Mn(II) oxidation processes at the surface of microbially colonized manganese deposits

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Manganese oxides widely appear in the natural settings. They are considered to be formed via inorganic and organic (mostly microbial) processes, and the latter is further divided into the direct and indirect processes. Some researchers suggested that the microbial process is several orders of magnitude faster than the inorganic process, and particularly the direct process by manganese-oxidizing bacteria has been studied in detail. In addition, the indirect process by photosynthetic microorganisms is also suggested to promote manganese oxide formation. However, most of these suggestions were derived from culture experiments and simulations, and the actual manganese oxidation processes in the natural environment are still not well understood. The present study, therefore, investigated manganese oxides formed in Sambe hot spring with geomicrobiological analyses, in order to clarify the fundamental manganese oxidation process at natural environment.
At Sambe hot spring, manganese oxides (ca. 1 cm thick crust) develop at about 150-200 m downstream from the vent site, and exhibit 1) an alternation of manganese and iron oxides (site 10.5), 2) a mixture of manganese oxide and calcite (site 11), and 3) a two-layer structure of manganese oxide and calcite (site 12.5). 16S rDNA analyses detected clones closely related with known manganese-oxidizing bacteria from all sites, and cyanobacteria from sites 11 and 12.5. To also taking the results of microelectrode measurements (pH, O_2, Mn(II), and Ca^{2+}) into account, the manganese oxides are primarily formed by microbial direct process at site 10.5, and by microbial direct and indirect processes at sites 11 and 12.5. Microelectrode measurements of formaldehyde-treated samples also demonstrated that the contribution of inorganic process was negligible.

