

ENVIRONMENTAL MANAGEMENT SCIENCE PROGRAM (EMSP) SYMPOSIUM

(Cosponsored with the Division of Analytical Chemistry)

(Cosponsored with the Division of Geochemistry)

(Cosponsored with the Committee on Environmental Improvement)

Subsurface Remediation Technology

Poster Session

DIVISION OF ENVIRONMENTAL CHEMISTRY

225th American Chemical Society Meeting

New Orleans, LA

Wednesday, March 26, 2003

6:00 p.m. - 8:00 p.m.

Organizer: T. Zachry

Presiding: G.C. Schatz

Paper

Contaminant transport through subsurface material from the DOE Hanford Reservation. M.N. Pace, M.A. Mayes, P.M. Jardine, S. Fendorf, T.L. Melhorn, X. Yin, J.L. Ladd, J. Teerlink and J.M. Zachara

Effect of water content on the behavior of surfactants and hydrophobic organic compounds in the immobilization zone for contaminants retardation. I.S. Park, J.W. Park, J.S. Cho and I. Hwang

Effects of pH and competing anions on the solution speciation of arsenic by ion exchange resins. C.A. Impellitteri, J.A. Ryan, S.R. Al-Abed, K.G. Scheckel, P.M. Randall and C.A. Richardson

Analysis of RDX and RDX breakdown products in environmental samples. D.R. Felt, A. Wani, S.L. Larson and J.L. Davis

Alkaline hydrolysis is an effective treatment technology for RDX-contaminated groundwater. S. Hwang, D.R. Felt, E.J. Bouwer, M.C. Brooks, S.L. Larson and J.L. Davis

Assessment of a sequential extraction procedure for perturbed lead contaminated samples with and without phosphorus amendments. K.G. Scheckel, C. Impellitteri and J.A. Ryan

Using organo-silicate nanocomposites for aqueous lead species removal. I. Abdel-Fattah and L.K. Isaacs

ABSTRACTS

Contaminant transport through subsurface material from the DOE Hanford Reservation. Molly N. Pace¹, Melanie A. Mayes¹, Philip M. Jardine¹, Scott Fendorf², T. L. Melhorn¹, Xiangping Yin¹, J. L. Ladd¹, J. Teerlink¹ and John M. Zachara³; ¹Environmental Sciences Division, Oak Ridge National Laboratory, P.O. Box 2008, MS 6038, Oak Ridge, TN 37831, pacem@ornl.gov; ²Department of Geological and Environmental Sciences, Stanford University; ³Environmental Molecular Science Laboratory, Pacific Northwest National Laboratory.

Accelerated migration of contaminants in the vadose zone has been observed beneath tank farms at the U.S. Department of Energy's Hanford Reservation. This paper focuses on the geochemical processes controlling the fate and transport of contaminants in the sediments beneath the Hanford tank farms. Laboratory scale batch sorption experiments and saturated transport experiments were conducted using reactive tracers U(VI), Sr, Cs, Co and Cr(VI) to investigate geochemical processes controlling the rates and mechanisms of sorption to Hanford subsurface material. Results indicate that the rate of sorption is influenced by changes in solution chemistry such as ionic strength, pH and presence of competing cations. Sediment characteristics such as mineralogy, iron content and cation/anion exchange capacity coupled with the dynamics of flow impact the number of sites available for sorption. Investigative approaches using a combination of batch and transport experiments will contribute to the conceptual and Hanford vadose zone.

Effect of water content on the behavior of surfactants and hydrophobic organic compounds in the immobilization zone for contaminants retardation. In Sun Park¹, Jae Woo Park², Jong Soo Cho¹ and Inseong Hwang¹; ¹Department of Environmental Engineering & Research, En3, Chungyang B/D 3 floor, Chung-Jung-Ro 1ga 58-1, Chung-Gu, Seoul 100-150, South Korea, Fax: 822-722-6535, tensunny@hanmail.net; ²Department of Civil Engineering, Hanyang University.

An immobilization zone can be constructed by modifying soils in the vadose zone with surfactants and, thus, can be used to promote retardation of organic contaminants in the subsurface. Column experiments were conducted to investigate the behavior of surfactants and organic contaminants in unsaturated and saturated conditions with different water contents (25%, 50%, 75%, 100%). The transport and sorption behavior of two surfactants tested (monoalkylated disulfonated diphenyl oxide, dialkylated disulfonated diphenyl oxide) in the columns containing an aluminum oxide were similar under the conditions with different water contents. However, transport of a model organic compound (naphthalene) was retarded as the water content decreased by enhanced partitioning of the compound into the surfactants that were sorbed on the aluminum oxide. This suggests that the immobilization method could well be applied to vadose zone. A transport model, CXTFIT 2.1, was also used to evaluate the behavior of the surfactants and naphthalene.

Effects of pH and competing anions on the solution speciation of arsenic by ion exchange resins. Christopher A. Impellitteri¹, James A. Ryan¹, Souhail R. Al-Abed¹, Kirk G. Scheckel¹, Paul M. Randall¹ and Collin A. Richardson²; ¹National Risk Management Research Laboratory, U.S. Environmental Protection Agency, 5995 Center Hill Avenue, Cincinnati, OH 45224, Fax: 513-569-7879, Impellitteri.Christopher@epa.gov; ²Morehouse College.

Anion-exchange resins (AER) are used to differentiate As(V) and As(III) by retaining As(V) and allowing As(III) to pass through. AERs allow rapid speciation of As in the field which precludes the effects of sample preservation on As speciation. Aqueous environmental samples contain anions that may interfere with the speciation of As. This study compares the speciation of As by two commercially available AERs. A silica-based AER was selected for further study. As(V) and As(III) were passed through the AER in the presence of NO_3^- , SO_4^{2-} , HPO_4^{2-} , Cl^- and HCO_3^- at pH 4, 6 and 8. Recoveries of As species in mixed systems range between 90 to 100%. Breakthrough curves for As(V) are presented which allow calculation of loading rates. HPO_4^{2-} has the greatest effect on the speciation of As by AER.

Analysis of RDX and RDX breakdown products in environmental samples. Deborah R. Felt¹, Altaf Wani¹, Steven L. Larson² and Jeffrey L. Davis²; ¹Applied Research Associates, Inc. Southern Division, 119 Monumnet Place, Vicksburg, MS 39180, dfelt@ara.com; ²U.S. Army Engineer Research and Development Center.

The identification and quantification of explosives and their degradation products in soil and natural waters is helpful in the design of remediation technologies, mobility investigations and performing risk assessments. The objective of this study was to develop a method for the determination of the degradation of nitramine compounds, specifically hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX). The analytical methods developed in this study were based on reversed-phase high performance liquid chromatography (HPLC) using both C-18 and CN bonded silica columns to eliminate common interferences. Contaminant identification was further confirmed by performing spectral analysis of the compounds upon elution. The proposed method yields good separation of RDX from its degradation products and from other common energetic compounds. Method detection limits for the proposed method ranged from 0.01 to 0.03 mg/L. This method satisfies the need for analytical techniques to monitor the formation and subsequent degradation products of toxic and carcinogenic nitrosyl substituted nitramines.

Alkaline hydrolysis is an effective treatment technology for RDX-contaminated groundwater. Sangchul Hwang¹, Deborah R. Felt², Edward J. Bouwer¹, Michael C. Brooks³, Steven L. Larson³ and Jeffrey L. Davis³; ¹Department of Geography and Environmental Engineering, Johns Hopkins University, Baltimore, MD 21218; ²Applied Research Associates, Inc. Southern Division; ³U.S. Army Waterways Experiment Station.

Kinetics and treatability of alkaline hydrolysis were investigated in batch reactor and continuous flow-stirred tank reactor (CFSTR) for remediating groundwater contaminated with hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX). The batch system (pH 11 to 13, RDX 1 to 10 mg/L) achieved pseudo first-order RDX transformation rates in the range of 0.2 to 47.5 min⁻¹, corresponding to 57.8 to 0.2 hrs of half-life period, respectively. In the CFSTR system (pH 11 to 11.9, HRT 0.54 to 2 days), the best alkaline RDX transformation was achieved a 99% RDX removal with the longest HRT and the highest reaction pH. Formate (~2 M/M RDXremoved) and nitrite (~0.2 M/M RDXremoved) were produced as the major hydrolysates, indicative of a simultaneous transformation mechanism by RDX ring cleavage and ring nitrogen elimination. The net OH⁻ demand was found to be 1.5, 390 and 130 M OH⁻/M RDXremoved at the pH of 11.9, 11.5 and 11.0, respectively, in the CFSTR system.

Assessment of a sequential extraction procedure for perturbed lead contaminated samples with and without phosphorus amendments. Kirk G. Scheckel, Christopher Impellitteri and James A. Ryan; National Risk Management Research Laboratory, U.S. Environmental Protection Agency, 5995 Center Hill Avenue, Cincinnati, OH 45224, Fax: 513-569-7879, Scheckel.Kirk@epa.gov, Impellitteri.Christopher@epa.gov.

Sequential extraction procedures (SEP) attempt to determine the solid-phase association of elements in natural matrices. However, a major obstacle confronting SEP is species alteration of extracted metals before separation of solids from solution. The objectives of this study were to investigate the potential formation of pyromorphite during the sequential extraction steps of Pb-spiked samples with and without phosphate amendments and examine the differences in the operationally defined distribution of Pb in samples with and without the presence of phosphate. The systems that were examined in the absence of phosphate behaved adequately according to operational definitions. The results changed when the samples were amended with phosphate. Pb redistribution occurred due to pyromorphite formation during the SEP as confirmed by X-ray diffraction and X-ray absorption spectroscopies. These results indicate that sequential extraction methods may not be suitable for Pb speciation in perturbed environmental systems.

Using organo-silicate nanocomposites for aqueous lead species removal. Tarek Abdel-Fattah and Larry K. Isaacs; Department of Biology, Chemistry and Environmental Science, Christopher Newport University, 1 University Place, Newport News, VA 23606, fattah@cnu.edu.

Adsorption of aqueous lead by organo-silicate nanocomposites is explored in this study. Small arms ranges nation-wide contribute thousands of tons of lead to earthen berms annually. Some ranges have experienced soluble lead and soil colloid attached lead in storm water run offs. Traditional physical separation, erosion control, soil modifications and phyto-remediation have effectively served control needs for many years, however they are very expensive and require continuous management. We explore an emerging technology within this effort to determine if synthesized silicate nanocomposites hexagonal meso-structure (HMS), MCM-41 and MCM-48 could serve as end of pipe adsorbents. These adsorbents are studied to determine their capacity for lead removal from aqueous media by batch adsorption studies. The data shows that, all adsorbents had great affinity for lead removal. HMS displayed the greatest affinity with nearly 100 percent of the lead removed within two hours. Langmuir and Freundlich model applications were examined. The Langmuir model represented all three adsorbents well, but the Freundlich only modeled MCM-48.