Biomineralization of Layer Silicates and Hydrated Fe/Mn Oxides in Microbial Mats: An Electron Microscopical Study

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Abstract: The formation of layer silicates on capsuled bacterial cell walls was studied in freshwater microbial mats. The trends associated with Al, Si, Mn and Fe deposits with capsules are consistent with occurrence of layer silicates with 14, 10 and 7 Å X-ray diffraction (XRD) patterns. Scanning electron microscope and transmission electron microscope (SEM and TEM) observations of the microbial mats revealed the presence of microcolonies of rod- and coccus-shaped bacteria with layer-silicate thin films. Field measurements of pH, temperature and Eh indicated that these conditions for bacterial crystallization of layer silicates and hydrated Fe/Mn oxides in freshwaters are as follows: pH 6.3 to 7.8, 12 to 20 ° C and Eh −24 to +200 mV. Glass slides kept for 3 weeks in the beakers with natural freshwater and river sediments were coated with brown materials. These materials were identified as layer silicates and colonized bacteria formed under photosynthetic conditions. The well-developed holdfasts on Leptothrix discophora bacterial cells are mainly associated with poorly crystalline layer silicates and hydrated Fe-Mn oxides. Semiquantitative elemental analyses of holdfasts using energy-dispersive X-rays (EDX) indicated that layer-silicate crystallization covers the cell at an early stage. Iron and manganese crystallization develops at a later stage, where aluminum substitution occurs in crystal structures. Laboratory experimental results indicated that layer silicates grew from a biochemical origin, rather than from inorganic origins in freshwater. Layer-silicate formation is linked with bacteria in microbial mats.

Key Words: Bacterial Cell • Electron Microscopy • Freshwater • Hydrated Fe-Mn Oxides • Layer Silicates • Microbial Mats

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