

Microbial Biofilms: Implications for Stromatolite Morphogenesis

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At present, morphology cannot be used uniquely as evidence for microbial participation in the formation of older Proterozoic and Archean stromatolites (Grotzinger and Rothman, 1996). Insights into microbial self-organization and behavior in biofilms could provide criteria with which to evaluate "biologically influenced" morphology in the rock record. Biofilm topography (thickness, surface roughness and pore spaces) is determined by factors such as the availability of nutrients, microbial metabolic and growth rates, light intensity, the supply of the sediment and the sediment grain size. We have begun a laboratory model study of microbial self-organization in response to these factors under conditions relevant for the early Precambrian: anaerobic, low sulfate and high carbonate concentrations. Our simple model community consists of a sulfate reducing bacterium (*Desulfovibrio desulfuricans*) and an anoxygenic phototrophic bacterium. Here we characterize the biofilms formed by *D. desulfuricans* and describe their response to the micritic sediments, pre-existing surface topography and their effect on the precipitation of calcium carbonate within the biofilm.

Cm³⁺ / Eu³⁺ coprecipitation with Powellite (CaMoO₄) during HLW glass corrosion

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The irreversible immobilisation of long-living fission products and actinides from High Level Waste (HLW) glass in secondary solid solution phases, which form during corrosion, represent a considerable radionuclide retention potential. Various secondary phases form within the leached layer of the dissolving HLW glass as well as at the leached layer / electrolyte interface.

Here we focus on the adsorption and co-precipitation of Cm and Eu (as a chemical non-radioactive homologue) with Powellite (CaMoO₄) which forms at the leached layer / electrolyte interface and contains, depending on the geochemical conditions in the near-field of a nuclear waste repository, up to 70% of the dissolved Mo (Abdelouas et al., 1997).

Batch adsorption experiments indicate that Eu³⁺ forms an outer-sphere complex with powellite under these conditions. However, co-precipitation experiments in mixed-flow reactors under steady state conditions have been used to determine homogeneous partition coefficients (D) for Eu³⁺ following the empirical Doerner & Hoskins approach (Doerner & Hoskins, 1925). In case of Eu³⁺, D varies between 200 and 1000 depending on the precipitation rate (pH 5.8, 21°C and 0.1 mol/L NaCl as a background electrolyte). The solution composition was monitored with ICP-MS. The composition of the precipitate was analysed with XPS.

Time resolved laser fluorescence spectroscopy (TRLFS) has been used to unravel the actual sorption/co-precipitation mechanism during precipitation under steady state conditions as well as static batch experiments (Kimura et al., 1994). The reduction of the number of water molecules in the hydration sphere to 1-3 clearly indicates the incorporation into the precipitated solid solution. XRD measurements have been used to actually verify the formation of a solid solution between CaMoO₄ and Na_{0.5}Eu_{0.5}MoO₄ during precipitation from aqueous solution.

Clearly, partition coefficients derived from well controlled experiments combined with spectroscopically identified sorption mechanisms provide reliable baseline data for performance assessment procedures.

References

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