

Measurements of bacterial mat metal binding capacity in alkaline and carbonate-rich systems

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Measuring the metal binding potential and reactivity of bacterial mats is challenging in alkaline and carbonate-rich systems. Traditional methods used to measure these parameters, such as potentiometric titrations and metal adsorption pH edges, are difficult to implement due to the presence of the carbonate minerals that buffer pH and prevent assessment of surface reactivity below pH 5. Additionally, under alkaline conditions metals may form hydroxide and/or carbonate precipitates. In this study we examined the metal binding capacity of four distinct bacterial mats harvested from Fairmont Hot Springs, BC, Canada. To prevent metal precipitation, the bacterial mat concentration was varied under a constant initial cadmium (Cd) concentration of 8.89 μM and at pH 8. In addition to the intact bacterial mats, a carbonate mineral sample and two acid-treated bacterial mats were used as end-members to assess the mechanisms of reactivity in the whole system. Freundlich adsorption isotherms were used to fit metal adsorption data and compare surface reactivity amongst mats. Two mats exhibited a higher affinity for Cd compared to the mineral at metal equilibrium concentrations above 2.5 μM , while two mats had lower affinities under all experimental conditions. Generally, we found that the acid-treated mats had higher Cd adsorption capacities than the carbonate mineral. When compared to their equivalent non-acid-treated mats, only one acid-treated mat had a higher affinity for Cd. Further, we modelled whether metal adsorption in the full mats, containing microbes and carbonate mineral, could be explained by a linear combination of the observed metal uptake in the end-member experiments. Metal adsorption additivity results were mixed. Metal uptake by one hot spring mat was found to be additive, while for the other mat the additive model significantly underestimated the observed Cd accumulation. This study demonstrates the potential as well as limitations of using modified metal adsorption edges to determine the metal binding affinity and surface reactivity of natural bacteria in alkaline and carbonate-rich systems.