LIYUAN LIANG

Environmental Sciences Division
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831-6038

Position Title: Group Leader
Earth and Aquatic Sciences
Office: (865) 241-3933
FAX: (865) 576-9977

RESEARCH INTERESTS

Contaminant transformation in aquatic and sediment environments: aqueous chemical speciation and surface chemical reactions that control the fates of metals (Hg, Sr), radionuclides (U, Tc), and organic pollutants (TCE, VC etc) in engineering systems and in the natural environment. Processes affecting colloidal particles in natural water/sediment environments: (i) Colloidal stability, deposition, and transport; (ii) chemical processes governing mineral oxide particle precipitation and dissolution in water

EDUCATION

Ph.D. Environmental Engineering, California Institute of Technology, Pasadena, California, USA 1988

M.S. Environmental Engineering, California Institute of Technology, Pasadena, California, USA 1983

B.S. Civil Engineering, Northeastern University, Boston, Massachusetts, USA 1982

EMPLOYMENT

Oct 2007 – present, Group Leader, Environmental Sciences Division, Oak Ridge National Laboratory (ORNL), Oak Ridge, TN

Lead subsurface science focus area research for the DOE Office of Biological and Environmental Research, developing collaborative research programs, develop research programs dealing with mercury contamination at Oak Ridge Site. Leader of Aquatic and Earth Sciences Group, Responsible for developing projects, allocating funds, ensuring staff coverage, dealing with personnel issues, space allocation, and annual appraisal promotion reviews. Developing new program dealing with mercury contamination at Oak Ridge Reservation with sponsors from Environmental Management at DOE Oak Ridge Office and Headquarters in Washington DC

Aug 2005 – Oct 2007, Office of Strategic Planning, ORNL, Oak Ridge, TN

Rotational position assisting in (1) Strategic and business planning, (2) Laboratory Directed Research and Development programs (e.g., chairing LDRD-Seed Money Review Committee with $5M/yr budget), and (3) Laboratory Director Office, specifically on initiatives related to Science to Energy and Environment

Research: lead an LDRD project that employs Neutron Reflectivity (NR) measurements at SNS and aqueous-surface approach to understand the interactions of microbial-membrane proteins with mineral surfaces

Oct 2006 – September 2007, Chief Scientist for Interfacial Environmental Biogeochemistry, Environmental Sciences Division, ORNL, Oak Ridge, TN

Coordinate activities between ESD and SNS in pursuing research ideas that require the use of neutrons. Organized various group discussions and PI-to-PI meetings, including ideas in plant sciences, vadose zone water distribution, CO_2 uptake by plants, and neutron diffraction of cellulose for bioenergy production. Lead a research project involving scientists from SNS, CSD, and ESD to investigate interactions of microbial derived membrane proteins at oxide mineral surface

2001 – Aug 2005, Senior Academic in School of Engineering and Director Cardiff Foundation of Environmental Research (CFER), Cardiff University, Wales, UK

Experimental and chemical modeling of aquatic colloids and chemical reactions in engineering systems relating to: (1) particle separation in drinking water and wastewater treatment, (2) ferrous iron oxidation as applied to mine water treatment, (3) development of CO_2 sequestration technologies. Taught and was responsible for following academic courses: (a) Advanced water engineering, (b) Waste management and recycling, (c) Environmental awareness and engineering, (d) Environmental impact studies, (e) Final year projects.

Director of Cardiff Foundation of Environmental Research (April 2001-Dec 2003): facilitating internal research communication and interfacing with external private and public sponsors to raise funds for the University from the Landfill Tax Credit Scheme in the United Kingdom

1999 – present, (part time from 2001–2005), Senior Staff Scientist, Environmental Sciences Division, ORNL

Research into geochemical reactions in subsurface environment, including interfacial reactions of colloidal particles in water, long-term performance of permeable reactive barriers, R&D of remediation technologies, and technology development for ocean CO_2 sequestration. Research emphasized on the use of neutron as a complementary research tool in understanding interfacial reactions between microbes and minerals in subsurface environment

1997 – 1999, Senior Lecturer, Department of Earth Sciences, Cardiff University, Wales, UK

Taught and contributed to courses on pollution impact on aquatic systems, global change, and environmental remediation technologies. Research focus: (1) dissolution of iron oxide induced by organic ligands and colloid mobility in sandy media, (2) chemical reactions pertinent to in situ treatment technologies.

Coordinated the Cardiff Institute for Environmental Research (CIER) by facilitating cross departmental research in Environmental Sciences and organizing internal University-wide research seminars and workshops

1993 – 1997, Staff Scientist (1995–1997, Group Leader), Environmental Sciences Division, ORNL

Focus on in situ permeable barriers in treating contaminated groundwater: research in understanding mechanism and kinetics of reductive dechlorination of volatile organic compounds by zero-valence metals. Worked with Department of Energy (DOE) site users (Paducah, KY, Portsmouth, OH and Y-12, Oak Ridge, TN) to perform bench-scale, pilot-scale and full-scale demonstrations.

Research in understanding metal sorption by natural organic sorbents (peat materials), Tc-99 removal from groundwater, peroxidation of organic contaminated soils, in assisting development of DOE in situ remediation integrated program

Led and coordinated Environmental Engineering research group to seek research opportunities in (1) in-situ physicochemical treatment technologies for groundwater remediation, and (2) mechanistic understanding of geochemical processes in natural systems

1990 – 1993, Research Assistant Professor, University Tennessee, leased employee to ORNL Environmental Sciences Division

Research in colloid transport in groundwater, with a focus on the influence of field geochemical factors on the chemical precipitation, dissolution and transport of colloidal iron oxide particles.

1988 – 1990 Assistant Professor, Department of Environmental Health, University of South Carolina, Columbia, USA

Developed and taught courses in hazardous material management. Research into the distribution of heavy metal contaminants in water columns and in sediments of river systems.

PRINCIPAL RESEARCH PROJECTS

I. Biogeochemical and Molecular Mechanisms Controlling Contaminant Transformation in the Environment, Science Focus Area Program, funded by Environmental Remediation Science Program, Biological and Environmental Research, DOE Office of Science, as Research Manager, 2008-2012

This project examines (1) how abiotic reactions affect Hg speciation and complexation, (2) what products or forms of Hg are bioavailable for microbial methylation, (3) what levels of Hg to initiate microbial demethylation and how this process can be tuned to favor demethylation, (4) what are the dominant microbes that participate in methylation or demethylation and how do geochemical conditions affect these transformations, and (5) how catalyzed chemical and photochemical reactions influence Hg speciation and transformations in water.

II. Geochemical and interfacial processes of metal oxide colloidal particles in water and subsurface environment. Laboratory studies aim to obtain mechanistic understanding of chemical reactions (aqueous and surface speciation, redox reaction, dissolution and chemical precipitation) involving solid-water interface and mineral solids using advanced techniques (neutron reflectivity, small angle neutron scattering, and small angle x-ray scattering). Fieldwork focuses on the influence of geochemical factors on the precipitation, dissolution and transport of colloidal iron oxide particles in groundwater.

III. R&D of Permeable Reactive Barrier Technology for Groundwater Remediation. Focus on mechanisms and kinetics of reductive dechlorination of volatile organic compounds and reductive precipitation of metals (and radionuclides) by zero-valence metals. Conducted bench-scale, pilot-scale and full-scale research projects at the US Department of Energy (DOE) facilities, in coordination with the other US federal agencies, such as EPA and DoD.

IV. Study of Clathrate CO_2 Gas Hydrate. (1) Development of injection nozzles for the formation clathrate CO_2 gas hydrate and (2) study of gas hydrate stability and kinetics of dissolution in water, which have implications for the

environment resulting from CO_2 sequestration in oceanic and geologic environments.

V. R&D of Remediation Technologies. Developed DOE in situ remediation integrated program and evaluated various treatment technologies, including metal (such as Sr-90) sorption by natural organic sorbents (peat materials); Tc-99 removal from groundwater with sorbents and Fe(0); Study of oxidation of organic contaminated soils (using permanganate and peroxide) and in situ permeable barriers in treating contaminated groundwater.

PROFESSIONAL ACTIVITIES

- Organizer for American Geological Union Fall Biosciences sessions, December, 2008
- Advisory Committee, session chair, and invited speaker for the 1st International Conference on Environmental Sciences and Technology, New Orleans, Jan 2005
- External examiner for PhD thesis at Nottingham University, UK. Nov 2004.
- Organizing Committee, International Symposium on Permeable Reactive Barriers, Belfast, UK, March 2004
- Conference co-organizer for Environmental particles symposium for 77th American Chemical Society Colloid and Surface Science Symposium, Atlanta, June 2003
- Co-organizer & speaker for a workshop by Permeable Reactive Barriers Network and First Faraday, UK Oct 2002
- Organizer for American Geological Union Fall Hydrology sessions, December, 2001
- Technical Committee for International Containment & Remediation Technology Conference and Exhibition, organized and chaired sessions on Reactive Barrier Technology: US Department Energy, Environmental Protection Agency, Department of Defense, NASA, Dupont and IT Group, Orlando, FL June 2001
- Founding member, Steering Committee for European Treatment Zones Team (1998-2000)
- Committee Member, Environment and Water Group, Society of Chemical Industry (1998-2000)
- Invited by the UK Environment Agency as an expert speaker at NATO CCMS Pilot study meeting on Permeable Wall Technology, February 1998, Vienna.
- Panel member, Environmental Protection Agency Roundtable on Permeable Reactive Walls, St. Petersburg Beach, FL, 1997
- Steering Committee Member, US Remediation Technology Development Forum (RTDF), Permeable Reactive Barriers Action Team (1996-2004)
- Chair and organizer for Session on Innovative Treatment Technologies for TCE Removal from Groundwater and Soils, Emerging Technologies in Hazardous Waste Management VII. American Chemical Society, American Academy of Environmental Engineers, Atlanta, GA, 1995
- Panel member, Environmental Protection Agency review for Mobilization of Colloid in Subsurface, Ada, OK, 1995

PATENTS

West, Tsouris & Liang: Method and Apparatus for Efficient Injection of CO_2 in Oceans," Patent # 6,598,407 (2003). US Patent Office.

West, Tsouris and Liang: Method For Continuous Production of a Hydrate Composite, submitted to US Patent Office, pending

EDITED BOOK:

Liang, Liyuan; Rinaldi, Romano; Schober, Helmut (Eds.), **Neutron Applications in Earth, Energy and Environmental Sciences,** Series: Neutron Scattering Applications and Techniques, Vol. 1, 2009, ISBN: 978-0-387-09415-1, Springer

PUBLICATIONS-Journal articles

- Liang, L and JJ Morgan, 1990. Chemical Aspects of Iron Oxide Coagulation in Water: Laboratory Studies and Implication for Natural Systems. Aquatic Sciences, 52: 32-55

- Liang, L, JA McNabb, JM Paulk, B Gu and JF McCarthy, 1993. Kinetics of Fe(II) Oxygenation at Low Partial Pressure of Oxygen in the Presence of Natural Organic Matter, Environ. Science and Technol., 27(9): 1864-1870
- Liang, L, JF McCarthy, LW Jolley, JA McNabb, and TL Mehlhorn, 1993. Iron Dynamics-Observations of Transformation during Injection of Natural Organic Matter in a Sandy Aquifer. Geochim. Cosmochim. Acta, 57: 1987-1999
- McCarthy, JF, TM Williams, L Liang, PM Jardine, AV Palumbo, LW Cooper, LW Jolley and DL Taylor, 1993. Mobility of Natural Organic Matter in a Sandy Aquifer, Environ. Sci. Technol. 27:667-676
- Gu B, J Schmitt, Z Chen, L Liang and JF McCarthy, 1994. Adsorption-desorption of Natural Organic Matter on Iron-oxide: Mechanisms and Models, Environ. Sci. Technol. 28 (1): 38-46
- Saiers, JE, GM Hornberger and L Liang, 1994. First- and Second-Order Kinetics Approaches for Modeling the Transport of Colloidal Particles in Porous Media. Water Resources Research, 30 (9): 2499-2506
- Gu, B, J Schmitt, Z Chen, L Liang and JF McCarthy, 1995. Interactions of the Fractionated Natural Organic Matter with Iron Oxide, Geochim. Cosmochim. Acta, 59 (2): 219-229
- Gu B, T Mehlhorn, L Liang and JF McCarthy, 1996. Competitive adsorption, displacement, and transport of organic matter on iron oxide: I. competitive adsorption. Geochim. Cosmochim. Acta. 60: 1943-1950
- Gu B, T Mehlhorn, L Liang and JF McCarthy, 1996. Competitive adsorption, displacement, and transport of organic matter on iron oxide: II. Displacement and transport. Geochim. Cosmochim. Acta. 60: 2977-2992
- Liang, L, B Gu, and X Yin, 1996. Removal of Technetium-99 from Contaminated Groundwater with Sorbents and Reductive Materials. Separations Technol. 6: 111-122
- Gu, B, K E Dowlen, L Liang, and JL Clausen. 1996. Efficient separation and recovery of technetium-99 from contaminated groundwater. Separations Technol. 6:123-132
- McCarthy, JF, B Gu, L Liang, J Mas-Pla, TM Williams, and T-CJ Yeh, 1996. Field tracer tests on the mobility of natural organic matter in a sandy aquifer. Water Resources Res. 32(5): 1223-38
- Satmark, B, Y Albinsson, and L Liang, 1996. Chemical effects of goethite colloid on the transport of radionuclides through a quartz-packed column. J. Contaminant hydrology, 21: 231-241
- Korte, N, L Liang, R Muftikian, C Grittini and Q Fernando, 1997. The dechlorination of hydrocarbons, Platinum Metals Review, 41(1): 2-6
- Korte, N, OR West, L Liang, MJ Pelfrey and TC Houk, 1997. A field-scale test facility for permeable reactive barriers at the Portsmouth gaseous diffusion plant. Federal facilities environmental journal, Autumn: 105-114
- Liang, L, NE Korte, JD Goodlaxson, J Clausen, Q Fernando, R Muftikian, 1997. Byproduct formation during reduction of TCE by zero-valence iron and palladized iron. Ground Water Monitoring & Review, Winter: 122-127
- Gu, B, L Liang, MJ Dickey and S Dai, 1998. Reductive Precipitation of Uranium(VI) by zero-valent iron, Environ. Sci. Technol., 32:3366-3373
- Birke, V, L Liang, H Burmeier, 1999. Durchströmte Reaktoren zur In-situ Grundwassersanierung. TerraTech, 1999(1): 23-25
- Gu, B, TJ Phelps, L Liang, MJ Dickey, BL Kinsall, and GK Jacobs, 1999. Biogeochemical Dynamics in Zero-Valent Iron Columns: Implications for Permeable Reactive Barriers. Environ Sci & Technol 33:2170-2177
- Gu, B, GM Brown, PV Bonnesen, L Liang, BA Moyer, R Ober, SD Alexandratos. 2000. Development of Novel Bifunctional Anion-Exchange Resins with Improved Selectivity for Pertechnetate: Column Breakthrough and Field Studies. Environ. Sci. Technol. 34: 1075-1080
- Korte, NE, JL Zutman, RM Schlosser, L Liang and Q Fernando, 2000. Field Application of Palladized Iron for the Dechlorination of Trichloroethene, Waste Management 20: 687-694
- Liang, L, A Hofmann, and B Gu. 2000. Ligand-Induced Dissolution And Release Of Ferrihydrite Colloids. Geochim. Cosmochim. Acta. 64(12): 2027-2037
- Liang, L, N Korte, B Gu, R Puls, C Reeter. 2000. Geochemical And Microbial Reactions Affecting The Long-Term Performance of In Situ Iron Barriers. Advances in Environ. Res., 4, 273-286

- Phillips, DH, B Gu, DB Watson, Y Roh, L Liang, and SY Lee, 2000. Performance Evaluation of a Zero-Valent Iron Reactive Barrier: Mineralogical Characteristics, Environ. Sci. Technol. 34: 4169-4176
- Phelps, TJ, DJ Peters, SL Marshall, OR West, L Liang, JG Blencoe, V Alexiades, and GK Jacobs, 2001. A new experimental facility for investigating the formation and properties of gas hydrates under simulated seafloor conditions, Review Sci. Instruments, 72(2): 1514-1521
- Korte, N, OR West, L Liang, B Gu, JL Zutman and Q Fernando, 2002. The effect of solvent concentration on the use of palladized-iron for the step-wise dechlorination of polychlorinated biphenyls in soil extracts, *Waste Manag*. 22, 343-349
- West, O.R., C. Tsouris, L. Liang, S. Lee, and S.D. McCallum, 2002. Negatively Buoyant CO_2 Hydrate Composite Material for Ocean Carbon Sequestration," AIChE Journal, **49**, 283-285
- Wang, W., B Gu, and L Liang, W. Hamilton 2003, Fabrication of Two- and Three-Dimensional Silica Nanocolloidal Particle Arrays, J. Phy. Chem. B; 107(15): 3400-3404
- Kamolpornwijit, W., L. Liang, O. R. West, G. R. Moline, A. B. Sullivan, 2003. Heterogeneity Development and Its Influence on Long-Term PRB Performance: A Column Study. J. Contaminant Hydrology, 66: 161-178
- Liang, L., A. B. Sullivan, O. R. West, Kamolpornwijit, W., G. R. Moline, 2003. Predicting the precipitation of mineral phases in permeable reactive barriers. Environ. Eng. Sci, 20 (6): 635-653
- Lee, SY, L. Liang, D. Riestenberg, OR. West, C. Tsouris, and E Adams. 2003. CO2 Hydrate Composite for Ocean Carbon Sequestration, Env Sci. & Technol., 37: 3701-3708
- Wang W., B. Gu, L. Liang, and W. Hamilton. 2003. Fabrication of Near-Infrared Photonic Crystals Using Highly-Monodispersed Submicrometer SiO2 Spheres, J. Phys. Chem. B., 107: 12113-12117
- Tsouris, C., P. Brewer, E. Peltzer, P. Walz, D.A. Riestenberg, L. Liang, and O.R. West, 2004. Hydrate Composite Particles for Ocean Carbon Sequestration: Field Verification, Env Sci. & Technol., 38: 2470-2475
- Kamolpornwijit W., L., Liang, G.R. Moline, T. Harts, and OR West 2004. Identification and quantification of mineral precipitates in Fe^0 fillings from a column study. *Environ. Sci. Technol., 38: 5757-5765*
- Wang W., B. Gu, L. Liang, W. Hamilton and D J. Wesolowski. 2004. Synthesis of Rutile (a-TiO_2) nanocrystals with controlled size and shape by low-temperature hydrolysis: effects of solvent composition. J Phys. Chem. B, 108 (29):14789-14792.
- Riestenberg, D.A., E. Chiu, M. Gborigi, L. Liang, O. R. West, and C. Tsouris, 2004. "Investigation of Jet Breakup and Droplet Distribution on Liquid CO_2 and water systems – Implications for CO_2 Hydrate Formation for Ocean Carbon Sequestration," American Mineralogist, 89: 1240-1246
- Wang W., B. Gu, and L. Liang. 2004. Effect of surfactants on the formation, morphology and surface property of synthesized SiO_2 nanoparticles. J. Dispersion Science and Technology, 25 (5): 595-603
- Gabitto J, Riestenberg D, Lee S, Liang LY, Tsouris C, 2004. "Ocean Disposal of CO_2: Conditions for Producing Sinking CO_2 Hydrate," Journal of Dispersion Science and Technology, 25 (5): 703-712.
- Wang W., B. Gu, L. Liang, and W. Hamilton. 2004. Adsorption and structural arrangement of cetyltrimethyl-ammonium cations at the silica nanoparticle-water interface. J. Phys. Chem. B., 108(45), 17477-17483
- Riding R., L. Liang, 2005. Geobiology of microbial carbonates: metazoan and seawater saturation state influences on secular trends during the Phanerozoic, Palaeogeography, Palaeoclimatology, Palaeoecology, 219, 101-115
- Riding R., L. Liang, Seawater chemistry control of limestone accumulation over the past 550 million years. 2005. *Revista Española de Micropaleontología,* 37(1):1-11
- Liang L, Moline, GR, W Kamolpornwijit and OR West, 2005. Influence of hydrogeochemical processes on zero-valent iron reactive barrier performance: A field investigation, J. Cont. Hydrology, 78: 291-312
- Kamolpornwijit, W. and L Liang, 2006. Investigation of Gas Production and Entrapment in Granular Iron Medium, J. Cont. Hydrology, 82: 338-356
- Barnes, A., D.J. Sapsford, M. Dey and K.P. Williams and L Liang, Oxidation of Fe(II) by molecular oxygen in the presence of Fe(OH)3 surfaces and elevated carbonate concentrations: consequences for passive

mine water treatment, in "Advances in Mineral Resources Management and Environmental Geotechnology", Hania, Crete, Greece, September 2006

- Hofmann, A. and L. Liang, 2007. Mobilization of colloidal ferrihydrite particles in porous media – an inner-sphere complexation approach, Geochim Cosmochim. Acta, 71: 5847–5861
- Wang, W, B Gu and L Liang, 2007. Effect of anionic surfactants on synthesis and self-assembly of silica colloidal nanoparticles, J Coll. Inter. Sci., 313 (1): 169-173
- Wang, W., Liang, L., Johs, A., Ankner, J. F., Gu, B., 2008. Controlled synthesis, manipulation of surface hydrophobicity, and self-assembly of hematite nanocrystals, Geochim Cosmochim. Acta, 72(12): A1001-A1001

PUBLICATIONS-Book chapters and reports

- Liang, L, 1988. Effects of Surface Chemistry on Kinetics of Coagulation of Submicron Iron Oxide Particles (a-Fe2O3) in Water, Report No. AC-5-88, California Institute of Technology
- Liang, L and JJ Morgan, 1989. Modeling of Oxide Coagulation in the Presence of Organics. ACS Symposium Series No. 416, Bassett, RL and A Melchior, Eds, p293-308
- Liang L, McCarthy, JF, TM Williams and LW Jolley. 1993. Iron Dynamics During Injection of Natural Organic Matter In A Sandy Aquifer. In manipulation of groundwater for environmental restoration. Lewis Publishers, Chelsea, MI. 263-267
- McCarthy, JF, L Liang, PM Jardine, TM Williams. 1993. Mobility of natural organic matter injected into a sandy aquifer. In manipulation of groundwater for environmental restoration. Lewis Publishers, Chelsea, MI. 35-40.
- Saiers, JE, JF McCarthy, PM Jardine, L Liang and GM Hornberger. 1993. Transport of TiO2 through Homogeneous And Structurally Heterogeneous Porous Media, in manipulation of groundwater for environmental restoration. Lewis Publishers, Chelsea, MI. 309-312
- Korte, NE, RL Siegrist, M Ally, B Bischoff, W Bostick, JM Strong-Gunderson, P Kearl, L Liang, D Marsh, A Mattus, a Palumbo, J Stockdale, P Taylor, OF Webb, 1994. In situ Treatment of Mixed Contaminants in Groundwater: Review of Candidate Processes, ORNL/TM-12772, Oak Ridge, TN
- Siegriest, RL, Gates, DD, West, OR Donaldson, TL, Liang, L, Webb, OF, Corder, SL Dickerson, KS, 1994. In situ Physical Chemical Treatment Technologies For Remediation Of Contaminated Sites: Applicability, Development, Status And Research, ORNL/M-3694, Oak Ridge, TN
- Brown, GM Bates, LM Bonnesen, PV Moyer, BA Alexandratos, SD, Hussain, LA Patel, VT Liang, L Siegrist, RL, 1995. Selective Resins for Sorption of Technetium From Groundwater, ORNL/FPO-95/38, Oak Ridge, TN
- Brown, GM Bates, LM Bonnesen, PV Moyer, BA Alexandratos, SD, Hussain, LA Patel, V Gu, B Liang, L Siegrist, RL, 1996. Sorption of Tc from Contaminated Groundwater on Resins FY 1996, ORNL/M-5088, Oak Ridge, TN
- Liang, L and JF McCarthy, 1995. Colloidal Transport of Metal Contaminants In Groundwater. In Metal Speciation and Contamination of Soil. HE Allen, CP Huang, GW Bailey, AR Bowers, eds, Lewis Pub. 87-112
- Brown, GM Presley, DJ Bonnesen, PV Bates, LM Moyer, BA Alexandratos, SD, Patel, V Gu, B Liang, L Siegrist, RL, 1996. Resins for Selective Sorption of Technetium From Groundwater FY 1996, ORNL-M-5480, Oak Ridge, TN
- Brown, GM Presley, DJ Bonnesen, PV Bates, LM Moyer, BA Alexandratos, SD, Hussain, LA Patel, V Gu, B Liang, L Siegrist, RL, 1996. Column tests of Resins for Selective Sorption of Technetium from Groundwater. ORNL-M-5508, Oak Ridge, TN
- Brown, GM Presley, DJ Bonnesen, PV Bates, LM Moyer, BA Alexandratos, SD, Patel, V Gu, B Liang, L Siegrist, RL, 1996.Column tests of Resins for Selective Sorption of Technetium from Groundwater: FY1997, ORNL/M-5920, Oak Ridge, TN
- West, OR, Liang, L Holden, WL, Korte, NE, Fernando, Q, Clausen, JL. 1996. Degradation of Polychlorinated Biphenyls (PCBs) Using Palladized Iron, R, ORNL/TM-13217, Oak Ridge, TN

- Gu, G, L Liang, P Cameron, OR West, 1997. TCE and PCB Degradation by Zero-Valence Iron in the Presence of Surfactants, International containment technology conference, St Petersburg, FL. 760-66
- Korte, NE, L Liang, B Gu, MT Muck, JL Zutman, RM Schlosser, RL Siegrist, TC Touk, Q Fernando, 1997. In Situ Treatment of Mixed Contaminants In Groundwater: Application Of Zero-Valence Iron And Palladized Iron For Treatment Of Groundwater Contaminated With Trichlorethene and Technetium-99. ORNL-TM-13530, Oak Ridge, TN
- Liang, L, OR West, NE Korte, JD Goodlaxson, DA Pickering, JL Zutman, FJ Anderson, CA Welch, MJ Pelfrey, MJ Dickey. 1997. A field-scale test of trichloroethylene dechlorination using iron filings for the X-120/X749 groundwater plume. ORNL-TM-13410, Oak Ridge, TN
- West, OR, RL Siegrist, TC Houk, L Liang, SY Lee, A Laase, DA Pickering, MJ Dickey, X Yin, B Gu, 1997. The X-625 Treatment Facility: Assessment of Reactive Barrier Technology at PORTS. POEF-LMES-174, Piketon, OH
- Gu, B, L Liang, GM Brown, PV Bonnesen, BA Moyer, SD Alexandratos, and Ober R 1998. A field trial novel bifunctional resins for removing pertechnetate (TcO4-) from contaminated groundwater. ORNL/TM-13593. Oak Ridge National Laboratory, Oak Ridge, TN
- Liang, L, B Gu, 1998. The treatment of groundwater with Mixed-Wastes: reductive dechlorination of TCE and reductive precipitation of uranium. NATO/ CCMS Pilot Study, Environmental Protection Agency 542-R-9-003, May 1998. NATO publication No 229: 36-43
- Walker, DW and L Liang, 2000. Modeling Flow in Fractured Media. ORNL/TM-2000/37. Oak Ridge, TN
- Gu, B., D.B. Watson, D.H. Phillips, and L. Liang. 2002. Biogeochemical, mineralogical, and hydrological characteristics of an iron reactive barrier used for treatment of uranium and other contaminants. In Groundwater Remediation of Trace Metals, Radionuclides, and Nutrients, with Permeable Reactive Barriers. D.L. Naftz, S.J. Morrison, J.A. Davis, C.C. Fuller (eds). Academic Press. pp. 305-342.
- Liang, L; Korte, NE; Moline, GR; West, OR 2001. Long-term Monitoring of Permeable Reactive Barriers, Oak Ridge National Laboratory, ORNL/TM-2001/1, Oak Ridge, TN
- L Liang, G R Moline, W Kamolpornwijit, B Gu, AB Sullivan, OR West, Performance Assessment of Zero-Valent Iron Permeable Reactive Barriers, TTP-ORO-9-SS30, report to DOE-SubConc, DNAPL product line. Oak Ridge National Laboratory Oak Ridge, TN August 31, 2001, 64pp
- Gerilynn Moline, Liyuan Liang, Wiwat Kamolpornwijit and Libby West, 2001. Long-term monitoring of permeable reactive barriers, Data acquisition report to DOE-Office of Science and Technology, September 31, 2001, 91pp
- Evaluation of Permeable Reactive Barrier Performance, prepared for Federal Remediation Technology Roundtables by the tri-agency Permeable Barrier Initiative (contributed by Gavasgar, A., L Liang, GR Moline, R Puls, C Reeter, B Sass, OR West, R Wilkin et al.), U.S. Department of Defense, U.S. Department of Energy, U.S. Environmental Protection Agency, Interstate Technology and Regulatory Cooperation, 60 pp, 2002, EPA 542-R-04-004
- L Liang, G Moline, A Sullivan, and OR West, 2002. Integration of geochemical data to hydraulic changes at Permeable reactive barriers sites, TTP No. ORO-9-SS-30, Deliverable Report to DOE SubCon Program, June 2002, 35pp