Metal binding by a novel biogenic chalkophore, methanobactin, and the effect on microbial activity

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One of the persistent and substantial problems in remediation of hazardous waste sites is the mobilization and uncontrollable transport of radionuclides and heavy metals from these sites to surrounding areas. Some microbially-mediated processes can at least temporarily immobilize and reduce the toxicity of these materials through dissimilatory reduction that leads to precipitation and sorption under anaerobic conditions. As such, microbial-mediated processes can limit the dispersal of these materials and thus also reduce the risk of exposure to surrounding areas. One must realize, however, that micro-organisms have effective and ubiquitous mechanisms to solubilize different metals and that non-specific binding of radionuclides and heavy metals by these biogenic metal chelators may increase their solubility, mobility, and bioavailability.

A group of cells ubiquitous in the environment, methanotrophs, require substantial amounts of copper as it is an integral part of one of their key enzymes, the particulate methane monooxygenase. These cells thus have strong mechanisms to sequester copper, and have recently been discovered to produce a novel biogenic metal chelator, what we term methanobactin. This compound, composed of 7 amino acids and two 2-thionyl-5-hydroxy-imidzole chromophores along with a pyrrolidine that confers a strong bend in the overall chain, binds copper quite well. The metal coordination environment is comprised of a dual N,S-donating system derived from the imidazolyl moieties and forms a distorted tetrahedral geometry. Of key interest here is that methanobactin will bind a variety of metals other than copper, including cadmium, cobalt, iron, mercury, manganese, zinc and uranium. Furthermore, cells expressing methanobactin can scavenge metals from other chelating agents as well as metals bound to soils. In this presentation, spectroscopic (UV/VIS and EPR) data along with the thermodynamics of metal binding by methanobactin will be discussed as well as the effects of such binding on methanotrophic activity. Finally, the diversity of methanotrophs that can express methanobactin as determined using PCR methodologies will be discussed.

Microbial diversity and geochemical heterogeneity within siliceous sinters

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The formation of sinters is of biological and geological interest because silica-rich geothermal environments are most similar to environments thought to harbor life on early Earth, and because deposits of precious minerals (ie, gold) are often associated with siliceous sinters. Recent studies have demonstrated a variety of thermophiles are found in association with siliceous sinters from a diversity of environments yet the role of microorganisms in sinter formation is not apparent.

The purpose of the study is to compare the microbial and geochemical diversity within siliceous sinter taken from spatially separate thermal springs of the Alvord Basin (OR, USA). Previous studies have indicated that the overall geochemistry of thermal waters emanating from the >200 thermal springs within the Alvord Basin is remarkably similar. As the role of microorganisms to the formation of siliceous sinter within any geothermal system is not clear, a comparison of the microbial diversity of the sinters formed within geochemically similar waters could lead to the delineation of a core group of microbes essential for sinter formation. Denaturing gradient gel electrophoresis was used to compare communities of ten different sinter samples from springs with temperatures ranging from 70-95°C. To determine sinter geochemistry, EDX and X-ray diffraction analyses were performed on the sinter samples. The springs within the Alvord Basin provide a unique opportunity to determine if functionally similar groups of microorganisms are necessary for sinter formation, and the correlation of certain microorganisms to the precipitation of precious metals.