Effects of common groundwater constituents on coupled Mn(II)/U(IV) oxidation by *Bacillus* sp. SG-1

SUNG-WOO LEE[1*], KELLY L. PLATHE[2], ZIMENG WANG[3], JUAN S. LEZAMA-PACHECO[4], JOHN R. BARGAR[4], DANIEL E. GIAMMAR[3], RIZLAN BERNIER-LATMANI[2], AND BRADLEY M. TEBO[1]

[1]Oregon Health & Science University, Beaverton, OR, USA
lees@ebs.ogi.edu (* presenting author), tebo@ebs.ogi.edu
[2]Ecole Polytechnique Federale de Lausanne, Lausanne, Switzerland
kelly.plathe@epfl.ch, rizlan.bernier-latmani@epfl.ch
[3]Washington University in St.Louis, St.Louis, MO, USA
zimengwang@wustl.edu, giammar@wustl.edu
[4]SLAC National Accelerator Laboratory, Menlo Park, CA, USA
jlezama@slac.stanford.edu, bargar@slac.stanford.edu

Abstract

Bioreduction of U(VI) to U(IV) is considered a promising strategy for immobilizing U in the subsurface. Until recently, the product of U(VI) reduction was considered to be crystalline uraninite (UO_2). Recent studies have shown that other non-UO_2 phases may also exist including monomeric U(IV) which is presumed to be more labile relative to UO_2 [1]. Manganese oxides (MnO_2) which can be formed microbially even under low oxygen concentrations, can oxidize U(IV) to U(VI), and thereby jeopardize the stability of U(IV) [2]. Once oxidized by biogenic MnO_2, the resulting U(VI) can sorb to the MnO_2 surface. As the presence of MnO_2 can greatly impact the fate and transport of U in the subsurface, it is imperative to understand the effect a variety of common groundwater constituents may have on microbial Mn(II)-oxidation rates and the structure of the biogenic manganese oxides which in turn potentially affect the stability of U(IV).

In this study, the effects of common groundwater constituents, O_2 (0-5 %), Ca^{2+} (5 mM), Mg^{2+} (5 mM), and HCO_3^- (1 mM), on the coupled Mn/U processes were investigated. A model Mn(II)-oxidizing microorganism, *Bacillus* sp. SG-1 spores, was incubated with Mn(II) in the presence and absence of the above solutes and U(IV) as either biogenic UO_2 or monomeric U(IV). It is hypothesized that conditions that stimulate microbial Mn(II)-oxidation or lead to the formation of U(VI) complexes will lead to faster Mn(II) and U(IV) oxidation rates. In contrast, constituents that provide more stability for U(IV) species or sorb strongly to the MnO_2 surface and reduce its ability to oxidize U(IV) will decrease or have little impact on the rate of U(IV) oxidation. As expected, increasing O_2 concentration led to increased Mn(II)-oxidation rates. Addition of Ca^{2+} stimulated Mn(II)-oxidation while Mg^{2+} inhibited Mn(II)-oxidation in the presence of U(IV). Specific experiments probed the biological and chemical basis for the stimulatory and inhibitory effects of individual groundwater constituents on Mn(II)-oxidation in the presence of U(IV).

[1] Alessi et al (2011) *Mineral. Mag.* **75**, 422.
[2] Chinni et al (2008) *Environ. Sci. & Technol.* **42**, 8709.

Cyanide Sorption on Granular Activated Carbon and Its Attenuation by UV-Light

SOO-OH PARK[1], HYO EUN LEE[1], YOUNG JAE KIM[1], GIEHYEON LEE[2], YOO HYUN SUNG[3], CHAN OH PARK[3], YOUNG JAE LEE[1*]

[1]Department of Earth and Environmental Sciences, Korea University, Seoul 136-701, Korea (*Correspondence: youngjlee@korea.ac.kr, orange261@korea.ac.kr , hyonim@korea.ac.kr, jjbsnlove@korea.ac.kr)
[2]Department of Earth System Sciences, Yonsei University, Seoul 120-749, Korea (ghlee@yonsei.ac.kr)
[3]Development and Environment Team, Korea Resources Corporation, Seoul 156-406, Korea (sungyh77@gmail.com, pckores@lycos.co.kr)

Cyanide (CN) has been the subject of interest due to its heavy toxicity on humans and ecosystems. Carbons such as charcoal and granular activated carbon (GAC) are commonly used to remove contaminants in environments. Despite the popular usage of carbon, cyanide uptake by GAC has not been systematically adressed yet. In addition, effects of UV-light on cyanide attenuation are barely studied over a wide range of physicochemical conditions. Thus, in this study, we investigate cyanide sorption on GAC and its attenuation by UV-light over a wide range of conditions such as different pHs and concentrations through batch experiments.

Cyanide uptake by GAC is effective at $[CN]_{initial} < 2$ mg/L. At pH 7.0, the sorption of cyanide on GAC is greater than that of pH 9.0. It is also found that the ratio of CN uptake by GAC increases at pH 9.0 whereas the ratio decreases at pH 7.0, suggesting that reactivity of GAC would increase as a function of pH. The cyanide uptake by GAC rapidly increases during the first 30 min, followed by sharp desorption until 3 hr, and then the sorption increases and reaches the maximum sorption during the duration of experiments, implying that the sorption mode could be changed. Total amount of cyanide desorbed from the GAC during the duration of the desorption is less than 1.5% of total sorbed cyanide, indicative of strong and stable sorption of cyanide on the GAC. It is noted that UV-light is much effective on the attenuation of cyanide but also the attenuation is achieved until $[CN]_{total}$ is up to 10 mg/L. Our findings demonstrate that both GAC and UV-light are very effective on the attenuation of cyanide over a wide range of environmental conditions.