Bison Pool" (YNP) has been chosen for a mutidisciplinary study of in situ biogeochemistry, colonization and metabolic strategies of SBCs, to constrain their physiochemical growth parameters. SBCs are common but not ubiquitous in YNP alkaline geyser basins, despite the relative geochemical homogeneity and widespread ecosystem suitability in these regions, as indicated by energetic profiling [4]. 16S rRNA and total lipid extract analyses have revealed a significant crenarchaeal component to the "Bison Pool" SBCs, in contrast to earlier studies of SBCs at Octopus Spring, a hot spring of similar geochemistry [5]. At "Bison Pool" the SBC bacterial component increases in complexity (going from 3 to 8 genera) while the archaeal component varies little (from 3 to 2 genera) in a 5°C gradient with distance from the hot spring source. These SBCs contain >90% silica, have $\delta^{13}C$ averaging -19‰ and $\delta^{15}N$ averaging +5‰. Isotopic analysis indicates that the crenarchaeal lipids are enriched in ^{13}C relative to the bacterial lipids, suggesting different C-fixation pathways for these two SBC groups. The simplicity of these communities makes the "Bison Pool" location an ideal setting for coordination of geochemical and genomic data, allowing an in depth analysis of SBC function, growth parameters, and formation criteria. This model may relate to microbe-mineral associations in ancient ecosystems.

References

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