Microbial siderophore effects on Pb sorption and mineral nucleation

SARA SUMMERS[1]*, GELIANG SONG[2], BRUCE BUNKER[2], AND PATRICIA MAURICE[1]

[1]University of Notre Dame, Civil Engineering & Geological Sciences, Notre Dame, IN 46556, USA
ssummer1@nd.edu (* presenting author), pmaurice@nd.edu
[2]University of Notre Dame, Physics, Notre Dame, IN 46556, USA
gsong@nd.edu, bunker@nd.edu

Siderophores are low molecular weight organic ligands released by many aerobic microorganisms and plants to acquire Fe. These ligands may also bind other metals such as Pb, thus affecting Pb sorption and nucleation and growth of Pb-bearing minerals. In this study, a combination of batch experiments and XAS analysis was used to determine the effects of the trihydroxamate siderophore desferrioxamine B (DFOB) on Pb sorption to montmorillonite (mmt) clay. In the absence of DFOB, Pb sorption increased with increasing pH and decreased at higher background electrolyte ($NaClO_4$) concentrations. In some instances, Pb carbonates were detected in the sorption experiments, with nucleation perhaps enhanced by the presence of the clay. DFOB was observed to have complex pH- and ionic-strength dependent effects on Pb sorption to mmt. Ternary surface complexes were observed when both Pb and DFOB were present, under pH conditions at which Pb-DFOB complexes form in solution.

In order to explore more thoroughly Pb carbonate formation, experiments were conducted in which cerussite ($PbCO_3$) and/or hydrocerussite ($Pb_3(CO_3)_2(OH)_2$) were grown in the presence and absence of DFOB. DFOB was found to strongly affect the crystal size and habit of the Pb(hydroxy)carbonate precipitates. XAS analysis of structure is ongoing.

Bacterial Necromass as a driver of bacterial weathering

STEPHEN SUMMERS*[1,2], CHARLES S. COCKELL[3] AND ANDREW S. WHITELEY[2]

[1]Department of Planetary Science, The Open University, UK,
stemme@ceh.ac.uk (* presenting author)
[2]Molecular Microbial Ecology Laboratory, Centre for Ecology & Hydrology, UK, aswhi@ceh.ac.uk
[3]School of Physics and Astronomy, University of Edinburgh, UK,
c.s.cockell@ed.ac.uk

Background

The rock – soil interface (critical zone) is where many crucial geochemical processes occur. This region of the Earth's crust is an important source of nutrients that are required for life; however these are locked away in minerals unavailable to most biota. Recent studies have shown that bacteria can play a pivotal role in the release of these elements in a biologically available form [1, 2]. Many bacteria that show the ability to weather minerals are known to be heterotrophic [3], yet the environments that are most significant when discussing weathering are limited in organics. We have investigated the question: can heterotrophic bacteria in the critical zone use isotopically labelled bacterial necromass as a source of carbon? Plants have been shown to actively select for bacterial communities in rhizosphere by manipulating the environment and providing nutrients [4, 5], yet where does organics originate in areas known to have significant weathering but lacking in plants.

A lake site in Skorradalur, Iceland that has been shown to have significant rates of weathering at locations in some cases devoid of plants was investigated. We show that necrotic bacterial matter is a source of carbon for the organisms in the critical zone. Some of this necromass may be accounted for by fresh bacterial input during spring snowmelt.

Results and Conclusions

Stable isotope probing was used to show that most bacteria in the critical zone are heterotrophic and able to utilize bacterial necromass to drive metabolic activity. Exceptions to this were of Nitrospirales, some of which are lithoautotrophic [6] and Rhizobiales some of which are methanotrophic and are capable of using methyl alcohol and methane as a sole carbon source.

Using flow cytometry observed cell concentrations within snow packs covering sample site were measured to be up to 4.4 $x10^5$ cells per millilitre. This is a substantial influx of fresh organic matter each spring as snow melts.

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