

NORTHWESTERN UNIVERSITY

The Chemistry of Zinc-Microbe Interactions in the
Sediments of Lake DePue, IL

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ABSTRACT

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The work described within examines metal speciation and the interactions between metals and microbiology in both laboratory settings and the natural environment. The approach is unique for its examination of metals using advanced microscopic and spectroscopic tools. The significance of this work is the novel approach that is taken in the collection, processing, and analysis of X-ray absorption data, using a continuous scanning technique (CS-XAS). This allows the acquisition of the experimental error, which can be carried through each step of the data reduction process. A computer code, SAMXAS was developed to utilize the data and the errors for the spectral deconvolution of environmental samples. The deconvolution was based upon a set of geochemically relevant reference compounds that are expected in sedimentary environments. To this end, a combination of analytical electron microscopy (AEM) and CS-XAS is exceptionally helpful. In addition to providing information on particle morphology and spatial relations, data from AEM gives the elemental associations on individual particles that can be used to infer their composition. From this information, the appropriate standard compounds can be chosen for XAS to verify the observations from AEM.

These techniques were then applied to examine the metal speciation in a complex, contaminated environment. Results from a study of Lake DePue, IL show that the metal speciation changes significantly as function of the contamination gradient. From joint observations with these two methods, zinc shifts from highly labile and mobile chemical forms in the most contaminated regions, to relatively stable, buried sulfides once transported away from the site. In addition, many of the speciation changes that occur in the sediments are mediated through microorganisms. Through the inference of chemical changes and direct microscopic evidence, these microbes are intimately associated with zinc contamination in the sediment. Isolates from the lake were grown in pure culture in the laboratory to examine the chemical changes that they govern in closer detail. With the aide of microcosm experiments and pure culture experiments, the microbes from Lake DePue display a wide array of chemical interactions with zinc and cadmium in the environment. These include the production of insoluble phosphates and the incorporation of zinc into thiol bound proteins.

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You do not like them.
So you say.
Try them! Try them!
And you may.
Try them and you may, I say.

Sam!
If you will let me be,
I will try them.
You will see.

Say!
I like green eggs and ham!
I do! I like them, Sam-I-am!
And I would eat them in a boat.
And I would eat them with a goat...

And I will eat them in the rain.
And in the dark. And on a train.
And in a car. And in a tree.
They are so good, so good, you see!

So I will eat them in a box.
And I will eat them with a fox.
And I will eat them in a house.
And I will eat them with a mouse.
And I will eat them here and there.
Say! I will eat them ANYWHERE!

I do so like
green eggs and ham!
Thank you!
Thank you,
Sam-I-am!

Dr. Seuss, from *Green Eggs and Ham*

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