

DIVISION OF ENVIRONMENTAL CHEMISTRY

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TUESDAY AFTERNOON

The C. Ellen Gonter Awards

Cosponsored by YCC

T. A. Anderson, *Organizer, Presiding*

1:30 — Introductory Remarks.

2:00 —**64.** New conceptual model for interpreting the redox behavior of magnetite in anoxic environments. **C. A. Gorski**, M. M. Scherer

2:30 —**65.** Sorption of selenium(*IV*) and selenium(*VI*) to synthetic pyrite (FeS₂) and stabilization *via* surface reactions. **D. Han**, B. Batchelor

3:00 —**66.** Precipitation of mercuric sulfide nanoparticles in NOM-containing water: Implications for the natural environment. **A. Deonarine**, H. Hsu-Kim

3:30 — Intermission.

3:45 —**67.** Interactions of Pb(*II*)/Pb(*IV*) solids with chlorine and their effects on lead release. **H. Liu**, G. V. Korshin, J. Ferguson

4:15 —**68.** *In situ* characterization of nitrifying biofilm: Minimizing biomass loss and preserving perspective. **R. Delatolla**, N. Tufenkji, Y. Comeau, D. Lamarre, A. Gadbois, D. Berk

4:45 —**69.** Photochemical fate of sulfadimethoxine in aquaculture waters. **J. Guerard**, Y. P. Chin, H. E. Mash

ABSTRACTS

ENVR 64

New conceptual model for interpreting the redox behavior of magnetite in anoxic environments

Christopher A. Gorski, *cgorski@engineering.uiowa.edu* and **Michelle M. Scherer**, *scherrerm@engineering.uiowa.edu*, *Civil and Environmental Engineering, University of Iowa, 4015 Seaman's Center, Iowa City, IA 52242*

Magnetite (Fe_3O_4) is commonly found in the environment, forming as a result of abiotic and biotic reduction of iron oxides, and oxidation of Fe^{II} and Fe^0 . Magnetite has been shown to react with several environmental contaminants, including both organic and inorganic compounds, yet several inconsistencies exist within the literature; for example, the extent of hexavalent uranium (U^{VI}) reduction ranges from negligible to significant under similar experimental conditions. Here, we explore the effect of Fe^{II} -content of magnetite on reactivity by synthesizing several batches with varying $\text{Fe}^{\text{II}}/\text{Fe}^{\text{III}}$ ratios. We find that the Fe^{II} -content significantly influences the kinetics and extent of nitrobenzene reduction. We also use substituted nitrobenzene compounds to investigate why reduction kinetics are slowed upon magnetite oxidation. Using these results, we propose that magnetite reactivity can be described well using a semiconductor model, as opposed to the traditional diffusion model.

ENVR 65

Sorption of selenium(IV) and selenium(VI) to synthetic pyrite (FeS_2) and stabilization *via* surface reactions

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In this study, pyrite (FeS_2) was synthesized to remove $\text{Se}(\text{IV})$ and $\text{Se}(\text{VI})$ selectively from solution because selenium has strong affinity to iron sorption sites. Transport of selenium in water could be limited by the formation of precipitates such as FeSe or FeSe_2 *via* its adsorption onto pyrite and subsequent reactions. Surface properties of pyrite were characterized by surface analysis techniques, including XRD, SEM and TEM. These analyses showed that synthetic pyrite was identical to mineral-type pyrite and had crystalline high regular rectangular-shaped morphology. XPS analysis of the pyrite surface after contact with $\text{Se}(\text{IV})$ showed important changes in both S 2p spectra and Se 3d spectra, that indicated that $\text{Se}(\text{IV})$ participated in surface reactions that formed precipitates. Additional evidence for the formation of precipitates was seen in

SEM images that showed rod-like particles. In contrast, no important changes in the pyrite surface were observed after contact with Se(VI) during a period of 30 days.

ENVR 66

Precipitation of mercuric sulfide nanoparticles in NOM-containing water: Implications for the natural environment

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The speciation and coordination of mercury(II) to natural organic matter (NOM) and sulfides governs its bioavailability and mobility in aquatic environments. In this study we explored the potential for HgS nanoparticles that coprecipitate with NOM. Dynamic light scattering was used to monitor the size of HgS colloids growing over time as a function of ionic strength and NOM type and concentration. Results indicated that humic substances and thiols stabilized HgS aggregates and decreased observed particle growth rates. Particles that formed in the presence of humics and thiolates were able to pass through 0.2 μm filters and appeared to be nanocrystalline in TEM images. Hg speciation calculations conducted to consider lower Hg concentrations typical of sediment porewater indicated that HgS(s) could be oversaturated under these conditions. These insights suggest that nanoparticulate HgS can exist in surface waters and porewater of contaminated sediments as a result of kinetically hindered aggregation/precipitation reactions.

ENVR 67

Interactions of Pb(II)/Pb(IV) solids with chlorine and their effects on lead release

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This study examined changes of colloidal properties of and lead release from representative solid phases of lead(IV) (PbO_2) and lead(II) (hydrocerussite, cerussite) and during the oxidation of the lead(II) solids by chlorine. Chlorine is determined to cause the ζ -potential of lead(II) solids to undergo significant changes apparently associated with the generation of Pb(III) intermediates that are formed before PbO_2 phase becomes abundant enough to be morphologically distinct. Simultaneously with the changes of the ζ -potential, a pronounced decrease of lead release from hydrocerussite takes place. In contrast with that, lead release from cerussite undergoes a transient initial increase before decrease takes place during the oxidation of that solid by chlorine. The existence of differences in processes governing lead release from

these Pb(II) solids is supported by SEM data showing different patterns of morphological changes of the cerussite and hydrocerussite crystal surfaces. In addition, PbO₂ phase tends to undergo colloidal mobilization in the presence of chlorine when its ζ-potential becomes increasingly negative. This study is of relevance to the drinking water distribution systems of all water utilities where lead-containing materials are exposed to water-containing free chlorine residual and also during maintenance of systems that use chloramine as the secondary disinfectant. Experimental results will help understand the impact of chlorine on the colloidal mobilization from both Pb(II) and Pb(IV) solids.

ENVR 68

***In situ* characterization of nitrifying biofilm: Minimizing biomass loss and preserving perspective**

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Methods for characterizing nitrifying bacteria within biofilms are of key importance in understanding and optimizing the nitrification kinetics of attached growth treatment facilities and are leading to improved methods of removing ammonia from wastewater. In this work, we propose an analytical protocol based upon environmental scanning electron microscopy (ESEM) and confocal laser scanning microscopy (CLSM) in combination with fluorescent *in situ* hybridization (FISH) to characterize the structure of nitrifying biofilm as it remains attached to the original reactor substratum. The use of ESEM eliminates the destructive preparatory procedures associated with traditional scanning electron microscopy. FISH and CLSM are both conducted directly on the biofilm as it remains attached to the substratum. This protocol therefore minimizes the loss of mass and distortion of *in situ* perspective commonly associated with traditionally applied microscopic techniques and thereby enables a more accurate estimation of the nitrifying biomass within biofilm attached to the substratum.

ENVR 69

Photochemical fate of sulfadimethoxine in aquaculture waters

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Sulfadimethoxine (SDM) is an antibiotic often used in combination with ormetoprim to prevent the spread of disease in freshwater aquaculture. It is known to undergo

photochemical degradation in natural sunlit surface waters, but the role of dissolved organic matter (DOM) in this process is poorly understood. Our results show that dissolved organic matter from eutrophic catfish pond water at the USDA facility in Stoneville, MS facilitates the rapid phototransformation of SDM. In contrast, DOM from an adjacent stream (Deer Creek) derived from allochthonous precursors does not enhance its photodegradation. We attribute these disparate results to DOM composition, whereby DOM originating from highly eutrophic water bodies is a better SDM photosensitizer. Experiments conducted concurrently using respective autochthonous (Pony Lake, Antarctica) and allochthonous (Suwannee River) derived fulvic acids corroborate these findings. Photo-derivatives assayed by mass spectrometry reveal the same major SDM photoproducts in the presence and absence of dissolved organic matter.