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Microbial geoengineering: Acid rock drainage biofilms, metals and Mn oxyhydroxides

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Microbial biofilms are essentially biologically driven, geochemically reactive interfaces between solid surfaces and aqueous solution. Field investigation of acid rock drainage (ARD) associated biofilms characterizing: (1) microgeochemical gradients (pH and O_2) (2) metal fractionation, and (3) microbial communities; over both seasonal and diel timescales, indicates biofilms are highly metal reactive [1].

Results show that biofilms accumulate metals seasonally within two microbially controlled solid fractions: amorphous hydrous manganese oxide (HMO) biominerals and the organic biofilm matrix. The biofilm geochemical microenvironment, driven largely by microbial activity, dynamically impacts biofilm metal behaviour over rapid diel timescales. Metal sequestration in the biofilms is independent of water column geochemistry.

On-going research aims to characterize the linkages amongst observed biofilm geochemical gradients, microbial activity, and metal dynamics in these highly reactive interfacial structures. We are using X-ray Absorption Spectroscopy (XAS, XANES) to characterize HMO biominerals and microscopy (STMX) to identify and characterize biofilm architecture and HMO biominerals, as well as molecular biological approaches to characterize microbial strains. Our model, thus far, of biofilm biogeochemical architecture and associated impacts for metal behaviour will be presented.

References

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2.6.P02

Geochemical and mineralogical constraints on algal distribution in acidic hydrothermal environments: Pisciarelli (Naples, Italy) as a model site

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In this paper we have considered Pisciarelli (Campi Flegrei, Italy) as a model site where to understand the factors influencing the distribution of microalgae into hydrothermal environments. This hydrothermal system is liquid-dominant with very low pH values both in water and in soil; spring water has a temperature up to 92°C. In this site fumarolic fluids ensures algae high flux of chemical species (such as carbon dioxide and ammonia) indispensable for their life. At Pisciarelli, chemico-physical conditions result to be extremely variable in different sites, seasons and years. Five ecological niches have been identified on the basis of temperature, pH and fluid vents conditions. In all the sampling sites algae interact with their substrate, being covered by alteration minerals. Generally, they act as nucleation site for neoforming minerals, offering, in some case, an ideal substrate for the formation of a thick silica crust on their surface. Where temperatures are progressively lower and the geochemical conditions do not allow the crust building, Cyanidiales, one of the most diffused group of algae at Pisciarelli, adopt another type of "covering", hiding themselves underneath alunite-sulphate layers.