

Curriculum Vitae

Name: Kim F. Hayes

Position: Arthur J. Decker Collegiate Professor of Civil and Environmental Engineering

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The Department of Civil and Environmental Engineering
The University of Michigan
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Degrees:

Ph.D. Environmental Engineering and Science, Stanford University, 1987. "Equilibrium, Spectroscopic, and Kinetic Study of Ion Adsorption at the Oxide/Aqueous Interface." Adviser: Professor James O. Leckie.

M.S. Chemical Engineering, Stanford University, 1982.

M.S. Environmental Engineering and Science, Stanford University, 1980.

B.S. Chemistry, Stanford University, 1980.

Positions at U of M:

Chair, Department of Civil and Environmental Engineering, University of Michigan, January 1, 2013 to June 30, 2017.

Interim Chair, Department of Civil and Environmental Engineering, University of Michigan, since September 1 2011- December 31, 2012.

Professor, Environmental and Water Resources Engineering, Department of Civil and Environmental Engineering, University of Michigan, since September 1, 2001.

Program Director, Environmental and Water Resources Engineering, Department of Civil and Environmental Engineering, University of Michigan, 2001 to 2007.

Associate Professor, Environmental and Water Resources Engineering, Department of Civil and Environmental Engineering, University of Michigan, 1994 - 2001.

Assistant Professor, Environmental and Water Resources Engineering, Department of Civil and Environmental Engineering, University of Michigan, 1988 - 1994.

Positions at other institutions or organizations:

Visiting Associate Professor, Soil Science Department, University of California at Berkeley, sabbatical leave appointment, 1994 - 1995.

Staff Scientist, Lawrence Berkeley National Laboratory, Earth Sciences Division, Berkeley CA, sabbatical leave appointment, 1994 - 1995.

Postdoctoral Fellow, Environmental Engineering and Science, Department of Civil and Environmental Engineering, Stanford University, 1987 - 1988.

Honors and Awards:

Arthur J. Decker Collegiate Professor of Civil and Environmental Engineering, October 1, 2016 to present.

Donald Malloure Department Chair of Civil and Environmental Engineering, July 1 2015 to June 30 2017.

Faculty Member Initiate, Inducted into Chi Epsilon, University of Michigan Chapter, May 2016.
Certificate of Appreciation, Outstanding Contribution to Organization of Division Symposium, Division of Environmental Chemistry, ACS 247th National Meeting, 2014.

2007 AEESP Outstanding Paper Award for Hayes et al., *Science*, **238**, 783-786, 1987.

Certificate of Appreciation for 25 years of service to Environmental Chemistry Division, American Chemical Society, 2007.

CH2M Hill Distinguished Lecture, Auburn University, May, 2006.

Certificate of Merit, American Chemical Society, paper award, 2005, 2014.

Distinguished Faculty Achievement Award, University of Michigan, 2004.

Association of Environmental Engineering and Science Professors (AEESP), Distinguished Service Award, 2003.

Gilbert Whitaker Fund Award, "Diffusion of Sustainable Engineering Principles into the College of Engineering Undergraduate Curriculum: Development of a Cornerstone Course, April 2003.

College of Engineering Service Award, University of Michigan, 2001.

Elected to Association of Environmental Engineering and Science Professors Board of Directors (2000-2003).

Certificate of Appreciation for Service, College of Engineering, University of Michigan 2000.

Award for Excellence in Teaching, Civil and Environmental Engineering, 1996.

National Science Foundation Presidential Young Investigator Award Recipient, 1989-1995.

Student advisee awards and achievements based on work at UM

NSF Faculty Career Awards

1. Lynn E. Katz, (Ph.D., 1993), received NSF Faculty Career Award for work extending her dissertation research completed at UM under the direction of K.F. Hayes.
2. Tohren C.G. Kibbey (Ph.D., 1997), received NSF Faculty Career Awards for work extending his dissertation research completed at UM under the direction of K.F. Hayes.
3. Elizabeth Butler (Ph.D., 1998) received NSF Faculty Career Award for work extending her dissertation research completed at UM under the direction of K.F. Hayes.

Dissertation Awards

1. Julie B. Zimmerman, 2004 Rackham Dissertation Award, "Formulation and Evaluation of Emulsion Systems for Petroleum and Bio-Based Semi-Synthetic Metal Working Fluids."

Professional Society Paper and Other Recognition Awards

1. Grace Rodriguez (MSE student), International Institute Individual Fellowship, University of

- Michigan, 2016. To cover supplies and expenses for a research proposal to perform summer research in Bangladesh.
2. Raghav Ready (Ph.D., student), International Institute Individual Fellowship, University of Michigan, 2016. To cover supplies and expenses for performing summer research in Bangladesh.
 3. Wenjia Fan, Certificate of Merit Award, "Experimental investigations of trace metal and radionuclide leaching from shales in contact with hydraulic fracturing fluid," 247th ACS Nat. Meeting, Dallas, TX, March 16-20, 2014, Co-authors B. Ellis and K. F. Hayes.
 4. Nadine Kotlarz, Fresh Idea Poster Competition Award, 21st Annual Michigan Section American Water Works Association/Michigan Water Environment Association Joint Exposition, Lansing, MI, Feb. 2012. Co-Authors G. Upadhyaya, K.F. Hayes and L. Raskin.
 5. Yuqiang Bi, Richard and Eleanor Towner Prize for Distinguished Academic Achievement, 2012.
 6. Yuqiang Bi, Department of Energy Subsurface Biogeochemistry Research Program Travel Fellowship to attend 7th annual Principal Investigator (PI) meeting April 30 – May 2, 2012.
 7. Andrea Trese, U.S. Student Fulbright award to work with Professor Moses Musaaazi on a biosand water filter research project in Uganda, including laboratory research and work with a local community, 2012. co-Advisors: Kim Hayes and Lut Raskin.
 8. Andrea Trese, National Security Education Program (NSEP) David L. Boren Fellowship, to support a four month stay in Tanzania to study Swahili and take part in an internship with the Zanzibar Water Authority focused on improving water supply for local citizens, 2012. co-Advisors: Kim Hayes and Lut Raskin.
 9. Tara M. Clancy, Center for the Education of Women Menakka and Essel Bailey Graduate Fellowship, 2012. co-Advisors: Kim Hayes and Lut Raskin.
 10. Tara M. Clancy, U.S. Department of State Critical Language Scholarship for participation in the Bangla/Bengali intensive summer language institute (Bengali-Intermediate), 2012. co-Advisors: Kim Hayes and Lut Raskin.
 11. Tara M. Clancy, Raoul Wallenberg International Summer Travel Fellowship, 2011. co-Advisors: Kim Hayes and Lut Raskin.
 12. Tara M. Clancy, U.S. Department of State Critical Language Scholarship for participation in the Bangla/Bengali intensive summer language institute (Bengali-Beginner), 2011. co-Advisors: Kim Hayes and Lut Raskin.
 13. Tara M. Clancy, Awarded 2nd Place in student competition, "Biologically Active Carbon Reactors for the Removal of Arsenic and Uranium from Drinking Water," ACE10, American Water Works Association Young Professionals Poster Session, Chicago, IL, June 20-24, 2010. Co-Authors G. Upadhyaya, J. Jackson, K.F. Hayes and L. Raskin.
 14. Tara M. Clancy, Awarded 1st Place in student competition, "Microbially Mediated Production of Iron Sulfides for Removal of Arsenic and Uranium from Drinking Water," Michigan Section American Water Works Association (AWWA), Joint Conference and Expo, Lansing, MI, February 2-3, 2010. Co-Authors G. Upadhyaya, J. Jackson, K. F. Hayes and L. Raskin.
 15. Tanya Gallegos, Paper Competition Award, "Mackinawite-Ferrihydrite Coated Sand for Remediation of Arsenite Contaminated Groundwater," Battelle Fifth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, California, May 2006, Co-authors L.M. Abriola and K.F. Hayes.
 16. 2nd Place Poster Award, Andres Clarens (#2 out of 30), Association of Environmental

- Engineering and Science Professors Biennial Meeting, Postdam, NY, 2005.
17. Tanya Gallegos, Certificate of Merit Award, "Uptake of As(III) by Nanoparticulate Mackinawite," 230th ACS Nat. Meeting, Washington DC, August 28-September 1, 2005, Co-authors L. Abriola and K. F. Hayes.
 18. 1st Place Poster Award to Andres Clarens (#1 out of 37 entries), International Society for Industrial Ecology Biennial Meeting, Stockholm, 2005.
 19. Andres Clarens, 1st Prize (1st of 80 papers), Technical Paper Competition at Society of Hispanic Professional Engineers, Dallas, TX, January 5-9, 2005, for paper entitled: "Comparison of Vegetable and Petroleum Base Oils in Metalworking Fluids Delivered in Aqueous and Carbon Dioxide Carriers." Co-authors S.J. Skerlos and K.F. Hayes.
 20. Tanya Gallegos, 2nd Prize (2nd of 80 papers), Technical Paper Competition at Society of Hispanic Professional Engineers, Dallas, TX, January 5-9, 2005, for paper entitled: "Reactive Ferrous Sulfide/Ferric Oxide Multilayer Films for Remediation of Arsenic Contaminated Groundwater." Co-authors L.M. Abriola and K. F. Hayes.
 21. Karlin Danielsen, 2005 ACS Environmental Chemistry Division Paper Award for a paper entitled: "Influence of Amine Buffers on Carbon Tetrachloride Reductive Dechlorination by the Iron Oxide Magnetite," co-authors, J. L. Gland, and K. F. Hayes.
 22. Hoon Y. Jeong, 2004 ACS Environmental Chemistry Division Paper Award for a paper entitled: "Sorption of Mercuric Ion on Iron Sulfide," co-authors B. Klaue, J. D. Blum, and K. F. Hayes.
 23. Andres Clarens, 2004 ACS Graduate Student Award in Environmental Chemistry.
 24. Julie B. Zimmerman, 2003 ACS Environmental Chemistry Student Paper Award for paper entitled' "Influence of Ion Accumulation on the Emulsion Stability and Machining Performance of Two Semi-Synthetic Metalworking Fluids," Co-authors K.F. Hayes and S.J. Skerlos.
 25. Hoon Y. Jeong, 2003 ACS Graduate Student Award in Environmental Chemistry.
 26. Karlin Danielsen, 2001 ACS Graduate Student Award in Environmental Chemistry.
 27. Julie B. Zimmerman, 2000 ACS Graduate Student Award in Environmental Chemistry.
 28. Chia Chen Chen, 1999 ACS Environmental Chemistry Student Paper Award for paper entitled' "X-ray Absorption Spectroscopy Investigation of Aqueous Co(II) Sorption at Clay-Water Interfaces." Co-author is K.F. Hayes.
 29. Elizabeth C. Butler, 1999 ACS Graduate Student Award in Environmental Chemistry.
 30. Tohren C. G. Kibbey, 1997 ACS Environmental Chemistry Student Paper Award for paper entitled, "A Numerical Thermodynamic Model for the Prediction of Mixed Surfactant Sorption in Natural Systems." Co-author is K.F. Hayes.
 31. David Lord, 1996 ACS Environmental Chemistry Student Paper Award for paper entitled, "The Effects of Solution Chemistry on Interfacial Tension in Air/Water/Octanoic and o-Xylene/Water/Octanoic Acid Systems." Co-authors are K.F. Hayes, A.H. Demond, and A. Salehzadeh.
 32. Tohren C. G. Kibbey, 1996 ACS Graduate Student Award in Environmental Chemistry.
 33. N. Assaf-Anid, 1993 ACS Environmental Chemistry Student Paper Award for paper entitled, "Effect of Redox Potential and pH on the Reductive Declorination of of Carbon Tetrachloride by Cyanocobalamin(II) in the Presence of Dithiothreitol." Co-authors are K.F. Hayes and T.M. Vogel.
 34. Lynn E. Katz, 1992 ACS Graduate Student Award in Environmental Chemistry.

NSF Graduate Student Fellowship recipients

1. Tara Clancy (Ph.D., 2015)
2. Ashley Hammerbeck (MSE, 2013)
3. Tohren Kibbey (Ph.D. 1997)

EPA Star Fellowship recipients

1. Tara Clancy, turned down to accept NSF Fellowship in same year (Ph.D., 2015)
2. Andres Clarens (Ph.D. 2008)
3. Julie Zimmerman (Ph.D. 2003)
4. Karen Mozealous (MSE 2000)
5. Matthew Cowell (MSE 2000)
6. Tohren Kibbey (Ph.D. 1997)

Graham Environmental Sustainability Institute Fellowship Recipients

1. Grace Rodriguez, Master's Fellowship, (2017)
2. Nadine Koltarz Ph.D. Fellowship (2013)
3. Tara Clancy Ph.D. Fellowship (2011)
4. Giridhar Upadhyaya Ph.D. Fellowship (2008)

Michigan Section American Water Works Association Fellowship

1. Kathryn Snyder (MSE, 2013)
2. Tara Clancy (Ph.D., 2015)
3. Giridhar Upadhyaya (Ph.D., 2010)
4. Nonso Gbemedu (MSE, 2008)

Other Fellowships

1. Grace Rodriguez, UM International Institute Individual Fellowship (2017)
2. Raghav Ready, UM International Institute Individual Fellowship (2014)
3. Tara Clancy, Michigan Section AWWA Fellowship for Water Quality and Treatment Study (2011)

Invention Disclosures (ID) and Patents (P)

- ID UM file no. 4035: Methods for Controlling Tool Temperature and Diffusive Flank Wear (Inventors: S.J. Skerlos, K.F. Hayes, and A. Clarens).
- ID UM file no. 4117: Metal Working Lubricants Delivered at Low Temperature and High Velocity with Rapidly Expanding Gases and Supercritical Fluids (Inventors: S.J. Skerlos, K.F. Hayes, and A. Clarens).
- ID UM file no. 4430: System and Method for Simultaneous Removal of Contaminants from Water (Inventors: L. Raskin, K.F. Hayes, and G. Upadhyaya).

- ID UM file no. 3024: Metalworking Fluid Formulations Based on Supercritical Dioxide (Inventors: S.J. Skerlos, K.F. Hayes, and A. Clarens).
- P: US Patent #8,167,092: Metalworking Fluid Formulations Based on Supercritical Dioxide (Inventors: S.J. Skerlos, K.F. Hayes, and A. Clarens). May, 1, 2012.
- P: US Patent #7,414,015: Metalworking Fluid Formulations Based on Supercritical Dioxide (Inventors: S.J. Skerlos, K.F. Hayes, and A. Clarens). August 19, 2008.

Service

External Service:

- External Review Committee, Department of Civil and Environmental Engineering, University of Wisconsin, Madison, WI, April 26-28th, 2015.
- Session Co-Organizer, “Water Quality Stewardship in Pursuit of Unconventional Oil and Natural Gas Reservoirs,” Division of Environmental Chemistry, Centennial Celebration, American Chemical Society 247th National Meeting, March 16-20th, 2014, Dallas Texas.
- Expert Reviewer, American Association for the Advancement of Science, Final Report for Funded Proposal of KACST (King Abdulaziz City for Science and Technology) Program, Winter 2014.
- Chair, External Advisory Board, University of Arizona Superfund Research Program, Sept. 2012 to present.
- Session Chair, “Uranium Biogeochemistry: Transformations and Applications,” International Workshop, Monte Verità, Ascona, Switzerland, March 11-16, 2012.
- University of Michigan Team Participant, University of Michigan and Bechtel Partner Session, Bechtel Corporation Office, Frederick, MD, February 21, 2012.
- Member, External Advisory Board, University of Arizona Superfund Research Program, Sept. 2011 to present.
- Member, MI Green Chemistry and Engineering Conference Steering Committee, 2011.
- Member, NSF Proposal Review Panel, Environment Health and Safety of Nanotechnology, December 16-17, 2010, Washington D.C.
- Invited Panel Member, American Association for the Advancement of Science, Proposal Reviews for KACST (King Abdulaziz City for Science and Technology) Program, Winter 2010 Competition.
- Invited Participant, Working Group on *In Situ* Biogeochemical Transformations,” Dallas, Texas at USEPA Region 6 headquarters, Nov. 5, 2009.
- Invited Panel Member for DOE Office of Biological and Environmental Research, Merit Review of the Scientific Focus Area (SFA) Science Plan in the Environmental Remediation Sciences Program (ERSP) focus area at Argonne National Laboratory (ANL), Review of Plan: April-May, 2009, ANL Review visit: June 10th – 11th, 2009.
- Invited Panel Member, American Association for the Advancement of Science, Proposal Reviews for KACST (King Abdulaziz City for Science and Technology) program, Winter 2009 Competition.
- Conference Organizer and Session Chair, “Metal and Metalloid Speciation and Adsorption in Honor of James O. Leckie,” 237th Amer. Chem. Soc. National Meeting, Salt Lake City, March 22-26, 2009.
- Invited Participant, Summit on “Biogeochemical Processes in the Degradation of Chlorinated

Solvents," Brooks City-Base, San Antonio Texas, April 25-26, 2007.

Environmental Protection Agency, Science Advisory Board Review Panel to Assess "Emergency Response Quality Assurance Sampling Plan for Hurricane Katrina Screening Level Sampling for Sediments in Areas Where Floodwater Receded, Southeast Louisiana, September 2005.

Environmental Protection Agency, Consultant to the Science Advisory Board, Member of the Metals Framework Document Assessment Panel, February 1-3, 2005.

National Science Foundation Review Panel: Environmental Engineering, Technology Panel, February 3-4, 2005.

Member, AEESP Mission Committee, June 2004 to 2005.

National Science Foundation Review Panel: Nanoscale Exploratory Research, March 2004.

Environmental Protection Agency, Consultant to the Science Advisory Board, Member of the Metals Assessment Panel, 2002.

Peer Reviewer of National Research Council (NRC) sponsored report on "Bioavailability of Contaminants in Soils and Sediments," June-July, 2002.

Peer Review Panel Member, Strategic Environmental Research and Development Program (SERDP), Solicitation on "In-Situ Sequestration Enhancement and Engineered Bioavailability Reduction of Metals in Soils solicitation," April 3rd – May 1st, 2002.

Symposium Organizer, "Interfacial and Colloidal Phenomena in Aquatic Systems," 76th ACS Colloid and Surface Science Symposium," University of Michigan, Ann Arbor, MI, June 23-26, 2002.

Session Chair, "Reactions at Solid-Water Interfaces: Metal Ions," in Symposium on Interfacial and Colloidal Phenomena in Aquatic Systems," 76th ACS Colloid and Surface Science Symposium," University of Michigan, Ann Arbor, MI, June 23-26, 2002.

Peer Review, Report on "Relationships of THM Precursors in Source Water to Distribution System Disinfection By-Product Levels," Environmental Protection Agency, New York City Water Shed Team, NY, NY, September 5, 2001.

Session Chair, "Topic 3. Biogeochemical Processes and Cycling in Aquatic Systems," 15th International Symposium of Environmental Biogeochemistry, Wroclaw, Poland, Sept. 11-15, 2001.

Member, "Futures Research in Natural Sciences" Proposal Review Panel, EPA 2000 Science to Achieve Results (STAR) Program, Office of Research and Development, Washington D.C., Nov. 13-15, 2000.

Executive Officer, AEESP (Association of Environmental Engineering and Science Professors), elected by the Board of Directors to 2 year term as Secretary of AEESP: 2000-2002.

Board of Directors, AEESP (Association of Environmental Engineering and Science Professors), governing body of AEESP elected by the membership, 3 year term: 2000-2003.

Session Chair, "Chemical Speciation and Reactivity in Water Chemistry and Water Technology," A symposium in honor of James J. Morgan, 220th ACS National Meeting, Washington D.C., August 20-25th, 2000.

Technical Advisory Board, Michigan Great Lakes Protection Fund, Department of Environmental Quality, State of Michigan, March 2000 - 2003.

Leader, Working Group on Sustainable Engineering, AEESP (Association of Environmental Engineering and Science Professors), January 2000-2001.

Member, Education Committee, AEESP (Association of Environmental Engineering and Science Professors), January 1999-present.

Member, Diversity Committee, AEESP (Association of Environmental Engineering and Science

Professors), January 1999-2000.
Member, EPA Office of Exploratory Research, Environmental Chemistry Proposal Review Panel, October 18-20, 1999, Washington D.C.
Convener: 21st Midwest Environmental Chemistry Workshop, October 16-18, 1998, Ann Arbor MI.
Session Chair: "Contaminant Speciation and Reactivity," 21st Midwest Environmental Chemistry Workshop," October 16-18, 1998, Ann Arbor MI.
Member, EPA/DOE/NSF/ONR Joint Program in Bioremediation Proposal Review Panel, Washington D.C, April 29 - May 2, 1998.
Member, EPA STAR Fellowships Chemistry and Material Sciences Panel to select the EPA Graduate Fellowship Recipients, January 12-14, 1998, Washington D.C.
Session Chair: "Sorption Phenomena IV-Surfactants and Mixtures," 70th Colloid and Interfacial Science Symposium, Postdam NY, June 1996.
Discussion Leader, "Solid-Liquid and Solid Gas Interphases: Surface Reaction Mechanisms and Kinetics," DOE Workshop on Molecular Environmental Science, Airlie VA, July 5-8, 1995.
Member, Department of Energy, Subsurface Science Program, Multiphase Fluid Flow Subprogram (1989-1995).
Member, NSF Minority Graduate Fellowship Program Committee, 1989-1994, Washington D.C.
Member, EPA Office of Exploratory Research Proposal Review Panel, Washington D.C, April 15-17, 1994.
Co-Chair, Second Forum on NSF Research Activities in Subsurface Systems, Ann Arbor MI, 1993 (organization of forum and discussion leader).
Member, NSF Equipment Grants Evaluation Panel Grants, April 9, 1991, Washington D.C.

Professional Organizations:

Association of Environmental Engineering and Science Professors
American Chemical Society
American Geophysical Union
American Society of Civil Engineers

Service at the University of Michigan:

University

Member, Advisory Committee, UM Transportation Research Institute, 2015- 2017.
Member, Distinguished University Professor Awards Committee, 2005-2007.
SNRE School Reviewer for the Provost's Office, Winter Term, 2005.
Rackham Divisional Board, 2001-2003.
Rackham Predoctoral Fellowship Awards Committee, 1991-1992.

College of Engineering (CoE)

Participant, CoE Leadership Retreat, June 28-29th, 2017.
Member, CoE Executive Committee, September 2009 – August 31, 2011.
Member, CoE Sustainability & Ethics Education Implementation Committee, Sept. 2009 -2012.

Member, CoE Alumni Society Awards Selection Committee, Winter 2010.
Member, CoE Budget Committee, 2009 – 2010.
Member, Mechanical Engineering, S. Skerlos Promotion and Tenure Casebook Committee, 2005-06.
Member, CoE AOSS/CEE Reorganization Committee, May 2002 – December 2002.
Chair, CoE Curriculum Committee, 1996-1998; member 1995-1998.
Co-Chair, CoE IESSET Curriculum Committee, 1998-2000, member 1997-2000.
Member, CoE ABET99 Committee, 1998-2000.
Member, CoE Nominating Committee, 1995-1996.
Member, CoE Feasibility Study Committee for the Formation of a Department of Environmental Engineering, 1992-1993.
Member, Department of NERS, L. Wang Promotion Committee, 2001-2002.
Freshman Mentor, CoE, 1993-1997.

Civil and Environmental Engineering Department (CEE)

Donald Malloure Department Chair, July 1, 2015 – to August, 2017.
Department Chair, January 1, 2013 to August 31, 2017.
Interim Chair, Sept 1, 2011 – Dec 31, 2012.
ex Officio member, CEE Executive Committee, , Sept 2011 –present.
Coordinator, CEE External Relations Committee, Sept 2012 – present.
Member, CEE Space/Facilities Planning Committee, Sept 2012 – present.
Member, CEE Strategic Plan Implementation Committee, Sept. 1, 2011 – present.
Chair, CEE, A. Michalak Promotion and Tenure Committee, 2008-09.
Program Director, Environmental and Water Resources Engineering, CEE, 2001-2007.
Chair, CEE, Honors and Awards Committee, 2005-2008.
Chair, CEE, J. Semrau Promotion Committee, 2006-2007.
Chair, CEE Graduate Committee, September 1999 to 2001.
Chair, CEE M. Barcelona Promotion Committee, 1995-1996.
Chair, CEE Faculty Search Committee, 1996-1999.
Member, CEE Executive Committee, 2001-to 2007.
Member, CEE Department Review Committee, 2000-2001.
Member, CEE Department Chair Search Committee, 2000-2001.
Member, CEE Faculty Search Committee, 1991-1993.
Member, CEE Department Chair Search Committee, 1993-1996.
Member, CEE, R Michalowski Tenure Committee, 2001-2002.
Member, CEE, J. Semrau Reappointment Committee, 1997-1998.
Member, CEE, J. Everett Tenure/Promotion Committee, 1997-1998.
Member, CEE, P. Goovaerts Reappointment Committee, 1999-2000.
Member, CEE Curriculum Committee, 1998 - 2001.
Member, CEE ABET Committee, 1998 -2001.
Member, CEE Graduate Committee, 1995-1997, 1998 to 2001.
Member, CEE Research Committee, 1988-1996.
Member, CEE Safety Committee, 1991-1993.
Chair, CEE Search Committee for Environ. Laboratory Manager, 1988.
Member, Completed Ph.D. Committees not as Chair or Co-Chair: 50.

CEE, Department of Education Fellowship Program, co-PI and co-administrator of a DoEd grant supporting 12 fellowships annually for the three year period, 1991-1994.

Research:

Characterization of Metal Ion Sorption. Over the past 30 years, a major research thrust of my research group has involved the investigation of metal ion sorption processes at mineral-water interfaces so that improved models for predicting sorption could be developed in more complex soil systems. This work started with the first successful application of x-ray absorption spectroscopy (XAS) for studying the coordination structure of ions sorbed at mineral-water interfaces (Hayes et al., Science 1987), and later led to successful characterization of metals sorbed in complex clay systems (Papelis and Hayes, 1996; Chen et al., 1998; Chen and Hayes, 1999; Chen et al., 2004; Hyun and Hayes, 2004, 2015) and the advancement of more accurate depictions of interfacial reactions in surface complexation models (Katz and Hayes, 1996 a,b; Hayes and Katz, 1997; Boyle-Wight, Katz and Hayes, 2002 a,b; Hyun et al., 2009). This work exemplified successful demonstrations of the applicability of state-of-the-art tools such as XAS for studying and characterizing aqueous environmental interfacial chemical reactions. It began with my dissertation work at Stanford University (Hayes, 1987) and was subsequently continued at UM through the dissertation work of two former Ph.D. graduates (Katz, Ph.D., 1993 and Chen, Ph.D., 1999) and work performed at UM by two former postdoctoral fellows (Papelis, 1992-1994; Hyun, 2002-2011).

These approaches were extended to anoxic systems by three Ph.D. graduates (Jeong, Ph.D. 2005, Gallegos Ph.D. 2007, Han, Ph.D. 2009), who characterized metal and oxyanion uptake by the reduced iron sulfide, mackinawite (Gallegos et al., 2007; 2008; Jeong et al. 2007a-c; 2008; 2010 a-c; Han et al., 2011a,b, 2015). And more recently by two former Ph.D. students (Upadhyaya, 2010; Clancy 2015) who characterized the interaction of As with iron sulfides created in an anaerobic biological activated carbon treatment system (Upadhyaya et al., 2010), and in iron sulfides encapsulated in cements (Clancy et al., 2015), and a previous postdoctoral fellow/assistant research scientist (2002-2011) who developed a mechanistic understanding of the reduction of U(VI) by solid phase iron sulfide and dissolved sulfide (Hyun et al. 2012, 2014). In addition, one Ph.D. graduate student (Bi, 2014) established the mechanistic basis for the inhibition by iron sulfide of the oxidation of U(IV) species to U(VI) by oxygen by characterizing solid and surface phase U speciation (Bi et al., 2013; Bi and Hayes, 2014a,b; Bi et al., 2015, 2016, and Carpenter et al., 2015).

My research team's expertise on the spectroscopic characterization of the coordination environments of sorbed metal ions has been applied in several collaborations on the use of nano-scale particles for metal ion remediation. One project involved preparing nano-structured materials with high metal ion and oxyanion selectivity as part of a NIEHS Center (1999-2006). Nano-structured materials were prepared by Pinnavaia (Michigan State University). My research team utilized x-ray absorption spectroscopy to characterize the coordination environment of the sorbed metal ions in these nanostructured materials to determine the basis for their high selectivity (Chen et al., 2004). Additionally, we utilized the facilities at two other National Laboratory, Stanford Synchrotron Radiation Laboratory and Pacific Northwestern National Laboratory, to investigate uranium reactions with iron sulfides, as part of a past DOE supported project in partnership with Arizona State University (co-PI, Rittmann) and Lawrence Berkeley National Laboratory (co-I, Davis). In the DOE project, we investigated the chemical reactions

controlling the mobility of uranium in groundwater under varying redox conditions in support of field studies being conducted at the former mill tailings site in Rifle CO (Bi et al., 2013, 2015; Bi and Hayes 2014a,b; Carpenter et al., 2015; Hyun et al. 2009; 2012; 2014; Zhou et al., 2014, 2015).

Surfactants for Groundwater Remediation. For more than ten years, my research team performed research on the application of surfactants for groundwater remediation. Highlights of this work included the development of a novel HPLC analytical chemistry method for separating and quantifying individual nonionic surfactant components in Poisson-distributed multi-component surfactant mixtures (Kibbey and Hayes, 1996), the application of this new method for studying surfactant sorption to aquifer materials (Kibbey and Hayes, 1997), and the development and demonstration of a numerical model for predicting surfactant sorption in polydisperse surfactant mixtures (Kibbey and Hayes, 1998 a,b). Later, we investigated the relationships among surfactant, organic liquid, and aquifer soil properties with the goal of establishing guidelines for minimizing surfactant losses through sorption, emulsion or partitioning (Butler and Hayes, 1999c; Zimmerman et al., 1999; Cowell et al., 2000). This work was part of a collaborative effort with others (Abriola, formally of UM CEE but now at Tufts University) to design optimal surfactant flushing systems for decontaminating soils. In a related collaboration with Demond (CEE), the mechanistic basis for the impact of surface active agents on transport properties of immiscible organic liquids in porous media was established. These results were highlighted in a dissertation (Lord, 1999) and a series of papers (Lord et al., 1997a,b and Lord et al., 1999).

During the 90s, my research group was also engaged in activities to move the laboratory work on surfactants for groundwater remediation to the field as part of a multi-investigator, multi-institutional project sponsored by the Michigan Department of Environmental Quality to cleanup a site in Oscoda, MI contaminated with tetrachloroethylene (PCE). This work involved three graduate students (Kibbey, Cowell, and Zimmerman) and resulted in the development of fundamental guidelines for selecting optimal surfactant systems based on contaminant and geochemical characteristics of a contaminated site. This work was published in one dissertation (Kibbey, 1997) and a series of papers (Kibbey and Hayes, 1998a,b; Zimmerman et al., 1999; and Cowell et al., 2000). In addition, a pilot-scale air-stripping system was tested for the stripping out the contaminants from surfactant flushing solution. This system was used in a pilot-scale demonstration at the site (June - August, 2000; as summarized in Abriola et al., 2004). The surfactant flushing solutions were pumped into the ground in a controlled-flow scenario to facilitate the removal of PCE entrapped in the subsurface soil. The PCE-laden surfactant solution emerging from the surfactant extraction solution was treated by air-stripping to remove the PCE. As part of this effort, a numerical model for air-stripping was modified for surfactant solutions and used to acquire the design parameters for the scale-up. Another aspect of the surfactant flushing technology was the development of a density modified displacement (DMD) approach to remove the denser than water organic liquids (DNAPL) entrapped in the subsurface pore spaces by turning DNAPLs into lighter than water liquids (LNAPL) so that they would not sink when mobilized and could be more easily extracted to the surface by surfactant flushing solutions. This work was in collaboration with researchers at Georgia Tech (Pennell, Ramsburg). Four articles were published in this area (Ramsburg et al., 2002, 2003; Kibbey et al., 2001; 2002).

Water Treatment and Purification Using Nanotechnology. My research group conducted fundamental studies of reductive dechlorination processes by natural and synthetic nanoparticulate material from the mid-1990s through 2013. The goal of this work was to establish the mechanistic basis by which reduced iron minerals dechlorinated priority pollutants to less harmful byproducts. One of the more exciting results from this work was the finding that the reduced iron sulfide mineral, mackinawite (FeS(s)), is highly reactive and nearly completely dechlorinates one and two-carbon chlorinated compounds to benign end products, in contrast to anaerobic microbiological systems that usually lead to the production of vinyl chloride (a toxic and non-desirable byproduct). The initial work led to the successful completion of one dissertation (Butler, 1998) and was published in a series of papers (Butler and Hayes, 1998; 1999; 2000; 2001; 2002).

Following up on the reductive dechlorination studies cited above, two additional graduate students successfully completed their Ph.D. dissertations in this topic area (Jeong, 2005 and Danielsen, 2004). The later student published two papers (Danielsen and Hayes, 2004; Danielsen et al. 2005) while the former has published six papers in this area (Jeong and Hayes, 2003; Jeong et al., 2007 a, b; Jeong and Hayes, 2007; Jeong et al., 2008; Jeong et al., 2010). A National Institute of Environmental Health Sciences (NIEHS) Center proposal supported this work from 1999-2006. In 2004-2005, a DOD/ESTCP project supported a feasibility study of using *in situ* precipitation of FeS in the field for reductive dechlorination of chloroethylene compounds (Hyun and Hayes, 2009, 2015). A later NSF project (2007-2010) investigated the potential for reduced iron minerals produced under simulated iron and sulfate reducing conditions to reductively dechlorinate chloroethylene compounds (Hyun and Hayes, 2009, 2015; Jeong et al., 2011; 2013; Han et al., 2012).

The feasibility of using FeS for treating toxic heavy metal (e.g., Cd and Hg) and metalloid (e.g., As) contaminated water was tested in a project sponsored by DOD/SERDP (2004-2009) to develop reduced iron nanoparticulate materials for field applications for groundwater remediation of metals. Five dissertations (Jeong, 2005; Gallegos, 2007; Han, 2009; Lee, 2009; Henderson, 2009) and related publications (Gallegos et al., 2007; 2008; Jeong et. al. 2008; 2010 a,b; Han et al. 2011a,b; 2013; 2014) resulted from this collaborative effort with faculty from UM (Adriaens, Demond, Olson, CEE) and Tufts University (Abriola). More recently, in 2015, my research team that included a postdoctoral fellow (Bi), and a research assistant (Zhang) initiated a study on the use FeS as a Fenton reagent for the advanced oxidation of pharmaceuticals and personal care products (PPCPs). That has so far resulted in one presentation at a national conference of the American Chemical Society (Zhang et al., 2016).

My research team and collaborators from Arizona State University (ASU: B. Rittmann) and USGS Menlo Park, CA (J. Davis), were awarded a grant from the DOE SBR program (2009-2013) to investigate the application of FeS for effective sequestration and protection of groundwater from U contamination at an old mill tailings sight in Rifle CO. The integrated field challenge research (IFCR) site at Rifle CO was one of 4 large-scale sites supported by DOE to demonstrate mechanism of contaminant transport and potential remediation methods for clean-up of contaminated groundwater at these sites. The primarily laboratory effort at UM was in support of the field studies at Rifle. Two UM graduate students (Bi and Carpenter), and one former assistant research scientist (Hyun), worked on this project resulting in one dissertation (Bi, 2014) and a series of publications (Hyun et al. 2009; 2012; 2014; Bi et al., 2013, 2015, 2016; Bi and Hayes 2014a,b; Carpenter et al., 2015; Zhou et al., 2014a,b, 2016).

In collaboration with Professor Raskin's (CEE) research group, my research team has been testing the potential for FeS, generated in biological activated carbon anaerobic drinking water treatment systems, to remove oxyacids including arsenic from contaminated drinking water supplies. This work led to an invention disclosure (UM 4430) and funding from Water Environment Federation (2009-2011) and NSF (2010-2013). This work was also showcased at the 2009 U-M Tech Transfer's Annual "Celebrate Inventions" in which inventors' from UM presented their work to community leaders, entrepreneurs, and industry representatives to initiate discussions on commercialization opportunities. One dissertation (Upadhyaya, 2010) and related publications have demonstrated the potential of these treatment systems (Upadhyaya et al., 2010; 2012a,b; Snyder et al., 2016). One dissertation (Clancy, 2015) evaluated the potential of various disposal methods for stabilizing As-laden iron oxide solid waste generated from a drinking water system for removing As. Three papers resulted from this effort (Clancy et al., 2013, 2015; Webster et al., 2016). Following this work, a three-year project "The Sustainability of Safe Drinking Water Supply in Bangladesh, an Integrated Assessment" was initiated in November 2015. In the summer of 2016, a team of two MSE students (Rodriquez and van Veldon) and one Ph.D. Student (Reddy) traveled to Bangladesh to assess the performance and sustainability of well-water monitoring for arsenic, and iron filtration systems for arsenic removal from well water in rural areas of the country. In collaboration with the Arsenic Asian Network NGO, the team also surveyed the local residence for their understanding and willingness to adapt sustainable water quality monitoring systems for arsenic.

My group was among the first to recognize the potential for reduced iron sulfide systems for treating waste mixtures and has been a leader in establishing the fundamental basis for the complex and favorable material behavior for water treatment.

Biogeochemical Transformation of Contaminants. Another thrust area my group examined is the interplay between microbiological and geochemical processes in contaminant fate and transport. Metals play a significant role in the regulation of enzymes and gene expression in microorganisms used for pollutant degradation. An NSF funded project (1997-2000) and collaboration with Professor Semrau (CEE) assessed the impact of copper speciation on a group of organisms known as methanotrophs. The ability of these organisms to co-metabolically degrade chlorinated compounds such as trichloroethylene depends on their ability to express an enzyme known as methane monooxygenase (MMO). My team's role was to characterize the speciation or form of copper in soil systems and to look at the impact of Cu speciation, once defined, on enzyme expression and gene regulation. A dissertation and series of papers were published highlighting this work (Morton et al., 1999; 2000; 2001; Morton 2000).

My research group also teamed up with another colleague at UM (Adriaens, CEE) to investigate the relative importance of microbiological (biotic) versus chemical (abiotic) processes on pollutant transformation reactions as part of a three year EPA grant (1997-2000). In one study, we found that the dissolution of the mineral quartz had a significant impact on biodegradation rates of the cationic surfactant, octylamine. This study, which was the basis for a Ph.D. dissertation (Selig 1997), illustrated that products from mineral dissolution can enhance the rates of microbiological growth and disappearance of inhibitory substrates such as octylamine by the formation of a less toxic octylamine-dissolved Si complex (Selig et al., 1997). My research team has also performed work demonstrating the relative importance of abiotic and biotic reductive dechlorination processes for the conversion of chlorinated contaminants to less harmful forms in groundwater systems. Three former graduate students (Butler, Danielsen, and

Jeong) completed dissertations and a series of papers on this topic as also mentioned above (Butler and Hayes, 1998; 1999, 2000; 2001; 2002; Danielsen and Hayes, 2004; Danielsen et. al, 2005; Jeong et al., 2003). One aspect supported by a DOD/SERDP funded project (2004-2009; Final Report: Hayes et al., 2009) was to establish the feasibility of using sulfate reducing bacteria (SRB) to regenerate FeS once the original FeS material had become oxidized. Similarly, a DOE SBR funded project (2009 - 2013), in part, investigated the potential for SRB generated FeS to inhibit U oxidative mobilization when oxidants are re-introduced in the groundwater (Bi et al., 2013, 2016; Bi and Hayes, 2014a,b; Carpenter et al., 2015).

As mentioned above, in collaboration with Professor Raskin's group, we developed an anaerobic biological activated carbon drinking water treatment system for the removal of arsenic, nitrate, and other oxyacids. Two former Ph.D. students (Clancy 2014; Upadhyaya, 2010) worked on this system which led to 4 publications (Upadhyaya et al. 2010; 2012 a,b; Snyder et al., 2016).

Industrial Ecology and Green Chemistry. From 2000 to 2011 in collaboration with Professor Skerlos (ME), we investigated ways to improve metal working fluids (MWFs) formulations with the goal of enhancing the longevity and reducing environmental impact of MWFs while maintaining performance. MFWs are a central and vital enabling technology for metal fabricated products in aerospace, automotive, electronics, and defense industries to name a few that form the backbone of the national economy. The U.S. consumption of MWFs in 1998 was over one billion gallons and is growing each year. During this period, MWF cost more than \$1 dollar per gallon to purchase and at least that much per gallon for disposal. Hence improvements in performance and longevity have potential for substantial cost savings. This work formed the basis for a 3-year EPA project (2004-2007) to develop vegetable based oil MWFs and a 3-year NSF project (2006-2009) to develop supercritical CO₂ based MWF formulations. The success of these efforts are represented in a variety of publications by our Ph.D. students (Zimmerman et al., 2003; 2004; Zhao et al., 2005; Clarens et al., 2006; Clarens et al., 2007a; 2007b; Skerlos et al., 2007; Clarens et al., 2008; Zhao et al., 2008; Clarens et al., 2009 a,b; McClean et al., 2009). The effort on scCO₂ led to 3 invention disclosures (UM 3024, 4035 and 4017), 2 patents (Metal Working Lubricant Formulations Based on Supercritical CO₂: #7,414,015 and #8,167,092) on the use and delivery of scCO₂ metalworking fluids, a startup company (Fusion Coolant), and significant industry interest and industrial partnerships (Ford Motor Company, Caterpillar, Pratt & Whitney, and Boeing Corporation). These partnerships led to the pilot testing of the new technology at Ford Motor Company and Caterpillar. Fusion Coolant, a startup company that evolved from this effort and based in Ann Arbor, has secured the rights to license the technology covered by the patent and invention disclosures, and is currently developing these technologies for market applications.

Reducing Water Footprints Associated with Geo-Energy Extractions. Starting in 2012, in collaboration with Assistant Professor Brian Ellis (CEE), our jointly advised research team has been investigating ways to reduce the water footprint and the potential for water quality impairment associated with the practice of high water volume hydraulic fracturing of shale gas plays. This led to funding by NSF (2012-2015) to investigate the interaction of fracking fluids with shale from two formations in the state of Michigan (Utica-Collingwood and Antrim). This has funded the work of one Ph.D. student (Fan) and resulted in seven presentations at national conferences so far. We also conducted in 2013 a field sampling campaign (in collaboration with Encana) to analyze shale formation brines and hydraulic fracturing waste flowback fluids from an active production well in Michigan to assess water quality concerns and treatment options.

Current efforts are also investigating the potential for specially functionalized strong acid resins for removing Radium from produced and flowback wastewater from fracking operations. One paper has so far resulted from this effort (Bi et al., 2016).

Current Grants and Contracts

Title: The Sustainability of Safe Drinking Water Supply in Bangladesh, an Integrated Assessment

Sponsor: UM Water Center of Excellence

Dates: 11/01/2015 – 10/31/2018

Amount: \$300,000 (my share ~1/2)

PIs and or co-PIs; co-PI (PI: L. Raskin)

Title: Extraction of radioactive and toxic element contaminants from organic-rich shale in contact with hydraulic fracturing fluids

Sponsor: NSF

Dates: 09/1/2013-8/31/2016

Amount: \$353,590 (my share ~1/2)

PIs and/or co-PIs: co-PI (PI: Brian Ellis)

Past Grants and Contracts (PI: ~\$4.9M; co-PI: ~\$4.7M; Total: ~\$9.6M)

Title: Biologically-Mediated Simultaneous Removal of Nitrate and Arsenic from Drinking Water Sources

Sponsor: NSF

Dates: 5/1/2010-5/30/2014

Amount: \$353,836 (my share ~1/2)

PIs and/or co-PIs: co-PI (PI: L. Raskin)

Title: Assessing the Role of Iron Sulfides in the Long Term Sequestration of U by Sulfate Reducing Bacteria

Sponsor: DOE SBR

Dates: 8/1/09 to 07/31/2013

Amount: \$1,237,117 (UM share: \$936,710)

PIs and/or co-PIs: PI (Co-PI: Bruce Rittmann ASU, ASU share: \$300,407)

Title: Development of a BAC Bioreactor System for the Simultaneous Removal of Nitrate and Arsenic from Municipal Water Supplies

Sponsor: WRF

Dates: 02/01/2010 to 01/31/2012

Amount: \$150,000 (my share ~1/2)

PIs and/or co-PIs: co-PI

Title: XAS Study of the Role of Iron Sulfide in the Protection of Reduced Uranium against Oxidative Mobilization

Sponsor: Stanford Synchrotron Radiation Lightsource User Facility

Dates: 2009-2012

Amount: project approved for up to 60 shifts per year of beamtime (8 hours per shift)
PIs and/or co-PIs: PI

Title: Assessing the Role of Iron Sulfides in the Long Term Sequestration of U by Sulfate
Reducing Bacteria

Sponsor: Pacific Northwest National Laboratory User facility

Dates: 2009-2012

Amount: project approved for Mossbauer 1500 hrs, Scanning Multiprobe Surface Analysis
System 80 hrs, and Dual-Beam FIB/SEM 80 hrs

PIs and/or co-PIs: PI

Title: Dechlorination of VC and cis-DCE by Reduced Iron Minerals Under Iron and Sulfate
Reducing Conditions

Sponsor: NSF

Dates: 9/15/07 to 08/31/2010

Amount: \$341,010

PIs and/or co-PIs: PI

Title: Carbon Dioxide Based Metal Working Fluids

Sponsor: NSF

Dates: 9/15/06 to 08/31/2010

Amount: \$350,000

PIs and/or co-PIs: PI (with co-PI: S. Skerlos, ME)

Title: IPA (Intergovernmental Personnel Agreement for Dr. Sung Pil Hyun)

Sponsor: Department of Interior

Dates: 7/1/07 to 9/31/09

Amount: \$139,953

PIs: PI

Title: Reduced Iron Sulfide Systems for Removal of Heavy Metal Ions from Groundwater

Sponsor: DOD: Strategic Environmental Research and Development Program (SERDP)

Dates: 9/01/04 to 06/30/2009

Amount: \$1,287,844

PIs and/or co-PIs: PI (with co-PIs: L. Abriola, P. Adrieans, A. Demond, and T. Olsen)

Title: Nanoscale FeS for removal of As and Cd from groundwater

Sponsor: Stanford Synchrotron Radiation Laboratory, Stanford, CA.

Dates: 2006-2009

Amount: project approved for up to 60 shifts of beamtime (8 hours per shift)

PIs and/or co-PIs: PI (with S.P. Hyun. University of Michigan)

Title: Investigations of Nanoscale and Granular FeS for Arsenic Remediation

Sponsor: Korea Institute of Geosciences and Mineral Resources (KIGAM)

Dates: 3/1/08 to 10/31/2008

Amount: \$20,000

PIs: PI

Title: Assessing the Role of Iron Sulfides in the Long Term Sequestration of Arsenic

Sponsor: Korea Institute of Geosciences and Mineral Resources (KIGAM)

Dates: 3/1/07 to 10/31/2007

Amount: \$20,000

PIs: PI

Title: Design of Novel Petroleum-Free Metal Working Fluids

Sponsor: EPA

Dates: 1/01/04 to 12/31/2007

Amount: \$325,000

PIs and/or co-PIs: PI (with co-PI S. Skerlos, ME)

Title: Functional Nanostructures for Ground Water Remediation

Sponsor: Michigan State University subcontract on a National Institute of Environmental Health Sciences Funded Center

Dates: 4/1/00 - 3/31/06

Amount: \$644,988 (my portion)

PIs and/or co-PIs: UM-PI (with T. Pinnavaia, Michigan State University)

Title: Reductive Process for Bioremediation of Chlorinated Solvent Metal Mixtures

Sponsor: Michigan State University subcontract on a National Institute of Environmental Health Sciences Funded Center

Dates: 4/1/00 - 3/31/06

Amount: \$325,820 (my portion)

PIs and/or co-PIs: UM-PI (with C. Criddle and A. Sporman, Stanford University)

Title: Enhancement of Source Area Reductive Dechlorination by the In Situ Formation of Catalytically-Active Iron Sulfide Precipitate

Sponsor: DoD-Environmental Security Technology Certification Program ESTCP

Dates: 8/1/02 to 8/31/05

Amount: \$70,000 (my portion)

PIs and/or co-PIs: UM-PI (PI R. Hoepfel at the Naval Facilities Engineering Service Center (PI-Ron Hoepfel) and a host of investigators at other institutions including Battelle, Surbec Art Environmental/University of Oklahoma, Michigan State University, Air Force (AFCEE), USEPA (NRMRL))

Title: An Optimal Microbial Control System to Enable Environmental Improvement of Aqueous Fluidic Systems

Sponsor: Institute for Environmental Science, Engineering, and Technology (IESET), College of Engineering, University of Michigan

Dates: 4/1/00 - 3/31/05

Amount: \$86,444

PIs and/or co-PIs: co-PI (with S. Skerlos, R.B. Brown, K. Kurbayashi, K.F. Hayes, A. Rihana)

Title: Molecular-Scale Investigation of Radiation Damage on Sorbent Properties of Barrier and Binding Materials for Radionuclide Sequestration

Sponsor: Stanford Synchrotron Radiation Laboratory, Stanford, CA.

Dates: 2002-2006

Amount: project approved for up to 60 shifts of beamtime (8 hours per shift)

PIs and/or co-PIs: PI (with C.-C. Chen, University of Texas at Austin; L. Wang and R. Ewing, University of Michigan)

Title: Radiation Effects on Sorption and Mobilization of Radionuclides during Transport through the Geosphere

Sponsor: Department of Energy Environmental Management Science Program (EMSP)

Dates: 2/15/01 - 2/14/03

Amount: \$600,000 (my portion approximately 1/3)

PIs and/or co-PIs: co-PI (with L. Wang and R. Ewing)

Title: Sources, Transport, and Fate of Toxic Metals in the Geosphere

Sponsor: University of Michigan's Office of the Vice President of Research

Dates: 4/1/00 - 3/31/01 with possible extension at same level of funding for an additional year.

Amount: \$100,000 (my portion \$11,500)

PIs and/or co-PIs: co-Investigator (with J. Blum and R. Ewing, PIs; and L. Abriola, J. Keeler, and L. M. Walter, co-Investigators)

Title: Molecular Structure of Toxic Metals Entrapped by Functionalized Nanoscale Particles

Sponsor: Stanford Synchrotron Radiation Laboratory, Stanford, CA.

Dates: 2001-2004

Amount: project approved for up to 60 shifts of beamtime (8 hours per shift)

PIs and/or co-PIs: PI (with C.-C. Chen, University of Texas at Austin; T. Pinnavaia, Michigan State University)

Title: Surfactant Partitioning Studies in the Presence of Dense Nonaqueous-Phase Organic Liquid Mixtures

Sponsor: EPA Great Lakes and Mid-Atlantic Hazardous Substance Research Center

Dates: 6/1/00 - 9/17/2002

Amount: \$105,681

PIs and/or co-PIs: PI

Number of GSRA's supported: 1 GSRA

Title: Competing Effects of Metal Ion Sorption to Oxides and Clays

Sponsor: Stanford Synchrotron Radiation Laboratory, Stanford, CA.

Dates: 1996-2001

Amount: project approved for up to 60 shifts of beamtime (8 hours per shift)

PIs and/or co-PIs: PI (with S.J. Traina, Ohio State University; C. Papelis, Desert Research Institute; L.E. Katz, Univ. Texas, Austin)

Title: Surfactant Enhanced Remediation of Dense Non Aqueous Phase Liquids: Investigating the Processes Influencing the Performance of Solubilization and Density Modified Displacement

Technologies

Sponsor: EPA Great Lakes and Mid-Atlantic Hazardous Substance Research Center

Dates: 5/17/98 - 9/17/2001

Amount: \$145,314

PIs and/or co-PIs: PI

Title: Copper Bioavailability on Microbial Degradation of Trichloroethylene

Sponsor: NSF

Dates: 9/1/97 - 8/31/2000

Amount: \$440,000 (my portion approx. 1/2)

PIs and/or co-PIs: co-PI (with J. Semrau)

Title: Assessment of Biotic and Abiotic Processes Controlling the Fate of Chlorinated Solvents in Mixed-Waste under Sulfate and Iron-Reducing Conditions Using Laboratory and In Situ Microcosms

Sponsor: EPA, DOE, NSF and ONR Joint Program on Bioremediation

Dates: 9/1/97 - 8/31/2000

Amount: \$449,975 (my portion approx. by 2/5)

PIs and/or co-PIs: PI (with P. Adriaens and M. Barcelona)

Title: Remediation of Chlorinated Solvents at the Bachman Road Site Using Innovative Technologies: Microbial Halorespiration and Surfactant-Enhanced Aquifer Remediation: Phase III. Pilot Demonstration

Sponsor: DEQ (Department of Environmental Quality), State of Michigan

Dates: 7/1/99 - 12/31/99

Amount: \$966,393 (my portion ~\$40,000)

PIs and/or co-PIs: co-PI (with M. Barcelona, B. Fathepure, L.M. Abriola, and P. Adriaens, UM; J. Tiege, Michigan State University; K. Pennell and F. Loffler, Georgia Tech.)

Title: Capillary Electrophoresis System for Engineering Teaching and Research

Sponsor: NSF

Dates: 9/51/99 - 8/31/00

Amount: \$48,000

PIs and/or co-PIs: co-PI (with W. Weber, PI, and P. Adriaens, J. Semrau, K.F. Hayes, and T. P. Yavaraski)

Title: Remediation of Chlorinated Solvents at the Bachman Road Site Using Innovative Technologies: Microbial Halorespiration and Surfactant-Enhanced Aquifer Remediation: Phase II. Remedial Design

Sponsor: DEQ (Department of Environmental Quality), State of Michigan

Dates: 1/1/99 - 6/31/99

Amount: \$619,198 (my portion ~\$60,000)

PIs and/or co-PIs: co-PI (with M. Barcelona, B. Fathepure, L.M. Abriola, and P. Adriaens, UM; J. Tiege, Michigan State University; K. Pennell and F. Loffler, Georgia Tech.)

Title: The Use of Surfactants to Enhance the Removal of Chlorinated Hydrocarbons from

Aquifer Materials: Correlation Development
Sponsor: EPA Great Lakes and Mid-Atlantic Hazardous Substance Research Center
Dates: 5/17/97 - 8/17/99
Amount: \$157,813
PIs and/or co-PIs: PI

Title: Remediation of Chlorinated Solvents at the Bachman Road Site Using Innovative Technologies: Microbial Halorespiration and Surfactant-Enhanced Aquifer Remediation: Phase I. Remedial Investigations
Sponsor: DEQ (Department of Environmental Quality), State of Michigan
Dates: 3/1/97 - 8/31/98
Amount: \$846,163 (my portion ~\$50,000)
PIs and/or co-PIs: co-PI (with B. Fathepure, L.M. Abriola, and P. Adriaens-UM; J. Tiedje-Michigan State University; K. Pennell-Georgia Tech.)

Title: The Use of Surfactants to Enhance the Removal of Chlorinated Hydrocarbons from Aquifer Materials
Sponsor: EPA Great Lakes and Mid-Atlantic Hazardous Substance Research Center
Dates: 9/1/93 - 5/31/97
Amount: \$311,483 (total for my subaccount)
PIs and/or co-PIs: co-PI (with L. Abriola, A. Demond, K. Pennell)

Title: Investigation of Abiotic and Biotic Reductive Dechlorination Processes in Anaerobic Subsurface Systems
Sponsor: EPA Great Lakes and Mid-Atlantic Hazardous Substance Research Center
Dates: 6/1/96 - 5/17/98
Amount: \$236,062 (my portion ~1/2 of total)
PIs and/or co-PIs: co-PI (with P. Adriaens)

Title: The Influence of Interfacial Properties on Two-Phase Liquid Flow of Organic Contaminants in Groundwater
Sponsor: U.S. Department of Energy (DOE)
Dates: 7/1/89 - 8/30/96
Amount: \$665,707 (my portion ~1/2 of total)
PIs and/or co-PIs: PI (with A. Demond)

Title: Effects of Interfacial Properties on Contaminant Transport and Transformation in Aquatic Systems (Presidential Young Investigator Award)
Sponsor: National Science Foundation (NSF)
Dates: 6/1/89 - 5/31/95
Amount: \$290,500
PIs and/or co-PIs: PI

Title: Effect of Cationic Surfactants and Chelating Agents on the Release of Metal Ions from Soil
Sponsor: The Procter & Gamble Company

Dates: 5/1/91 - 6/31/95

Amount: \$81,000

PIs and/or co-PIs: PI

Title: High Performance Liquid Chromatograph for Environmental Engineering Teaching and Research

Sponsor: Hewlett-Packard Company, University Grants Program

Dates: 2/24/94

Amount: \$51,625

PIs and/or co-PIs: PI (with P. Adriaens, W. Weber, Jr., and T.P. Yavaraski)

Title: Assistance for Graduate Students in Environmental and Water Resources Engineering

Sponsor: United States Department of Education

Dates: 6/91 - 4/95

Amount: \$500,000

PIs and/or co-PIs: co-PI (with A. H. Demond)

Title: Remediation of Contaminated Aquifers with Surfactants: The Effect of Surfactant Adsorption-Desorption

Sponsor: EPA Great Lakes and Mid-Atlantic Hazardous Substance Research Center

Dates: 9/1/90 - 8/31/93

Amount: \$158,700

PIs and/or co-PIs: PI

Title: Ford Motor Company Fund Support for Presidential Young Investigators

Sponsor: Ford Motor Company

Dates: 9/1/92 - 8/31/93

Amount: \$17,500

PIs and/or co-PIs: PI

Title: Second Forum on NSF Research Activities in Subsurface Systems

Sponsor: National Science Foundation

Dates: 5/1/92 - 10/31/92

Amount: \$26,206

PIs and/or co-PIs: co-PI (with L. M. Abriola and A. H. Demond)

Title: Spectroscopic Studies of the Association of Hazardous Components with Soils

Sponsor: United States Air Force

Dates: 12/1/90 - 11/31/91

Amount: \$15,000

PIs and/or co-PIs: PI

Title: Effects of Interfacial Properties on Contaminant Transport and Transformation Processes in Aquatic Systems

Sponsor: Cray Research Foundation

Dates: 6/1/90 - 5/31/91

Amount: \$5,000
PIs and/or co-PIs: PI

Title: Effects of Surfactants on Partitioning of Hazardous Organic Components of JP-4 Fuel onto Low Organic Carbon Soils

Sponsor: United States Air Force, Research Initiation Grants Program

Dates: 1/1/90 - 12/31/90

Amount: \$20,000

PIs and/or co-PIs: PI

Number of GSRA's supported: None

Title: FT-IR Spectroscopic Investigation of Surfactant Adsorption at Mineral/Water Interfaces

Sponsor: United States Air Force

Dates: 6/10/89 - 8/18/89

Amount: \$10,000

PIs and/or co-PIs: PI

Publications: (citations as of September, 2017: 4,881 citations/H-Index of 35 based on *ISI Science Citation Index*; 7,594 citations/H-Index of 47 based on *Google Scholar*)

Full articles in refereed publications (journals, transactions, or archives that have appeared or have been accepted; graduate student advisees underlined):

1. T.M. Webster; R. Reddy, J. Tan, J. Van Nostrand, J. Zhou, K.F. Hayes, L. Raskin, "Anaerobic disposal of arsenic-bearing wastes results in low microbially-mediated arsenic volatilization," *Environmental Science and Technology*, 50(20), 10951-10959, 2016.
2. Y. Bi, H. Zhang, B.R. Ellis, and K.F. Hayes, "Removal of Radium from Shale Gas Wastewater by Ion Exchange Resin," *Environmental Engineering Science*, 33 (10), 791-798, 2016.
3. T.M. Webster, A.L. Smith, R. Reddy, A.J. Pinto, K.F. Hayes, L. Raskin, "Anaerobic microbial community response to methanogenic inhibitors 2-bromoethanesulfonate and propynoic acid," *MicrobiologyOpen*, 5(4), 537-550, 2016.
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10. K.F. Hayes and J.O. Leckie, "Mechanism of Lead Ion Adsorption at the Goethite/Water Interface," Chapter 7 in Geochemical Processes at Mineral Surfaces, J.A. Davis and K.F. Hayes, Eds., ACS Symposium Series No. 323, 1986.
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1. D.A. Dzombak and K.F. Hayes, Comment on "Recalculation, Evaluation, and Prediction of Surface Complexation Constants for Metal Adsorption on Iron and Manganese Oxides," *Environmental Science and Technology*, **26**, 1251-1253, 1992.
2. K.F. Hayes and W. E. Kaskan, "Inhibition of CH₄/Air Flames Stabilized on a Porous Borner with CH₃Br," *Combustion and Flame*, **24**, 405-407, 1975.

Refereed conference or symposium proceedings (graduate student advisees underlined):

1. Upadhyaya, G., P.K. Ghosh, K. F. Hayes, and L. Raskin, Drinking Water Production Using An Anaerobic Fixed-Bed Bioreactor From Water Sources Contaminated With Nitrate And Uranium, Water Quality Technology Conference & Exposition, Toronto, Ontario, Canada, Nov. 4-8, 2012.
2. D.J. MacLean, K.F. Hayes, Y.-E. Park, S.J. Skerlos, T. Barnard, T. Hull, J. Pawelec, "Impact of Supercritical Carbon Dioxide Metalworking Fluids on Tool Life in Turning of Sintered Steel and Milling of Compacted Graphite Iron," *Proceedings of the ASME International Manufacturing Science and Engineering Conference 2009*, Purdue University, West Lafayette, Indiana, USA, October 4-7, 2009.
3. A.F. Clarens, J. Temme, Y.-E. Park, K.F. Hayes, F. Zhu, and S.J. Skerlos, "Evaluation of Cooling Potential and Tool Life in Turning Using Metalworking Fluids Delivered in Supercritical Carbon Dioxide," *Proceedings of the ASME International Manufacturing Science and Engineering Conference 2009*, Purdue University, West Lafayette, Indiana, USA, October 4-7, 2009.
4. H.Y. Jeong and K.F. Hayes (Invited), "Impact of Heavy Metals on Transformation of Chloroethylenes by Mackinawite," *231th American Chemical Society National Meeting*, March 26 – 30, 2006. Atlanta GA.
5. H.Y. Jeong and K.F. Hayes, "Impact of Heavy Metals on Transformation of Chloroethylenes by Mackinawite," *The Battelle Fifth International Conference on Remediation of Chlorinated and Recalcitrant Compounds*, Monterey, California, May 2006.
6. T.J. Gallegos, K.F. Hayes, and L.M. Abriola, "Mackinawite-Ferrihydrite Coated Sand for

- Remediation of Arsenite Contaminated Groundwater,"*The Battelle Fifth International Conference on Remediation of Chlorinated and Recalcitrant Compounds*, Monterey, California, May 2006.
7. A.F. Clarens, K.F. Hayes, and S.J. Skerlos, "Development and Performance Testing of Metalworking Fluids Utilizing Supercritical Carbon Dioxide as a Carrier," *Proceedings of the International Symposium on Supercritical Fluids*, May 1-4, 2005 Orlando, Florida.
 8. T.J. Gallegos, K.F., Hayes, and L.M. Abriola, 2004. Sorption of Arsenite onto Mackinawite Coated Sand; *Proceedings of EGS-AGU-EUG Joint Assembly*, Montreal, Canada, May 17, 2005.
 9. S.J. Skerlos, P. Adriaens, K.F. Hayes, J.B. Zimmerman, and F. Zhao, "Ecological Material and Green Manufacturing: Design and Technology for Metal Working Fluid Systems," *Proceedings of the World Engineering Congress*, Shanghai, China, November 2-6, 2004.
 10. A.J. Clarens, J.B. Zimmerman, H.R. Landis, K.F. Hayes, and S.J. Skerlos, "Experimental Comparison of Vegetable and Petroleum Base Oils in Metal Working Fluids Using the Tapping Torque Test," *Proceedings of the Japan-USA Symposium on Flexible Manufacturing*, Denver, CO, July 19-21, 2004.
 11. J. B. Zimmerman, K. F. Hayes, and S. J. Skerlos, "Comparative Life Cycle Analysis of Petroleum- and Bio-Based Metal Working Fluids," *Industrial Society of Industrial Ecology Annual Meeting*, Ann Arbor, Michigan, June 29-July 2, 2003.
 12. S. J. Skerlos, K. F. Hayes, W.R. Morrow, J.B. Zimmerman, "Diffusion of Sustainable Systems Engineering Through Interdisciplinary Graduate and Undergraduate Education," *American Society of Mechanical Engineers, MED 14*, v14, Washington D.C., Nov. 2003, 599-606.
 13. M.L. McCormick, P.T. Jung, P.G. Koster van Groos, K. F. Hayes, P. Adriaens, E. Petrovskis, and K.L. Skubal, "Assessing biotic and abiotic contributions to chlorinated solvent transformation in iron reducing and sulfidogenic environments," In *Groundwater Quality: Natural and Enhanced Restoration of Groundwater Pollution* (Proceedings of the Groundwater Quality 2001 Conference held at Sheffield, UK, June 2001), IAHS Publ. no. 275:119-125, 2002.
 14. C.A. Ramsburg, K.D. Pennell, T.C.G. Kibbey, and K.F. Hayes, "Density Modified Displacement of Trichloroethylene Using an n-Butanol/Surfactant Macroemulsion Conditioning Flood," *Proceedings and Student Paper Competition for the 3rd Conference on Remediation of Chlorinated and Recalcitrant Compounds*, Monterey, CA, May 20-23, 2002.
 15. K. Danielsen and K.F. Hayes, "The Influence of Geochemistry on Carbon Tetrachloride Dechlorination Rates and Product Distributions in Magnetite Mediated Systems," *Proceedings for the 3rd International Conference on Remediation of Chlorinated and Recalcitrant Compounds*," Monterey, CA, May 20-23, 2002.
 16. P. Adriaens, M. J. Barcelona, K. F. Hayes, M. L. McCormick, K. L. Skubal, "Biotic and Abiotic Dechlorination in Iron-Reducing and Sulfidogenic Environments," *International In Situ and On-Site Bioremediation Symposium, 6th*, San Diego, CA, United States, June 4-7, 8:193-199.
 17. S.J. Skerlos, P. Adriaens, K.F. Hayes, A. Rihana, K. Kurabayashi, S. Takayama, J.B. Zimmerman, and F. Zhao, "Challenges to Achieving Sustainable Aqueous Systems: A Case Study in Metalworking Fluids," *Proceedings of EcoDesign 2001: 2nd International*

Symposium on Environmentally Conscious Design and Inverse Manufacturing, Tokyo, Japan, December 2001.

18. M.L. McCormick, P.T. Jung, P. G. Koster van Groos, K.F. Hayes, and P. Adriaens, "Assessing biotic and abiotic contributions to chlorinated solvent transformation in iron reducing and sulfidogenic environments," *Groundwater Quality 2001, 3rd International Conference*, University of Sheffield, U.K, June 18-21, 2001.
19. P. Adriaens, M.J. Barcelona, K.F. Hayes, M.L. McCormick, and K. L. Skubal, 2001, "Biotic and Abiotic Dechlorination in Iron-Reducing and Sulfidogenic Environments," *In Situ and On-Site Bioremediation*, *Sixth International Symposium*, June 4-7, San Diego, CA.
20. M.A. Cowell, T.C.G. Kibbey, J.B. Zimmerman, and K.F. Hayes, "Partitioning of Surfactants into Non-Aqueous Phase Liquid (NAPL) Contaminants in Surfactant Enhanced Aquifer Remediation: Relationships between Partitioning Behavior and Surfactant/NAPL Properties," *Enviromeet'98 Symposium*, Irving CA, July 20-23, 1998.
21. J.B. Zimmerman, T.C.G. Kibbey, M.A. Cowell, and K.F. Hayes, "A Quantitative Assessment of the Influence of Surfactant Partitioning into Non-Aqueous Phase Organic Liquid (NAPL) Contaminants on Solubilization Efficiency in Surfactant Enhanced Aquifer Remediation," *Enviromeet'98 Symposium*, Irving CA, July 20-23, 1998.
22. D.L Lord, K.F. Hayes, and A.H. Demond, "Effects of Surface Chemistry on Interfacial Tension, Wettability, and Capillary Pressure in Multiphase Subsurface Waste Systems," *Enviromeet'98 Symposium*, Irving CA, July 20-23, 1998.
23. K.R. Srinivasan, J.D. Morton, and K.F. Hayes, "Remediation of Contaminated Aquifers with Surfactants: Effect of Surfactant Sorption and Desorption," *Proceedings of the 1993 Joint CSCE-ASCE National Conference on Environmental Engineering*.
24. F.N. Desai, H.R. Hamad, and K.F. Hayes, "Determination of Dynamic Electrophoretic Mobility of Quartz by Electrokinetic Sonic Amplitude (ESA) Measurements," *Symposium on Electroacoustics for Characterization of Particles in Suspension*, National Institute of Standards and Technology, Gaithersburg, MD, Feb. 3-4, 1993.

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1. K.F. Hayes (invited), "Nano-scale FeS_{x-1} as a key agent for pollutant transformations and redox buffering in suboxic systems," Goldschmidt 2017, Paris, France, August 13-18, 2017.
2. K.F. Hayes (Invited), "Reactivity of nanoparticulate iron sulfide (mackinawite)," 253rd ACS National Meeting, San Francisco CA, April 2 - 6, 2017.
3. W. Fan, K.F. Hayes, and B.R. Ellis, "Arsenic mobilization in carbonate-rich shales during hydraulic fracturing," 253rd ACS National Meeting, San Francisco CA, April 2 - 6, 2017.
4. Reddy, R.R., G. A. van Velden, G. D. Rodriguez, M. R. Karim, M. J. Abedin, T. M. Webster, A. Agrawal, K. F. Hayes, L. Raskin, "The sustainability of safe drinking water rural Bangladesh," 24th Triennial Borchardt Conference, Ann Arbor, MI, February 21-22, 2017.
5. W. Fan, K.F. Hayes, and B.R. Ellis, "Impact of Carbonate Dissolution on Arsenic Release during Shale Gas Extraction," Goldschmidt 2016, Yokohama, Japan, June, 26-July 1, 2016.

6. Y. Bi, H. Zhang, K. Wigginton, K. F. Hayes, "Chemistry & Application of Advanced Oxidation Processes for Water Treatment," 251st American Chemical Society National, San Diego CA, March 13-17, 2016.
7. W. Fan, K.F. Hayes, B.R. Ellis, "Exploring the origin of Radium in shale gas produced water," 251st ACS National Meeting, San Diego CA, March 14-18, 2016.
8. Y. Bi, W. Fan, T. Yavarski, B.R. Ellis, K.F. Hayes, (2016). "Direct Analysis of Radium-226 in Shale-Gas Wastewater Using Inductively Coupled Plasma - Mass Spectrometry," PITTCON, Atlanta GA, March 6-10, 2016.
9. L. Raskin, G. Upadhyaya, K. F. Hayes, N. Kotlarz, M. J. Kirisits, A. E. You, and J. Brown "Hexavalent Chromium Removal From Drinking Water Sources Using Fixed-Bed Bioreactors," 2016 American Water Works Association International Symposium on Biological Treatment in Long Beach, California, January 27-28, 2016.
10. W. Fan, K.F. Hayes, B.R. Ellis, "Assessing Radium Activity in Shale Gas Produced Brine," 2015 AGU Fall Meeting, San Francisco CA, December 14-18, 2015.
11. R. Reddy, A. Kabir, S. Uddin, A. S. Khan, W. Ullah, A. Haqim, J. Tan, K. F. Hayes, L. Raskin, and T. Clancy, "Safe handling and disposal of arsenic-bearing drinking water treatment wastes in Bangladesh," 2015 Oklahoma University Water Conference and International Water Prize Award Ceremony, Norman OK, Sept. 21-23, 2015.
12. K.F. Hayes (invited), J. Carpenter, and Y. Bi. "Impact of nano-scale iron sulfides on abiotic oxidative dissolution of UO₂," Goldschmidt 2015, Prague, Czech Republic, August 16-21, 2015.
13. B. R. Ellis (invited), W. Fan, M. Tang, K. F. Hayes, W. Xiong, D. E. Giammar, and P. Skemer, "Alteration of Fracture Geometries During Flow of Acidic Fluids: Implications for Subsurface Energy Technologies," 250th ACS National Meeting, Boston MA, August 16-20, 2015.
14. Y. Bi, H. Zhang, K.F. Hayes, E.R. Ellis, "Removal of Radium from Shale Gas Wastewater Using Cation Exchange Resin," Association of Environmental Engineering and Science Professors, New Haven, CT, June 13-16, 2015.
15. Y. Bi, M. Stylo, R.B.-Latmani, and K.F. Hayes "Rapid Mobilization of Noncrystalline U(IV) Coupled with FeS Oxidation," 249th ACS National Meeting Denver, Colorado, March 22-26, 2015.
16. Y. Bi, H. Zhang, K.F. Hayes, B.R. Ellis "Removal of Radium from Shale Gas Wastewater Using Cation Exchange Resin," 249th ACS National Meeting Denver, Colorado, March 22-26, 2015.
17. T.M. Clancy, R. Reddy, J. Tan, K. F. Hayes, L. Raskin, "Linking microbial activity with arsenic fate during cow dung disposal of arsenic-bearing wastes, 2014 AGU Fall Meeting, San Francisco, December 15 -19, 2014.
18. W. Fan, K.F. Hayes, B.R. Ellis, "Investigation of Controlling Factors Impacting Water Quality in Shale Gas Produced Brine," 2014 AGU Fall Meeting, San Francisco CA, December 15 -19, 2014.
19. B.R. Ellis, K.F. Hayes, and W. Fan "Evaluating Naturally Occurring Radioactive Materials in Michigan Basin Shale Gas Produced Fluids," at 2014 SSSA Session on "Environmental Impacts of Hydraulic Fracturing, ISR U Mining, and Alternative Energy" in Long Beach, CA, Nov. 2-5, 2014.
20. Y. Bi, and K.F. Hayes "Nano-FeS Control of Uraninite Reoxidation in Oxidic Groundwater," Goldschmidt 2014, Sacramento CA, June 8 - 13, 2014.

21. W. Fan, T. Zhang, J. Carpenter, K.F. Hayes, and B.R. Ellis, "Experimental investigations of trace metal and radionuclide leaching from shales in contact with hydraulic fracturing fluids," 247th ACS National Meeting & Exposition, Dallas, TX, March 16- 20, 2014.
22. G. Upadhyaya, N. Kotlarz, K.F. Hayes, L. Raskin, J. Brown, Efficient Removal of Multiple Contaminants Using Two-Stage Biologically Active Carbon Bioreactors, 2013 Water Quality Technology Conference, Long Beach, California, November 3-6, 2013.
23. B.R. Ellis and K.F. Hayes "Geochemical investigations of Michigan basin organic-rich shales in contact with hydraulic fracturing fluids," Geochemistry Division Session on Geochemistry of Shales: From Gas to Hydraulic Fracturing, 246th ACS National Meeting & Exposition, Indianapolis, IN, Sept. 8-12, 2013.
24. T.M. Clancy, K.V. Snyder, K.F. Hayes, L. Raskin, "Release of arsenic from concrete stabilized drinking water treatment waste under environmentally relevant conditions," 246th ACS National Meeting, Indianapolis, IN, Sept. 8-12, 2013.
25. Y. Bi, J. and K.F. Hayes, "Enhanced Stability and Inhibited Dissolution of Uraninite by Nanoparticulate Iron Sulfide Under Oxic Conditions," in Geochemical mechanisms of mineral-based amendments for soil and sediment remediation, Goldschmidt 2013, Florence, Italy, August 25-30, 2013.
26. B.R. Ellis and K.F. Hayes, "Water quality concerns surrounding shale gas development in the Michigan Basin," at the conference on Overcoming the Environmental and Community Challenges of Hydraulic Fracturing for Shale Gas," Engineering Conferences International, Boulder CO., August 4 - 8, 2013.
27. B.R. Ellis and K.F. Hayes, "Assessing the state of play for the unconventional drilling in the Michigan Basin," 2013 AEESP 50th Anniversary Conference, Environmental Engineers and Scientists of 2050: Education, Research, and Practice, University of Colorado, Denver CO, July 14 - 16, 2013.
28. T.M. Clancy, K.V. Snyder, K.F. Hayes, L. Raskin, "Evaluating the use of concrete stabilized arsenic-bearing waste," 2013 AEESP 50th Anniversary Conference, Environmental Engineers and Scientists of 2050: Education, Research, and Practice, University of Colorado, Denver CO July 14 - 16, 2013.
29. T.M. Clancy, K.V. Snyder, K.F. Hayes, L. Raskin, "Microbial activity related to arsenic-bearing waste stability in disposal environments," 5th International Conference, Microbial Ecology and Water Engineering 2013 (MEWE 2013), Ann Arbor, Michigan, July 7 - 10, 2013.
30. Y. Bi, J. Carpenter, and K.F. Hayes, " Impact of iron sulfide minerals on UO₂ reoxidation in groundwater", 245rd National Meeting of American Chemical Society, New Orleans LA, April 7-11, 2013.
31. G. Upadhyaya, K.F. Hayes, L. Raskin, J. Brown, "Fixed-Bed Biological Active Carbon (BAC) Bioreactors Remove Multiple Contaminants Simultaneously," American Water Works Association 2013 Biological Treatment Symposium, Denver, CO, March 28 - 29, 2013.
32. N. Kotlarz, T.P. Yavaraski, G. Upadhyaya, R. Darnton, K.F Hayes, L. Raskin, "Overcoming Obstacles to Hexavalent Chromium Analysis at Trace Levels," PITTCON, Pennsylvania Convention Center Philadelphia, PA, March 17 - 21, 2013.
33. G. Upadhyaya, P. K. Ghosh, K.F. Hayes, T. Clancy, Y. Bi, J. Carpenter, and L. Raskin, "Drinking Water Production Using an Anaerobic Fixed-bed Bioreactor from Water Sources Contaminated with Nitrate and Uranium," Water Quality Technology

- Conference and Exposition, Toronto, Ontario Canada, Nov. 4 -8, 2012.
34. S.P. Hyun (invited), J.A. Davis, and K.F. Hayes, "Uranium (VI) reactions with aqueous and ferrous sulfide," in special symposium on Redox Transformations of Metals in Sediments at Molecular and Pore Scales, 243rd National Meeting of American Chemical Society, San Diego CA, March 25-29, 2012.
 35. Y.Bi, J. Carpenter, S.P. Hyun, and K.F. Hayes, " Inhibition of UO₂ oxidative dissolution by synthetic FeS and the implications for long-term immobilization," in special symposium in Honor of Martin Reinhard, 243rd National Meeting of American Chemical Society, San Diego CA, March 25-29, 2012.
 36. K.F. Hayes (invited), Y. Bi, J.C. Carpenter, S.P. Hyun, and R. Kukkadapu "Column and Batch Reactor Studies of the Inhibition of UO₂ oxidative dissolution by synthetic FeS," Uranium biogeochemistry: transformations and applications," International Workshop, Monte Verità, Ascona Switzerland, March 11-16, 2012.
 37. T.Clancy, T.-H. Chiao, G. Upadhyaya, A. Pinto, J. C. Brown, K. F. Hayes, C. Xi, and L. Raskin, "Backwashing and disinfection to optimize chemical and microbiological effluent quality from a fixed-bed bioreactor removing nitrate and arsenic," Water Quality Technology Conference and Exposition (WQTC), Phoenix, AZ, November 13-17, 2011.
 38. J.C. Carpenter, S.P. Hyun, and K.F. Hayes, "Influence of iron sulfide minerals on oxidation of reduced uranium solids in natural sediments," 242st National ACS meeting, August 28 - September 1, Denver, CO, 2011.
 39. J.C. Carpenter, G. Upadhyaya, T. Clancy, C. Zhou, and K.F. Hayes, "Synchrotron X-ray diffraction study of biotic and abiotic mackinawite related to uranium bioremediation and arsenic removal from drinking water," 242st National ACS meeting, August 28 - September 1, Denver, CO, 2011.
 40. E.N. Herbert, G. Upadhyaya, L. Raskin, K.F. Hayes, and V.C. Li, "Development of Bacterially-mediated self-healing in engineered cementitious composite," 3rd International Conference on Self-Healing Materials-ICSHM 2011, The Assembly Rooms, Bath, UK, 27-29 June 2011.
 41. J.C Brown,, G. Upadhyaya, T.M. Clancy, K.F. Hayes, and L. Raskin, Simultaneous Removal of Multiple Contaminants from Drinking Water Using Fixed-bed Anaerobic Bioreactors, International Water Association Leading Edge Technology (LET) Conference, Amsterdam, The Netherlands, June 6-10, 2011.
 42. Y. Bi, S. P. Hyun, K.F., Hayes, "Oxidative dissolution of uraninite by dissolved oxygen under simulated groundwater conditions in the presence of mackinawite (FeS)," 241st National ACS meeting, March 25-29, San Francisco, CA, 2011.
 43. P.K. Ghosh, , G. Upadhyaya, L. Raskin, and K. F. Hayes, Comparison of uranium and nitrate removal from simulated groundwater using mixed microbial consortia in the presence and absence of iron, International Water Association, Conference on Microbes in Wastewater and Waste Treatment, Bioremediation, and Energy Production, BITS – Pilani, Goa campus, Goa, India, January 24 – 27, 2011.
 44. S.P. Hyun, J.A. Davis, and K.F. Hayes, "Abiotic Reduction of U(VI) by Dissolved Sulfide," American Geophysical Union Fall Meeting, December 13-17, San Francisco, CA, 2010.
 45. J.C. Carpenter, S.P. Hyun, and K.F. Hayes, "Synchrotron X-ray Characterization of mackinawite and uraninite relevant to bioremediation of uranium contaminated groundwater," American Geophysical Union Fall Meeting, December 13-17, San

- Francisco, CA, 2010.
46. Y. Bi, S. P. Hyun, K.F., Hayes, “Oxidative dissolution of uraninite by dissolved oxygen under simulated groundwater conditions in the presence of mackinawite (FeS),” American Geophysical Union Fall Meeting, December 13-17, San Francisco, CA, 2010.
 47. G. Upadhyaya, T. Clancy, J. Jackson, J. Brown, K.F. Hayes, and L. Raskin, “Spatial Distribution of Arsenate and Sulfate Reducing Bacteria and their Activities in a Biofilm Reactor that Simultaneously Removes Nitrate, Arsenic, and Sulfate from Drinking Water,” ISME 13, August 22-27, 2010, Seattle, WA.
 48. G. Upadhyaya, J. Jackson, T. Clancy, J. Brown, K. F. Hayes, and L. Raskin, “Effect of Backwashing on Nitrate and Arsenic Removal from Drinking Water using Fixed-bed Biologically Active Carbon Reactors”, AWWA Annual Conference and Exposition (ACE) 2010, Chicago, Illinois, June 20-24, 2010.
 49. H.Y. Jeong, K. Sun, and K.F. Hayes, “Microscopic and Spectroscopic Characterization of Hg(II) Immobilization by Mackinawite (FeS),” 2010 Spring Union Meeting for Geoscience and Technology, Koan Society of Economic and Environmental Geology, Geological Society of Korea, and the Korean Society of Petroleum Geology, Daegu, Korea, April 28 -30, 2010.
 50. G. Upadhyaya, J. Jackson, T. Clancy, J. Brown, K. F. Hayes, and L. Raskin, “Microbial Community in a Fixed-bed Bioreactor System used for Simultaneous Removal of Nitrate and Arsenic from Drinking Water”, The Water Research Conference, Marriott Lisbon, Portugal, April 11-14, 2010.
 51. Y.-S. Han, S.P. Hyun, H.Y. Jeong, and K.F. Hayes, “Abiotic dechlorination of cis-dichloroethylene (cis-DCE) and vinyl chloride (VC) by reduced iron minerals,” in Aquatic Redox Chemistry Symposium in Honor of Donald L. Macalady, 239th ACS National Meeting, San Francisco, CA, March 21-25th, 2010.
 52. Y. Bi, S. P. Hyun, and K.F. Hayes, “Rates and mechanisms of iron(II) oxidation by dissolved oxygen,” in Aquatic Redox Chemistry Symposium in Honor of Donald L. Macalady, 239th ACS National Meeting, San Francisco, CA, March 21-25, 2010.
 53. S.P. Hyun, Y. Bi, R. Kukkadapu, K. Sun, J. Bargar, and K.F. Hayes, “Iron sulfide protection of reduced U against oxidation by dissolved oxygen,” in Aquatic Redox Chemistry Symposium in Honor of Donald L. Macalady, 239th ACS National Meeting, San Francisco, CA, March 21-25, 2010.
 54. G. Upadhyaya, J. Jackson, K. F. Hayes, J. Brown, and L. Raskin, “Application of a Fixed-Bed Bioreactor System to Achieve the Simultaneous Removal of Arsenic and Nitrate from Water,” Inorganic Contaminants Workshop, Denver, CO, Feb 28 - Mar 2, 2010.
 55. T. Clancy, G. Upadhyaya, J. Jackson, K. F. Hayes and L. Raskin, “Microbially Mediated Production of Iron Sulfides for Removal of Arsenic and Uranium from Drinking Water” Michigan AWWA & MWEA Joint Expo, Lansing Center, Feb 2, 2010.
 56. G. Upadhyaya, J. Jackson, K. F. Hayes, J. Brown, and L. Raskin, “Biologically mediated simultaneous removal of nitrate and arsenic from drinking water sources,” Water Quality Technology Conference & Exposition, Seattle, Washington, Nov 15-19, 2009.
 57. H.Y. Jeong and K.F. Hayes “Arsenic mobilization during mackinawite (FeS) oxidation,” The 2009 Fall meeting by Korean Society of Soil and Groundwater Environment (KOSSGE), Jungwon University, Chungcheongbuk-do, South Korea, Oct 15 – Oct 16,

- 2009.
58. H.Y. Jeong, K. Anantharaman, S.P. Hyun, and K.F. Hayes, "Abiotic Reductive Dechlorination of Cis-DCE by Reduced Fe Species," 36th Annual Northeast Regional ACS Meeting, Hartford, CT, Oct. 7 – 10, 2009.
 59. H.Y. Jeong, and K.F. Hayes (invited), "Arsenic Mobilization During Mackinawite (FeS) Oxidation," 237th ACS National Meeting, Salt Lake City, UT, March 22-26, 2009.
 60. G. Upadhyaya, J. Jackson, K. F. Hayes, J. Brown, and L. Raskin, "Simultaneous Removal of Nitrate and Arsenic from Drinking Water Sources Using Fixed-Bed Biologically Active Carbon (BAC) Filters," AEESP Conference, Iowa City, Iowa, Jul 26 – 29, 2009.
 61. H.Y. Jeong, K. Anantharaman, L. Rajewski, and K.F. Hayes, "Reductive Dechlorination of *cis*-Dichloroethylene by Fe-Bearing Precipitates formed Under Reducing Conditions," 237th ACS National Meeting, Salt Lake City, UT, March 22-26, 2009.
 62. S.P. Hyun, K.F. Hayes, and J.A. Davis, "Surface Complexation Modeling of U(VI) Adsorption by an Aquifer Sediment from a Former Mill-Tailings Site at Rifle, CO," 237th ACS National Meeting, Salt Lake City, UT, March 22-26, 2009.
 63. Y.-S. Han, A.H. Demond, K.F. Hayes, "FeS-Coated Sand for Removal of Arsenic(III), Under Anaerobic Conditions: Comparison of Batch and Column Experiments," 237th ACS National Meeting, Salt Lake City, UT, March 22-26, 2009.
 64. G. Upadhyaya, T.P. Yavaraski, K.F. Hayes, and L. Raskin, "Optimization of an ICP-MS Method for Arsenic Speciation in Complex Sample Matrices," Pittcon-2009, Chicago, IL, March 8-13, 2009.
 65. L. Wang, L.M. Abriola, Y.S. Han, K.F. Hayes and A.H. Demond, "Modeling As(III) Removal by Synthesized FeS-Coated Sand in Batch and Column Systems," 2008 Goldschmidt Conference, Vancouver, Canada, July 13 – 18, 2008.
 66. K.F. Hayes (invited), T.G. Gallegos, H.Y. Jeong, and S.P. Hyun, "Sorption of As(III), Cd(II), and Hg(II) by Nanoparticulate Iron Sulfide: Uptake Mechanisms and Modeling," 235th National American Chemical Society Meeting, Division of Geochemistry, Special Symposium on Advanced Approaches to Investigating Adsorption at the Solid-Water Interface, New Orleans, April 6 -10, 2008.
 67. H.Y. Jeong, K.F. Hayes, S.W. Park, and C.W. Kim, "Remobilization of Arsenic(III) Sorbed by Mackinawite (FeS) under Oxic Conditions," 235th National American Chemical Society Meeting, Division of Geochemistry, Special Symposium on Advanced Approaches to Investigating Adsorption at the Solid-Water Interface, New Orleans, April 6 -10, 2008.
 68. G. Upadhyaya, J. Brown, K.F. Hayes, L. Raskin (2008), "Biologically mediated simultaneous removal of arsenic, perchlorate, and nitrate from drinking water", The 2008 Borchardt Conference – A Seminar on Advancement in Water and Wastewater; Ann Arbor, Michigan, Feb 27-28, 2008.
 69. G. Upadhyaya, J. Brown, K.F. Hayes, L. Raskin (2008), "Biologically mediated simultaneous removal of arsenic, perchlorate, and nitrate from drinking water", Water, Health + the Environment Conference: Establishing the Research Agenda.; Ann Arbor, Michigan, Feb 26-27, 2008.
 70. D. Renock, S. Utsunomiya, T. Gallegos, K.F. Hayes, R.C. Ewing, U. Becker, "Arsenic Uptake and Release on Sulfide Nanoparticles," 2007 Goldschmidt Conference, Cologne

University, Germany, August 19 -24 2007.

71. A.F. Clarens, Kim F. Hayes, Steven J. Skerlos, “Re-Inventing Metalworking Fluids: Toward Sustainable Manufacturing Through Green Engineering,” Association of Environmental Engineering and Science Professors Conference, Virginia Polytechnic University, July 31, 2007.
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4. K.F. Hayes, S. J. Traina, C. Papelis, L.E. Katz, J.D. Morton, R. Amata, W. Um, and E. Boyle-Wight, "Competing Effects of Metal Ion Sorption on Oxides and Clays," 1998 Stanford Synchrotron Radiation Laboratory Activity Report, Proposal Number 2526, 1999.
5. K.F. Hayes, S.J. Traina, C. Papelis, and L.E. Katz "Competing Effects of Metal Ion Sorption to Oxides and Clays," 1996 Stanford Synchrotron Radiation Laboratory Activity Report , Proposal Number 2382, 1997.
6. C. Papelis, C.C.-Chen, and K.F. Hayes, "XAS Study of Metal Ion Partitioning at Clay-Water Interfaces," 1995 Stanford Synchrotron Radiation Laboratory Activity Report , 1996.
7. K.F. Hayes, J. E. Penner-Hahn, and L.E. Katz, "XAS Study of Metal/Ion Partitioning at Water/Mineral Interfaces," 1994 Stanford Synchrotron Radiation Laboratory Activity Report, 1995.
8. C. Papelis, C.C.-Chen, and K.F. Hayes, "XAS Study of Metal Ion Partitioning at Clay-Water Interfaces," 1993 Stanford Synchrotron Radiation Laboratory Activity Report, 1994.
9. A.H. Demond and K.F. Hayes, "The Influence of Interfacial Properties on Two-Phase Liquid Flow of Organic Contaminants in Groundwater," DOE/ER/60820-4, U.S. Dept. of Energy, Washington, D.C., Progress Report, April, 1994, 10 pp.
10. K.F. Hayes, L.E. Katz, and J.E. Penner-Hahn, "XAS Study of Metal/Ion Partitioning at Water/Mineral Interfaces," Stanford Synchrotron Radiation Laboratory Activity Report 93-01, 1993.
11. K.F. Hayes, A.H. Demond, and F.N. Desai. "The Influence of Interfacial Properties on Two-Phase Liquid Flow of Organic Contaminants in Groundwater," DOE/ER/60820-3, U.S. Dept. of Energy, Washington, D.C., 1993, Final Report, 50 pp.
12. L.M. Abriola, A.H. Demond, K.F. Hayes, "Second Forum on NSF Research Activities in Subsurface Systems," Summary Report, October 7-9, 1992.

13. K.F. Hayes, "Effects of Interfacial Properties on Contaminant Transport and Transformation in Aquatic Systems," Project Summary, Second Forum on NSF Research Activities in Subsurface Systems, October 7-9, 1992.
14. A.H. Demond, and K.F. Hayes, "The Influence of Interfacial Properties on Two-Phase Liquid Flow of Organic Contaminants in Groundwater," DOE/ER/60820-2, U.S. Dept. of Energy, Washington, D.C., 1991, Progress Report, 18 pp.
15. K.F. Hayes, L.E. Katz, and J.E. Penner-Hahn, "XAS Study of Metal Partitioning at Water/Mineral Interfaces," National Synchrotron Light Source, Brookhaven National Laboratory, Activity Report 91-01, 1991.
16. K.F. Hayes and W. Siegfried, "Effects of Surfactants on Partitioning of Hazardous Organic Components of JP-4 Fuel onto Low Organic Carbon Soils," USAF Final Report, Contract No. F49620-88-C-0053/SB5881-0378, March, 1991, 15 pp.
17. K.F. Hayes and A.H. Demond, "Effects of Surfactants on NAPL Mobility in the Subsurface Systems," in "Concepts in Manipulation of Groundwater Colloids for Environmental Restoration," DOE/ER/60820-1, US Department of Energy Report, Manteo, NC, October 15-18, 1990, 5 pp.
18. K.F. Hayes, "An FTIR Spectroscopic Investigation of Surfactant Adsorption at the Mineral/Water Interface," 1989 USAF-UES Summer Faculty Research Program, Air Force Office of Scientific Research Final Report, September 1989, 14 pp.
19. K.F. Hayes, G. Redden, W. Ela, J.O. Leckie. "Application of Surface Complexation Models to Radionuclide Adsorption: Sensitivity Analysis of Model Input Parameters," NUREG-CR-5547, U.S. Nuclear Regulatory Commission, Washington DC, April 1989, 44 pp.
20. G.E. Brown, Jr., C. J. Chisholm, K.F. Hayes, A.L. Roe, G.A. Parks, K.O. Hodgson, and J.O. Leckie, "In Situ X-ray Absorption Study of Pb(II) and Co(II) Sorption Complexes at the γ -Al₂O₃/Water Interface," Stanford Synchrotron Radiation Activity Report 88-01, 1988.
21. C. Papelis, K.F. Hayes, and J.O. Leckie, "HYDRAQL: A Program for the Computation of the Chemical Equilibrium Composition of Aqueous Batch Systems Including Surface-Complexation Modeling of Ion Adsorption at the Oxide/Solution Interface," Technical Report No. 306, Department of Civil Engineering, Stanford University, September 1988, 130 pp.

Abstracts in non-refereed conference proceedings (graduate student advisees underlined):

1. K.F. Hayes, "Impact of Iron Sulfide on the Oxidative Dissolution of Reduced Uranium," 2012 Subsurface Biogeochemical Research (SBR) Contractor-Grantee Workshop, Office of Science, Biological and Environmental Research, Department of Energy, Washington D.C., April 30-May 2nd, 2012.
2. K.F. Hayes, Y. Bi, J. Carpenter, S.P. Hyun, B.E. Rittmann, R. Vannela, C. Zhou, J.A. Davis, J. Bargar, R. Kukkadapu, "Assessing the Role of Iron Sulfides in the Long Term Sequestration of Uranium by Sulfate Reducing Bacteria," 2012 Biogeochemical Research (SBR) Contractor-Grantee Workshop, Office of Science, Biological and Environmental Research, Department of Energy, Washington D.C., April 30-May 2nd, 2012.
3. Y. Bi, J. Carpenter, S.P. Hyun, and K.F. Hayes, "Inhibition of UO₂ oxidative dissolution

- by synthetic FeS and the implications for long-term immobilization,” 2012 Biogeochemical Research (SBR) Contractor-Grantee Workshop, Office of Science, Biological and Environmental Research, Department of Energy, Washington D.C., April 30-May 2nd, 2012.
4. P. M. Fox, J. A. Davis, R. Kukkadapu, S. P. Hyun, D. M. Singer, H. Guo, J. R. Bargar, and K. F. Hayes, “Coupled Abiotic Fe, S, and U Redox Reactions in Rifle IFRC Sediments,” 2012 Biogeochemical Research (SBR) Contractor-Grantee Workshop, Office of Science, Biological and Environmental Research, Department of Energy, Washington D.C., April 30-May 2nd, 2012.
 5. G. Upadhyaya, K. Snyder, T.M. Clancy, A. Jenkins, X. Chu, J.C. Brown, K.F. Hayes, and L. Raskin, “Using Microbes to Remove Arsenic and other Contaminants from Drinking Water,” Student Global Health Day, University of Michigan, November 11, 2011.
 6. K.F., S. P. Hyun, Y. Bi, J. Carpenter, T. Clancy, and G. Upadhyaya; B. E. Rittman, R. Vannela, C. Zhou; J. A. Davis, J. Bargar, R. K. Kukkadapu, L. Kovarik, M. Bowden, “Assessing the Role of Iron Sulfides in the Long Term Sequestration of Uranium by Sulfate Reducing Bacteria,” 2011 Biogeochemical Research (SBR) Contractor-Grantee Workshop, Office of Science, Biological and Environmental Research, Department of Energy, Washington D.C., April 26-28, 2011.
 7. P. M. Fox, J. A. Davis, R. K. Kukkadapu, S. P. Hyun, J. Bargar, K. H. Williams, K. F. Hayes, and M. Swanson-Theisen, “Geochemical Effects of Iron and Sulfate Reduction in the Rifle IFRC Aquifer: Mineral Transformations, Solid-Phase U Accumulation, and Abiotic U(VI) Reduction,” 2011 Biogeochemical Research (SBR) Contractor-Grantee Workshop, Office of Science, Biological and Environmental Research, Department of Energy, Washington D.C., April 26-28, 2011.
 8. S.P. Hyun, Y. Bi, J. Carpenter, T. Clancy, R. Kukkadapu, J.A. Davis, and K.F. Hayes, “Experimental Study of Uranium Redox Chemistry under Simulated Sulfate Reducing Conditions,” Rifle IFRC 2011 Planning Meeting, Carmel CA, March 8-11, 2011.
 9. Upadhyaya, G., T.M. Clancy, J.C. Brown, K.F. Hayes, and L. Raskin, Simultaneous Removal of Nitrate and Arsenic from Drinking Water Using Fixed-bed Anaerobic Bioreactor System, 22nd Triennial Borchardt Conference, Ann Arbor, MI, Feb. 23-24, 2011.
 10. K.F. Hayes, S. P. Hyun, Y. S. Han, K. Sun, Y. Bi, J. Carpenter, T. Clancy, G. Upadhyaya, L. Raskin, B. E. Rittmann, R. Vannela, C. Zhou, J.A. Davis, J. Bargar, and R. K. Kukkadapu, “Assessing the Role of Iron Sulfides in the Long Term Sequestration of Uranium by Sulfate Reducing Bacteria,” 2010 Subsurface Biogeochemical Research (SBR), Contractor-Grantee Meeting Workshop, Office of Science, Biological and Environmental Research, Department of Energy, Washington D.C., March 29-31, 2010.
 11. Y.-S. Han, A. H. Demond and K.F. Hayes “Impact of Dissolved Si on the Uptake of As(III) by FeS-Coated Sand under Anoxic Conditions,” *SERDP Partners in Environmental Technology Symposium & Workshop*, Washington, D.C., Dec. 2-4, 2008.
 12. L. Wang, L.M. Abriola, Y.-S. Han, T.J. Gallegos, K.F. Hayes, and A.H. Demond, “Modeling As(III) Removal by FeS-Coated Sand in Batch and Column Systems,” *SERDP Partners in Environmental Technology Symposium & Workshop*, Washington, D.C., Dec. 2-4, 2008.
 13. Y.-S. Han, T J. Gallegos, A. H. Demond and K.F. Hayes, “FeS-Coated Sand for Removal

- of Arsenic(III) Under Anaerobic Conditions: Batch and Column Experiments,” *SERDP Partners in Environmental Technology Symposium & Workshop*, Washington, D.C., Dec. 4-6, 2007.
14. A.F. Clarens, Kim F. Hayes, Steven J. Skerlos, “Re-Inventing Metalworking Fluids: Toward Sustainable Manufacturing Through Green Engineering,” Association of Environmental Engineering and Science Professors Conference, Virginia Polytechnic University, July 31, 2007.
 15. T.J. Gallegos, K.F. Hayes, and L.M. Abriola, “Sequestration of As(III) by Nanoparticulate Mackinawite Under Anoxic Conditions,” *Partners in Environmental Technology Symposium & Workshop*, Washington D.C. , November 28–30, 2006.
 16. A.F. Clarens, J.B. Zimmerman, K.F. Hayes, G. Keoleian, and S.J. Skerlos, “Vegetable oil-in-Supercritical Carbon Dioxide based Metalworking Fluids,” 2005 AEESP Research and Education Conference,” July 23 -27th, 2005, Postdam, NY.
 17. J.B. Zimmerman, K.F. Hayes, and S.J. Skerlos, “Investigations of High-Performance Vegetable Oil-Based Metal Working Fluids for Hardwater Stability,” 25th Midwest Environmental Chemistry Workshop, University of Illinois at Chicago, October 4-6, 2002.
 18. K.M. Danielsen, and K.F. Hayes, “The Influence of Geochemical Conditions on Carbon-tetrachloride Dechlorination Rates and Product Distributions in Magnetite Mediated Systems,” Program and Abstracts, 24th Midwest Environmental Chemistry Workshop, Minneapolis, Minnesota, October 5-7, 2001.
 19. H.-H. Hsu, M. Naruse, and K. F. Hayes, “A Thermodynamic Theory of Nonionic Surfactant Partitioning at the NAPL/Water Interface,” 24th Midwest Environmental Chemistry Workshop, October 5-7, 2001, University of Minnesota, Minneapolis, MN.
 20. H.Y. Jeong and K.F. Hayes, "Immobilization of Mercuric Ions by Synthetic FeS," 24th Midwest Environmental Chemistry Workshop, October 5-7, 2001, University of Minnesota, Minneapolis, MN.
 21. K.M. Danielsen, and K.F. Hayes, “The Importance of Geochemical Conditions on Magnetite Mediated Transformations of Chlorinated Aliphatic Compounds,” Program and Abstracts, 23rd Midwest Environmental Chemistry Workshop, Kalamazoo, Michigan, October 7-8, 2000.
 22. A. Ramsburg, T.C.G. Kibbey, K. Pennell, and K.F. Hayes, "Density Modified Displacement of Non-Aqueous Phase Liquids," Abstracts of the EPA Innovative Clean-up Approaches: Investment in Technology Development, Results and Outlook for the Future, Indian Lakes Resort, Bloomingdale, IL, November 2-4, 1999 (8 pages).
 23. M.A. Cowell, Kibbey, T.C.G., Zimmerman, J.B., Hayes, K.F. “Partitioning of Surfactants in Water/Non-Aqueous Phase Liquid (NAPL) Systems: Effects of Surfactant and NAPL Properties,” 22nd Annual Midwest Environmental Chemistry Workshop, October 1999, Houghton, MI.
 24. H.Y. Jeong and K.F. Hayes, "Impact of Transition Metals and Post-Transition Metals on the Reductive Dechlorination of HCA by Iron Sulfide," 22nd Annual Midwest Environmental Chemistry Workshop, October 1999, Houghton, MI.
 25. K. Mozealous and K.F. Hayes, "Wettability Alteration of Aquifer Solids by DNAPL Wastes," EPA STAR Fellowship Recipient's Annual Meeting, Washington D.C., July 18,19, 1999.
 26. C.C.-Chen and K.F. Hayes, "Identification of the Structure of Sorbed Co(II) and Sr(II)

- Surface Complexes at Clay-Water Interfaces," 21st Midwest Environmental Chemistry Workshop, October 16-18, 1998, University of Michigan, Ann Arbor MI.
27. E.C. Butler and K.F. Hayes, "Transformation of Trichloroethylene and Tetrachloroethylene by Iron Sulfide," 21st Midwest Environmental Chemistry Workshop, October 16-18, 1998, University of Michigan, Ann Arbor MI.
 28. M.A. Cowell, T.C.G. Kibbey, J.B. Zimmerman, K.F. Hayes, "Partitioning of Surfactants Between Aqueous and Organic Phases During Aquifer Remediation: Effects of Surfactant/Organic Properties," 21st Midwest Environmental Chemistry Workshop, October 16-18, 1998, University of Michigan, Ann Arbor MI.
 29. D.L. Lord, A.H. Demond, and K.F. Hayes, "Effects of Solute Chemistry on Soil Transport Properties," 21st Midwest Environmental Chemistry Workshop, October 16-18, 1998, University of Michigan, Ann Arbor MI.
 30. J.D. Morton, K.F. Hayes, and J.D. Semrau, "Metal Bioavailability: A Model System Using Methanotrophs," 21st Midwest Environmental Chemistry Workshop, October 16-18, 1998, University of Michigan, Ann Arbor MI.
 31. J.B. Zimmerman, M.A. Cowell, T.C.G. Kibbey, and K.F. Hayes, "Partitioning of Surfactants into Nonaqueous Phase Liquids: Implications for Remediation," 20th Annual Midwest Environmental Chemistry Workshop, Indiana University, Bloomington IN, November 8-9, 1997.
 32. E.C. Butler and K. F. Hayes, "Transformations of Halogenated Organic Pollutants by Iron Sulfide: Rates, Pathways, and Products," 20th Annual Midwest Environmental Chemistry Workshop, Indiana University, Bloomington IN, November 8-9, 1997.
 33. E.C. Butler and K.F. Hayes, "Reductive Dechlorination of Hexachloroethane by Iron Sulfide," Forum on Environmental Remediation & Environmental Toxicology," Lansing MI, September 19-20, 1996.
 34. E.C. Butler and K.F. Hayes, "Micellar Solubilization of Hexane and ortho-Dichlorobenzene by ethoxylated Dodecyl Alcohol Mixtures," Forum on Environmental Remediation & Environmental Toxicology," Lansing MI, September 19-20, 1996.
 35. T.C.G. Kibbey and K.F. Hayes, "Sorption of Polydispersed Ethoxylated Nonionic Surfactants to Aquifer Materials," Forum on Environmental Remediation & Environmental Toxicology," Lansing MI, September 19-20, 1996.
 36. H. Selig, K.F. Hayes, and P. Adriaens, "Bioavailability of Octylamine in the Presence of Silica Particles," 17th Midwest Environmental Chemistry Workshop, Michigan State University, East Lansing MI, October 8-9, 1994.
 37. J.D. Morton and K.F. Hayes, "Study of the Structure of Cationic Surfactants Sorbed to Quartz and Mica Using Atomic Force Microscopy," 15th Midwest Environmental Chemistry Workshop, University of Wisconsin, Madison WI, October 10-11, 1992.
 38. T.C.G. Kibbey and K.F. Hayes, "Phenanthrene Partitioning and Spectroscopic Studies of the Sorbed Structure of Cationic Surfactants on Silica," 15th Midwest Environmental Chemistry Workshop, University of Wisconsin, Madison WI, October 10-11, 1992.
 39. C.-C. Chen and K.F. Hayes, "Effect of Cationic Surfactants/EDTA on the Sorption of Metal Ions to Soil Constituents," 15th Midwest Environmental Chemistry Workshop, University of Wisconsin, Madison WI, October 10-11, 1992.
 40. F.N. Desai, B. Witherell, A.H. Demond, and K.F. Hayes, "The Influence of Adsorption on Capillary-Pressure Saturation Relationships," 13th Environmental Chemistry Workshop Abstracts, University of Illinois, Urbana IL, October 14-16, 1990.

41. C.K. Kenesey and K.F. Hayes, "The Formation of Surface Coatings on Mineral Phases in Mixed Organic/Metal Ion Systems," 13th Environmental Chemistry Workshop, University of Illinois, Urbana IL, October, 14-16, 1990.
42. H.R. Hammad, F.N. Desai, K.F. Hayes, and A.H. Demond, "The Relationship between Interfacial Properties and Wettability of Silica in Xylene-Water Systems," 13th Environmental Chemistry Workshop, University of Illinois, Urbana IL, October 14-16, 1990.
43. W. Siegfried and K.F. Hayes, "The Effect of CTAB on the Adsorption of Naphthalene to Silica," 13th Environmental Chemistry Workshop, University of Illinois, Urbana IL, October 14-16, 1990.
44. K.F. Hayes (invited) and A.H. Demond, "The Effects of Surfactants on NAPL Mobility in the Subsurface," MANTEO III Symposium on Concepts in Manipulation of Groundwater Colloids for Environmental Restoration, U.S. Department of Energy, Manteo NC, October 15-18, 1990.

Invited Lectures, Presentations or Seminars (graduate student advisees underlined):

1. K.F. Hayes, J. Carpenter, and Y. Bi. "Impact of nano-scale iron sulfides on abiotic oxidative dissolution of UO₂," Goldschmidt 2015, Prague Czechoslovakia, August 16-21, 2015.
2. Ellis, B.R., Hayes, K.F., Becker, U. "Selective Removal of Radium from Produced Brine from Unconventional Shale Gas Reservoirs: Functionalized Resins and Chelator Strategies", Petroleum Environmental Research Fund, Shell Research Center, Houston, TX, November 5, 2014.
3. K.F. Hayes, "Impact of Iron Sulfide on the Oxidative Dissolution of Reduced Uranium," 2012 Subsurface Biogeochemical Research (SBR) Contractor-Grantee Workshop, Washington D.C., April 30-May 2nd, 2012.
4. S. P. Hyun, J.A. Davis, and K.F. Hayes, "Uranium (VI) reactions with aqueous and ferrous sulfide," in special symposium on Redox Transformations of Metals in Sediments at Molecular and Pore Scales, 243rd National Meeting of American Chemical Society, San Diego CA, March 25-29, 2012.
5. K.F. Hayes, Y. Bi, J.C. Carpenter, S.P. Hyun, and R. Kukkadapu "Column and Batch Reactor Studies of the Inhibition of UO₂ oxidative dissolution by synthetic FeS," Uranium biogeochemistry: transformations and applications," International Workshop, Monte Verità, Ascona Switzerland, March 11-16, 2012.
6. J.C. Brown, G. Upadhyaya, T.M. Clancy, K.F. Hayes, and L. Raskin, "Simultaneous Removal of Multiple Contaminants from Drinking Water Using Fixed-bed Anaerobic Bioreactors," International Water Association Leading Edge Technology (LET), Amsterdam, The Netherlands, June 6-10, 2011.
7. G. Upadhyaya, T.M. Clancy, A. Jenkins, K. Snyder, J.C. Brown, K.F. Hayes, and L. Raskin, "Biologically Mediated Removal of Multiple Contaminants from Drinking Water Sources, MAC-EPID Pre-Symposium, School of Public Health, University of Michigan, March 31, 2011.
8. S.P. Hyun, Y. Bi, J. Carpenter, T. Clancy, R. Kukkadapu, J.A. Davis, and K.F. Hayes, "Experimental Study of Uranium Redox Chemistry under Simulated Sulfate Reducing Conditions," Rifle IFRC 2011 Planning Meeting, Carmel CA, March 8-11, 2011.

9. G. Upadhyaya, J. Jackson, T. Clancy, J. Brown, K.F. Hayes, and L. Raskin, "Anaerobic fixed-bed bioreactor system for simultaneous removal of nitrate and arsenic from drinking water," University of Ghent, Belgium, April 9, 2010.
10. G. Upadhyaya, J. Jackson, K.F. Hayes, J. Brown, and L. Raskin, "Simultaneous Removal of Nitrate and Arsenic from Drinking Water Sources using Fixed-bed Biological Active Carbon (BAC) Filters, MI American Water Works Association Research and Technical Practices (RTP) May Seminar, Lansing MI, May 19, 2009.
11. H.Y. Jeong, and K.F. Hayes, "Arsenic Mobilization During Mackinawite (FeS) Oxidation," 237th ACS National Meeting, Salt Lake City, UT, March 22-26, 2009.
12. S.J. Skerlos, K.F. Hayes, A.F. Clarens, F. Zhao, "Current Advances in Sustainable Metalworking Fluids Research, "Invited Keynote Paper and Presentation, Global Conference on Sustainable Product Development and Life Cycle Engineering, University of Pusan, Pusan, Korea, Sept. 29 – Oct. 1, 2008.
13. K.F. Hayes, T.G. Gallegos, H.Y. Jeong, and S.P. Hyun, "Sorption of As(III), Cd(II), and Hg(II) by Nanoparticulate Iron Sulfide: Uptake Mechanisms and Modeling," 235th National American Chemical Society Meeting, Division of Geochemistry, Special Symposium on Advanced Approaches to Investigating Adsorption at the Solid-Water Interface, New Orleans, April 6 -10, 2008.
14. K.F. Hayes, Distinguished Lecture, "Reduced Iron Sulfide Systems for Sequestration of Metals and Transformation of Chlorinated Pollutants," Auburn University, May 2006.
15. H.Y. Jeong and K.F. Hayes, "Impact of Heavy Metals on Transformation of Chloroethylenes by Mackinawite," 231th American Chemical Society National Meeting, March 26 – 30, 2006. Atlanta GA.
16. T.J. Gallegos, K.F. Hayes, and L.M. Abriola, "Reactive Ferrous Sulfide/Ferric Oxide Multilayer Films for Remediation of Arsenic Contaminated Groundwater." Society of Hispanic Professional Engineers, National Technical and Career Conference, January 2005, Dallas, TX.
17. A.F. Clarens, K.F. Hayes, S. J. Skerlos, (2005) "Performance Testing of Novel Vegetable Oil Metalworking Fluids Utilizing Supercritical Carbon Dioxide vs. Water as a Carrier," Society of Hispanic Professional Engineers, National Technical and Career Conference, January 2005, Dallas, TX.
18. H.Y. Jeong, B. Klaue, J.D. Blum, and K.F. Hayes, "Sorption of Mercuric Ion on Iron Sulfide," 228th ACS Nat. Meeting, Philadelphia, PA, August 22-26, 2004.
19. S.J. Skerlos and K.F. Hayes, "Diffusion of Sustainable Systems Engineering Through Interdisciplinary Graduate and Undergraduate Education," ASEE 2003 Annual Conference and Exposition, Nashville, Tennessee, June 22-25, 2003.
20. K.F. Hayes (Keynote Lecture) E.C. Butler, H.Y. Jeong, K.M. Danielsen, M.L. McCormick, and P. Adriaens, "Abiotic and Biotic Transformation of Chlorinated Compounds under Iron and Sulfate Reducing Conditions," *Proceedings of the 15th International Symposium of Environmental Biogeochemistry*, Eds. J. Weber, E. Jamroz, J. Drozd, and A. Karczewska, Wroclaw, Poland, Sept. 11-15, 2001.
21. K.F. Hayes (Keynote Lecture), "Reductive Dechlorination by Reduced Iron Minerals: Impact of Solution Conditions and Mineral Properties," at the International workshop on Surface Chemical Processes in Natural Environments, Monte Verita, Ascona, Switzerland, October 1-6, 2000.
22. K.F. Hayes, P. Adriaens, E.C. Butler, M.L. McCormick, K.L. Skubal, H. Y. Jeong, and

- K.M. Danielsen, "Abiotic and Biotic Transformation of Chlorinated Compounds Under Iron and Sulfate Reducing Conditions," Special Symposium on Chemical and Biological Interactions in Contaminant Fate, Division of Environmental Chemistry, 220th ACS National Meeting, Washington D.C., August 20-24, 2000.
23. K.F. Hayes (Keynote Lecture), "Abiotic Reductive Dechlorination Processes," Symposium Chemistry Forum 2000, Warsaw, Poland, May 8-10, 2000.
 24. C. A. Ramsburg, T.C.G. Kibbey, K.D. Pennell, and K.F. Hayes (invited), "Density Modified Displacement of Dense Nonaqueous Phase Liquids (DNAPLs)," *EPA Symposium on Innovative Clean-up Approaches: Investments in Technology Development, Results and Outlook for the Future*, November 2-4, 1999, Bloomingdale, IL.
 25. A.H. Demond, K. F. Hayes, D. L. Lord, F. Desai, and A. Salehzadeh, "Impact of Organic Compound Chemistry on Capillary Pressure-Saturation Relationships of Sands," abstracts of the International Workshop on Characterization and Measurement of the Hydraulic Properties of Unsaturated Porous Media, U.S. Salinity Laboratory, Riverside CA, October, 1997.
 26. A.H. Demond K.F. Hayes, D. L. Lord, F. Desai, and A. Salehzadeh,, "The Impact of Solution Chemistry on the Subsurface Movement of Organic Liquid Contaminants," Department of Civil Engineering, Northwestern University, Chicago, IL, May 21, 1997.
 27. A.H. Demond, K.F., Hayes, D. L. Lord, F. Desai, and A. Salehzadeh, "The Impact of Solution Chemistry on the Subsurface Movement of Organic Liquid Contaminants," Department of Civil Engineering, University of Minnesota, October 17, 1997.
 28. C. Papelis, C.-C. Chen, and K.F. Hayes, "Effects of Cation and Sorption Site Type on Metal Ion Sorption on Marine Clay Minerals: Application of X-ray Absorption Spectroscopy," 14th International Symposium of Chemistry of the Mediterranean on Chemical Speciation in the Marine Environment, Primosten, Croatia, May 15-23, 1996.
 29. K.F. Hayes, "Metal Ion Speciation and its Significance in Ecosystem Health," Workshop on Soil Chemistry and Ecosystem Health, Soil Science Society of America, St. Louis MO, October, 28, 1995.
 30. K.F. Hayes, "Effects of Sorption on Metal Ion Contaminant Transport," Lawrence Berkeley Laboratory Earth Sciences Division Seminar Series, Berkeley CA, May 26, 1995.
 31. K.F. Hayes, "Distinguishing Among Different Types of Surface Complexes at the Mineral/Water Interface: XAS and Sorption Studies," Chemical Engineering Seminar Series, Department of Chemical Engineering, University of California at Davis, Davis, CA, May 22, 1995.
 32. K.F. Hayes, "Effects of Sorption on Metal Ion Contaminant Transport," Surface and Subsurface Hydrology Seminar Series, Department of Civil Engineering, University of California at Berkeley, Berkeley CA, March 20, 1995.
 33. K.F. Hayes, "Distinguishing Among Different Types of Surface Complexes at the Mineral/Water Interface: XAS and Sorption Studies," Soil Science Department, University of Saskatchewan, Saskatoon, Saskatchewan, Canada, March 10, 1995.
 34. K.F. Hayes, "Distinguishing Among Different Types of Surface Complexes at the Mineral/Water Interface: XAS and Sorption Studies," Presented at the Fall Seminar Series of the W.M. Keck Laboratories, California Institute of Technology, Pasadena CA, October 12, 1994.

35. K.F. Hayes, "Distinguishing Among Different Types of Surface Complexes at the Mineral/Water Interface: XAS and Sorption Studies," American Geophysical Union Spring Meeting, Baltimore MD, May 23-27, 1994.
36. K.F. Hayes, "Effects of Sorption Processes on Contaminant Transport," University of Alabama-Birmingham, School of Public Health, Department of Environmental Health Sciences, Birmingham AL, October 29, 1993.
37. K.F. Hayes, "Effects of Interfacial Properties on Contaminant Transport and Transformation in Aquatic Systems," Second Forum on NSF Research Activities in Subsurface Systems, Ann Arbor MI, October 7-9, 1992.
38. K.F. Hayes, "Effect of Cationic Surfactants and Chelating Agents on the Release of Metal Ions from Soil," The Procter and Gamble Co., Ivorydale Technical Center, Cincinnati OH, July 31, 1992.
39. K.F. Hayes, "The Effects of Interfacial Properties on Transport and Transformation Reactions of Environmental Contaminants," Environmental Engineering Special Seminar Series, Duke University, Durham NC, April 5, 1991.
40. K.F. Hayes, "The Effects of Surfactants on Transport Properties of Immiscible Organic Liquids," Seminar Series on the Environmental Fate of Organic Contaminants, The Procter and Gamble Company, Cincinnati OH, January 10-11, 1991.
41. K.F. Hayes, "The Effects of Surfactants on PAH Contaminant Mobility," Shell Development Company, Houston TX, November 29-30, 1990.
42. K.F. Hayes, "An FTIR Spectroscopic Investigation of Surfactant Adsorption at the Mineral-Water Interface," Summer Faculty Research Program Seminar Series, Tyndall Air Force Base FL, August 15, 1989.
43. K.F. Hayes, "The Kinetics of Surface Complexation," Gordon Research Conference in Environmental Sciences, New Hampton School NH, June 20-24, 1988.

Teaching and Mentoring

Supervision of Assistant Research Scientist: 1

1. Sung Pil Hyun, Ph.D., Department of Geological Sciences, Seoul National University, Korea, 2000; October 2009 to October 2011. Currently employed as Senior Researcher at Korea Institute of Geoscience and Mineral Resources, Daejeon, Korea.

Visiting Professor and Scholars: 2

1. Jinju Geng, Associate Professor, Environmental Chemistry, Nanjing University, China, 2013-2014 (co-advise with L. Raskin).
2. Pranab K. Ghosh (co-supervisor L. Raskin), Visiting Assistant Professor, Civil Engineering Department, IIT, Guwahati, India, 2010-2011 (co-advised with L. Raskin).

Supervision of Postdoctoral Fellows: 13

1. Yuqiang Bi, Ph.D., University of Michigan, Ann Arbor, MI, Postdoctoral Fellow, May, 2014 – 2016.
2. Giridhar Upadhyaya (co-supervisor L. Raskin), Ph.D., University of Michigan, Ann

- Arbor, MI, 2010, Postdoctoral Fellow, Sept. 2010 – 2012. Employed as a Project Engineer by Carollo Engineering.
3. Young Soo Han, Ph.D., University of Michigan, Ann Arbor, MI, 2009, Postdoctoral Fellow from September 2009 – August 31st, 2010. Employed as Research Scientist at KIGAM, S. Korea.
 4. Hoon Young Jeong, Ph.D., University of Michigan, Ann Arbor, MI, 2001, Postdoctoral Fellow from January 2006 – 2008. Associate Professor, Department of Geological Sciences, Pusan National University, S. Korea.
 5. Sung Pil Hyun, Ph.D., Department of Geological Sciences, Seoul National University, Korea; 2000; Postdoctoral Fellow from April 2002 to September 2009. Employed as Senior Researcher at Korea Institute of Geoscience and Mineral Resources, Daejeon, Korea.
 6. Raveender Vannela (co supervisor- P. Adriaens), Postdoctoral Fellow from 2005 – 2007. Employed as a Research Associate at Arizona State University.
 7. Michael McCormick (co supervisor- P. Adriaens), Ph.D. Environmental Engineering, University of Michigan, Ann Arbor, MI, 2001; Postdoctoral Fellow from January 2002 – December 2002. Professor and Chair of Biology at Hamilton College, NY.
 8. Fred Desai (co supervisor- A. Demond), Ph.D. Chemical Engineering, University of Akron, Akron, OH, 1989; Postdoctoral fellow 1989-1993. Employed at Procter & Gamble Company, Cincinnati, OH.
 9. King-Hsi Kung, Ph.D. Soil Chemistry, Cornell University, Ithaca, NY, 1989; Postdoctoral Fellow from 1990-1992. Employed at Los Alamos National Laboratory, Los Alamos, NM.
 10. Sun Jing Belfield, Ph.D. Department of Polymer Chemistry, Syracuse University, NY, 1989; Postdoctoral Fellow in 1993. Current employment not known.
 11. Charalambos Pangelis, Ph.D. Environmental Engineering and Science, Stanford University, Stanford, CA, 1992; Postdoctoral Fellow from 1992-1994. Associate Professor at University of New Mexico.
 12. Tohren C. G. Kibbey, Ph.D. Environmental Engineering, University of Michigan, Ann Arbor, MI, 1997; Postdoctoral Fellow from 1997-1999. Employed as an Associate Professor at the University of Oklahoma.
 13. Elizabeth C. Butler, Ph.D. Environmental Engineering, University of Michigan, Ann Arbor, MI, 1998; s Postdoctoral Fellow from 1998-1999. Employed as an Associate Professor at the University of Oklahoma.

Ph.D. Graduate Advising as Chair or co-Chair: 19 (18 graduated)

1. Nada Anid (Chair: T. M. Vogel), "Reductive Dechlorination by Metals and Organometallic Compounds," (May 1993). Tenured Professor and Dean of School of Engineering and Computing Sciences at New York Institute of Technology.
2. Lynn E. Katz (Co-Chair: W.J. Weber, Jr.) "Surface Complexation of Modeling of Cobalt Ion Sorption at the Alumina/Water Interface: Monomer, Polymer, and Precipitation Reactions" (May 1993). Professor at University of Texas at Austin. NSF Young Investigator Award recipient.
3. Tohren C. Kibbey (Chair) "Selective Sorption of Polydispersed Ethoxylated Nonionic Surfactants to Aquifer Materials," (April 1997). Professor at University of Oklahoma.

NSF Career Award recipient.

4. Hildegard Selig (co-Chair: P. Adriaens), "The Effect of Silica on the Kinetics of Octylamine Biodegradation," (April 1998), Lives in Lansing MI.
5. Elizabeth C. Butler (Chair), "Transformation of Halogenated Organic Contaminants by Iron Sulfide," (October 1998). Professor at University of Oklahoma. NSF Career Award recipient.
6. David Lord (co-Chair: A. H. Demond), "Influence of Organic Acid and Base Solution Chemistry on Interfacial and Transport Properties of Mixed Wastes in the Subsurface," (May 1999). Postdoctoral Fellow at New Mexico Tech, Socorro, NM.
7. Chia-Chen Chen (Chair) "Characterization of Surface Hydroxyl and Fixed Charge Surface Sites for Trace Metal Sorption in Mineral Systems," (February 2000). Last known position was as a Postdoctoral Fellow at University of Texas at Austin.
8. John D. Morton (co-Chair: J. Semrau), "The Bioavailability of Chelated and Soil-Adsorbed Copper and the Resulting Effect on Soluble Methane Monooxygenase Activity in *Methylosinus trichosporium* Ob3b," (May 2000). Employed at World Bank, Washington D.C.
9. Quibo Xie (co-Chair: M. Barcelona), "Characterization of Subsurface Petroleum Contamination via TPH, Soil Properties and Redox Capacity for Remediation Design and Operations," (December 2001). Environmental Inspector, Prudent Engineering LLP, Tarrytown NY.
10. Julie Beth Zimmerman (co-Chairs: Jonathan Bulkley, SNRE and Steve Skerlos, ME), "Formulation and Evaluation of Emulsifier Systems for Petroleum and Bio-Based Semi Synthetic Metal Working Fluids," (August 2003). Associate Professor, Yale University.
11. Karlin M. Danielsen (Chair), "Reductive Dechlorination of Carbon Tetrachloride by Magnetite," (December 2004). Employed in Ann Arbor area.
12. Hoon Young Jeong (Chair), "Remediation of Heavy Metals and Chlorinated Organic Pollutants by FeS (December 2005). Associate Professor, Department of Geology, Pusan National University, S. Korea.
13. Tanya J. Gallegos (co-Chair: L. Abriola), "Sequestration of As(III) by Synthetic Mackinawite under Anoxic Conditions," (August 2007), Mendenhall Fellow, USGS, Denver CO.
14. Andres Clarens (co-Chair: S. Skerlos, ME), "Carbon Dioxide Based Metal Working Fluids," (May 2008), Associate Professor, University of Virginia.
15. Young-Soo Han, (co-Chair: A. Demond), "Iron Sulfide-Coated Sand for Remediation of Arsenic(III)-Contaminated Anoxic Groundwater," (September 2009), Employed as a Research Scientist at KIGAM, S. Korea.
16. Giridhar Upadhyaya (co-Chair: L. Raskin), "Biologically Mediated, Simultaneous Removal of Nitrate and Arsenic from Drinking Water Sources," (September 2010) Employed as a Project Engineer by Carollo Engineering.
17. Yuqiang Bi (Chair), "Influence of Mackinawite on Long-Term Stability of Reduced Uranium," (August 2014), Postdoctoral Fellow, Arizona State University.
18. Tara Clancy (co-Chair: L. Raskin), "Biogeochemical Evaluation of Disposal Options for Arsenic-Bearing Wastes Generated During Drinking Water Treatment," January 2015, Postdoctoral Associate, Soil and Crop Sciences, Cornell University.
19. Wenjia Fan (co-Chair: Ellis, co-advisor), "Experimental Investigations of Trace Metal and Radionuclide Leaching from Shales in Contact with Hydraulic Fracturing Fluids,"

Ph.D. candidate since Fall 2014.

Completed Ph.D. Committees (not as chair or co-chair): 50

1. Sandra Fernando, Actinide sorption and reduction on iron and aluminum (oxyhydr) oxides,” Earth and Environmental Sciences, August 2015.
2. Derya Ayril, “Impact of Clay-DNAPL Interactions on the Diffusion of Chlorinated Solvents in Low Permeability Zones,” CEE Department, January 2015.
3. Monica Higgins, “Evaluation of Permeable Reactive Barrier Media for Environmentally Sustainable Groundwater Remediation,” CEE Department, August 2011.
4. Sukhwan Yoon, “Towards Practical Application of Methanotrophy in Chlorinated Hydrocarbon Degradation, Greenhouse Gas Removal, and Metal Immobilization,” CEE Department, May 2010.
5. Devon John Renock, “Redox Processes in Sulfide Minerals,” Geology Department, April 2010.
6. Andrew Henderson, “Extending Long Term Performance of Permeable Reactive Barriers with Modified Reactive Media Distribution,” CEE Department, December 2009.
7. Dong-Hee Lim, “Density Functional Theory Studies on the Relative Reactivity of Chloroethenes on Zerovalent Iron,” CEE December 2008.
8. Jun Hee Lee, “Chemical optimization of *in situ* emplacement of nano-particulate iron sulfide in porous media, CEE December 2008.
9. Subhashis Biswas, “Interaction of Mineral Surfaces and Adsorbates: A Computational Modeling Approach,” Geology Department, December 2007.
10. Elijah Peterson, Carbon Nanotubes: Carbon-14 labeling and Ecological Availability, CEE Department, August 2007.
11. Jodi Ryder, “An Experimental Investigation of the Factors Affecting the Wettability of Aquifer Materials,” CEE, July 2007.
12. Frances N Skomurski, “The Corrosion of Uranium Dioxide: An Atomic-Scale Investigation,” Geology Department, June 2007.
13. Lixin Jin, “Silicate weathering in carbonate-bearing glaciated mid-continental watersheds, A field and laboratory investigation,” Geology Department, December 2006.
14. Shu-Chi Chang, “Rapid Detection and Enumeration of Mycobacteria in Metalworking Fluids,” CEE, July, 2005.
15. Shawn Hunter, “Acid-Catalyzed Organic Synthesis in Carbon Dioxide-Enriched High-Temperature Water,” ChE, May, 2005.
16. Hsin-Lan Hsu, “Determination of Interfacial Tension and Contact Angle of Dense Non-Aqueous Phase Liquid Waste Mixtures,” CEE, May 2005.
17. Chongzheng Na, “Formation of Cyanogen Chloride from Amino Acids and its Stability with Free Chlorine and Chloroamine,” CEE, May 2005.
18. Fu Zhao, “Microfiltration Recycling of Semi-Synthetic Metalworking Fluids: A Model Based Design Approach,” ME, December 2004.
19. Eduardo F. da Silva, “Numerical Modeling of Arsenic Transport in Groundwater,” CEE, December 2004.
20. Jennifer M. Brunner Dunn, “The Partial Oxidation of p-Xylene in High Temperature Water,” ChE, June 2004.
21. Thomas J. Phelan, “Subsurface Compositional Simulation Incorporating Solute-

- Chemistry Dependent Interfacial Properties,” CEE, June 2004.
22. O’Carroll, Denis, “Assessment and Modeling of the Influence of Wettability on Dense Non-Aqueous Phase Liquid (DNAPL) Capillary Hysteresis Behavior and the Relative Permeability in Saturated Porous Media,” January, 2004.
 23. Huang, Quingguo, “A Mechanistic Study of Peroxidase-Catalyzed Phenol Coupling in Water/Soil/Sediment Systems,” CEE, January 2003.
 24. Charles Andrew Ramsburg, “Development of Surfactant-Based Immiscible Displacement Technologies for Remediation of Aquifer Contaminated with Dense Non-Aqueous Phase Liquids,” School of Civil and Environmental Engineering, Georgia Institute of Technology, September 2002.
 25. Michael L. McCormick, “Biotic and Abiotic Transformations of Alkyl Halides in Iron-Reducing Environments,” CEE, January 2002.
 26. Jong-in Han, “Diversity of Particulate Methane Monooxygenase (pMMO) in Methanotrophs: Kinetics, Genetics and *in situ* Real-Time Expression,” January 2002.
 27. Binxi Gu, "Radiation and Thermal Effects on Zeolites, Smectites and Crystalline Silicotitanates," NERS Department, since May, 2001.
 28. Naoko Akiya, "Molecular-Level Insights into Chemical Reactions in High Temperature Water," Department of Chemical Engineering, April 2001.
 29. Martin David Johnson, "Understanding Phenanthrene sorption/desorption mechanisms and rapidly predicting long-term desorption rates using superheated water extraction," July 2000.
 30. Sonny T. Lontoh, "Substrate Oxidation by Methanotrophs Expressing Particulate Methane Monooxygenase (pMMO)," June, 2000.
 31. Q. Shiang Fu, "Reductive Transformation of Chlorinated Dioxins in Sediments: An Assessment of the Contribution of Chemical and Microbial Catalysis," April 2000.
 32. Vivek Jain, "Permeability Reduction in Surfactant Enhanced Aquifer Remediation Due to In Situ Emulsification," December 1999.
 33. John Michael Lendvay, "Biogeochemistry and Transformation Potential of Chloroethene Contaminated Sediments at the Groundwater-Surface Water Interface," Department of Civil and Environmental Engineering, January 1999.
 34. Angela Lindner, "Methanogenic Oxidation of Polychlorinated Biphenyls: A Mechanistic Approach to Biodegradation," Department of Civil and Environmental Engineering, April 1998.
 35. Eugene J. LeBoeuf, "Macromolecular Characteristics of Natural Organic Matter and Their Influence on Sorption and Desorption Behavior of Organic Chemicals," Department of Civil and Environmental Engineering, January 1998.
 36. Weilin Huang, "Effects of Sorbent Heterogeneity on Sorption and Desorption of Phenanthrene in Subsurface Systems," Department of Civil and Environmental Engineering, May 1997.
 37. Suparna Mitra, "Determination of Rates of Mass Transfer of Polynuclear Aromatic Hydrocarbons from a Multicomponent Non-Aqueous Phase Liquid and Its Implications on Bioavailability," Department of Civil and Environmental Engineering, April 1997.
 38. Ziyi Hu, "A Study of Phase Behavior, Structural Development and Application of Sodium Di-2-Ethylhexyl Phosphate (NADEHP) Systems," Department of Chemical Engineering, 1996.
 39. Tim Dekker, "An Assessment of the Effects of Field-Scale Formation Heterogeneity on

- the Surfactant-Enhanced Aquifer Remediation Process," Department of Civil and Environmental Engineering, 1996.
40. James Joseph Dynes (External Reviewer), "Interaction of Selenite with Hydroxy-Aluminum Species as Influenced by Organic Acids and pH," Department of Soil Science, The University of Saskatchewan, March 1995.
 41. Tanju Karanfil, "Oxygen Sensitivity of Natural and Synthetic Organic Macromolecule Sorption by Carbon," Department of Civil and Environmental Engineering, 1995.
 42. Erik Petrovskis, "Mechanisms of Nonspecific Reductive Dechlorination by Anaerobic Bacteria," Department of Civil and Environmental Engineering, The University of Michigan, 1995.
 43. Mamadou Samba Diallo, "Solubilization of Nonaqueous Phase Liquids and Their Mixtures in Micellar Solutions of Ethoxylated Nonionic Surfactants," Department of Civil and Environmental Engineering, 1995.
 44. James Kilduff, "Polyelectrolyte Adsorption by Activated Carbon and the Effects of Preloading on Trichloroethylene Adsorption," Department of Civil and Environmental Engineering, 1995.
 45. Thomas Young, "Phenanthrene Sorption to Organic Matter: Investigations in Aqueous and Supercritical Fluid Systems," Department of Civil and Environmental Engineering, 1995.
 46. Margaret Carter, "Analysis and Modeling of the Impacts of Background Organic Matter on TCE Adsorption by Activated Carbon," Department of Civil and Environmental Engineering, 1993.
 47. Loring Nies, "Microbial and Chemical Reductive Dechlorination of Polychlorinated Biphenyls and Chlorinated Benzenes," Department of Civil and Environmental Engineering, 1993.
 48. Ali R. Siahpush, "Surfactant Mediated Degradation of Polynuclear Aromatic Compounds, Ph.D., Department of Chemical Engineering, The University of Michigan, 1992.
 49. Paul M. McGinley, "Subsurface Soil Reactivity and its Implications for the Sorption and Transport of Hydrophobic Organic Contaminants," Department of Civil and Environmental Engineering, 1991.
 50. Chandra Vijayalakshmi, "Microemulsion Mediated Extraction and Separation of Metal Ions," Department of Chemical Engineering, 1990.

Current Ph.D. Dissertation Committees (not as chair or co-chair): 1

1. Benjamin Gebarski, Ph.D. Candidate, Earth and Environmental Sciences, since Dec. 2014.

MSE Students Advised:

The following list gives the names of those who performed directed studies or research under my guidance but who either did not pursue a Ph.D. degree in Environmental Engineering (EE) after completing the requirements for our MSE degree or who have not yet achieved candidacy.

1. Will Siegfried (MSE in EE, May 1991).

2. Guan-Ru Duh (MSE in EE, May 1992).
3. Carol Kenesey-Cross (MSE in EE, May 1993).
4. Haza R. Hammad (MSE in EE, Dec. 1993).
5. Alok Mital (MSE in EE, May 1997).
6. Colin Heitzmann (MSE in EE, May 1999).
7. Karen Mozealous (MSE in EE, May 2000).
8. Matthew Cowell (MSE in EE, May 2000).
9. Todd Redder (MSE in EE, May 2000).
10. Hsin-Lan Hsu (MSE in EE, May 2001).
11. Miyuki Naruse (MSE in EE, May 2002).
12. Paul Koster van Groos (MSE in EE, May, 2002).
13. Andres Clarens (MSE in EE, May 2003).
14. Kirk Tracey (MSE in EE, May 2003).
15. Akshay Kumar (MSE in EE, May 2004).
16. Douglas Maclean (MSE in EE, December 2008; S. Skerlos, co-advisor)
17. Nonso Gbemedu (MSE in EE, May 2008).
18. Karthic Anatharaman (MSE in EE, December 2008).
19. Angela Park (MSE in ME December 2009; S. Skerlos, co-advisor).
20. Jeffrey Jackson (MSE in EE, April 2010; L. Raskin, co-advisor).
21. Julian Carpenter (MSE in EE, April 2011).
22. Ashley Hammerbeck (MSE in EE April 2013; L. Raskin, co-advisor).
23. Katherine Snyder (MSE in EE April 2013; L. Raskin, co-advisor).
24. Tianshu Zhang (MSE in EE December 2013; B. Ellis, co-advisor).
25. Ana Estrella You (MSE in EE in May 2014; co-advised by L. Raskin).
26. Raghav Ready (MSE in EE in May 2014; co-advised by L. Raskin).
27. Wenjia Fan (MSE student in EE in May 2014; B. Ellis, co-advisor).
28. Hui Zhang (MSE student in EE in May 2015)

Undergraduate Research Students Advised:

1. James Tan (co-supervisor with L. Raskin), Stabilization of arsenic-laden solids from drinking water treatment, 2013 - 2015.
2. Kathryn Snyder, (co-supervisor with L. Raskin), Biological Activated Carbon Drinking Water Treatment Systems, 2011 – 2012.
3. Bryan VanDuinen, “Column reactor studies of oxidative dissolution of UO_2 ” Spr/Sum 2011.
4. Qian Hao, “Analytical methods for measuring Fe, S, and U in column reactor studies” W12 and SURE student, Spr/Sum 2011.
5. Lawrence Lai, “Batch reactor studies of oxidative dissolution of UO_2 ” W11.
6. Emily Herbert (co-supervisor with L. Raskin and V. Li), “Investigations of self-healing concrete through application of microbial spore formers,” 2010-2011.
7. Alyssa Jenkins (co-supervisor with L. Raskin), Biological Activated Carbon Drinking Water Treatment Systems, 2010 – 2011.
8. Andrea Trese, (co-supervisor with L. Raskin), Biological Activated Carbon Drinking Water Treatment Systems, 2010 - 2011.
9. Lauren Rajewski, Reductive dechlorination of cis-DCE by iron bearing precipitates

- formed under reducing conditions, F07 - W09.
10. Alicia Lane, As(V) uptake by FeS, Fall 06-W07.
 11. Anthony Martus, Effects of Sulfur to Iron ratio on the Formation of Nanoscale FeS, F06-W07.
 12. Chuck Sayao (co-supervisor with S. Skerlos), Evaluation of Metal Working Fluid Additives, Spring-Summer 2005 .
 13. Vernon Z. Tan, Project Design Document for Biomass Power Project in Third World Country, Independent Study, 2004.
 14. Kate Baldwin (co-supervisor with L. Abriola), Column Studies of Arsenic Adsorption on Mackinawite Coated Sands, Independent Study, 2004.
 15. Dawn Kujat: "Pendant Drop Surface and Interfacial Tension Measurements of Surfactant Solutions," Marian Sarah Parker Scholars Program, Summer Research Internship 1993.
 16. Abimbola Nkwa: "Du Nuoy Ring Surface Tension Measurements of Surfactant Solutions," Undergraduate Research Opportunity Program, 1992-1993.
 17. David Peevers: "EDTA Mobilization of Metal Ions," 1993-94 (NSF directed research).

Courses Taught at the University of Michigan:

CEE260 Environmental and Sustainable Engineering Principles

CEE260 Environmental Engineering Principles

CEE265 Sustainable Engineering Principles

CEE581 Aquatic Chemistry

CEE583 Surfaces and Interfaces in Aquatic Chemistry

CEE594 Environmental Soil Chemistry

CEE260 Environmental Engineering Principles. A sophomore level environmental engineering course required for all CEE majors. This course covers the basic principles underlying the physical and chemical processes which control the concentration of contaminants in water, air and soil. The overall objective of this course is to teach the student about health impacts and regulations governing typical contaminants, and to make basic calculations as to the fate and transport of contaminants in the environment and their removal from water, air and soil. After this course, the student should be able to: 1) work with the basic units of concentration, mass loading and flux, 2) given the exposure pathway, compute the acceptable level of exposure for a particular chemical, 3) given the rate of reaction and the flowrate, compute the size of reactor needed to accomplish a particular removal efficiency or compute contaminant concentrations in lakes and rivers, 4) given the characteristics of a chemical, estimate where a contaminant will accumulate in the environment, and 5) understand how issues other than technological soundness influence approaches to environmental quality. This course was revised and renamed in F05.

CEE260 Environmental and Sustainable Engineering Principles (a revised and renamed version of CEE 260 introduced in F05). The deteriorating quality of our environment is a concern that an increasing number of engineers are being called upon to confront, with designing for minimal impact on the environment now seen as a critical activity for many engineering disciplines. To understand how to improve environmental quality and to minimize the impact of engineering decisions on the environment, training in the basic concepts of environmental engineering *and* in the principles of sustainable systems engineering is needed. To practice

sustainable engineering, an engineer must learn the fundamentals of environmental pollution prevention, life cycle assessment, and economic decision-making, while also learning to use these concepts toward the design of products and processes that minimize environmental impact. To improve environmental quality, an engineer must also learn about pollutant properties, health risks, exposure pathways, transport and transformation processes, and remediation processes. The overall objective of this course is to teach students the basic principles of environmental and sustainable engineering systems.

CEE265 Sustainable Engineering Principles. (a new required course in the CEE undergraduate curriculum F11). Designing for minimal impact on the environment and optimizing life-cycle costs are critical activities for many engineering disciplines. Engineers need to use the basic concepts of sustainable engineering principles to understand how to make engineering decisions that protect or improve both the environment and society while also ensuring return on investment. To practice sustainable engineering, an engineer must learn the fundamentals of environmental pollution prevention, life cycle assessment, and economic decision-making, while also learning to use these concepts toward the design of products and processes that minimize environmental impact. This in turn requires consideration of material selection, mass and energy balances of inputs and outputs, and quantification of pollutant emissions during the life cycle of products, processes, or services. Engineers thus should have an understanding of basic computational tools and metrics that can be used to assess relative environmental impacts of engineering decisions on both human and ecosystem health at local, regional, and global scales. The overall objective of this course is to teach students the basic principles of sustainable engineering.

CEE 581 Aquatic Chemistry provides undergraduate and graduate students with a strong foundation in aquatic chemical principles with an emphasis on chemical equilibrium computations. This course provides an introduction to the principals of aquatic chemistry and reactions applicable to the analysis of the chemical composition of natural and engineered water treatment systems. Four principal chemical reaction classes are covered: (1) acid-base, (2) precipitation-dissolution, (3) complexation, and (4) oxidation-reduction reactions. Emphasis is placed on developing problem solving skills and includes the use of graphical, analytical (e.g., the Tableaux method), and computer solution (MINEQL+) techniques. Problems are selected from a host of environmentally relevant systems including water treatment, groundwater remediation, and fate of pollutants in natural aquatic systems. This course serves the dual purpose of introducing chemistry and engineering design to both graduate and upper-level undergraduate students. This is one of the required technical elective classes in the ABET approved curriculum for undergraduate students selecting the environmental concentration in the in CEE.

CEE 583 Surfaces and Interfaces in Aquatic Systems introduces graduate environmental engineering students to the physical-chemical principles that control the reactive properties of interfaces. Despite the importance of interfacial processes in controlling the fate and transport of contaminants in groundwater environments, most students have little training in this area. Because the concept of interfacial properties like surface tension is foreign to many students, a set of laboratory experiments has been designed to make these concepts more easily understood.

In these experiments, the students measure interfacial properties such as surface and interfacial tension, and the effects of surfactant sorption on these properties. Each experiment covers one of the fundamental equations discussed in the course and helps the students to visualize the effects of changing solution chemistry on interfacial processes. This course serves as a technical elective in the EWRE graduate program.

CEE 594 Environmental Soil Chemistry is a graduate level course introducing students to pollutant transformation and sorption reactions that take place at the soil-water interface. This course provides an introduction to the principles of surface chemistry of soil constituents emphasizing the impact of surface chemical properties on contaminant fate and transport. Topics covered include soil solution chemistry and contaminant speciation, structure of minerals, and soil organic matter reactive surface functional groups. Physical-chemical properties of inorganic and organic contaminants that determine their relative affinity for soil constituents are introduced. Reactivity trends of inorganic and organic contaminants as a function of soil and contaminant properties are also a focus. Examples of sorption models that account for the impact of soil solution chemistry and soil properties on sorption processes are highlighted. Tools for characterizing soil properties, surface chemical reactions, and contaminant speciation in the context of sorption modeling are discussed. Environmental Soil Chemistry is a graduate program technical elective in the EWRE program.