



LARRY D. McKAY
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Degrees

- 1992 PhD, Earth Sciences, University of Waterloo, Ontario, Canada
1981 Bachelors of Applied Science, Geological Engineering, Univ. of British Columbia

Professional Experience

- 2009-present *Head*, Department of Earth & Planetary Sciences, Univ. of Tennessee
2004-present *Jones Professor of Hydrogeology*, Dept. Earth & Planetary Sciences, Univ. of TN
2004-2007 *Associate Head*, Department of Earth and Planetary Sciences, Univ. of Tennessee
1998-2004 *Jones Associate Professor of Hydrogeology*, Dept. of Geol. Sci. Univ. of TN
1993-1998 *Jones Assistant Professor of Hydrogeology*, Dept. of Geol. Sci., Univ. of TN
1992 *Post-doctoral Research Assoc.*, Geol. Survey of Denmark & Tech. U. of Denmark
1986-1991 *PhD Candidate*, Dept. of Earth Sciences, University of Waterloo, Ontario
1981-1986 *Consulting Engineer* in western Canada and South America on groundwater supply, geotechnical, and mining-related projects

Academic Awards and Scholarships

- 2011 Elected *Fellow of the American Assoc. for the Advancement of Science (AAAS)*
2009 Elected *Fellow of the Geological Society of America (GSA)*
2008-09 *GSA Hydrogeology Division Birdsall-Dreiss Distinguished Lecturer*. Visited >50 universities or research institutes in the U.S., Canada, Europe, etc.
2000 UT College of Arts and Sciences *Junior Faculty Research Award*
1998 UT Chancellor's Award for *Professional Promise in Research*
1996-2001 UT/ORNL Science Alliance *Faculty Research Awards* (\$5000/yr)
1988-1990 Natural Sciences & Eng. Research Council (NSERC) - *Postgraduate Scholarship*
1986-1987 NALACO/Canadian Council of Professional Engineers Scholarship
1981 Dr. A.E. Aho Memorial Award for *Academic Excellence*

Professional Registration, Membership and Service

- 1984-present *Registered Professional Engineer*, Province of British Columbia, Canada
1996-2005 *Associate Editor*, Journal of Ground Water
2011 *Guest Editor* for Theme issue of Journal of Ground Water
2007-present Member of Advisory Board for Canadian Water Network's Pathogen Research Initiative
- Currently Member of the American Association for the Advancement of Science (AAAS), Geological Society of America (GSA), National Ground Water Association (NGWA), the American Geophysical Union (AGU), the Consortium of Universities for the Advancement of Hydrologic Sciences (CUAHSI) and the East Tennessee Geological Society
- Currently Frequent reviewer of proposals for NSF, NSERC, DOE, USDA and USGS; reviewer of manuscripts for Journal of Contaminant Hydrology, Water Resources Research, Journal of Environmental Quality, Environmental Science & Technology, Hydrogeology Journal, Journal of Environ. Eng., Geoderma, etc.

Scholarly Research Interests

Geoscience Career Planning & Increasing Diversity in Geoscience Programs

I teach several courses in geoscience career planning, including a PhD level course on Academic Career Preparation in Science and Engineering, as well as an undergraduate course on Career Planning for Geoscience and Environmental Studies. In addition, I've worked on a variety of projects aimed at increasing diversity in geoscience programs and public education on environmental issues. These include participating in an NSF-funded diversity grant, an NIEH-funded Environmental Justice/Neighborhood Environmental College project and a recently submitted proposal to the NSF GEOPATH program, to help students transferring from community colleges to UT. Some of these projects straddle the lines between outreach, teaching and scholarship.

Microbial fate and transport in Groundwater and Surface Water

My earliest investigations of microbial transport in groundwater began during my PhD thesis, when I carried out the first ever field experiment on transport of bacteriophage in fractured clays. This experiment demonstrated that fractured clay soils provide relatively little protection against microbial contamination. Later experiments examined the influence of environmental factors (flow rate, pH, ionic strength, etc.) on microbial retention. Recent research in this area includes investigations of microbial water quality in community water supply wells in east Tennessee, monitoring studies of the impact of manure application to cropland on water quality in wells and surface water at the UT Dairy Farm, and a study of latrines and sewage ponds on the microbial water quality of wells in Bangladesh.

Hydrology of fractured shale and clay soils

One of my principal research interests is the hydrology of fine-grained, highly weathered and fractured media. This began with research on the influence of fractures on groundwater flow and contaminant transport in glacial tills in Ontario (i.e., my PhD research), and Denmark, and

has continued with a focus on fine-grained saprolite, flood plain sediments, shales and, most recently, karst. My research includes the origin of fractures and macropores and the influence of infilling materials (mainly pedogenic clays and Fe/Mn oxides) on hydraulic conductivity and groundwater flow. A recent project involves examining the influence of climate on weathering of shale bedrock, in a transect from upstate New York to northern Alabama. Developing methods for measuring and predicting diffusion-controlled exchange of solutes between the fast flow regime of the fractures and the essentially immobile water in the clay/shale matrix is a central part of this work.

Fate & Transport of Industrial and Defense-related Contaminants in the Subsurface

I've worked extensively on field and lab studies of industrial and defense related contaminants in the subsurface. Most recently, this has involved byproducts of TNT manufacturing (Volunteer Army Ammunition Plant in Chattanooga) and residues from incomplete combustion at explosives testing ranges. Earlier work included studies of dissolution and biodegradation of chlorinated solvents in groundwater, as well as transport of radiogenic tritium from shallow burial grounds on the US Dept of Energy's Oak Ridge Reservation. Currently, I'm working on a project on biodegradation of organic contaminants in a shallow aquifer and wells near the Y-12 plant on the DOE Oak Ridge Reservation.

Peer-reviewed Journal Publications

(61 total, Web of Science h-index = 22)

- Cheng, C.L., E. Perfect, B. Donnelly, H.Z. Bilheux, A.S. Tremsin, L.D. McKay, V.H. DiStefano, J.C. Cai, and L.J. Santodonato, 2015, Rapid imbibition of water in fractures within unsaturated sedimentary rock, *Advances in Water Resources*, v. 77, 82-89, doi:10.1016/j.advwatres.2015.01.010.
- Layton, A., A. Chauhan, D. Williams, B. Mailloux, P. Knappett, A. Ferguson, L.D. McKay, Md. J. Alam, Kazi Matin Ahmed, A. van Geen, G. Sayler, 2014, Metagenomes of microbial communities in arsenic and pathogen contaminated well and surface water from Bangladesh, *Genome Announcements*, v. 2, 6, November/December.
- Roy, A., E. Perfect, W.M. Dunne and L.D. McKay, 2014, A technique for revealing scale-dependent patterns in fracture spacing data, *J. Geophys. Res. Solid Earth*, 119, doi:10.1002/2013JB010647.
- Cheng, C., M. *Gragg, E. Perfect, M.D. White, P.L. Lemiszki, and L.D. McKay, 2013, Sensitivity of injection costs to input petrophysical parameters in numerical geologic carbon sequestration models, *Intl. Journal of Greenhouse Gas Control*, v. 18, 277-284.
- Dere, A.L., T.S. White, R. April, B. Reynolds, T. Miller, E. Knapp, L.D. McKay, and S. L. Brantley, 2013, Climate dependence of feldspar weathering in shale soils along a latitudinal gradient, *Geochimica et Cosmochimica Acta*, doi.org/10.1016/j.gca.2013.08.001.
- Knappett, P., L.D. McKay, A. Layton, D. Williams, M. Alam, B. Mailloux, A. Ferguson, P. Culligan, M. Serre, M. Emch, K. Matin Ahmed, G. Sayler & A. van Geen, 2012, Unsealed tubewells lead to increased contamination of drinking water, *J. of Water and Health*, v. 10, no. 4, 565-578.

- Ferguson, A.S., A. Layton, B. Mailloux, P. Culligan, D. Williams, A. Smartt, G. Sayler, J. Feighery, L.D. McKay, P. Knappett, E. Alexandrova, T. Arbit, M. Emch, V. Escamilla, K. Matin, M. Alam, P. Streatfield, M. Yunus, A. van Geen, 2012, Comparison of fecal indicators with pathogenic bacteria and rotavirus in groundwater, *Science of the Total Environment*, vol. 431, 314-322.
- Lavoie, B., M. Mayes and L.D. McKay, 2012, Transport of explosive residue surrogates in saturated porous media, *Water, Air & Soil Pollution*, Vol. 223, No. 5, 1983-93.
- Vulava, V., L.D. McKay, M. Broholm, J. McCarthy, S. Driese and G. Sayler, 2012, Dissolution and transport of coal tar compounds in fractured clay-rich residuum, *J. of Hazardous Materials*, vol. 203, 283-289.
- Knappett, P., L.D. McKay, A. Layton, D. Williams, M. Alam, M. Huq, J. Mey, J. Feighery, P. Culligan, B. Mailloux, J. Zhuang, V. Escamilla, M. Emch, E. Perfect, G. Sayler, K. Matin Ahmed, A. van Geen, 2011, Implications of fecal bacteria input from latrine-polluted ponds to sandy aquifers, *Environ. Sci. Technol.*, vol. 46, No. 3, 1361-1370.
- Wu, J., A. van Geen, K. Ahmed, Y. Akita, Md. J. Alam, P. Culligan, V. Escamilla, J. Feighery, A. Ferguson, P. Knappett, B. Mailloux, L.D. McKay, M. Serre, P.K. Streetfield, Md. Yunus, M. Emch, 2011, Increase in diarrheal disease associated with arsenic mitigation in Bangladesh, *PLoS-One*, Vol. 6, No. 12, e29593.
- Ferguson, A., B. Mailloux, K. Ahmed, A. van Geen, L.D. McKay, and P. Culligan, 2011, Hand pumps as reservoirs for microbial contamination of well water, *Journal of Water and Health*, vol. 9, issue 4, 708-717.
- Knappett, P., V. Escamilla, A. Layton, L.D. McKay, M. Emch, D. Williams, Md. R. Huq, Md. J. Alam, L. Farhana, B. Mailloux, A. Ferguson, G. Sayler, K. M. Ahmed and A. van Geen, 2011, Impact of population and latrines on fecal contamination of ponds in rural Bangladesh *Science of the Total Environment*, vol. 409, issue 17, 3174-3182
- Schultz, B., S. Driese, and L.D. McKay, 2011, Genesis of clay-rich soils from carbonate bedrock on upland surfaces in the valley and ridge province in eastern TN, U.S.A., *Southeastern Geology*, v. 48, No. 1, 1-22.
- van Geen, A., K.M. Ahmed, Y. Akita, Md. J. Alam, P.J. Culligan, J. Feighery, A. Ferguson, M. Emch, V. Escamilla, P. Knappett, A. Layton, B. Mailloux, L.D. McKay, J. Mey, M. Serre, P. Streatfield and M. Yunus, 2011, Fecal contamination of shallow tubewells in Bangladesh inversely related to arsenic, *Environmental Science & Technology*, Vol. 45, No. 4, 1199-1205.
- McKay, L.D., 2011, Foreword: Pathogens and fecal indicators in groundwater, *Ground Water*, vol. 49, no. 1, 1-3.
- Tithof, P.K., S.M. Richards, M. Algayyar, F. Menn, V. Vulava, L.D. McKay, J. Sanseverino, G. Sayler, D. Tucker, C. Leslie, K. Lu and K. Ramos, 2011, Activation of group IVC phospholipase A₂ by polycyclic aromatic hydrocarbons induces apoptosis of human coronary artery endothelial cells, *Archives of Toxicol.*, Vol. 85, No. 6, 623-634.
- Johnson, T., L.D. McKay, A. Layton, G. S. Fout, S. Jones, G. Johnson, J. Cashdollar, D. Ahling, L. Villegas, D. Williams and G. Sayler, 2011, Viral and bacterial contamination in karst aquifers in eastern Tennessee, U.S.A., *Ground Water*, Vol. 49, No. 1, 98-110.
- Knappett, P., A. Layton, L.D. McKay, D. Williams, B. Mailloux, Md. R. Huq, Md. J. Alam, K. Matin Ahmed, Y. Akita, M. Serre, G. Sayler, and A. van Geen, 2011, Effectiveness of ultrafiltration for sampling microorganisms in ground water, *Ground Water*, Vol. 49, No. 1, 53-65.

- Driese, S.G., G.A. Ludvigson, J.A. Roberts, D.A. Fowle, L.A. González, J.J. Smith, V.M. Vulava and L.D. McKay, 2010, Micromorphology and stable isotope geochemistry of historical pedogenic siderite formed in PAH-contaminated alluvial clay soils, Tennessee, USA, *J. of Sedimentary Research*, v. 80, 943-954.
- Zhuang, J., N. Goeppert, C. Tu, J. McCarthy, E. Perfect, and L.D. McKay, 2010, Colloid transport with wetting fronts: Interactive effects of solution surface tension and ionic strength, *Water Research*. Vol. 44, Issue 4, 1270-1278.
- Mayes, M.A., G. Tang, P. Jardine, L.D. McKay, X. Yin, M. Pace, J. Parker, F. Zhang, T. Melhorn, R. Dansby-Sparks, 2009, Influence of sedimentary bedding on reactive transport parameters under unsaturated conditions, *Soil Sci. Soc. America Journal*, 73:1938-1946.
- Bell, A., A. Layton, L.D. McKay, D. Williams, R. Gentry and G. Sayler, 2009, Factors influencing the persistence of fecal *Bacteroides* in stream water, *J. of Environ. Quality*, 38, 1224-1232.
- Knappett, P., M.B. Emelko, J. Zhuang, and L.D. McKay, 2008, Transport and retention of MS-2 bacteriophage and microspheres in saturated porous media: Impact of ionic strength and grain size, *Water Research*, doi:10.1016/j.watres.2008.07.041.
- Kenst, A., E. Perfect, S. Wilhelm, J. Zhuang, J. McCarthy, and L.D. McKay, 2008, Virus transport during infiltration of a wetting front into initially unsaturated sand columns, *Environmental Science & Technology*, 42, 1102-1108.
- Driese, S.G., Z. Li, and L.D. McKay, 2008, Evidence for high-frequency mid-Holocene climate changes recorded in alluvial floodplain catena, southeastern Tennessee, USA, *J. of Quaternary Research*, 69, 276-291.
- Roy, A., E. Perfect, W.M. Dunne, and L.D. McKay, 2007, Fractal characterization of fracture networks: An improved box-counting technique, *Journal of Geophysical Research*, 112, B12201, doi:10.1029/2006JB004582.
- Gentry, R.W., A. Layton, L.D. McKay, J. McCarthy, D. Williams, S. Koirala, and G. Sayler, 2007, Efficacy of *Bacteroides* for reducing uncertainty for source fecal loads in a mixed use watershed, *Journal of Environmental Quality*, 36, 1324-1330.
- Pace, M., M. Mayes, P. Jardine, L.D. McKay, X.L. Yin, T.L. Mehlhorn, Q. Liu, H. Gurleyuk, and J. Zachara, 2007, Transport of Sr^{2+} and SrEDTA^{2-} in partially-saturated and heterogeneous sediments, *Journal of Contaminant Hydrology*, 91, 267-287.
- Vulava, V., L.D. McKay, S.G. Driese, F. Menn and G. Sayler, 2007, Distribution and transport of coal tar derived PAHs in fine-grained residuum, *Chemosphere*, 68, 554-563.
- Gentry, R.W., J.F. McCarthy, A. Layton, L.D. McKay, V. Garret, D. Williams, S. Koirala, G. Sayler, 2006, *E. coli* loading at or near base flow in a mixed use watershed, *Journal of Environmental Quality*, 35, 2244-2249.
- Layton, A.C., L.D. McKay, D.W. Williams, V. Garrett, and G.S. Sayler, 2006, Development of *Bacteroides* 16S rRNA gene TaqMan™ PCR assays for the quantification of fecal source pollution in water samples: *Applied and Environ. Microbiol.*, 72(6), 4214-4224.
- Lenczewski, M., L.D. McKay, A. Pitner, S. Driese, and V. Vulava, 2006, Pure-phase transport and dissolution of TCE in sedimentary rock saprolite, *Ground Water*: 44(3), 406-414.
- McKay, L.D., S.E. Driese, K. Smith, and M. Vepraskas, 2005, Hydrogeology and pedology of saprolite formed from sedimentary rock parent material, eastern TN, U.S.A., *Geoderma*: 126, 27-45.
- Jorgenson, P.R., L.D. McKay, and J. Kistrup, 2004, Aquifer vulnerability to pesticide migration through till aquitards, *Ground Water*, 42(6), 841-855.

- Lenczewski, M.E., L.D. McKay, and A. Layton, 2004, Biodegradation of TCE in undisturbed columns of fractured saprolite: *Ground Water*, 42(2), 534-541.
- Driese, S. and L. McKay, 2004, Epi-fluorescence micromorphology of saprolite reveals evidence for colloid transport and retention in microscale pore systems: *Geoderma*, 121, 143-152.
- McCarthy, J. and L.D. McKay, 2004, Colloid transport in the subsurface: Past, present and future challenges, *Vadose Zone Journal*, 3, 326-337.
- Perfect, E., L.D. McKay, S.G. Driese, S.C. Cropper, G. Kammerer, and J.H. Dane, 2004, Scaling capillary pressure-saturation relations for saprolite, Correction for uncertainty introduced by measurements on tall columns, *Vadose Zone Journal*, 3, 493-501.
- Lenczewski, M.E., P. Jardine, L.D. McKay, and A. Layton, 2003, Natural attenuation of trichloroethylene in fractured shale bedrock: *J. Contam. Hydrology*, vol. 64, p. 151-168.
- Stewart, M.A., P.M. Jardine, M. Barnett, T. Mehlhorn, L. Hyder, and L.D. McKay, 2003, Influence of soil geochemical and physical properties on the sorption and bioaccessibility of Cr(III): *J. Environ. Quality*, v. 32, p. 129-137.
- Stewart, M.A., P.M. Jardine, M. Barnett, L.D. McKay, T. Mehlhorn, S. Fendorf, and K. Paul, 2003, Effects of contaminant concentration, aging, and soil properties on the bioaccessibility of Cr(III) and Cr(VI) in soil: *Soil & Sediment Contam.*, 12(1), 1-21.
- McCarthy, J.F., L.D. McKay, and D.D. Bruner, 2002, Influence of ionic strength and cation charge on transport of colloidal particles in fractured shale saprolite: *Environ. Sci. Technol.*, v. 36, no. 17, p. 3735-3743.
- McKay, L.D., A.D. Harton, and G.V. Wilson, 2002, Influence of flow rate on transport of phage in a highly weathered and fractured shale: *J. Environ. Quality*, 31, 1095-1105.
- Driese, S.G., L.D. McKay, and C.P. Penfield, 2001, Lithologic and pedogenic influences on porosity distribution and groundwater flow in fractured sedimentary saprolite: an application of environmental sedimentology: *J. of Sedimentary Res.*, v. 71, p. 843-857.
- McCarthy, J.F., K.M. Howard, and L.D. McKay, 2000, Effect of pH on sorption and transport of FBA groundwater tracers in shale saprolite: *J. of Environ. Quality*, 29(6), p. 1806-1813.
- McKay, L.D., W.E. Sanford, and J.M. Strong, 2000, Field-scale migration of colloidal tracers in a fractured shale saprolite: *Ground Water*, v 38, p. 139-147.
- Cumbie, D.H., and L.D. McKay, 1999, Influence of diameter on particle transport in a fractured shale saprolite: *Journal of Contaminant Hydrology*, v. 31, p. 2-20.
- McKay, L.D., J. Fredericia, M. Lenczewski, J. Morthorst, and K.E.S. Klint, 1999, Spatial variability of contaminant transport in a fractured till, Avedore, Denmark: *Nordic Hydrology*, v. 30, p. 333-360.
- McKay, L.D., and T. Kammer, 1999, Incorporation of hydrogeology into the curriculum of an Appalachian field camp: *Journal of Geoscience Education*, v. 47, p. 124-130.
- McKay, L.D., D.J. Balfour, and J.A. Cherry, 1998, Lateral chloride migration from a landfill in a fractured clay-rich glacial deposit: *Ground Water*, v. 35, p. 988-999.
- Jørgensen, P.R., L.D. McKay, and N.Z.H. Spliid, 1998, Evaluation of chloride and pesticide transport in a fractured clayey till using undisturbed columns and numerical modeling: *Water Resources Research*, v. 34, p. 539-553.
- Stafford, P.L., L.E. Toran, and L.D. McKay, 1998, Influence of fracture truncation on dispersion: A dual permeability model: *J. of Contaminant Hydrology*, v. 30, p. 79-100.
- McKay, L.D., P.L. Stafford, and L.E. Toran, 1997, EPM modeling of a field-scale tritium tracer experiment in fractured, weathered shale: *Ground Water*, v. 35, p. 997-1007.
- Allen-King, R. M., L.D. McKay, and M. R. Trudell, 1997, Organic-carbon dominated

- trichloroethene sorption in a clay-rich glacial deposit, *Ground Water*, 35(1), 124-130.
- Hinsby, K., L.D. McKay, P. Jorgensen, M. Lenczewski, and C. Gerba, 1996, Fracture aperture measurements and migration of solutes, viruses and immiscible creosote in a column of clay-rich till, *Ground Water*, 34(6), 1065-1075.
- McKay, L.D., and J. Fredericia, 1995, Distribution, origin and hydraulic-influence of fractures in a clay-rich glacial deposit, *Canadian Geotechnical Journal*, 32(6), 957-975.
- McKay, L.D., Cherry, J. A., and R. W. Gillham, 1993, Field experiments in a fractured clay till:
1. Hydraulic conductivity and fracture aperture, *Water Resour. Res.*, 29(4), 1149-1162.
- McKay, L.D., R. W. Gillham, and Cherry, J.A., 1993, Field experiments in a fractured clay till:
2. Solute and colloid transport, *Water Resour. Res.*, 29(12), 3879-3890, 1993.
- McKay, L.D., J.A. Cherry, R.C. Bales, M.T. Yahya, and C.P. Gerba, 1993, A field example of bacteriophage as tracers of fracture flow, *Environ. Sci. Technology*, 27(6), 1075-1079.
- Garga, V.K., and L.D. McKay, Cyclic triaxial strength of mine tailings, 1984, *ASCE – J. of Geotechnical Engineering*, 110(8), 1091-1105.

Peer-reviewed Monographs and Book Chapters (2)

- Gentry, R.W., L.D. McKay, N. Thonnard, J.L. Anderson, D. Larsen, J.K. Carmichael, and D.K. Solomon, 2006, Novel techniques for investigating recharge to the Memphis aquifer, *AWWA Research Foundation*, IWA Publishing, 97 p.
- McKay, L.D., 1998, Hydrogeology and groundwater contamination, Chapt. 1 in *Microbial pathogens within aquifers: Principles and protocols*, S.D. Pillai, Editor, Springer -Verlag Publ., Berlin, Germany.

Guest Editor of Pathogens Issue for Journal of Ground Water

Dr. McKay was the Guest Editor for a Theme Issue on Pathogens and Fecal Indicators for the *Journal of Ground Water*. Eleven articles were accepted for the special issue, which was published in January of 2011.

Grants or Contracts (career total ~\$2.3 M as PI and \$2.5M as Co-I)

Research Grants

- \$22,500 Subcontract to Penn State for NSF CZO project (L. McKay, PI for UT subcontract; S. Driese, Co-PI) Shale Hills Critical Zone Observatory, 2009-2012.
- \$192,182 Subcontract from UT-Batelle for SERDP (DOE-DOD-EPA) project (L. McKay, UT -PI), Mobility of particulate and dissolved munitions constituents in the vadose zone at operational ranges, Jan/09 to Dec/11.
- \$242,000 Subcontract from Columbia University for National Institute of Health project (L. McKay, UT- PI; A. Layton, Co-PI), Does arsenic mitigation in Bangladesh increase exposure to bacterial and viral pathogens? Aug/07 – July/10.
- \$146,936 Tetra Tech Env. and Dept. of Defense (L. McKay, PI; J. Sanseverino, Co-PI), Volunteer Army Ammunition Plant – Bench-scale remediation studies, term Aug 2007 – Jan 2009.

\$60,000 TN Dept. of Environment and Conservation (A. Layton, PI; L. McKay and R. Gentry, Co-PIs) Determination of sources and concentrations of fecal bacteria in selected watersheds in Tennessee, June 1/07 – Dec 31/08.

\$100,000 NSF (G. Baker, PI; L. McKay, C. Mora and M. Rogge, Co-PIs) Enhancing diversity via targeted education and outreach through the East TN Geosci. Program, 2007-2009.

\$972,000 National Institute of Environmental Health, (M. Rogge, PI; L. McKay one of 7 Co-PI's) Alton Park/Piney Woods Environmental Health and Justice Collaborative. Term 2005-2009.

\$125,000 TN Dept. of Environment and Conservation (L. McKay, PI; J. McCarthy and R. Gentry are Co-PI's), Development of improved methods for fluorescent dye tracing, 2005-2007.

\$41,728 Tetra Tech Env. and Department of Defense (L. McKay, PI; V. Vulava, Co-PI), Groundwater age-dating with $3\text{H}/3\text{He}$ and CFCs at the Volunteer Army Ammunition Plant, term April/05 to May/06.

\$50,000 TN Dept. of Environment and Conservation (L. McKay, PI; A. Layton and R. Gentry, Co-PI's), Determination of sources and concentration of fecal bacteria in Chatata and Oostanaula Creeks, term 2005-2006.

\$160,000 National Science Foundation (E. Perfect, PI; L. McKay and 2 others are Co-PI's), Acquisition of an unsaturated flow apparatus (UFA) with technical support to investigate hydrologic processes in the vadose zone, term 2003-05.

\$161,920 TN Dept. of Environment and Conservation, (R. Gentry, PI; L. McKay and J. McCarthy are Co-PI's) Efficacy of using algae chloroplasts and Berillyum-7 to aid in designation of aquifers as Ground Water Under the Direct Influence of Surface Water (GWUDI), term 2004-2006.

\$188,611 TN Dept. of Environment and Conservation, (L. McKay, PI; A. Layton, Co-PI) Assessing the extent of viral contamination in fractured and karstic aquifers, 2002-2004.

\$34,070 US Geological Survey, (R. Gentry, PI; L. McKay, Co-PI) Evaluation of pathogen occurrence and causation within the Stock Creek watershed (Knox County) as a model for watershed restoration, term 2003-04

\$22,000 TN Dept. of Environment and Conservation, (L. McKay, PI; A. Layton, Co-PI) Testing of real-time PCR assays for the quantification of *E. coli* and host-specific fecal anaerobes in Stock Creek, term 2003-2004.

\$25,000 TN Dept. of Environment and Conservation, (R. Gentry, PI; L. McKay, Co-PI) An evaluation of watershed management practices & occurrence of *E. coli*, term 2003-2004.

\$397,031. Dept. of Energy, Basic Energy Sciences Program, (N. Thonnard, PI, L. McKay, Co-PI), Completion of Kr-81 and Kr-85 analysis development and testing in aquifer recharge studies, term 2001-04

\$375,883. National Science Foundation, (N. Thonnard, PI, L. McKay, Co-PI), Development completion of rare krypton isotope analysis and validation, term 2001-04

\$30,000. TN Dept. of Environment and Conservation, (L. McKay, PI, A. Layton, Co-PI) Development and testing of real-time PCR assays for the quantification of *E. coli* and host-specific fecal anaerobes in surface waters, term 2002-03

\$75,000. American Water Works Assoc. Research Fund and Memphis Light, Gas and Water, (R. Gentry, PI, L. McKay & others, Co-PIs), Utilization of environmental tracers to investigate recharge to the Memphis aquifer. Term 2000-03

\$23,956. US Geological Survey, (L. McKay, PI), Investigation of factors controlling transport of

microbial pathogens in saprolite soils, term 2001-02
\$24,000. ORNL subcontract (L. McKay, Co-PI), Quantifying the bio-availability of chromium in contaminated soils, term 2000-01.
\$85,000. US Geol Survey, (N. Thonnard, PI, L. McKay & others, Co-PIs) Development and testing of Krypton tracers for use in groundwater, term 1997-99.
\$599,000. Dept. of Energy, Dense organic solvents in the subsurface (L. McKay, PI), this includes UT subcontracts to ORNL and Univ. of Waterloo, term 1996-2000
\$160,000. Dept. of Energy/ORNL, Colloids in groundwater (L. McKay, PI), term 1996-1999.
~\$150,000. ORNL/DOE, (L. McKay, PI) Projects related to migration of contaminants in fractured and highly weathered bedrock at the Oak Ridge Reservation, term 1993-96.

ORNL Technical Support Funding

This amounts to approximately \$1.2 M since 1993 and consists mainly of funding for UT technicians working on ORNL research projects where I've managed the accounts, but played a minor role in the research. I've handled many of these contracts, but the only active one is shown below:

\$672,500 total (~\$70K/year) Subcontract from UT-Batelle (L. McKay, UT-coordinator)
Technical support for the Natural & Accelerated Bioremediation Field Research site (NABIR) at Oak Ridge National Laboratory (2003 – present).

GSA Hydrogeology Division Birdsall-Dreiss Distinguished Lecturer

Dr. McKay was chosen as the 2008 Birdsall-Dreiss Distinguished Lecturer by the Geological Society of America Hydrogeology Division. Dr. McKay prepared 3 lectures, as shown below, which host institutions could request. Additional information is available at <http://web.utk.edu/~hydro/Birdsall-Dreiss.html>

Cracks in the Clay – a lecture on the influence of fractures, root holes and other macropores on groundwater flow and contaminant transport in fine-grained sedimentary deposits

Germs and Geology – a lecture on the development and application of emerging microbial sampling and detection methods on investigations of pathogens and fecal indicators in streams and aquifers

Chattanooga Creek – a case history on environmental contamination and social impacts related to a former coal gasification plant located in a low income neighborhood.

Dr. McKay gave one or more of the Birdsall-Dreiss lectures at 50 universities, research institutions or conferences in 2008 and 2009. Locations in 2008 include: University of Tennessee, Dhaka Univ., Bangladesh, Florida International Univ., Univ. of South Florida, Tulane Univ., LSU, College of Charleston, Hollings Marine Station, SC, USGS – Richmond, VA, College of William and Mary, Clemson Univ., Stanford Univ., USGS – Menlo Park, CA, UC Davis, Univ. of Toronto, Univ. of Waterloo, Appalachian State Univ., UNC – Chapel Hill, NGWA GW Summit, MIT, U. Mass. – Amherst, Smith College, Boston Univ., Univ. of Kansas, Univ. of Arkansas, Penn State Univ., ETH – Zurich, Switzerland, EAWAGS, Switzerland, Karl Eberhard's Univ., Tübingen, Germany, UFZ – Leipzig, Germany, Univ. of Goettingen, Germany, Univ. of

Copenhagen, Denmark, UMB – As, Norway, Northern Illinois Univ., Iowa State Univ., Univ. of Northern B.C., Univ. of B.C., Univ. of Ottawa, Queen’s Univ., Laval Univ., Univ. of Montana – Missoula, GSA Annual Meeting, Grand Valley State Univ. and Michigan State Univ. Follow-up talks as the “former Birdsall-Dreiss Lecturer” were given in 2009 at Canterbury Univ. and Lincoln Univ. (both in New Zealand), Univ. of New South Wales, Flinders Univ. and the IAH Conference (all in Australia) and at Baylor Univ. in Texas.

Invited Talks at Conferences, Seminars or Universities (past 5 years)

McKay, L.D., Germs and Geology, Dept of Geology Seminar, Univ. of Delaware, Apr 4/2013.

McKay, L.D., A. Layton, P. Knappett, B. Mailloux, P. Culligan, A. Ferguson, J. Feighery, M. Emch, V. Escamilla, M. Serre, Y. Akita, J. Wu, K. Matin, M. Alam, M. Yunus, K. Streatfield and A. van Geen, An overview of hydrogeological and societal factors influencing fecal contamination and waterborne disease in aquifers in rural Bangladesh, Conference on Assessing Pathogen Fate, Transport and Risk in Natural and Engineered Water Treatment, Banff, Alberta, Canada, Sept 23-26, 2012.

McKay, L.D., Germs and Geology, 1st Annual Watershed Symposium, University of Tennessee, Knoxville, TN, Nov 14, 2011.

Mayes, M., B. Lavoie, L.D. McKay and S. Minkin, Mobility of particulate and dissolved nutrients constituents in the vadose zone at operational ranges, SERDP/ESTCP Environmental Technology Technical Symposium, Washington, D.C., Nov. 30 – Dec. 1, 2010.

van Geen, A., K. Ahmed, Y. Akita, J. Alam, P. Culligan, M. Emch, V. Escamilla, J. Feighery, A. Ferguson, P. Knappett, A. Layton, B. Mailloux, L.D. McKay, M. Serre, P. Streatfield, M. Yunus, J. Wu. (5 separate talks or posters), I – Identifying sources, II – Impact on diarrheal disease, III – Pathogens and indicators, IV – Identifying sources, V – Confounding factors, National Institutes of Health Ecology and Evolution of Infectious Disease – Investigator’s Conference, Atlantic City, NJ, March 23-24, 2010.

McKay, L.D., Germs and Geology, Southeastern Center for Emerging Biologic Threats – Conference on factors influencing emerging infectious diseases in the southeast, Emory Univ., Atlanta, GA, June 23-24, 2009.

Talks at Conferences, Seminars or Workshops (past 5 years)

McKay, L.D. and T.C. Hazen, Evaluating the effectiveness of a “for-credit” course in academic career preparation, Geological Society of America Meeting, Baltimore, MD, November 1-4, 2015.

McKay, L.D., D. Street, A. Layton, R.W. Hunter and A. Ludwig, Impact of cropland manure application on water quality at the UT Little River Dairy Farm, TN AWRA Symposium, Montgomery-Bell, TN, April 1-3, 2015.

Cheng, C.L., E. Perfect, L.D. McKay, et al., Neutron imaging rapid water imbibition in fractures and matrix in sedimentary rock cores, American Physical Society Annual Meeting, San Antonio, TX, March 2-6, 2015.

McKay, L.D., D. Street, A. Layton, R.W. Hunter, and A. Ludwig, The impact of cropland manure application on water quality in surface water, drain tile discharge and groundwater at a

- university dairy farm, Geological Society of America, Annual Meeting, Vancouver, BC, Canada, Oct 19-22, 2014.
- Paradis, C.J., ... L.D. McKay and T.C. Hazen, The memory effect: In-situ electron donor biodegradation rates as a function of exposure history in a shallow groundwater system, Geological Society of America, Annual Meeting, Vancouver, BC, Canada, Oct 19-22, 2014.
- Ayers, K., A. Layton and L.D. McKay, Factors influencing diarrheal pathogen presence in groundwater tubewells of Bangladesh, American Society for Microbiology General Meeting, Denver, CO, May 18-21, 2013.
- Moskal, J., M. Friday, A. Dere, L.D. McKay, Saprolite fabric in weathered shale in east Tennessee with comparison to Pennsylvania and Puerto Rico, SE Section Meeting, Geol. Society of America, San Juan, Puerto Rico, March 20-21, 2013
- Hunter, R.W., L.D. McKay, A. Layton, M. Borchardt, Measuring microbial and nutrient-related impacts of dairy operations on streams and groundwater at a university dairy research center, Conference on Assessing Pathogen Fate, Transport and Risk in Natural and Engineered Water Treatment, Banff, Alberta, Canada, Sept 23-26, 2012.
- Ayers, K., A. Layton, A. Smartt, L. McKay, A. van Geen and G. Sayler, Presence of diarrheal disease pathogens in Bangladesh surface water and well water, TN Water Resources Symposium, Burns, TN April 11-13/2012
- McKay, L.D., et al., The value of field occurrence studies of fecal contamination in aquifers and wells, Geological Society of America, Annual Meeting, Minneapolis, MN, Oct 9-12, 2011.
- Knappett, P., L.D. McKay, et al., Transport of fecal bacteria from ponds to aquifers in rural Bangladesh: The role of adjacent grain size, GSA Fragile Earth Conference, Munich, Germany, Sept 4-7, 2011.
- Culligan, P., ...L.D. McKay, et al., Aquifers and tubewells as vehicles of diarrheal disease in Bangladesh: Ecological and hydrogeological factors, National Institutes of Health Ecology and Evolution of Infectious Disease – Investigator’s Conference, Spring 2011.
- McKay, L.D., R.W. Hunter, J. Lee, Hydrogeologic controls on water quality at a university dairy farm, TN Water Resources Symposium, Montgomery Bell State Park, April 13-15, 2011.
- McKay, L.D., J. Zhang, D. Williams, B. Lavoie, F. Bogle, et al., Bench-scale treatability using chemical agents in clay-rich residuum contaminated with residues from explosives manufacturing, TN Water Resources Symposium, Montgomery Bell State Park, April 13-15, 2011.
- McKay, L.D., J. Zhang, D. Williams, B. Lavoie, F. Bogle, et al., Bench-scale treatability using chemical agents in clay-rich residuum contaminated with residues from explosives manufacturing, TN Water Resources Symposium, Montgomery Bell State Park, April 13-15, 2011.
- McKay, L.D., R.W. Hunter, J. Lee, Hydrogeologic controls on water quality at a university dairy farm, American Geophysical Union – Annual Meeting, San Francisco, CA, Dec 13-17, 2010.
- Van Geen, L., ...L.D. McKay, et al., Could arsenic mitigation lead to increased diarrheal disease in Bangladesh?, American Geophysical Union – Annual Meeting, San Francisco, CA, Dec 13-17, 2010.
- Feighery, J., ...L.D. McKay, et al., Comparing laboratory column test treatments with field profiles of fecal indicator bacteria and virus from concentrated source areas, American

- Geophysical Union – Annual Meeting, San Francisco, CA, Dec 13-17, 2010.
- Knappett, P., L.D. McKay, et al., Factors influencing fecal contamination in ponds of Bangladesh, American Geophysical Union – Annual Meeting, San Francisco, CA, Dec 13-17, 2010.
- Britto, R., M. Patel, F. Bogle, and L.D. McKay, Comparison of ozone and alkaline hydrolysis testing of DNT in saturated soils, Batelle Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, May 24-27, 2010.
- Lavoie, B., S. Minkin, M. Mayes, J. Biggerstaff, E. Perfect and L.D. McKay, Transport of dissolved and particulate explosive compounds in saturated flow column experiments, GSA NE-SE Joint Regional Meeting, Baltimore, MD, March 13-16, 2010.
- Layton, A., D. Williams, L.D. McKay, and J. Farmer, Identifying and detecting waterborne pathogens in Tennessee, TN Water Resources Symposium, Montgomery Bell State Park, April, 2010
- Mayes, M.A., L.D. McKay, F. Zhang, K. Koehn, E. Perfect and B. Lavoie, Mobility of particulate and dissolved munitions constituents in the vadose zone at operational ranges – 1. Susceptibility Analysis, SERDP (DoD) Conference, Washington, D.C., Dec 2009.
- Mayes, M.A., L.D. McKay, J. Biggerstaff, B. Lavoie, S. Minkin, and E. Perfect, Mobility of particulate and dissolved munitions constituents in the vadose zone at operational ranges – 2. Transport Studies, SERDP (DoD) Conference, Washington, D.C., Dec 2009.
- Knappett, P., L.D. McKay, A. Layton and others, Transport of fecal microorganisms from latrine ponds to aquifers in Bangladesh, AGU Annual Meeting, San Francisco, CA, Dec 2009.
- Driese, S., G. Ludvigson, J. Roberts, D. Fowle, L. Gonzalez, L.D. McKay and V. Vulava, Formation of pedogenic siderite in PAH-contaminated alluvial clay soils, Tennessee, USA: Part I: Insights from field relationships and micromorphology, GSA Annual Meeting, Portland, OR, October, 2009.
- Ludvigson, G., S. Driese, J. Roberts, D. Fowle, L. Gonzalez, L.D. McKay and V. Vulava, Formation of pedogenic siderite in PAH-contaminated alluvial clay soils, Tennessee, USA: Part II: Stable isotope data on modern analogue for a deep-time paleoclimate proxy, GSA Annual Meeting, Portland, OR, October, 2009.
- McKay, L.D., J. Zhuang and E. Perfect, Transport of colloids with transient wetting fronts, First International Conference on Microbial Transport and Survival in Porous Media, Niagara on the Lake, Ontario, May 10-13, 2009.
- DiClaudio, M., J. Sanseverino, J. Easter, L.D. McKay, A. Layton and G. Sayler, Reduction of toxicity of nitroaromatic-contaminated soils as detected by *Saccharomyces cerevisiae* BLYR, Annual Meeting of American Society for Microbiology, Philadelphia, PA, May 17-21, 2009.
- Knappett, P., L.D. McKay, A. Layton, et al., Ultrafiltration performance as determined by recovery of in situ bacteria and viruses, First International Conference on Microbial Transport and Survival in Porous Media, Niagara on the Lake, Ontario, May 10-13, 2009.
- Brown, T., L.D. McKay and J. McCarthy, Fluorescence characterization of carbonate aquifers in East Tennessee, AGU Chapman Conference, Birmingham, UK, Oct 20-23, 2008.
- Knappett, P.S., L.D. McKay, A. Layton et al., Investigating fecal contamination pathways to an unconfined sandy aquifer in Bangladesh, GSA – ASA Joint Annual Meeting, Houston, TX, Oct 5-9, 2008.
- Donat, R., E. Perfect, R. Gentry, L.D. McKay and E. van den Berg, Modeling the scale-dependent relationship between effective and slug test-determined saturated hydraulic

- conductivities, GSA – ASA Joint Annual Meeting, Houston, TX, Oct 5-9, 2008.
- Brown, T., L.D. McKay, J. Zhuang and S. Jones, Factors Inhibiting the Implementation of Low-concentration dye tracer tests, NGWA Ground Water Summit, Memphis, TN Mar 30 – Apr 3, 2008.
- Knappett, P., L.D. McKay and A. Layton, The efficacy of Bacteroides as a fecal tracer in shallow groundwater, NGWA Ground Water Summit, Memphis, TN Mar 30 – Apr 3, 2008.

Supervision of Graduate Students and Post-doctoral Researchers

Doctoral Candidates (4 completed, 1 in-progress)

- Lenczewski, Melissa, 2001, Biodegradation of TCE in a fractured shale saprolite near Oak Ridge, TN.
- Pace, Molly, 2005, Unsaturated flow and transport of ⁹⁰Sr, Co(II)EDTA and U(VI) in undisturbed cores from the Hanford Formation, Hanford, WA. Co-supervised with Dr. P. Jardine, ORNL.
- Mayes, Melanie, 2006, Hydrologic, geochemical and sedimentary processes governing the transport of radionuclides in Hanford region sediments. Co-supervised with Dr. P. Jardine, ORNL.
- Knappett, Peter, 2010, Sources and transport pathways of fecal bacteria and pathogens to aquifers in rural Bangladesh. Co-supervised with Dr. A. Layton, UTK.
- Charles Paradis, in-progress, Groundwater Ecosystem Responses to Repeated Exposures of Electron Donors. Co-supervised with Dr. T. Hazen, UTK.

Masters Students (19 completed)

- Stafford, Paige, 1995, Simulation of a field-scale tritium tracer experiment in a fractured, weathered shale using discrete-fracture/matrix-diffusion and equivalent porous medium models. Co-supervised with Dr. L. Toran, ORNL.
- Harton, Angela, 1996, Influence of flow rate on transport of bacteriophage in fractured shale saprolite
- Cumbie, Dennis, 1997, Influence of particle diameter on transport of colloids in shale saprolite
- Howard, Kevin, 1997, Factors influencing transport behavior of PFBA's in a highly weathered shale saprolite. Co-supervised with Dr. J. McCarthy, ORNL.
- Zondlo, Tom, 1998, Development and testing of underwater thermal and chemical survey methods for locating karst spring discharge
- Cropper, Clark, 1998, Investigations of air/DNAPL entry and migration in undisturbed columns of saprolite
- Haun, Deirdre, 1998, Influence of chemical perturbations on mobility of colloids in a fractured shale saprolite. Co-supervised with Dr. J. McCarthy, ORNL.
- Pitner, Andrew, 2000, Influence of immiscible matrix entry and aqueous diffusion on distribution of TCE contamination in fractured shale saprolite
- Stewart, Melanie, 2001, Bioavailability of chromium in contaminated soils. Co-supervised with Dr. P. Jardine, ORNL.
- Smith, Kevin, 2001, Influence of illuviated clays and soil cements on hydraulic conductivity in saprolite derived from sedimentary rock. Co-supervised with Dr. S. Driese,

UT.

Johnson, Trisha, 2005, Extent and seasonal variability of bacterial and viral contamination in karst aquifers. Co-supervised with Dr. A. Layton, UT.

Dickerson, Syreeta, 2005, The influence of seasonal flooding on distribution of coal tar compounds in Chattanooga Creek floodplain sediments.

Schultz, Bryan, 2005, Pore structure and grain size distribution in thick profiles of fine-grained residuum developed from weathering of Knox Group limestone. Co-supervised with Dr. S. Driese, UT.

Bell, Alyssa, 2007, Investigations of physical and chemical factors influencing fecal persistence and concentration in stream water. Co-supervised with Dr. Alice Layton, UT.

Brown, Terri, 2009, Fluorescence characterization of karst aquifers in East Tennessee.

Lavoie, Beth, 2010, Fate and transport of particulate explosive residues in soils at active Department of Defence testing ranges. Co-supervised with Dr. Melanie Mayes, ORNL.

Ayers, Kati, 2013, Factors influencing diarrheal pathogen presence in tubewells in Bangladesh. Co-supervised with Dr. Alice Layton, UT.

Hunter, Robert, 2013, Hydrogeology of the UT Little River Animal Agriculture Research Unit and impacts of dairy operations on groundwater.

Street, Derek, 2014, Quantitative characterization and waterborne transport of fecal indicators at the Little River Animal and Agriculture and Environmental Research Unit. Co-supervised with Dr. Alice Layton, UT.

Post-doctoral Researchers and Visiting Scientists

Dr. Vijay Vulava, Federal Institute of Technology, Zurich, Switzerland (2001-2006)

Ms. Nadine Goeppert, PhD Candidate at Karlsruhe Univ., Germany (May – Nov/05)

Dr. Sid Jones, Northwestern Univ. (2002-2004)

Dr. Mette Broholm, Danish Technical University (summer 2001)

Dr. Miri Rietti-Shati, Weizmann Institute, Israel. (2000-2001)

Courses Taught

Geol 103 – Earths' Environment (1996, 2002, 06, 07, 09, 10 & 2012)

Geol 103 – Earths' Environment Lab (2015)

Geol 440 – Field Camp (co-taught with 3 other faculty in 1996, 97, 98, 99, 2000 & 2002)

Geol 455 – Environmental Geology (co-taught in 2011, 2013 & 2014)

Geol/CE 485 – Principles of Hydrogeology (1993, 94, 95, 97, 97, 98, 99, 02, 03, 06, 10 & 2013)

Geol 486 – Hydrogeology Lab (1998, 99, 2000, 2001)

Geol 490 – Careers in Geology and Environmental Studies (2015)

Geol 585 – Contaminant Hydrogeology (1994, 96, 98, 2000, 02, 04, 06, & 09)

Geol 586 – Field and Lab Methods in Hydrogeology (1995, 97, 99, 2003, 05, 07, 09 & 2012)

Geol 685 – Seminar in Hydrogeology (2000, 03, 05 & 2007)

Geol 690 – Seminar on Academic Careers in the Earth Sciences (2008, 2011, 2014 & 2016)