LISA BITHELL KIRK, Ph.D., P.G.

PRINCIPAL GEOCHEMIST, Enviromin, Inc.
ASSISTANT RESEARCH PROFESSOR,
MSU Chemical and Biological Engineering

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SUMMARY

Dr. Lisa Kirk is Principal Geochemist and President/owner of Enviromin, Inc., a consulting practice specializing in microbial and environmental geochemistry and its application to mine waste management. Services include:

- Design, implementation, and evaluation of environmental geochemistry programs, including sampling strategy, test methods, analytical approaches, and data analysis,
- Abiotic and biotic characterization of mine waste to evaluate release and attenuation of metals, N and S,
- Conceptual design of mine facilities (waste rock, tailing, underground workings, and pits) to promote source control of acidity and metal release,
- Geochemical modeling of contaminants, using PHREEQ-C/Pitzer, MINTEQA2, and Geochemists Workbench®,
- Strategic consultation and regulatory liaison, including third-party technical oversight, in support of mine permitting, compliance, and closure, and
- Applied biogeochemical research into innovative methods of mine waste characterization and geochemical stabilization.

Dr. Kirk is also Assistant Research Professor in the Montana State University Chemical and Biological Engineering Department and works in the inter-disciplinary Center for Biofilm Engineering, where she develops and manages industrial clients and mining projects within the CBE Industrial Associate program, in collaboration with other academic investigators.

Dr. Kirk's expertise lies in the aqueous and biogeochemistry of mined materials, and their evaluation and assessment throughout the mine life cycle. She is experienced in mine planning, operations, and closure; geochemical modeling and characterization; design of geochemical sampling and analytical programs; mined land reclamation; and environmental assessment. Her experience includes the development and implementation of laboratory test methods for assessment of metal mobility, acid generation potential, and seepage attenuation for various materials. Dr. Kirk also has expertise in assessment, fate and transport, and management of acid rock drainage and metal release potential, as well as geochemical modeling of rock-water interactions and prediction of post-mine pit lake water chemistry. She is experienced in identifying and implementing best management practices (BMP) for management of mine waste rock, tailing, pits, and other facilities. Dr. Kirk has completed environmental geochemistry investigations and surface water characterization projects throughout the United States, and in Canada, South America, and Africa. She provides agency liaison and strategic support for permit development, regulatory compliance, and closure projects.

Dr. Kirk was a graduate fellow of the Inland Northwest Research Alliance, the Montana Water Center, and the U.S EPA Science to Achieve Results (STAR) program. Her ongoing work as a research scientist in the MSU Center for Biofilm Engineering is focused on understanding the subsurface ecology of microbial selenium reduction in mine waste, with a goal of developing operational strategies for *in situ* source control and improved metallurgical performance in diverse settings. Her interdisciplinary research involves the fields of microbiology, aqueous geochemistry, and mineralogy, and relies heavily on analytical chemistry and molecular biology methods. Enviromin's research into the microbial ecology of mine waste seeks to broaden that scope to more diverse styles of mineralization, facilities, and climates. Both roles feed her passion for innovation in management of mineral resource production at the industrial/academic interface, and rely on her 30 years of experience and leadership in mining environmental geology and geochemistry.

EDUCATION

Montana State University
PhD. Ecology and Environmental Science/Microbial Geochemistry
University of Colorado
MS. Geology/Aqueous Geochemistry
University of Pennsylvania
BS. Geology/Geology & Environmental Science

AWARDS

2008	Southwest Montana Junior Achievement Volunteer of the Year, for development of Bozeman, Montana High School Youth Mentoring program
2007	U.S. EPA Science to Achieve Results (STAR) Fellow, 2007-2010
2007	Montana Water Center, Fellow, 2007
2005	Honorable Mention, National Science Foundation Graduate Fellowship.
2004-2006	Fellow – Inland Northwest Research Alliance/DOE Subsurface Research Initiative Program

PROFESSIONAL REGISTRATIONS

Registered Professional Geologist – Wyoming, 1998; Pennsylvania, 1994; Washington, 2002 to present
Registered Member – Society for Mining, Metallurgy, and Exploration, No 4053453, 2011 to present

PROFESSIONAL EMPLOYMENT HISTORY

2014-present	Assistant Research Professor, Chemical and Biological Engineering Department/ Center for Biofilm Engineering, Montana State University, Bozeman, Montana
2012-2014	Research Scientist, Center for Biofilm Engineering, Montana State University
2004-present	Principal Geochemist, Enviromin, Inc., Bozeman, Montana
2004-2011	Graduate Fellow, Land Resources and Environmental Science, Montana State University
1998-2004	Senior Geochemist/Project Manager, Maxim Technologies/TetraTech, Bozeman Montana
1993-1998	Senior Geochemist/Project Manager, Schafer & Associates, Bozeman, MT
1991-1993	Consulting Geochemist, Cooke City, Montana
1990-1991	Project Geochemist, Hydrometrics, Cooke City, Montana
1985-1987	Project Geologist, Goodson and Associates, Inc, Lakewood, Colorado
1982-1985	Geologist, U.S. Geological Survey, Denver, Colorado

PROFESSIONAL EXPERIENCE

Microbial and Environmental Geochemistry Projects

Teck Coal Watershed Selenium Management Program, British Columbia and Alberta, Canada. *Microbial Geochemist, R&D Advisory working group* - Ongoing research program focused on stabilization of Se in coal mine waste. Co-led MSU research team involved in characterization of microbial community diversity and abundance in varied mine waste environments in BC and Alberta watersheds. Designed, managed, and interpreted results of aseptic field sampling program and laboratory experiments describing presence-absence of key metabolic processes and kinetics of Se reduction in the presence of varied carbon substrate. Conducted preliminary work on use of Se isotopes as reduction biomarkers and methods of carbon analysis. In progress.

Teck Resources Advanced Research Technology (ART), **Water Treatment Efficacy Study**. *Principal Geochemist/Research Scientist.* Co-led team effort to analyzed transformation of Se in analog and pilot water treatment reactors using FEM-EDX and TOF-SIMS; geochemical extractions and aqueous analyses;

confocal microscopy and live-dead staining; and analysis of microbial community. Provided similar support for column studies. 2013-2014.

Water Treatment Companies, Se water treatment process optimization. *Principal Geochemist/Research Scientist.* Analysis of microbial community and mineral scales, Se transformation. In progress.

Kinross/Echo Bay Kettle River Operations, *In Situ* Biological Reduction and Water Treatment Plan Optimization. *Principal Geochemist/Research Scientist.* Co-lead biogeochemistry evaluation of water treatment process and evaluate options for subsurface *in situ* waste management using aqueous geochemistry, mineralogy, microbial community, and microscopy analytical methods.

U.S. Forest Service (USFS) New World Mining District Adit Closure Biogeochemistry Study– Montana. *Principal Geochemist.* Geochemical modeling and microbial community evaluation of acid water quality pre and post-closure using a hydraulic adit plug. 2012-2013.

Tintina Resources Black Butte Copper Project, White Sulphur Springs, MT. *Principal Geochemist*. Direct sampling, analysis, modeling and facility design related to environmental geochemistry of proposed underground massive sulfide copper deposit mining project. In progress.

Butte Highlands Joint Venture, Montana. *Principle Geochemist*. Design and implement geochemical testing of cemented waste backfill. Supervise kinetic testing of waste rock for proposed gold mine. 2012-2013.

Agrium Groundwater Validation Program – Southeastern Idaho. *Principal Geochemist*. Independent third party review for geochemical baseline studies for NEPA evaluation. Assessment of manganese cycling in backfilled waste and influence on secondary contaminant mobility. 2010-2013.

Kinross Lobo Marte Environmental Geochemistry Baseline Study. *Principal Geochemist*. Independent third party review for hydrogeochemical assessment of groundwater conditions. 2009-2012.

Agrium North Rasmussen Ridge Expansion – Southeastern Idaho. *Principal Geochemist*. Independent third party review for hydrogeochemical assessment of groundwater conditions. Completed 2011.

Astaris Dry Valley Mine Operational Geochemistry Program – Southeastern Idaho. *Senior Geochemist/Project Manager.* Developed and implemented an operational geochemistry program to validate baseline studies, identify suitability criteria for waste rock management, and implement waste management programs to control trace element release potential (in particular, selenium) for an active phosphate mine. *In situ* hydrogeochemical monitoring and geochemical characterization methods, including column testing, were used to meet regulatory compliance requirements and modify closure designs. 2001-2003.

J.R. Simplot Company Deer Manning Creek Expansion – Southeastern Idaho. *Senior Geochemist*. Developed environmental geochemistry baseline data for proposed phosphate mine expansion, including evaluation of potential for selenium release, through baseline sampling, column testing, and *in situ* monitoring program. Evaluated potential for impact to water resources and identify operational management scenarios. 2002-2004.

Agrium No. Rasmussen Ridge Expansion – Southeastern Idaho. *Senior Geochemist*. Developed environmental geochemistry baseline data for proposed phosphate mine expansion. Included evaluation of potential for selenium release through column testing program. Developed geochemical model of trace element attenuation downgradient of backfilled mine panels using PHREEQE-C. 2000-2002.

Getchell Gold Mine – Nevada. *Senior Geochemist*. Conducted geochemical and mineralogical assessment of ARD and metal release potential for mined materials. 1995-1997.

Environmental Impact Statements/Environmental Assessments Baseline Studies

Operating Gold Mine, Expansion Permitting Baseline Geochemistry Study- *Montana***.** *Principal Geochemist.* Designed and supervised implementation of baseline geochemistry sampling and analysis program for gold mine expansion using static and kinetic methods. Statistical analysis of exploration data using R model. Applied molecular biology methods to analysis of downhole biofilm affecting groundwater quality. Ongoing.

Kinross Round Mountain Expansion Project EIS – Nevada. *Senior Geochemist/Consultant* provided third party review of geochemical evaluation and pit lake modeling for the Round Mountain mine expansion and EIS evaluation. 2009-2010 for RMX and 2013-present for WEX.

Montanore Mine EIS–Montana. *Senior Geochemist/Consultant* to Kootenai National Forest, Region One. Review and evaluate geochemical data for proposed waste rock, heap leach, and open pit mine facilities for proposed gold mining operations. Participate in agency liaison. Prepare technical review report , DEIS, and FEIS. 2013.

Montana Tunnels Mine Expansion – Montana. *Senior Geochemist*. Reviewed and evaluated geochemical data for proposed waste rock, heap leach, and open pit mine facilities for proposed gold mining operations. Prepared EIS under subcontract to Tetratech EMI, Inc and Montana Department of Environmental Quality. 2007-2008.

Twin Mining, Atlanta Gold EIS – Idaho. *Senior Geochemist*. Reviewed and evaluated geochemical data for proposed waste rock, heap leach, and open pit mine facilities for proposed gold mining operations. Prepared EIS under subcontract to Maxim/Tetratech EMI, Inc and USFS Boise National Forest. 2006.

Placer South Pipeline Expansion – Nevada. *Senior Geochemist*. Reviewed and evaluated geochemical data for proposed waste rock, heap leach, and open pit mine facilities for proposed expansion of gold mining operations. Prepared EIS/environmental assessment (EA) under subcontract to Enviroscientists, Inc. 2003.

Coeur Kensington Mine – Alaska. *Senior Geochemist*. Evaluated alternative plan of operation involving subaqueous placement of tailing and prepared EIS and National Pollution Discharge Elimination System (NPDES) permit under subcontract to Tetra Tech Inc. Worked with Region 10 EPA staff. 2002.

Newmont Gold Company Leeville and Pete Mines – Nevada. *Senior Geochemist.* Reviewed and evaluated geochemical data for proposed waste rock, heap leach, and open pit mine facilities for proposed expansion of gold mining operations. Prepare EIS/EA. 2000.

FMC Dry Valley Phosphate Mine – Southeastern Idaho. *Lead Geochemist*. Completed baseline environmental geochemistry and pit lake geochemistry assessments in support of NEPA evaluation and preparation of an EIS. Prepared EIS. 2000.

J.R. Simplot Smoky Canyon Project – Southeastern Idaho. *Lead Geochemist*. Responsible for environmental geochemistry baseline characterization. Developed column testing protocol used to predict seepage from overburden in waste rock piles. 2000.

Phelps Dodge Chino Mine – Arizona. *Geochemist*. Provided senior review of geochemical baseline data for waste rock and mine pit geochemistry model for an EIS. 1996.

Getchell Gold Mine – Nevada. *Geochemist*. Prepared portion of an EA addressing ARD risk and reclamation options for proposed expansion of the mine. 1995.

U.S. Bureau of Reclamation Transmission Line Siting – Montana. *Project Manager/Geologist*. Managed impact assessment efforts of earth science team responsible for assessment of impacts to atmospheric, geological, hydrological, and paleontological resources. 1985.

Mine Planning and Closure

U.S. Forest Service (USFS) New World Mining District Closure Design and Construction Project – Montana. *Lead Geochemist*. Supervised geochemical assessment of mine wastes in waste dumps and abandoned mine pits. Team leader for water treatment evaluation, including active and passive treatment options for point source acid rock drainage (ARD) contamination from underground and surface mine workings. Responsible for development of a mass load model for two key drainages characterizing ARD point and non-point sources for use in evaluating effectiveness of potential closure options. Member of team conducting evaluation of underground mine workings and defining alternatives for open pit and adit closure. 2004.

Talc Mine Environmental Geochemistry and Asbestiform Mineral Assessment – Montana. *Lead Geochemist/Project Manager*. Responsible for evaluation of mine waste and post mine pit environmental geochemistry issues at two mines. Evaluated occurrence of potentially asbestiform minerals in talc deposits, through mapping, sampling, and laboratory analysis. Developed plan for management of asbestiform minerals in waste for one mine site. 2000.

McDonald Gold Project – Montana. *Senior Geochemist/Project Manager*. Responsible for assessment of environmental geochemistry and post-mine pit lake geochemistry. Predicted pit water chemistry based on geochemical and hydrologic data, using PHREEQE, MINTEQA2 and other models of mineral solubility and sorption processes. Prepared limnologic model of mine lake using CE-QUAL-W2. Developed stochastic model of post mine lake chemistry using @RISK. Managed development of transient model. 1998.

Precious Metal Mining Operations – Nevada. *Lead Geochemist/Project Manager*. Responsible for ARD studies involving mineralogical evaluation (including petrographic, XRD, SEM-EDS, X-ray photoelectron spectroscopy, and other methods), and customized testing protocol development at Coeur Rochester and Barrick Goldstrike mines. 1998.

Mayflower Mine Development Project – Montana. *Project Manager*. Responsible for environmental baseline study and development of land application system. 1998.

Cominco Red Dog – Alaska. *Lead Geochemist/Project Manager*. Responsible for ARD study involving waste rock geochemistry for massive sulfide base metal deposit. 1994.

Placer Dome Golden Sunlight Mine – Montana. *Project Manager/Senior Geochemist*. Managed interdisciplinary study to demonstrate closure plan performance based on hydrologic, geochemical and soil characteristics of reclaimed sites at the mine. This included *in situ* monitoring of waste rock geochemistry and hydrology, geochemical characterization of mined rock and preparation of related technical reports in support of the expansion environmental impact statement (EIS) completed in the mid-1990s. 1997.

Crown Butte Mines New World Mineral Exploration/Mine Development Project – Montana. *Geochemist*. Assisted in water quality and ARD data collection and interpretation. Used PHREEQE to study solute concentrations in acid mine watershed. Prepared informational materials concerning water quality and earth science issues for public relations use. 1993.

Abandoned Mine Land (**AML) Projects**. *Lead Geochemist*. Designed programs to predict, demonstrate, and evaluate mine facility performance. Map abandoned mined lands. 1985-1990.

Wyoming AML Subsidence Control Project – Rock Springs, Wyoming. *Site Geologist*. Responsible for supervising drill and grout subsidence control program in residential area. 1988.

Office of Surface Mining Reclamation and Enforcement (OSMRE) AML Research Program. *Geologist*. Responsible for data collection, field investigation, and analysis of data. Assisted with project planning and

coordination of research to evaluate the use of geophysical instrumentation in subsurface void detection. 1986-1988.

Geological and Geochemical Research

Research Scientist, Center for Biological Engineering, Montana State University, 2011 to present. Industrial outreach coordinator for mining projects. Identify, develop, and attract funding from industrial clients for interdisciplinary microbial geochemistry research projects related to waste stabilization, improved metal recovery and water treatment. Assist in management of projects being conducted by faculty members, professional staff, and students, ensure quality and schedule control, prepare reports, provide client management, and communicate results to stakeholders.

Montana State University/Inland Northwest Research Alliance.and US EPA STAR Program. Research Fellow. Identification and characterization of microbes involved in selenium biotransformation in subsurface mine backfill environments. Identification of microbial habitat needed to foster selenium immobilization. 2006-2010.

Mt. Gunson Cu-Pb-Zn Mining District – Southern Australia. M.S. Aqueous Geochemistry Thesis Project. Developed comprehensive model of trace element geochemistry for highly saline groundwaters from the mining district (using multivariate statistical and thermodynamic computer models) to assess the use of hydrogeochemical exploration techniques in locating stratabound copper deposits. 1989-1990.

U.S. Bureau of Mines Research Program. Geologist. Participated in program to assess coal depositional environments and associated sedimentary structures that affect coal mine roof control in the western United States. Compiled and evaluated mine safety statistics. 1987.

U.S. Geological Survey (USGS) Laboratory and Field Projects. Geologist. Assisted USGS research geologist with various mineralogy and geochemistry projects. 1982-1986.

USGS Wilderness Study, San Juan Mountains – Colorado. Geologist. Conducted ore microscopy and electron microprobe studies of mineralized rocks. Used data with geochemical studies to evaluate mineral phase relationships and petrogenesis in order to characterize episodic mineralization related to Tertiary volcanic activity in the mountains. Participated in evaluation of mineralization, ore grade, and production volume for a wilderness mineral potential study. 1982-1984.

USGS Study. Geologist. Organized and analyzed geochemical data relating to Jurassic uranium deposits to determine major elemental associations. 1982.

Expert Witness/Strategic Consultation

International Finance Corporation Axmin Passendro Project–Central African Republic, Africa. *Senior Geochemist* provided third party review of geochemical evaluation for the Passendro gold mine project EIA. 2012.

Strategic Selenium Advisory Panel, British Columbia and Alberta, Canada. *Principal Microbial Geochemist*– British Columbia and Alberta, Canada. Member of interdisciplinary advisory panel tasked with providing guidance for management of selenium release associated with Teck coal mining operations in SE Canada. 2010-2011.

USFS Rock Creek Copper Project – Montana. *Senior Geochemist.* Third party review of geochemical characterization to evaluate adequacy of NEPA analysis and assistance with appeals/potential litigation preparation. 2003.

Crown Jewel Environmental Impact Statement – Washington. *Senior Geochemist*. Reviewed geochemical characterization. Assisted with pit modeling. Provided expert witness services. 1996.

PRESENTATIONS

Kirk, L. and K. Seipel, 2014. *Searching for Black Swans - Kinetic Testing of Low S Tailings*. How Long is Long Enough: Case Studies in Humidity Cell Tests, Society for Mining, Metallurgy and Exploration annual meeting, Salt Lake City, February 2014.

Kirk, L.B. and R. Mongrain, Session Chairs. Microbes in Mine Waste, Society for Mining, Metallurgy and Exploration annual meeting, Salt Lake City, February 2014.

Kozubal, M., L. Bozeman, and L. Kirk. *Microbial Mechanism for Sulfur Oxidation is Highly Conserved: Importance for Mined Environments*. Microbes in Mine Waste, Society for Mining, Metallurgy and Exploration annual meeting, Salt Lake City, February 2014.

Skorupa, D. L. Kirk, C. Hwang, R. Macur, D. Walker, M. Fields, D. Goeres and B. Peyton, 2013. *Spatial Analysis of a Selenium-Reducing Microbial Community in Mined Waste Rock*. Microbes in Mine Waste, Society for Mining, Metallurgy and Exploration annual meeting, Salt Lake City, February 2014.

Kirk, L.B., D. Skorupa, and B. Peyton, 2013. *Microbial Ecology of Mined Environments*. Talk presented at Montana Biofilm Meeting, February 5, 2013.

Skorupa, D. D. Goeres, L. Kirk, R. Macur, D. Walker, and B. Peyton, 2013. *Spatial Analysis of the Microbial Community in Mined Waste Rock: Activities & Signatures*. Presented at the Montana Biofilm Meeting, Center for Biofilm Engineering, February 2013.

Kirk, L.B., 2013. *Environmental Geochemistry of Revett-style Cu-Ag Deposits, NW Montana*. Talk presented at Society for Mining, Metallurgy and Exploration annual meeting, Denver, February 25, 2013.

Kirk, L.B., L. Bozeman and M. Kozubal. 2013. *Microbial Ecology of Iron Cycling in Mined Environments*. Talk presented at Society for Mining, Metallurgy and Exploration annual meeting, Denver, February 23, 2013.

Kirk, L.B., 2012. *Environmental Geochemistry of Revett-style Cu-Ag deposits, NW Montana*. Talk presented at Montana Mine Design and Closure Conference, Butte MT.

Kirk, L.B., M. Kozubal, and B.M. Peyton, 2012. *Molecular tools for microbial community analysis in mine waste*. Talk presented at Society for Mining, Metallurgy and Exploration annual meeting, Seattle, February 2012.

Kirk, L.B. and B.M. Peyton, 2011. *New insights on metal biogeochemistry and the microbial ecology of mine waste–Is the mining industry putting them to good use?* Talk presented at Society for Mining, Metallurgy and Exploration annual meeting, Denver, February 2011. Awarded best environmental division paper for 2011.

Kirk, L.B., B.D. Stewart, R. Macur, and R. Gerlach, 2011. *Lithology-dependent selenate reduction by native bacteria in phosphate mine waste.* Talk presented at Society for Mining, Metallurgy and Exploration annual meeting, Denver, February 2011.

Kirk, L.B. and R. Bowell, 2009. Environmental Session Chair. *Strategies for Optimizing Mine Waste Management.* Northwest Mining Association Annual Meeting, Reno NV.

Kirk, L.B., B. Peyton and R. Heibert, 2009. *Biotechnology in Operational Mine Waste Management*. Talk presented at NWMA Annual Meeting, Reno NV, Dec. 2009.

Kirk, L.B., B. Streit, and O.V. Singh, 2009. *Can OMIC sensors detect ecological stress?* Workshop at EPA STAR Fellows Conference, Washington DC, September 2009.

Kirk, L.B., S.E. Childers, B. Peyton, T. McDermott, R. Gerlach, and T.M. Johnson, 2009. *Geomicrobiological Control of Selenium Solubility in Subsurface Phosphate Overburden Deposits*. Talk presented at Goldschmidt Geochemistry Conference, Davos, June 2009. In Goldschmidt Abstracts – K, Abstract A661, Geochimica et Cosmochimica Acta, Vol.73, No.13, Supplement June, 2009.

Kirk, L.B., S. Childers, B. Peyton, T. McDermott, R. Gerlach, and J. Bozeman, 2008. *In-Situ Subsurface Microbial Transformation of Selenium as Source Control in Backfilled Phosphate Overburden, SE Idaho*. Talk presented at 24th Annual MT Section of American Water Resources Association, Big Sky MT. Second place student award.

Kirk, L.B., 2008. Environmental Session Chair: *Use and Misuse of Prediction in Mine Permitting and Environmental Management.* Northwest Mining Association Annual Meeting, Reno NV.

Kirk, L.B., S. Childers, and T.R. McDermott, 2006. *Lithologic Controls of Microbial Selenium Redox Transformations in Phosphate Backfill.* Poster presented at Inland Northwest Research Alliance Environment and Subsurface Science 2006 Annual Meeting, Moscow ID.

Kirk, L.B., 2005. *What's New in Mine Waste Characterization?* Invited presentation at Mine Design, Operations, and Closure conference, Polson, Montana.

Kirk, L.B., Parks, J, and G. Tomaino, 2005. *Life Cycle Approach to Characterization of Potentially Asbestiform Rock, Barretts Regal Talc Mine, Dillon MT*. Presented at SME Annual meeting, Salt Lake City UT, February 2005.

Kirk, L.B., 2005. Session Chair, *Changing Sampling Needs throughout Mine Life*, Industrial Minerals Program, SME Annual meeting, Salt Lake City UT, February 2005.

Kirk, L.B., 2004. *Pits, Pads and Piles in Closure*. US Army Corps of Engineers RAMS Program Site Characterization Short Course, Northwest Mining Association Annual Meeting, Dec. 6, 2004.

[4]Kirk, L.B., 2002. *Creativity in Mine Design – Case Studies in Life Cycle Environmental Management*. Invited lecturer Senior Creativity in Design Seminar, School of Engineering and Applied Science, University of Pennsylvania, Philadelphia, November 4, 2002.

Kirk, L.B., T. Kuxhaus, M.R. Pearson and S. Matolyak, 2002. *Predicting Selenium Release from Phosphate Overburden Using Column Tests*. Invited Paper presented at the Society for Environmental Toxicology and Chemistry North American Meeting, Salt Lake City Utah, November 2002.

Kirk, L.B., T. Grotbo and S. McIntosh, 2002. *Issues Affecting NEPA Reform*. presented at the Montana Mining Association Meeting, Butte MT, October 2002.

Kirk, L.B. (Instructor) and M. Burnside, 2002. *Risk Based Management in Mine Design and Operations*. In proceedings of USFS-USBLM Short Course on Permitting Exploration and Mining Projects on Federal Lands, presented at NWMA 2002 annual meeting, Spokane Washington, December 2002.

Kirk, L.B., 2001. *Environmental Management – Life Cycle Pollution Control*. Invited lecturer, Pollution Science course, Montana State University, March 2001.

Kirk, L.B. and A.R. Kirk. 2001. *What can we achieve in closure: The New World Mining District USFS Mining District response and restoration project, Cooke City MT.* Northwest Mining Association Annual Meeting, Spokane. December.

Kirk, L.B., F. Guard, K. Miller, and J. Cunningham, 2001. *Comparison of SPLP and Column Leach Data for Prediction of Environmental Geochemistry, Meade Peake Member, Phosphoria Formation, J.R. Simplot Smoky Canyon Mine, Caribou County, Idaho.* presented at the 5th Ground Water Technical conference for Idaho, Boise Idaho. October.

Kirk, L.B. (Instructor) and A.R. Kirk, 2000. *A Geoenvironmental Model for the New World Polymetallic replacement/skarn deposit*. In: Proceedings of USGS Short Course on Geoenvironmental Mineral Deposit Models. Presented at Fifth International Conference on Acid Rock Drainage, Denver CO, June 2000.

Kirk, L.B., C. Hatton, D. Morey and R. Lambeth (Instructors), 2000. *Bond Cost Estimation for Mine Closure*. USBLM, USFS, and NDEP Short course at Reno, Nevada, April 2000.

Kirk, L.B., C. Hatton, D. Morey, R Lambeth, P. Werner, and D. Williams (Instructors), 1999. *Estimating Costs of Mine Closure*. USBLM National Training Center course, January 1999.

Kirk, L.B., W. Schafer, S. Kranz, and J. Volberding. 1997. *Mine lake geochemical prediction and alternatives assessment for SPJV McDonald Project*. Poster presented at Fourth International Conference on Acid Rock Drainage, Vancouver, B.C., Canada. May 31 – June 6.

Luckay, C., L.B. Kirk, and W. Schafer. 1997. *Instrumentation for monitoring the hydrogeochemical performance of mining facilities*. presented at Northwest Mining Association annual meeting, Spokane, Washington.

Kirk, L.B. and W.M. Schafer. 1996. *Designing mines for closure*. presented at Northwest Mining Association annual meeting, Spokane, Washington.

Schafer, W.M., E. Spotts, L. Kirk and others, 1995. *Acid Rock Drainage Prediction and Control Short Course*, presented at Northwest Mining Association Annual Meeting, Dec. 4-5, 1995.

Kirk, L.B. 1994. *Methods for monitoring acid-generating materials in waste rock piles*. presented at Northwest Mining Association meeting.

Grauch, R.I., A.R. Kirk, K. Hon, K.R. Ludwig, H.H. Mehnerg, J.A. Zamudio, and L.M. Bithell. 1984. *Episodic uranium mineralization in the western San Juan Caldera Complex, Colorado*. Presented at IAEA meeting, El Paso, Texas.

PUBLICATIONS

In preparation

Kirk, L.B., J.J. Bozeman, M. Kozubal and S.E. Childers, 2014, in preparation. *Subsurface Microbial Selenium Reduction by Native Consortia in Phosphate Mine Waste, S.E. Idaho*. Target Journal: Applied Environmental Microbiology.

Kirk, L.B., J. J. Bozeman, B.D. Stewart, R. Gerlach, and B. M. Peyton, 2014, in preparation. *Rate of Selenate Reduction by Native Microbes in Saturated Phosphate Mine Waste*. Target Journal: Applied Geochemistry.

Kirk, L.B., L. Bozeman, and M. Kozubal, 2014, in preparation. *Microbial diversity of Iron Cycling Communities in Mine Affected Environments*. Target Journal: Geobiology.

Skorupa, D., L. Kirk, R. Macur, D. Walker, D. Goeres, and B. Peyton, 2014. in preparation. *Microbial Communities and Selenium Reduction in Two Coal Waste Rock Deposits*. Target Journal: Applied Environmental Microbiology.

Skorupa, D., D. Goeres, L. Kirk, R. Macur, D. Walker, and B. Peyton, 2014, in preparation. *Microbial diversity in unamended waste rock systems*. Target Journal: Applied Geochemistry (special issue on BC coal selenium management).

Macur, R., Walker, D., Kirk, L and B. Peyton, 2014, in preparation. *Effects of Carbon Amendments on native Se-reducing communities in saturated waste rock systems*. Target: Applied Geochemistry (special issue on BC coal selenium management).

Hwang, C., F. Roberto, K. Hollis, L. Kirk, and M. Fields, 2014, in preparation. *Bacterial Community Changes with Depth and Metal Geochemistry in Spent Ore Gold Heap Leach*. Target: Environmental Science and Technology.

Published

Kirk, L.B., 2014. *In Situ Microbial Reduction of Selenate in Backfilled Phosphate Mine Waste*, S.E. Idaho. Doctoral Dissertation, Montana State University Land Resources and Environmental Sciences.

Kirk, L.B., L.R. Bozeman, A.R. Kirk, and M.B. Marks, 2013. *Geochemistry of Improved Groundwater Quality Resulting from Adit Plugging, Glengarry Mine, New World District, Cooke City MT USA*. Proceedings of the Reliable Mine Water Technology International Mine Water Conference, Golden CO, August 2013.

Swanson, S., R. Abbott, W. Funk, L. Kirk, G. McKenna, H. Ohlendorf, and T. Sandy, 2011. *Building Stakeholder Engagement in Sustainable Solutions: The Strategic Advisory Panel on Selenium Management*. Proceedings of Mine Closure Conference, 2011, Banff, BC.

Kirk, L.B., B.D. Stewart, R. Macur, and R. Gerlach, 2010. *Speciation of Selenium by Facultative Bacteria in Phosphate Mine Waste.* Talk presented at Goldschmidt Geochemistry Conference, Knoxville, June 2010. In Goldschmidt Abstracts – K, Abstract A519, Geochimica et Cosmochimica Acta, Vol.74, No.12, Suppl.1.

Kirk, L.B., S.E. Childers, B. Peyton, T. McDermott, R. Gerlach, and T.M. Johnson, 2009. *Geomicrobiological Control of Selenium Solubility in Subsurface Phosphate Overburden Deposits*. Talk presented at Goldschmidt Geochemistry Conference, Davos, June 2009. In Goldschmidt Abstracts – K, Abstract A661, Geochimica et Cosmochimica Acta, Vol.73, No.13, Supplement June, 2009.

Kirk, L.B., M. McCleary, and R.W. Weimer, 2006. *Operational Validation of Environmental Geochemistry at the Stillwater Mine, Nye MT*. Proceedings of the 2006 Billings Land Reclamation Symposium, p 363-374.

Kirk, L.B.and A.R. Kirk, 2005. *Environmental Mineral Deposit Model for the New World Polymetallic Replacement/Skarn Deposit: Implications for Mine Closure*. Mining Engineering, October 2005, p. 39-45.

Kirk, L.B., W.M. Schafer, J. Volberding, and S. Kranz. 1996. *Mine lake geochemical prediction for the SPJV McDonald Project*. In: Planning, Rehabilitation and Treatment of Disturbed Lands. Proceedings of the Seventh Billings Mine Land Reclamation Symposium. March 17-23. p. 393-403.

Kirk, L.B. 1990. *Hydrogeochemical Exploration for Cu-Pb-Zn deposits, Mt. Gunson, Stuart Shelf, South America* [master's thesis]. Available from: University of Colorado, Boulder, Colorado. 263 pp.

Colaizzi, G.J. and L.M. Bithell. 1986. *Methods of controlling abandoned mine subsidence*. In: Proceedings of the Governor's Workshop on Mine Subsidence, University of Wyoming, Laramie, Wyoming. October 31.

Laird, R.B., A.L. Amundson, G.J. Colaizzi, and L.M. Bithell. 1985. *Geologic conditions affecting coal mine*

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Bithell, L.M. 1983. *Status of the resource recovery industry: an overview*. Journal of Resource Management and Technology 12(2):1-12.

CERTIFICATIONS AND CONTINUING EDUCATION

*Mine Safety and Health Administration Mine Safety Training (*40-hour) – April 2014
Environmental Model Parameterization Short Course – 2001
Environmental Toxicology – University of Idaho, 2000
Pit Lake Hydrogeochemical Modeling Short Course – 1999
Closure, Remediation, and Management of Precious Metal Heap Leach Facilities Short Course – 1998
Characterization, Management and Treatment of Water: Metal- Mining Operations Short Course – 1995
Managing Environmental Problems at Inactive and Abandoned Metals Mine Sites Short Course – 1994
Statistics for Environmental Compliance Short Course – 1997
Management of Technical Professionals – 1997

PROFESSIONAL AFFILIATIONS

Acid Rock Drainage Technical Initiative (ADTI), 2012 to present
International Mine Water Association, 2013 to present
The Geochemical Society, 2008 to present
Society for Mining, Metallurgy, and Exploration, Registered Member No 4053453, 2011 to present
American Exploration and Mining Association
    Federal Environmental Issues Committee Chairperson, 1997 to 2000
    Technical Review Committee Co-chairperson, 2000 to present
American Association for the Advancement of Science, 2010 to present