Michael J. Friedel

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PROFILE - Updated 19 August 2020

I am an Associate Researcher (Earth and Environmental Systems) at Semeion Centro Ricerche, **I**T. I develop and apply innovative algorithms and workflows that discover, quantify, and predict linkages and their response to climate, hydrologic and biogeochemical cycles and geophysical systems across spatiotemporal scales for solving Energy, Environmental and Security challenges. My research uses artificial-adaptive system (data mining, genetic programming, learn-heuristics, machine-learning, metamodeling, multimodal transfer learning, and physics-informed learning), numerical (traditional and joint multiphysics inversion) and uncertainty quantification (Bayesian, Monte Carlo) methods. I design, collect, and integrate big data including direct (physical, chemical, biological) and indirect (geophysical and remote sensing) measurements across multiscale environmental networks (space, airborne, surface, borehole) to improve solution predictability.

Prior to these roles, I was a Senior Computational Scientist at Pacific Northwest National Laboratory, USA; the Environmental Data Analytics Science Leader at Lincoln Agritech - Lincoln University and Senior Research Scientist (Hydro-Geophysics) at GNS Science, NZ; and Senior Research Scientist (Geophysicist and Hydrologist) and Supervisory Hydrologist at US Geological Survey, USA. During this period, I successfully developed and applied numerical and machine learning workflows to test hypotheses and answer questions in Earth and Environmental System themes: Climate and land-use change, Ecosystem, Energy and minerals, Natural hazards, Solid-earth, and Water Science. This work resulted in 120 publications, 150 conference presentations, and $33M+ research grants. During this period, I managed multimillion-dollar national/international projects with academic appointments as Adjoint Associate Professor in the School of Geography, Environment, and Earth Sciences at Victoria University, NZ; and Mathematical and Statistical Sciences at the University of Colorado, USA. I also served as Instructor in the Department of Geography and Environmental Sciences at the University of Colorado, USA; and Visiting Professor developing and teaching courses and mentoring students for the Geology Department at Colorado College, USA; Department of Environmental Science, University of Kuopio, FN; Geosciences Institutes at the Universities of Brasilia and Campinas, BR; and held Senior Research positions (Hydrologist, Hydrogeologist, Geophysicist, Hydrogeophysicist) with the Institute of Geological and Nuclear Science, NZ and the US Geological Survey, USA

EDUCATION

Degrees

PhD, Water Resources Science, University of Minnesota	1999-2002
Dissertation: Estimation of coupled water, heat, & solute transport parameters	
MS, Geo-Engineering, University of Minnesota	1989-1991
Thesis: Simultaneous water and heat transfer model development and application	
MS, Geosciences, Geophysics/Hydrogeology, University of Wisconsin	1983-1986
Thesis: A numerical investigation of Rayleigh-wave ground motion	
BS, Geosciences, University of Wisconsin	1980-1983

Postgraduate Training MBA (mini), University of St Thomas, United States 1996

RESEARCH EXPERIENCE

Associate Researcher - Earth and Environmental Systems   1/1/2018 – Present
[Semeion Research Institute]   Rome, IT

Key Projects:
- Data driven predictions of expected ultimate recovery of shale gas
- Multiphysics-informed learning for reduced order variably saturated zone transport
- Multimodal machine learning for mapping 3D subsurface systems

Key Collaborators: Brazil (Federal University of Brasilia, Federal University of Santa Catarina, Hydrogeophysics Group, Aarhus University, Technology Partnerz, PEMEX, US Forest Service,)

Senior Computational Scientist (Level 4)- Geophysics/Hydrogeophysics   7/20/2019–8/17/2020
Pacific Northwest National Laboratory, Subsurface Science & Technology Group   Richland, WA, USA

Scientific Leader/Investigator: Lead development of integrated research initiatives, white papers, concept proposals scopes of work, and letters of intent for earth systems and environmental science, and energy development. Lead *machine learning* research conducted within multidisciplinary (biologic, climate, geomechanical, geological, geophysical hydrogeological) teams. Set technical direction in hydrogeophysical monitoring and data assimilation, integration, estimation methods to characterize surface and subsurface properties and processes in collaboration with other specialists. Participate on committees such as Earth Systems Science Division AI/ML strategy working group. Serve as co-investigator in which I design and participate in multidisciplinary, multi-laboratory, multi-institutional, scientific proposals and studies that provide answers to National Challenges involving Energy and Environment.

Key Contributions:
- Automated seismic travel-time picking by machine learning for fracture flow imaging
- Joint inversion of electrical resistivity measurements for leak detection
- Multimodal transfer learning in surface and subsurface systems (white paper/EED initiative)
- Multi-scale subsurface data assimilation, visualization and simulation for CO_2 injection
- Multiphysics-informed learning for reduced order vadose zone flow and transport modeling

Key Collaborators: Demark (Hydrogeophysics Group, Aarhus University), Italy (Semeion Institute), USA (National Renewable Energy Technology Laboratory, Department of Energy; Crustal Imaging, US Geological Survey-Denver; Math & Statistics, University of Colorado-Denver).

Environmental Data Analytics Science Leader   11/15/2017–7/15/2019
Lincoln University, Lincoln Agritech Ltd, Environmental Research Group   Hamilton, NZ

Scientific Leader: I led scientists and engineers in broad research area to develop coupled groundwater, hydrologic and vadose simulation models and tools applicable across catchment scales that extend field research and serve as decision support tools for producers, agricultural industry, Ministry for the Environment; and Ministry of Business, Innovation and Employment. Other aspects involved assessing adequacy of current research and commercial work; provide thought leadership to identify future

directions and funding opportunities; lead development of proposals and partnerships; develop, mentor, and coach team members; and represent the Institute at briefings, meetings, and conferences.

Scientific Investigator: I designed and participated in multidisciplinary, multi-institutional, multinational scientific studies that provided answers to National Challenges involving human activities and associated changes (land use intensification, climate change) on freshwaters and their links to aquatic and terrestrial ecosystems. Developed and applied innovative methods to discover, quantify, and predict linkages and interactions among climate, hydrological and biogeochemical cycles across spatiotemporal scales that inform decision makers and drive adaption strategies for water security and ecosystem sustainability. Employed artificial-adaptive systems (evolutionary, machine-learning, learn-heuristics, metamodeling, and multimodal transfer learning), process-based (traditional/joint numerical) and statistical (Bayesian and stochastic) methods, *big data* collected across *multiscale* environmental networks, and software for transdisciplinary answers to questions related to: (1) the efficacy of field-scale agricultural practices designed to prevent nutrient and/or agrochemical loss; (2) how land use and climate change effect hydrological and biogeochemical processes that govern water quality and aquatic ecosystem function; and (3) how hydrologic, chemical and biological processes interact at the aquatic-terrestrial interface. Led the design, collection, and integration of big data including direct (physical, chemical, biological) and indirect (geophysical and remote sensing) measurements collected across *multiscale* environmental networks (space, airborne, surface, and borehole) to improve theory, scalability, and predictability. Developed and taught courses on data analytics in agroecosystem modeling. Provided mentorship (visiting scientists, post-doctoral fellows, and doctoral candidates at universities in the USA and abroad); and presented and published scientific findings through peer-reviewed venues.

Key Projects:
- Critical pathways – Quantifying dynamic subsurface contaminant transfers to lower order streams
- Our land & water–Natural/anthropogenic controls on GW/SW interaction and nitrate reduction
- Sources and flows – Predicting 3D groundwater redox status across agriculturally-dominated regions
- Precision agriculture – Remote classification vegetation/soils and crop yield prediction
- Smart 3D aquifer mapping – Metamodeling of hydrostratigraphy with airborne EM measurements
- Pathway partitioning – Groundwater modeling with novel chemistry-assisted mixing constraints
- Smart idea - Identifying climate and land-use change signals in urbanizing freshwater ecosystems

Key Collaborators: Australia (Geoscience Australia), Brazil (Federal University of Brasilia, Federal University of Santa Catarina, University of Campinas, Empresa Brasileira de Pesquisa Agropecuária), China (Beijing Water International; Institute of Quality and standard for Agricultural Products), Denmark (Aarhus University), Italy (Semeion Institute), New Zealand (Aqualinc, GNS Science, ESR, Environment Canterbury, Environment Southland, Hawkes Bay Regional Council, Tasman Regional Council, Waikato Regional Council, Ventures Southland; Ministry of Business, Innovation and Employment; private sector companies), USA (United States Geological Survey-Denver; University of Colorado-Denver).

Senior Research Hydrogeophysicist   6/1/2014–11/15/2017
Institute of Geological and Nuclear Science, Hydrogeology Department   Lower Hutt, NZ

Science leader: I applied scientific knowledge to assess adequacy of ongoing research and commercial work and development of future directions. Identified and led strategic program development activities including funding initiatives, proposal development, and partnerships with indigenous people, regional

councils, Crown Research Institutes, international organizations and universities. Represented the Institute at briefings, meetings, and conferences.

Scientific investigator: I developed complex multidisciplinary scientific studies that addressed critical ground-water, surface-water and ecosystem issues in complex, large-scale hydrologic systems (catchment, region, nationwide). Used multiple innovative geophysical and hydrogeologic techniques to solve complex groundwater problems. Conducted stochastic inversion of airborne electromagnetic data to characterize heterogeneous groundwater systems based on probable resistivity/conductivity distributions. Applied aquifer-test analysis theory and interpretation techniques to determine aquifer hydraulic properties and geostatistical modeling to simulate the uncertainty in their spatial distribution. Conceptualized, developed and calibrated numerical models (vadose zone and groundwater flow) to evaluate flow and transport response to changes in natural and anthropogenic stresses including ground-water/surface-water interactions. Applied parameter estimation, sensitivity, and uncertainty methods in the analysis of geophysical, groundwater, hydrologic, vadose zone, and watershed data and model responses. Conducted ground-water resource assessments involving the use and analysis of existing and new monitoring and geophysical data, geohydrologic framework characterizations, application of flow and recharge models, and predicting water balances. Conducted ground-water/surface-water interaction studies. Developed and applied advanced workflows (involving machine learning, numerical, statistical and uncertainty methods) to integrate multidisciplinary data for answers involving effects of climate and land-surface change on ecosystem, environment, and water resources. Facilitated accomplishments in combination with guidance and training of field methods and modeling to junior staff, doctoral candidates, and visiting scientists. Presented and published findings at national and international venues.

Key Projects: Initiated and Completed
- Conditional uncertainty in rainfall-recharge estimates
- Evolutionary-gradient numerical inverse solver
- Estimation and scaling of hydrostratigraphic units from hydrogeophysical data
- Estimation of water fluxes at earth-atmospheric boundary with remote sensing
- Evaluating role of large earthquakes on aquifer dynamics
- Hydrogeophysical modeling of heat and fluid flow in geothermal systems
- Improved lateral crustal imaging with seismic and magnetotelluric data and models
- Imputation and clustering of sparse hydrogeophysical data
- Influence of climate, land-use, and land cover on flow, transport, and ecology
- Mapping soil and vegetation with machine-learning and EO-1 Hyperion satellite data
- Mapping geothermal/mineral resources by machine-learning and WorldView-3 satellite data
- Physical/biogeochemical interaction among groundwater, surface-water, and ecology
- Predicting aquatic species and metrics under climate change and urbanization
- Predicting groundwater recharge as function of stream flow and oxygen isotopes
- Reduced order analysis of multi-scale geophysical and geoenvironmental systems
- Scaling and estimation of hydrogeophysical data and processes
- Sea-level rise effects on coastal water supply (quantity/quality)
- Spatiotemporal downscaling of New Zealand climate station network
- Unconventional shale-gas prospecting with quantity, quality, maturation data
- Unsaturated-zone fate and transport of water, gas, solutes in dual porous media

Key Collaborators: Australia (Geoscience Australia), Brazil (Federal University of Natal; Empresa Brasileira de Pesquisa Agropecuária), China (Chinese Academy of Sciences; Sun Yat-sen University), Georgia (Tblisi State University), Italy (Semeion Institute; University of Florence), New Zealand (Regional councils, Ministry of Business, Innovation and Employment), Spain (Institute of Environmental Assessment and Water Research), USA (United States Geological Survey-Denver; University of Colorado-Denver).

Senior Research Geophysicist, GS-1315-14   10/1/2005 – 5/30/2014
U.S. Geological Survey, Crustal Geophysics & Geochemistry Science Center   Denver, CO, USA

Science leader/manager: Developed, participated, and led national and international research and consulting teams that characterized, monitored, and modeled the occurrence, distribution, and trends in quantity and quality of ground- and surface-water in response to natural and human pressures. Identified funding opportunities, led proposal development, developed and maintained partnerships (local, national, international), participated in short- and long-term strategic planning.

Scientific investigator: Designed studies and collected multidisciplinary measurements (aquatic biology, biogeochemistry, climate, ecology, geophysics, hydrology, hydrogeology, hydrometeorology, and remote sensing) in different configurations (borehole, surface, airborne, satellite); developed and applied data-driven workflows (combined evolutionary, machine learning, numerical, optimization, and statistical methods) for transdisciplinary answers to questions in climate and land use, ecosystem, energy and minerals, natural hazard, crustal, and hydrologic (surface/ground water and vadose) sciences. Planned, developed, and maintained program of research and cooperative investigations involving geophysical, hydrogeologic and hydrologic survey design, data collection and monitoring; performed traditional and joint geophysical inversions, geostatistical modeling and simulation, and groundwater and vadose zone flow and reactive transport modeling analysis and interpretation. Developed and taught courses on groundwater flow and reactive transport modeling (conceptualization, calibration, uncertainty). Provided mentorship (visiting scientists, post-doctoral fellows, and doctoral candidates at universities in the USA and abroad); and presented and published scientific findings through peer-reviewed venues.

Key Projects: Initiated and Completed
- Aquatic-mining ecosystem connectivity and response
- Biodegradation of organic compounds in porous media
- Climate-change effects on groundwater recharge
- Climate and hydrology in formation of acid-rock drainage
- Connectivity mapping among groundwater system variables
- Coupled watershed processes under climate change
- Detection and discrimination of unexploded ordnance
- Differentiating background and mine-related acidity and metals
- Dual permeability and reactive transport model development
- Economic feasibility of mining undiscovered mineral deposits
- Effect of climate-change impacts on coastal environments
- Efficacy of reactive barriers to mitigate mine-waste
- Flood-warning system for Haitian government
- Forecast change in ecological integrity for metropolitan Chicago, USA
- Forecasting post-fire debris and flood response in western USA

- Groundwater modeling of climate change on Bishkek region, Kyrgyz republic
- Hillslope weathering and shallow ground-water quality
- Hydrogeologic properties from magnetic resonance data
- Hydrogeologic map of Mauritania, Africa
- Imaging and quantifying uncertainty in lithospheric boundaries
- Infiltration and drainage equations for arid intermountain valleys
- Joint prediction of well yield (groundwater) in northeastern Brazil
- Joint inversion of seismic and magnetotelluric data for crustal imaging
- Joint estimation of extreme rainfall in coastal ungauged basins
- Landscape discrimination using remote sensing data and artificial adaptive systems
- Metal mine-waste speciation and toxicity effects on aquatic receptors
- Mineral-resource effects on aquatic ecosystems
- Multiphase fluid flow and transport
- Multivariate geostatistical modeling of spatially-limited data
- Post-fire debris-flow volumes and their uncertainty
- Modeling hydrologic and geomorphic hazards across post-fire landscapes
- Modeling reactive transport in Aries River basin tailings
- Near real-time airborne electromagnetic 3D imaging of surficial aquifers
- Optimization of stochastic reservoir operations
- Persistence of El Niño-Southern Oscillation over 2,000 years
- Predicting coastal hydro-meteorological hazards
- Predicting background and mine-related acidity and metals
- Probable flooding in ungauged basins
- Quantifying streamflow prediction uncertainty in ungauged basins
- Quantifying uncertainty in joint seismic crustal imaging
- Reconstruction of global temperature change and solar activity
- Reconstructing conditional trends in climate change at regional and global scales
- Sediment transport in mining-affected Aries River basin
- Scaling of ground-water recharge measurements
- Spatial continuity from spatially-limited data for numerical inverse problems
- Statistical reliability of geophysical instruments to unexploded ordnance
- Stresses on water-quality in existing and proposed mining watersheds
- Stochastic assessment of undiscovered mineral resources
- Tailings and waste dump inventory and risk prioritization for Romania
- Uncertainty in joint-inverse depth estimates of Moho
- Uncertainty in airborne estimates of gold mineralization
- Uncertainty in multi-component reactive groundwater systems
- Variably-saturated dual permeability gas, flow and transport modeling
- Vertical drainage and groundwater flow in arid intermountain valleys
- Water-quality response across hydrothermal alteration-mining gradient

Key Collaborators: Brazil (University of Campinas; University of Brasilia; Empresa Brasileira de Pesquisa Agropecuária, Geological Survey of Brazil), Finland (University of Kuopio, Geological Survey of Finland), Georgia (Tblisi State University), Haiti (Geological Survey of Haiti), Italy (Semeion Institute), Kyrgystan

(Research Institute of Irrigation, Hydrogeology and Water Economy), Mauritania (Ministre du Petrole, de L' Energie et des mines), Romania (Romanian National Agency for Mineral Resources), USA (Univ of Colorado-Denver).

Senior Research Hydrologist, GS-1315-13   10/1/2001–9/30/2005
U.S. Geological Survey, Colorado Water Science Center   Denver, CO, USA Science leader/manager: Participated in short- and long-term strategic planning; developed and maintained a program of research and cooperative hydrological investigations that included data collection, modeling, and analysis; identified funding opportunities, led marketing strategies and proposal development, and developed partnerships among local, State, Federal, and International agencies and universities. Provided technical oversight to multiple hydrologic investigations and hydrologic research; applied knowledge of advanced hydrologic principles and related sciences to assess the adequacy of ongoing work and development of future directions; represented USGS at meetings and conferences; explained complex hydrologic and earth science information to a wide variety of individuals; coordinated project planning and review processes to ensure on-time completion of work products; resolved problems between employees and scientific collaborators; set goals and obtain buy-in from team members and those who supervised me.

Scientific investigator: Coordinated, led and participated on research teams that characterized, monitored, and modeled the occurrence, distribution and fate of water quality in surface and groundwater basins of Colorado and High-Plains aquifer. Proposed and designed field studies, conducted field sampling, collected data, and developed and applied modeling techniques and software for understanding effect of agricultural, wildfire, and reservoir stresses on hydro(geo)logic systems; mentored project chief and visiting post-docs and USGS scientists.

Key Projects: Initiated and Completed
- Agricultural land-use study in South Platte River basin
- Calibration and predictive analysis of vadose zone models
- Enhanced remediation of toluene biodegradation in vadose zone
- Hydrologic risk assessment and flood protection for coastal basins
- Post-wildfire assistance to US Federal Emergency Management Agency
- Post-wildfire flood potential in Willow and Mitchell Creek watersheds
- Preferential flow and transport in the High Plains aquifer
- Probable effects of proposed reservoir on river quantity, quality, ecological integrity
- Satellite resolution and effects on wildfire-induced flood models
- Water and solute transport in variably-saturated dual porous soils
- Stratified sample design for water quality studies
- Stochastic optimization of reservoir operations for water-quality and ecological benefits

Key collaborators: Colorado Springs Utilities, Denver Water, Northern Water Conservancy District, USGS National Research Program, US Bureau of Reclamation, US Federal Emergency Management Agency, others.

Supervisory Hydrologist, GS-1315-13   10/1/1997-9/30/2001
U.S. Geological Survey, Illinois Water Science Center   Urbana, IL, USA
Science leader/manager: Assisted Director with short and long-term strategic resource and program planning; periodically assisted with Center operations and resource management in Director's absence. Promoted and prioritized hydrologic and water-quality work; coordinated and prepared scope of work and financial plans with annual budgets to ~$2.0M; determined project staffing needs and hired scientists with experience in aquatic biology, data base administration, ecology, geomorphology, surface water, and groundwater data collection and modeling; determined assignments, awards, and promotions; reviewed and ensured timely completion and quality of technical proposals, work plans, presentations, and reports; and evaluated employee performance. Motivated scientific teams toward common goals; guided and participated in project designs, data collection, analyses, and interpretation; promoted team workshops on field data collection and modeling applications; identified, planned, promoted, and coordinated multi-state monitoring activities with cooperating companies, State and Federal agencies, National Synthesis Teams, and related studies; devised and promoted new scientific approaches; developed, participated and chaired reviews at science center, headquarter, and stakeholder meetings.

Scientific investigator: I developed multidisciplinary scientific studies that addressed critical ground-water, surface-water and ecosystem issues in complex, multistate hydrologic systems. Applied aquifer-test analysis theory and interpretation techniques to determine aquifer hydraulic properties and geostatistical modeling to simulate the uncertainty in their spatial distribution. Conceptualized, developed and calibrated numerical models (watershed, hydrologic, vadose zone and groundwater flow) to evaluate flow and transport response to changes in natural and anthropogenic stresses including ground-water/surface-water interactions and flooding. Applied parameter estimation, sensitivity, and uncertainty methods in the analysis of geophysical, groundwater, hydrologic, vadose zone, and watershed data and model responses. Conducted ground-water resource assessments (quantify and quality) involving the use and analysis of existing and new monitoring and geophysical data, geohydrologic framework characterizations, application of flow and recharge models, and predicting stochastic water balances. Conducted reach-scale ground-water/surface-water interaction studies. Developed and applied advanced workflows to integrate multidisciplinary data for answers involving effects of climate and land-surface change on ecosystem, environment, and water resources. Facilitated accomplishments in combination with guidance and training of field methods and modeling to junior staff. Presented and published scientific findings at national and international venues.

Key Projects: Initiated and Completed
- Upper Illinois River Basin Study, National Water Quality Assessment Program
- Urban land-use gradient study in the Upper Illinois River Basin
- Development and application of variably saturated mass and energy transport model
- Source-water risk assessment in the Upper Illinois River Basin
- Water-quantity testing and water-quality sampling/analysis (occurrence, distribution, trends)
- Regularized calibration and uncertainty analysis in surface and groundwater modeling

Key collaborators: Central Lake County Joint Action Water Agency, Illinois Environmental Protection Agency, Illinois State Water Survey, US Environmental Protection Agency, Northwest Suburban Municipal Joint Action Water Agency, others.

Research Geophysicist/Hydrologist, GS-1315-13   6/1/1987 – 9/30/1997
U.S. Geological Survey, Twin Cities Research Center   Urbana, IL, USA

Science leader/manager/scientist: I promoted and prioritized work; coordinated and prepared the scope of work and financial plans with annual budgets to ~$1.0M; lead, coordinated, mentored and participated in international transdisciplinary research and consulting team activities that characterized, monitored, and modeled the response of mining-related environmental and health & safety concerns. I designed geophysical (azimuthal, surface, borehole, crosshole, tomographic), groundwater and unsaturated zone studies; conducted packer, pump, slug testing, collected physical and chemical data; and developed and applied conceptual, predictive analytic and numerical modeling flow and transport techniques and software. My geophysical fieldwork supported solutions for engineering, groundwater, minerals, seismology, and vadose-zone studies.

Key data, methods and modeling: Some geophysical methods and modeling involved *electrical and electromagnetic* (controlled source audiomagnetotellurics, time and frequency domain electromagnetic, DC resistivity, ground penetrating radar, EM induction, induced polarization, magnetotelluric, radio wave, time-domain reflectometry, and very low frequency); *potential fields* (gravity and magnetics); *seismic* (birefringence, guided waves, ray tracing, particle motion, refraction, reflection, surface wave); *seismology*: earthquake seismicity (natural and artificial, acceleration, dispersion, source location and rupture). Some hydrologic methods and modeling involved physical installation and development (lysimeters, piezometers, wells), physical testing (deformation, discharge, stress-strain, injection, infiltrometer, mechanical, pump, water level), saturated/unsaturated water-quality sampling (physical, chemical, biologic). In addition, I mentored scientists and collaborated with researchers at other federal agencies and universities.

Key Projects: Initiated and Completed
- Acid-mine drainage studies
- Cavity and tunnel detection by geophysical methods
- Development and application of analytic-element model groundwater model software
- Development and application of finite-element model for coupled transport in freezing soils
- Development and application of geotomographic software for mining applications
- Geomechanical and geophysical technology for imaging fractured rock
- Geophysical assessments of mineral deposits
- Geophysical monitoring of injection/extraction of subsurface fluids
- Hydromechanical flow and reactive transport modeling in fracture rock
- Hydrothermal flow and transport modeling in porous and fracture rock
- Flow & transport modeling of in-situ leaching uranium, copper, and base sulfide deposits
- Modeling in-situ leach mining of tailings and fractured rock deposits
- Mine-structural integrity using geophysics (active/passive)
- Monitoring mining-induced stresses by seismic tomography
- Porous/fractured, saturated/unsaturated flow/transport methods/modeling
- Stochastic flow and transport in fractured rockmass

Key collaborators: Australia (Western Mining Corporation); South Africa (University of Johannesburg), USA (US Dept of Army, and various mining companies)

PROFESSIONAL EXPERIENCE

Academic Appointments

Associate Professor - Adjoint, Math & Statistical Sciences, University of Colorado	2014-2017
Associate Professor - Adjunct, Geog & Environmental Science, Victoria University	2014-2017
Associate Professor - Visiting, Geosciences Institute, University of Brasilia	2013
Associate Professor - Visiting, Geosciences Institute, University of Campinas	2013
Associate Professor - Visiting, Center Environ Studies, University of Campinas	2013
Associate Professor - Visiting, Center Meteor & Clim Res, University of Campinas	2012
Advisory Member, Center for Comp & Math Biol, University of Colorado	2010-present
Instructor, Geography & Environmental Science, University of Colorado	2009
Assistant Professor - Visiting, Geosciences Institute, University of Brasilia	2008
Assistant Professor - Visiting, Environmental Sciences, University of Kuopio	2007
Member, Graduate School, Colorado School of Mines	2006-2009
Assistant Professor - Visiting, Middle East Peace Process, US Department of State	2006
Assistant Professor - Visiting, Hohai University	2005
Member, Graduate School, University of Colorado	2004-2009
Assistant Professor - Visiting, Energy and Fluid Sci, University of Central America	2003-2006
Assistant Professor - Visiting, Geology, Colorado College	2003
Research Assistant, US Army High Perform Comp Cent, University of Minnesota	1995-1996

Non-Academic Appointments

Associate Researcher, Earth and Environmental Systems, Semeion Institute	2018-present
Data Analytics Science Leader, Environmental Research, Lincoln Agritech Ltd	2017-2019
Senior Hydrogeophysicist, Hydrogeology, Inst of Geological and Nuclear Sciences	2014-2017
Senior Research Geophysicist, (1) Crustal Geophysics & Geochemistry Science Center, and (2) Central Mineral & Environmental Resource, US Geological Survey	2005-2014
Visiting Scientist, Geoscience Australia, Groundwater Innovation, AU	2016
Visiting Scientist, Empresa Brasileira de Pesquisa Agropecuária, Satellite Mon, BR	2012
Visiting Scientist, Hydrogeology & Water Economy Institute, KG	2010
Visiting Scientist, USGS National Training Center, USA	2010
Visiting Scientist, Geological Survey of Brazil, Groundwater Section, BR	2008
Senior Research Hydrologist, Colorado Water Science Center, US Geological Survey	2001-2005
Supervisory Res Hydrologist, Illinois Water Science Center, US Geological Survey	1997-2001
Research Geophysicist, Geotechnology, US Bureau of Mines	1986-1997

PUBLICATIONS (* ISI Web of Science, ** Student, Post-Doc, Visiting Scientist)

1. **Friedel, M.J.**, Rechden, R., 2020, Estimated Ultimate Recovery Using the Digital Analogue Shale Model, On-line journals: SPE, AAPG, SEG (citations forthcoming).
2. **Friedel, M.J**., Wilson, S.R., Close, M.E., Buscema, M., Abraham, P., Banasiak, L., 2019 Comparison of four learning-based methods for predicting groundwater redox status, Journal of Hydrology, 580, 124200 https://doi.org/10.1016/j.jhydrol.2019.124200 [IF: 4.5] *
3. Iwashita, F.[**], **Friedel, M.J.**, Ferreira, F.J.F, 2018, A self-organizing map approach to characterize hydrogeologic properties of the Serra-Geral transboundary fractured aquifer, Hydrology Research Journal. 49(3), 794-814. https://doi.org/10.2166/nh.2017.221 [IF: 2.5] *
4. **Friedel, M.J.**, Buscema, M., Vicente[**], E., Iwashita, F.[**], Koga-Vicente[**], A., 2017, Mapping fractional soils and vegetation components from Hyperion satellite imagery using an unsupervised machine-learning workflow, International Journal of Digital Earth, 11(7), 670-690. https://doi.org/10.1080/17538947.2017.1349841 [IF: 3.0] *
5. **Friedel, M.J.,** 2016, Estimation and scaling of hydrostratigraphic units: application of unsupervised machine learning and multivariate statistical techniques to hydrogeophysical data, Hydrogeology Journal, 24, 2103-2122. https://doi.org/10.1007/s10040-016-1452-5. [IF: 2.4] *
6. Tindall, J., **Friedel, M.J**., 2016, Transport of Atrazine and Dicamba through silt and loam soils, Global Journal of Earth Science and Engineering, 3, 27-42. https://doi.org/10.15377/24095710.2016.03.01.3 [IF: 1.1] *
7. Tindall, J., **Friedel, M.J.**, 2016, Transport of Atrazine versus Bromide and δO^{18} in sand, Journal Water, Air, & Soil Pollution, 227-294. https://doi.org/10.1007/s11270-016-2983-z.[IF: 1.9] *
8. **Friedel, M.J.**, Esfahani, A., Iwashita, F., 2015, Toward real-time 3D mapping of surficial aquifers using a hybrid modeling approach, Hydrogeology Journal, 24(1), 211-229. https://doi.org/10.1007/s10040-015-1318-2 [IF: 2.4] *
9. Esfahani, A.A.[**], **Friedel, M.J.**, 2014, Forecasting conditional climate-change using a hybrid approach, Environmental Modelling & Software, 52, 83-97. https://doi.org/10.1016/j.envsoft.2013.10.009 [IF: 4.8] *
10. **Friedel, M.J.,** 2014, Data-driven modeling of background and mine-related acidity and metals in river basins, Environmental Pollution, 184, 530-539. https://doi.org/10.1016/j.envpol.2013.09.036 [IF: 5.7] *
11. Moreira, L.P.[**], **Friedel, M.J.**, França G.S., 2013, Uncertainty analysis in the joint inversion of receiver function and surface-wave dispersion, Paraná Basin, southeast Brazil. Bulletin of Seismological Society of America, 103 (3), 1981-1992. http://dx.doi.org/10.1785/0120120167 [IF: 2.3] *
12. **Friedel, M.J.**, Iwashtia, F.[**], 2013, Hybrid modeling of spatial continuity for applications to environmental inverse problems, Environmental Modelling & Software, 43, 60-79. https://doi.org/10.1016/j.envsoft.2013.01.009 [IF: 4.8] *
13. **Friedel, M.J.,** 2012, Hybrid modeling to predict the economic feasibility of mining undiscovered porphyry copper deposits. Applied Soft Computing 13, 1016-1032. https://doi.org/10.1016/j.asoc.2012.09.019 [IF: 4.9] *
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15. **Friedel, M.J.**, Souza, O.F., Iwashita, F., Yoshinaga, S. P, Silva, A M, 2012, Data-driven modeling for groundwater exploration in fractured crystalline terrain, Northeast Brazil, Hydrogeology Journal, 20(6), 1061-1080. https://doi.org/10.1007/s10040-012-0855-1 [IF: 2.4] *

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71. **Friedel, M.J.,** 2015, Hydrogeophysical Modeling Geothermal Field Data. GNS Science Rpt,10 pp.

72. Moreira, L.P., **Friedel, M.J.**, França G.S., 2013, Joint inversion of receiver function, surface wave dispersion, and magnetotelluric data for 2D crustal modeling.

73. **Friedel, M.J**., Moreira, L.P., 2013. Joint-inverse framework with PEST examples to improve subsurface modeling, Annual Report, Energy and Minerals Program, USGS. See 2013 AGU abstract (S23A-2469).

74. Koga-Vicente, A, **Friedel, M.J.**, 2012, Modeling the effects of climate-variability on hydro-meteorological risks along coastal São Paulo State, Brazil.

75. Litvak, R.G., **Friedel, M.J.**, 2012. Evaluation of measures to mitigate ground-water flooding in Bishkek region of Kyrgyzstan, Final Technical Report submitted to U.S. Civilian Research and Development Foundation (through Kyrgyz Hydrogeology and Water Economy Problems Laboratory) cooperative grants program (Award Number: KYG2-2936-BI-09), 33 pp.

76. **Friedel, M.J.**, 2011. Guidance document: Considerations for improving USGS stochastic mineral resource assessments, Annul Report, Energy and Minerals Program, USGS. See also 2011 AGU union session (Pres. 107).

77. Wnuk, C., **Friedel, M.J.**, R. Olson, D. Luppnow, 2007, Hazards risk mitigation and emergency preparedness project: technical assistance for mining waste facilities, Administrative report submitted to World Bank (through Futures Group), 753 pp

78. **Friedel, M.J.**, M.I.L. Ionescu, and M.J. Alder, 2007, Design of short- and long-term environmental monitoring system to evaluate spill response and effectiveness of tailing management and waste dump facilities, rehabilitation activities for maintaining surface and groundwater quality in the Aries River basin, Romania, Administrative Report submitted to World Bank (Futures Group), 26 pp.

79. Smith, M., **Friedel, M.J.**, 2006, Soliette River flood hazard warning system – review as a function of rainfall quantity and rainfall intensity, Administrative Report submitted to United States Agency International Development, 19 pp

Reports in Preparation (research completed)

80. **Friedel, M.J.**, Multiphysics-informed decision tree learning algorithm for variably saturated subsurface transport modeling, LDRD, Pacific Northwest National Laboratory.

81. **Friedel, M.J**., Regionalization workflow for predicting 3D groundwater-redox status at the national scale using sparse data: New Zealand case study.

82. **Friedel, M.J.**, Modeling mineral-resource effects on aquatic ecosystems using machine learning and multivariate statistical techniques: Application to Central Colorado, USA.

83. **Friedel, M.J.**, Intelligent scaling of ground-water recharge measurements.

84. **Friedel, M.J.**, Machine-learning paradigm for predicting climate-change effects on ground-water recharge in the Midwestern United States.

85. **Friedel, M.J.**, Modeling warm-season persistence of the El Niño-Southern Oscillation phenomena over the past 2,000 years.

PROFESSIONAL ACTIVITY

Research prizes, fellowships, awards and appointments

Research Associate, Machine Learning, Earth & Environmental Sciences, Semeion Institute, Rome Italy	2018-present
Letter of appointment, Strategic Big Data Consultant, SUSTECH Environmental Ltd, Southern University of Science and Technology, China	2017-2019
Foreign travel grant, US Department of State, USA	2014
Leadership Training (20 of 10,000 employees), US Geological Survey, USA	2013
Foreign travel grants, North Atlantic Treaty Organization, Turkey & Azerbaijan	2007, 2008

AWARDS

Research Associate, Machine Learning, Earth & Env Syst Sci, Semeion Institute, Rome, IT Letter of Appointment, Strategic big-data consultant, SUSTech Shenzhen, China	2018
Foreign Travel grant, Machine-learning workshop, Semeion Institute, Rome Italy	2014
USGS Leadership training institute (20 candidates of 10,000 employees per year)	2013
Foreign Travel grants, NATO Advanced Study Workshops, Izmir, Turkey/Baku, Azerbaijan	2007

CONFERENCE PRESENTATIONS (** Student, Post-Doc, Visiting Scientist)

1. **Friedel, M.J.**, 2020, Multiphysics-informed decision tree learning algorithm for vadose zone transport modeling, H111 - Scientific Machine Learning and Physics-informed Data-driven Methods for Flow, Transport, and Coupled Processes across Temporal and Spatial Scales, American Geophysical Union, San Francisco, CA, 7-11 December 2020.

2. **Friedel, M.J.**, 2020, Multiphysics-informed learning algorithm for vadose zone transport modeling – preliminary results, Harnessing the data revolution: Knowledge guided machine learning: A framework for accelerating scientific discovery (Workshop), Minneapolis, MN, August 2020. NSF Awards: 1934668 (CSU), 1934548 (Penn State), 1934633 (UW), 1934721 (UMN). [INVITED]

3. **Friedel, M.J.**, Rechden, R., 2020, Estimated Ultimate Recovery Using the Digital Analogue Shale Model, Theme 6: "Big Data" Applications to Unconventional Reservoirs, Unconventional resources technology conference, Austin, TX, July 2020. [VOICE-OVER PRESENTATION]

4. **Friedel, M.J.,** Minsley, B., Moreira, L.P., 2019, ID: 619814: Helicopter electromagnetic informed learning to estimate uncertainty in subsurface models, H43F-2050 - Advances and applications of data integration, inverse methods and machine learning in Hydrogeophysics II Posters, American Geophysical Union, San Francisco, CA, 9-13 December 2019.

5. **Friedel, M.J.**, Wilson, S., Close, M., Buscema, M., Abraham, P., Banasiak, L., 2019, Predicting probable 3D groundwater redox status in agriculturally-dominated regions of New Zealand, Land Use and Water Quality, Agriculture and the Environment, Aarhus, Denmark, 3-6 June 2019. https://www.luwq2019.dk/upload/LuWQ2019_conference_programme_FINAL_20190526.pdf

6. **Friedel, M.J.**, Buscema, M., 2019, Identifying climate- and land-use change signals in a freshwater ecosystem, Land Use and Water Quality, Agriculture and the Environment, Aarhus, Denmark, 3-6 June 2019.
https://www.luwq2019.dk/upload/LuWQ2019_conference_programme_FINAL_20190526.pdf

7. Wilson, S., **Friedel, M.J.**, Close, M., Abraham, P., Banaskiak, L., 2018, Investigation of methods to predict groundwater redox status using limited sample data, New Zealand Freshwater Sciences Society Conference, Nelson, New Zealand, 10-14 December. (Presented by Wilson) https://ourlandandwater.nz/wp-content/uploads/2019/03/SF_Prediction-of-Redox-NZFSS.pdf

8. **Friedel, M.J.**, Wilson, S., Close, M., Buscema, M., Abraham, P., Banasiak, L., 2018, Predicting NZ groundwater-redox status: machine-learning considerations & preliminary results, Hydrological Society Annual Conference, Christchurch, New Zealand, 4-7 December.

9. Close, M., Wilson, S., Friedel, M.J., Abraham, P., Banasiak, L., 2018, Investigation of methods to predict groundwater redox status with variable amounts of available well data, Hydrological Society Annual Conference, Christchurch, New Zealand, 4-7 December. https://ourlandandwater.nz/wp-content/uploads/2019/03/SF_MClose_Prediction-of-Redox-HydroSoc-2018.pdf

10. **Friedel, M.J.**, Minsley, B., Moreria, Lucas P., 2018, From stochastic airborne EM inversion to geologic model: application of a two-step machine learning workflow, Hydrological Society Annual Conference, Christchurch, New Zealand, 4-7 December.

11. **Friedel, M.J.,** Symington, N., Hala, L., Tan, KP, Lawrie, K., 2018. Improved groundwater system characterization and mapping using hydrogeophysical data and machine-learning workflows. Australasian Exploration Geoscience Conference – Exploration Innovation Integration, Sydney, Australia, 19-21 February. https://doi.org/10.1071/ASEG2018abW10_3H

12. Lawrie, K., Brodie, R., Lescinsky, D., Symington, N., Christensen, N.B., **Friedel, M.J.**, Halas, L., 2017, Transforming groundwater system and critical zone mapping and assessment in a big data environment, Session: Applications of Hydrogeophysics to Groundwater Characterization, Monitoring, and Management (11146), National Groundwater Association Meeting, Denver, CO, May 8-2017. (Presented by Lawrie)

13. **Friedel, M.J.,** Daughney, C., 2016, Statistical robustness of machine-learning estimates for characterizing a groundwater-surface water system, Southland, New Zealand, Achieving deep learning by systemizing machine learning with big data engines I, Poster IN11B-1619, Earth and Space Science Informatics, American Geophysical Union, San Francisco, CA, 2016. 2016AGUFMIN11B1619F

14. **Friedel, M.J.,** Daughney, C., 2016, Machine-learning based assistance for groundwater model calibration, Water Infrastructure & Environment, 28 Nov–2 Dec, 2016, Queenstown, New Zealand.

15. **Friedel, M.J**., 2016, Smart aquifer characterization and mapping with machine-learning and evolutionary techniques, Australian Earth Sciences Convention, Adelaide, Australia, 26-30 June. [INTERNATIONAL, KEYNOTE] http://aesc2016.gsa.org.au/assets/AESC-Program-as-at-230616.pdf

16. **Friedel, M.J.,** Cox, S., Williams, C. 2016, Holden, C. 2016, Evaluating the role of large earthquakes on aquifer dynamics using data fusion and knowledge discovery techniques, poster EGU016-3327, Session GM4.2/HS11.12/NH4.9 - Perturbation of Earth's surface systems by earthquakes, European Geosciences Union General Assembly, 17-22 April, 2016, Vienna, Austria. 2016EGUGA..18.3327F

17. **Friedel, M.J.,** 2016, An ensemble training scheme for machine-learning classification of Hyperion satellite imagery, poster EGU016-3329, Session BG4.9 - Mapping, Monitoring & Modelling of Vegetation Characteristics using Earth Observation, European Geosciences Union General Assembly, 17-22 April 2016, Vienna, Austria. 2016EGUGA..18.3329F

18. **Friedel, M.J.,** Buscema, M. 2016, Modeling an aquatic ecosystem: application of an evolutionary algorithm with genetic doping to reduce prediction uncertainty, poster EGU016-18106, Session NP4.5/ESSI1.5 – Big data and machine learning in geosciences, European Geosciences Union General Assembly, 17-22 April, 2016, Vienna, Austria. 2016EGUGA..1818106F

19. **Friedel, M.J.,** 2015, Data fusion and knowledge extraction in hydrogeology (85836), Advances in hydrogeophysics posters, H13A-1489, American Geophysical Union, December 2015, San Fran., CA. 2015AGUFM.H13A1489F

20. Moriera, L.P. **, **Friedel, M.J.,** 2015, Hybrid geophysical inversion using genetic algorithm and gradient descendant methods (65813), Joint inversion methods and other interpretation strategies to integrate multi-disciplinary geophysical data, NS51A-1961, American Geophysical Union, December 2015, San Francisco, CA. (Presented by Moreira) 2015AGUFMNS51A1961M

21. **Friedel, M.J.,** Rawlinson, Z, 2015, Data to knowledge: hydrogeophysical data fusion and estimation of aquifer properties in the Otago region, NZ, Hydrologic Society Meeting, December 3-5, 2015, Hamilton, NZ.

22. **Friedel, M.J.,** Rissmann, C., Daughney, C., Kees. L., 2015, Data to knowledge: identifying lithologic controls on GW/SW interaction using machine-learning and clustering techniques, Southland, NZ, Hydrologic Society Meeting, December 3-5, 2015, Hamilton, NZ.

23. **Friedel, M.J.,** Buscema, M., 2015, artificial adaptive systems: data to knowledge in environmental science, Hydrologic Society Meeting, December 3-5, 2015, Hamilton, NZ.

24. Daughney, C., Rissmann, C., **Friedel, M.J**., Hodson, R., Morgenstern, U., Martindale, H., Rodway, W., Moreau, M., Kees, L., 2015, Hydrochemistry and water dating for characterisation of the Southland regional groundwater-surface water system. Hydrologic Society Meeting, December 3-5, 2015, Hamilton, NZ. (Presented by Daughney)

25. **Friedel, M.J.,** 2015, Using artificial adaptive systems to select input for ecosystem models, 2015 International conference on water resource and environment, July 25-28, Beijing, China.

26. Daughney, C., Rissmann, C., **Friedel, M.J**., Hodson, R., Morgenstern, U., Martindale, H., Rodway, W., Moreau, M., Kees, L., 2015, Hydrochemistry and water dating for characterisation of a regional groundwater-surface water system, Southland, New Zealand. 42nd IAH Congress - AQUA2015 - Hydrogeology: Back to the Future! September 13-18, Roma, Italy. (Presented by Daughney)

27. **Friedel, M.J.,** Rawlinson, Z., Westerhoff, R., 2015, Intelligent mapping of an alluvial aquifer in the Otago region, New Zealand. Poster EGU015-7433, Hydrogeophysics in subsurface hydrology (HS8.1.2), European Geosciences Union General Assembly, April 2015, Vienna, Austria.

28. **Friedel., M.J.**, Buscema, M., Daughney, C., Litvak, R., Chambel, A., 2014, Evaluating ground-water quality using artificial adaptive systems, H41G-0931, American Geophysical Union, December 2014, San Francisco, CA.

29. Vicente, L. **, Koga-Vicente, A. **, **Friedel, M.,** Victoria, D., Zullo, J., Gomes, D., Bayma-Silva., G., 2014, Land use and land cover change modeling using remote sensing and soft computing approach to assess sugarcane expansion impacts in tropical agriculture, B33E-0215, Mapping, Methods, Modeling, and Monitoring: Agicultureas For Means of Global Change Assessment I Posters, American Geophysical Union, December 2014, San Francisco, CA. (Presented by Vicente)

30. Moreira, L. **, da-Cunha, L., **Friedel, M.**, 2104, Phosphate mineral deposits characterization using multivariate data and SOM-based processing, NG31A-3790, Neural Networks in Geophysics Posters, American Geophysical Union, December 2014, San Francisco, CA. (Presented by Moreira)

31. **Friedel, M.J.,** 2014, Modeling the effects of stressors on aquatic ecosystems, H11H-1251, Soil and Water: Delivering Valuable Ecosystem Services: Land Use Effects (Oral), 2014 Water Symposium, Integration: The Final Frontier, November 25, 2014, Blenheim, NZ.

32. Rawlinson, Z., **Friedel, M.J.,** Westerhoff, R., 2014, Mapping hydrogeological properties using helicopter electromagnetic (HEM) data In Otago, New Technologies (oral), 2014 Water Symposium, Integration: The Final Frontier, November 25, 2014, Blenheim, NZ. (Presented by Rawlinson)

33. **Friedel, M.J.**, 2014, Uncertainty and upscaling in rainfall-recharge modeling, NIWA Rainfall Recharge Workshop, Christchurch, NZ, August 26, 2014 (no abstract).

34. **Friedel, M.J**., Esfahani, A., 2013, Influence of global volcanic processes on climate modulation in the southwestern US, 132-2 (205), Session 132, T24. Climate Change in the Interior Western United States from the Last Glacial Maximum to the Holocene (Posters), Geological Society of America, Joint Annual Meeting, Denver, Colorado, 27-30 Oct. 2013.

35. Vicente, L.E. **, **Friedel, M.J**., Iwashita, F., Koga-Vicente, A. **, 2013, Mapeamento de características de solos tropicais utilizando Self-Organizing Map aplicado à dados hiperespectrais, SBSR Brazilian Remote Sensing Symposium, April 2013, Foz do Iguaçu, PR, Brazil. [INTERNATIONAL] (Presented by Vicente)

36. **Friedel, M.J.,** 2013, Big data integration for regional hydrostratigraphic mapping, H11H-1251, Regional groundwater systems: advances in modeling, characterization, and applications I Posters, American Geophysical Union, December 2013, San Francisco, CA.

37. Moreira, L. **, **Friedel, M.J**., 2013, A hybrid data-integration scheme for improved crustal imaging, S23A-2469: Advances in seismic imaging: Towards integrated GeoModels on all scales – Shallow/Industry III Posters, American Geophysical Union, December 2013, San Francisco, CA.

38. Lins, D.B, Zullo, J, **Friedel, M.J.,** 2013, Integrating vegetation index time series and meteorological data to understand the effect of the land use/land cover in the climatic seasonality of the Brazilian Cerrado, GC23B-0928, Global Environmental Change General Contributions II Posters, American Geophysical Union, December 2013, San Francisco, CA. (Presented by Lins)

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39. Vicente, L.E. **, Koga-Vicente, A. **, **Friedel, M.J**., Victoria, D., Gomes, D., Bayma, G., Zullo, J., 2013, Modeling tropical land-use and land-cover change related to sugarcane crops using remote sensing and soft computing techniques, B41A: Earth Observations for Global Agricultural Monitoring II Posters, American Geophysical Union, December 2013, San Francisco, CA. (Presented by Vicente)

40. Lins, D.B. **, Zullo, J, **Friedel, M.J**., 2013, Downscaling in climate models: an application for generation of alcohol production scenarios in Brazil, 345-3 145, Session 345, T79 Geochemical mapping at regional to continental scales (posters). Climate Change in the Interior Western United States from the Last Glacial Maximum to the Holocene, Geological Society of America, Joint Annual Meeting, Denver, Colorado, 27-30 Oct., 2013. (Presented by Lins)

41. Esfahani, A.A. **, **Friedel, M.J**., 2012, A fractal approach to the climate of southwestern United States, 29th IUGG Conference on Mathematical Geophysics, Poster Session 1, Informatics, Edinburgh, Scotland, 13 June [INTERNATIONAL] (Presented by Esfahani)

42. Moreira, L. **, **Friedel, M.J**., Franca, G., 2012, Joint inversion of receiver function, surface wave dispersion, and magnetotelluric data for 2D crustal modeling, Nonlinear geophysics session NG31B-1582, American Geophysical Union, December 2012, San Francisco, CA.

43. **Friedel, M.J.,** Esfahani, A. **, Abraham, J., 2012, Application of machine-learning to characterize an alluvial aquifer in western Nebraska, Hydrology session H13B-1327, American Geophysical Union, December 2012, San Francisco, CA

44. **Friedel, M.J**., Finn, C.A., Horton, J.D., 2012, Hydrogeology Ground-water flow, hydrostratigraphy, and potential water-resource targets in Mauritania, Africa, Hydrology session H13B-1327, American Geophysical Union, December 2012, San Francisco, CA

45. **Friedel, M.J**., 2012, Remote detection, classifying, and imaging using a hybrid paradigm, U.S. Department of Army, Engineer Research Development Center, 14 November, 2012, Arlington, Virginia. [INVITED] (no abstract)

46. **Friedel, M.J.,** Finn, C.A., Horton, J.D., 2012, Hydrogeology of Mauritania, Africa, Mauritania Minerals Project Workshop, Denver, CO, 13 June (no abstract)

47. **Friedel, M.J**., Esfahani, A. **, Schmidt, T.S., Smith, K., Mast, M.A., 2012, Connectivity mapping among variables in a mining-aquatic ecosystem, poster presentation (abstract #32), EPA Hardrock Mining Conference: Advancing Solutions for a New Legacy, Denver, CO, 3-5 Apr.

48. **Friedel, M.J**., Schmidt, T.S., Smith, K., Mast, M.A., 2012, Development of Aquatic-Mining Ecosystem Models Using Computational Intelligence, poster presentation (abstract #30), USEPA Hardrock Mining Conference: Advancing Solutions for a New Legacy, Denver, CO, 3-5 Apr.

49. Moreira, L.P. **, **Friedel, M.J.,** França G.S., 2012, Uncertainty in crustal imaging of the Paraná Basin. European Geosciences Union General Assembly, PSD5.5 - Active seismic investigations of the Earth's crust, poster XY487, 24 April.

50. Vicente, E., **Friedel, M.J**., Iwashita, F., 2011, Landscape discrimination in Brazil using hyperion data and a self-organizing map approach, Union session (U22b) oral presentation at 2011 Fall Meeting, AGU, San Francisco, Calif., 5-9 Dec. (Presented by Vicente)

51. Iwashita, F. **, **Friedel, M.J**., Fraser, S., 2011, Application of soft computing in hydrogeologic characterization of the Serra Geral-Guarani aquifer system, Parana state, Brazil, Union session (U22b) oral presentation at 2011 Fall Meeting, AGU, San Francisco, Calif., 5-9 Dec. (Presented by Iwashita)

52. **Friedel, M.J.,** 2011, Applications of soft computing in undiscovered global porphyry copper assessments, Union session (U22b) oral presentation at 2011 Fall Meeting, AGU, San Francisco, Calif., 5-9 Dec. [INVITED]

53. **Friedel, M.J.,** 2011, Computational intelligence in earth systems – applied soft and hybrid modeling, U.S. Department of Army, Engineer Research Development Center, 30 November 2011, Vicksburg, Mississippi. [INVITED] (no abstract)

54. Asch T., **Friedel, M.J**., 2011, ALLTEM UXO discrimination results from the Aberdeen proving ground using a hybrid generalized neural analysis standard dipole inversion classification scheme, In: Advances in Classification Methods for Military Munitions Response, Symposium on the Application of Geophysics to Engineering and Environmental Problems, April 12, Charleston, South Carolina. (Presented by Asch)

55. Esfahani, A.**, **Friedel, M.J**., 2011, A fractional climate forecast for southern and southwestern United States, Land-climate interactions from models and observations: Implications from past to future climate, poster session CL2.15, European Geosciences Union General Assembly, 3-7 April, 2011, Vienna, Austria. [INTERNATIONAL]

56. Moreira, L.P.**, **Friedel, M.J**., 2011, Joint inversion of receiver function, surface wave dispersion, and magnetotelluric data for 2D crustal modeling, The Lithosphere-Asthenosphere Boundary (LAB) Dilemma, poster session GD2.4/SM4.1/TS10.2, European Geosciences Union General Assembly, 3-7 April, 2011, Vienna, Austria. [INTERNATIONAL]

57. **Friedel, M.J**., Long, K., 2011, A data-driven economic filter for stochastic mineral assessments, Soft Computing Techniques in Geosciences, poster session NP1.3/ESSI21, European Geosciences Union General Assembly, 3-7 April, Vienna, Austria. [INTERNATIONAL]

58. **Friedel, M.J**., 2011, El Niño-Southern Oscillation (ENSO) phenomenon – event reconstruction and analysis over the past 2000 years, ENSO – Dynamics, predictability, poster session NP2.1, European Geosciences Union General Assembly, 3-7 April, Vienna, Austria. [INTERNATIONAL]

59. Iwashita, F., F. **, **Friedel, M.J**., Souza Filho, C.R., Fraser, S. J., 2011, Using self-organizing maps to analyze high-dimensional geochemistry data across Paraná, Brazil. In: Proceedings 15th Simpósio Brasileiro de Sensoriamento Remoto. Curitiba, Brazil. [INTERNATIONAL] (Presented by Iwashita)

60. **Friedel, M.J**., 2010, Post-fire debris flow prediction using a two-step hybrid approach, U.S. Geological Survey, 3rd Modeling Conference, Denver Colorado, June 2010.

61. **Friedel, M.J**., 2010, Intelligent post-fire hydrologic and geomorphic landscape modeling, U.S. Geological Survey, 3rd Modeling Conference, Denver, Colorado, June 2010.

62. **Friedel, M.J**., 2010, Intelligent exploration for shallow groundwater in fractured rock systems, U.S. Geological Survey, 3rd Modeling Conference, Denver, Colorado, June 2010.

63. **Friedel, M.J**., 2010, Forecasting climate change effects on ground water recharge using an unsupervised artificial neural network, U.S. Geological Survey, 3rd Modeling Conference, Denver, Colorado, June 2010.

64. Brown, P. and **Friedel, M.J**. 2010, Overview of new Monte Carlo software for quantitative mineral resource estimation, U.S. Geological Survey, 3rd Modeling Conference, Denver, Colorado, June 2010. (Presented by Brown)

65. Brown, P. and **Friedel, M.J**., 2010, Test results comparing the new US Geological Survey Monte Carlo quantitative resource estimation simulation software application to MARK3, U.S. Geological Survey, 3rd Modeling Conference, Denver, Colorado, June 2010. (Presented by Brown)

66. Iwashita, F. **, Silvana A., Vieira Monteiro, A.M., **Friedel, M.J**., 2010, Evaluating the effects of positioning errors on the accuracy of species distribution models using synthetic data, U.S. Geological Survey, 3rd Modeling Conference, Denver, Colorado, June 2010. (Presented by Iwashita)

67. Iwashita, F. **, **Friedel, M.J**., Carlos de Souza-Filho, 2010, Surveying soil chemical weathering in Parana state/Brazil: A data mining-GIS hybrid approach, U.S. Geological Survey, 3rd Modeling Conference, Denver, Colorado, June 2010. (Presented by Iwashita)

68. Manning, A., **Friedel, M.J.,** Verplanck, P.L., Todd, A.S., 2010, Applying numerical modeling to evaluate the significance of climate and hydrology in the formation of natural acid-rock drainage in mineralized watersheds. Session 74: Integrated approaches to modeling geochemical, hydrological, and ecological processes in watersheds, Geological Survey of America, Joint Annual Meeting, Denver, Colorado, 31 October - 3 November 2010. (Presented by Manning)

69. **Friedel, M.J**., 2010, Nonlinear modeling of coupled watershed processes using a data-driven approach, Session 74: Integrated approaches to modeling geochemical, hydrological, and ecological processes in watersheds, Geological Survey of America, Joint Annual Meeting, Denver, Colorado, 31 Oct.- 3 Nov, 2010.

70. Koga-Vicente, A. **, **Friedel, M.J**., 2010, Comparison of empirical and data driven hydrometeorological hazard models on coastal cities of São Paulo, poster NH51A-1220 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec. (Presented by Koga-Vicente)

71. **Friedel, M.J**., 2010, Hindcasting 2000 years of Pacific sea and land surface temperature changes, poster H21G-1125 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.

72. Esfahani, A.A. **, **Friedel, M.J**., 2010, The fractal nature of climate change - 2000 years in retrospect, H21G-1126 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.

73. Iwashita, F. **, **Friedel, M.J**., Ribeiro, G.F., Fraser, S.J., de Souza-Filho, C.R., 2010, Using self-organizing maps to predict soil texture and hydraulic conductivity in the Poços de Caldas, Modelagem numérica e experimental de processos geológicos, Grande Área: MÉTODOS E TÉCNICAS EM GEOLOGIA, 45º Congresso Brasileiro de Geologia, Belem, Brazil, October 26-31. [INVITED, INTERNATIONAL] (Presented by Iwashita)

74. **Friedel, M.J**., 2010, Climate change effects on ecosystem services in the United States – issues of national and global security, NATO Advanced Study Workshop – Climate change Effect on Water Supplies – Issues of National and Global Security, Izmir, Turkey, Sept.1-5, 2010. [INTERNATIONAL, KEYNOTE]

75. Johnson, R.H., Manning, A.H., and **Friedel, M.J**., 2009, Evaluating the utility of watershed-scale numerical models in the U.S. Geological Survey's mineral, environmental assessment project, Toward More Effective Use of Ground Water Modeling II: Improved Conceptual Models and Data Integration 2009 Ground Water Summit: The Science and Engineering Conference, April 21, 2009. (Presented by Johnson)

76. **Friedel, M.J.,** 2008, Overview of USGS groundwater research activities, INMET, Brasilia, Brazil – Invitation to speak about USGS and personal research [INVITED] (no abstract)

77. **Friedel, M.J**., 2008, Methods for predicting wildfire-induced debris flows, Integrated Wildfire, presentation to USGS Central Region management, Snow Mountain Ranch, Tabernash, CO, Sept. 11, 2008. [INVITED] (no abstract)

78. **Friedel, M.J.,** 2008. Hazards and risks – flooding, 2nd USGS Modeling conference, National Hazards Panel, Perdido Beach, Alabama, February 2008. [INVITED, KEYNOTE]

79. **Friedel, M.J**., 2008, Application of stochastic modeling to forecast likely urbanization effects on ecological integrity in the Upper Illinois River Basin, USA, Extended abstract, United States Geological Survey, 2nd Modeling Conference, Gulf Shores, Alabama, February 10-15, 2008

80. **Friedel, M.J**., 2008, Joint inverse modeling to estimate extreme rainfall events and their uncertainty in ungauged coastal basins, El Salvador, Central America, Extended abstract, United States Geological Survey, 2nd Modeling Conference, Gulf Shores, Alabama, February 10-15, 2008

81. **Friedel, M.J**., 2008, Joint inverse modeling to estimate flood-flow depths and their uncertainty in ungauged coastal basins, El Salvador, Central America, Extended abstract, United States Geological Survey, 2nd Modeling Conference, Gulf Shores, Alabama, February 10-15, 2008

82. **Friedel, M.J**., Souza, O.F. **, Yoshinaga, S. P, Silva, A M, 2008, Application of a joint inversion strategy to improve electromagnetic imaging of hydrogeologic structures in Northeastern Brazil, EOS Trans. AGU, 89(53), Fall Meet. Suppl., Abstract, NS31A-1224.

83. **Friedel, M.J**., 2008, Quantifying ground-water recharge using a coupled water-heat-solute transport model: optimal nonlinear parameter estimation, nonuniqueness, and predictive uncertainty, Trans. AGU fall meeting, San Francisco, CA, Dec 10, 2008.

84. Johnson, R.H., and **Friedel, M.J**., 2008, Factoring uncertainty into restoration modeling of in-situ leach uranium mines, 330-8, Hydrogeology III - Uranium, Metals, and Other Contaminants in Groundwater, Geological Society of America, 2008 Joint Annual Meeting, 5-9 Oct. 2008. (Presented by Johnson)

85. **Friedel, M.J**., 2008, Numerical modeling strategies in resource assessments – past, present, and future. SP 41. Modelagem numérica e experimental de processos geológicos, Grande Área: MÉTODOS E TÉCNICAS EM GEOLOGIA, 44º Congresso Brasileiro de Geologia, Curitiba, Brazil, October 26-31. [INTERNATIONAL, KEYNOTE]

86. Tindall, J.A., Figueroa-Johnson, M., and **Friedel, M.J**., 2007, Comparison of soil-water sampling techniques, Trans. AGU, 83(42), Fall Meet. Suppl., H53F-1489. (Presented by Tindall)

87. **Friedel, M.J**., 2007, Assessment and management of mining-related environmental risks with applications, University of Kuopio, Kuopio, Finland [INVITED, INTERNATIONAL]

88. **Friedel, M.J.,** 2007, Overview of hazards risk mitigation and emergency preparedness project, Bucharest, Romania, presentation to World Bank Experts, stakeholders, and concerned citizens, 2007. [INVITED, INTERNATIONAL]

89. **Friedel, M.J**., 2006, Overview of hazards risk mitigation and emergency preparedness project, Bucharest, Romania, presentation to World Bank Experts, stakeholders, and concerned citizens, January 2006. [INVITED, INTERNATIONAL] (no abstract)

90. **Friedel, M.J**., 2005, Combined groundwater-geophysical inverse modeling to reduce predictive uncertainty, presentation as part of Groundwater Resources Program research initiative in Linking Geologic Models to MODFLOW, DFC, Bldg 53, Central Region conference room, F1216, Lakewood, CO, presentation to regional groundwater specialist (A. Burns) and invited scientists, June 16, 2005. [INVITED (no abstract)

91. Figueroa, M. **, Tindall, J.A., and **Friedel, M.J**., 2006, Comparison of $d^{18}O$ composition of water extracted from suction lysimeters, centrifugation, and azeotropic distillation, Trans. AGU, 83(42), Fall Meet. Suppl., H13-6703 (Presented by Figueroa)

92. Little, J. **, Tindall, J.A., and **Friedel, M.J**, 2005, Scaling relations between laboratory and field scale hysteretic measurements for a sandy-loam soil, Trans. AGU, 83(42), Fall Meet. Suppl., H13-6703. (Presented by Little)

93. **Friedel, M.J**., 2005, Effects of Coal-bed methane discharge waters on vegetation and soil ecosystem in Powder River Basin, Wyoming, USA, International Symposium on Methodology in Hydrology, Nanjing, China, Oct. 30 - Nov. 2, 2005. [INTERNATIONAL, KEYNOTE]

94. **Friedel, M.J**., 2005, Simultaneous estimation of recurrent rainfall amounts in ungaged coastal basins of El Salvador, International Symposium on Methodology in Hydrology, Nanjing, China, Oct. 30 - Nov. 2, 2005. [INTERNATIONAL, KEYNOTE]

95. **Friedel, M.J**., 2005, Probable flooding in ungaged coastal basins of El Salvador, International Symposium on Methodology in Hydrology, Nanjing, China, Oct. 30 -Nov. 2, 2005. [INTERNATIONAL, KEYNOTE]

96. **Friedel, M.J**., 2005, Urbanization effects on ecological integrity in the Upper Illinois River Basin, USA, NATO Advanced Study Workshop - Groundwater and Ecosystems, Canakkale, Turkey, Sept. 5-7, 2005. [INTERNATIONAL, KEYNOTE]

97. Little, J. **, Tindall, J.A., and **Friedel, M.J**., 2004, Correlated moisture content, pressure and temperature data for development of hysteretic moisture retention curves, Trans. AGU, 83(42), Fall Meet. Suppl., H33B-0464. (Presented by Little)

98. **Friedel, M.J**., 2004, Reliability in urban ground-water recharge estimates through the vadose zone: managing sustainable development in arid and semiarid regions, NATO Advanced Study Institute - Management and Sustainable Development of Urban Groundwater Systems, Baku, Azerbiajan, Aug. 10-20, 2004. [INTERNATIONAL, KEYNOTE]

99. **Friedel, M.J**., 2003, Potential post-fire debris flow hazards associated with Wulfsohn and Gelenwood alluvial fans, Glenwood Springs, Colorado, presentation to Mayor and city council, May 28, 2003. [INVITED] (no abstract)

100. **Friedel, M.J**., 2003, Predicting maximum likely debris flows: from pre-fire streamflow measurements to post-fire hazard mapping, presentation at Colorado Stream Gauging Symposium, 2003, Breckenridge, CO, May 8, 2003. [INVITED]

101. **Friedel, M.J**., 2002, Application of genetic algorithms and programming to water resource problems, oral and cyber presentation to USGS earth scientists, USGS National Training Center, Lakewood, CO, December 4, 2002. (no abstract)

102. **Friedel, M.J.,** 2002, Stochastic modeling of quantity and quality of Colorado River streamflow following development and operation of Sulphur Gulch reservoir, presentation to Denver Water and Northern Colorado Water Conservancy District management and engineers, and attorneys of Trout-Whitman, Loveland, CO, November 22, 2002. [INVITED] (no abstract)

103. **Friedel, M.J**., 2002, Application of stochastic simulation to assess the effects of development and operation of Sulphur Gulch reservoir on changes in Colorado Water Quality, presentation to Denver Water and Northern Colorado Water Conservancy District management and engineers, Denver Water, Denver, CO, August 9, 2002. [INVITED] (no abstract)

104. **Friedel, M.J**., 2002, Drought effects on water quantity and quality. U.S. Geological Survey drought workshop, Pueblo, CO, July 2002. [INVITED]

105. **Friedel, M.J**., 2002, Drought effects on water quantity and quality. U.S. Geological Survey drought workshop, Greeley, CO, July 2002. [INVITED]

106. **Friedel, M.J**., 2002, Transport model parameter nonuniqueness and its effect on recharge prediction in a coupled variably saturated ground-water system. U.S. Geological Survey artificial recharge workshop, Sacramento, CA, April 2002.

107. **Friedel, M.J**., 2002, Coupled ground-water model calibration and predictive analysis - space age technology or science fiction? U.S. Geological Survey, Recharge Estimation Workshop, Lakewood, CO, February 26, 2002. [INVITED]

108. **Friedel, M.J**., 2002, Salinity issues in Western United States. Proceedings Western drought effects on water quantity and quality. American Institute of Hydrology, Minneapolis, MN, August 9, 2002. [INVITED]

109. **Friedel, M.J**., 2002, Quantifying ground-water recharge using a coupled water-heat-solute transport model: optimal nonlinear parameter estimation, nonuniqueness, and predictive uncertainty, Trans. AGU fall meeting, San Francisco, CA, Dec 10, 2002.

110. **Friedel, M.J**., 2002, Quantifying ground-water recharge using a coupled water-heat-solute transport model: nonlinear parameter estimation, nonuniqueness, and predictive uncertainty, Trans. AGU, 83(42), Fall Meet. Suppl., H21D-0860, 2002.

111. **Friedel, M.J**., 2001, Developed and presented seminar on Model calibration and simulation of urbanization and its effects on ecological integrity. U.S. Geological Survey, Colorado-District, Denver, CO, Jan. 2001. [INVITED] (no abstract)

112. **Friedel, M.J.,** 2001, Developing an Urbanization TMDL ... good, bad, and the ugly. Upper Illinois River Basin - National Water Quality Assessment liaison meeting, Chicago, IL, April 20, 2001. (no abstract)

113. **Friedel, M.J.,** 2001, Overview of VST2D model applications and future extensions to regional ground-water specialists and ground-water resources program management, Lakewood, CO, Oct. 9, 2001. [INVITED] (no abstract)

114. Arnold, T., **Friedel, M.J**., and Warner, K.L., 2001, Hydrogeologic inventory of the upper Illinois River Basin – creating a large data base from well construction records. Geological Society of America April 22, 2001 in Bloomington, Illinois. (Presented by Arnold)

115. **Friedel, M.J**., 2001, Salinity overview of water resources in the South Platte River Basin, A Colorado Salinity/Selenium Symposium and Workshop, Soil Water Conservation Society, Colorado Springs, CO, October 4, 2001. [INVITED] (no abstract)

116. **Friedel, M.,** 1999, VST2D – Variably saturated water-heat-solute transport model. U.S. Geological Survey - Unsaturated Zone Interest Group, Menlo Park, CA, Jan. 13, 1999. [INVITED] (no abstract)

117. **Friedel, M.J.,** 1999, Ground-water risk assessment – Cyprus mine tailings impoundment. U.S. Geological Survey - Unsaturated Zone Interest Group, Menlo Park, CA, Jan. 13, 1999. [INVITED]

118. **Friedel, M.J**., 1998, Developed and presented seminar on land use gradient study: predicting the effects of urbanization on water quality. U.S. Geological Survey, National Water Quality Assessment Leadership Team, Reston, VA, Dec. 1998. [INVITED] (no abstract)

119. **Friedel, M.J**., 1998, Probabilistic assessment of source drinking water in the Upper Illinois River Basin. U.S. Geological Survey, National Water Quality Assessment Leadership Team, Reston, VA, Dec. 1998. [INVITED] (no abstract)

120. Nieber, J.L., **Friedel, M.J.,** and Sharratt, B.S., 1997, Modeling equations for two-dimensional coupled heat, fluid, and solute transport in variably saturated, variably-frozen soils, CRREL Special Report 97-10: Proceedings International symposium on physics, chemistry and ecology of seasonally frozen soils, Fairbanks, Alaska, June 10-12, pp. 140-146. [INVITED]

121. Scott, D.F, Williams, T.J., and **Friedel, M.J.,** 1996, Application of seismic tomography in underground mining, Proceedings 15th International Conference on Ground Control in Underground Mining, Golden, CO, Aug. 13-15. [INVITED]

122. Williams, T. J., Scott, D. F., and **Friedel, M.J**., 1996, Application of seismic tomography to underground mining: Part 2, 66th Annual International Meeting: Society of Exploration Geophysics, Denver, CO, Nov. 15. pp. 2057-2059. (Presented by Williams)

123. Scott, D. F., Williams, T.J., and **Friedel, M.J.,** 1996, Application of seismic tomography to underground mining: Part 1, 66th Annual International Meeting: Society of Exploration Geophysics, Denver, CO, Nov. 15, pp. 2053-2056. (Presented by Scott)

124. Scott, D.F., **Friedel, M.J.**, Jackson, M.J., and Williams, E., 1995, Use of tomographic imaging as a tool to identify areas of high stress in remnant ore pillars in deep underground mines. U.S. Bureau of Mines Technology Transfer Seminar: Mechanics and Mitigation of Violent Failure in Coal and Hard Rock mines, of Coal Pillar Behavior, U.S. Bureau of Mines Special Publication, 01-95, Coeur d' Alene, ID; Price, UT, Norton, Va; May, pp. 323-335. [INVITED]

125. Westman, E., **Friedel, M.J.**, Jackson, M.J., and Williams, E., 1995, Imaging coal structure stress distribution with seismic tomography. U.S. Bureau of Mines Technology Transfer Seminar: Mechanics and Mitigation of Violent Failure in Coal and Hard Rock Mines, of Coal Pillar Behavior, U.S.

Bureau of Mines Special Publication 01-95, Coeur d' Alene, ID; Price, UT, Norton, VA; May, pp.101-119. [INVITED]

126. Jackson, M.J., **Friedel, M.J.**, Tweeton, D.R., Scott, D.F., and Williams, T.J., 1995, Imaging underground mine structures using seismic tomography. Proceedings Symposium on Application of Geophysics to Engineering and Environmental Problems, March 1995, pp. 112-127. (Presented by Jackson)

127. **Friedel, M.J.**, Scott, D.F., Jackson, M.J., Williams, T.J., and Killen, S.M., 1995, 3-D seismic tomographic investigation of mechanical conditions in a deep US gold mine, Proceedings Mech. Jointed and Faulted Rock-2, Vienna Austria, April 13-17, pp. 689-695. [INVITED, INTERNATIONAL]

128. Jackson, M.J., **Friedel, M.J.**, Tweeton, D.R., Scott, D.F., and Williams, T.J., 1995, Three-dimensional imaging of underground mine structures using geophysical tomography with tests for resolution and robustness. Proceedings CAMI '95: 3rd Canadian Conference on Computer Applications in the Mineral Industry, Montreal, Quebec, Canada, October 22-25. [INVITED]

129. Moyle, P.R., Fay, J.M., and **Friedel, M.J.**, 1994, Integrated geophysical characterization of mine-waste sites in the Coeur d' Alene Mining District, ID. Proceedings Symposium on Application of Geophysics to Engineering and Environmental Problems, March 27-31, pp. 857-868. (Presented by Moyle)

130. **Friedel, M.J.**, and Wedepohl, E., 1994, Case studies of radio wave tomography at base metal and gold ore bodies in the USA and Southern Africa. Society of Mining Metallurgy, & Exploration, Albuquerque, NM, 1994, March 27-31, pp. 32-44. [PRESENTED]

131. **Friedel, M.J.**, 1994, Integrated-geophysical technology for void detection and geological/hydrological characterization. U.S. Bureau of Mines - Abandoned Mine Land Geophysical Workshop, Minneapolis, MN, March 24, 1994.

132. **Friedel, M.J.,** 1994, 3D tomographic imaging of anomalous conditions in a deep mine. Paper presented at Symposium on Application of Geophysics to Engineering and Environmental Problems, Boston, MA, March 20-25, 1994, pp. 92-107.

133. **Friedel, M.J**., Jackson, M.J., Williams, E., Olson, M.S., 1994, Tomographic imaging of coal pillar conditions: observations and implications. Society of Mining Metallurgy, & Exploration Annual Meeting, February 14-17, Albuquerque, NM, Preprint 94-110, 17p.

134. **Friedel, M.J.,** and J. Jackson, M.J., 1993, Application of seismic tomography for assessing yield pillar stress conditions. Paper presented at Twelfth Conference on Ground Control in Mining, Lakeview Resort and Conference Center, Morgantown, WV, August 3-5, 1993, pp. 292-301. [INVITED]

135. Hauser, K.L., and **Friedel, M.J.,** 1993, Geophysical techniques applied to cavity detection at the Wharf Mine, Lead, South Dakota. Proceedings 4th Tunnel Detection Symposium, Golden, CO., pp. 617-636. (Presented by Hauser)

136. Jackson, M., Wedepohl, E., **Friedel, M.J**., and Hauser, K., 1993, Forward modeling of electromagnetic wave propagation in layered media: implications for cross-borehole radio-wave detection of voids in coal measure rocks. Proceedings 4th Tunnel Detection Symposium, Golden CO, pp. 399-412. (Presented by Jackson)

137. **Friedel, M.J**., Jessop, J.A., and Thill, R.E., 1992, Mining applications of seismic tomography. Proceedings 62nd Annual International Meeting: Society of Exploration Geophysics, New Orleans, LA, November 10-14, pp. 58-62.

138. Thill, R.E., **Friedel, M.J.**, Jessop, J.A., and Jackson, M.J., 1992, Integrated geophysics and geotomography for ground control applications. Proceedings 4th Ground Control Symposium, Southern Illinois University, Mt.Vernon, IL, November 2-4, pp. 51-69. (Presented by Thill)

139. Jessop, J.A., Borek, D.L., Jackson, M.J., Tweeton, D.R., and **Friedel, M.J.**, 1992, Evaluation of a stope leaching site using geotomography. Proceedings Engineering Foundation Conference, In Situ Minerals Recovery-II , Santa Barbara, CA, October 25-30, pp. 599-616. (Presented by Jessop)

140. Schmidt, R.D., Early, D., III, and **Friedel, M.J.**, 1992, Analysis and implications of dynamic transmissivity conditions during in situ copper leaching. Proceedings Engineering Foundation Conference, In Situ Recovery of Minerals II, Santa Barbara, October 25-30, pp. 259-286. (Presented by Schmidt)

141. Tweeton, D.R., Hanson, J.C., **Friedel, M.J.**, and Dahl, L.J., 1992, Field tests of geophysical methods for monitoring the flow patterns of leach solution. Proceedings Engineering Foundation Conference, In Situ Recovery of Minerals II, October 25-30, Santa Barbara, CA, pp. 179-199. (Presented by Tweeton)

142. Jackson, M.J., Tweeton, D.R., and **Friedel, M.J.**, 1992, Approaches for optimizing the use of available information in crosshole seismic tomographic reconstruction. Proceedings GeoTech '92 Geo-Computing Conference, Denver, CO, August 31-September 3, pp. 130-143.

143. Jessop, J.A., **Friedel, M.J.**, Tweeton, D.R., and Jackson, M.J., 1992. Fracture detection with seismic crosshole tomography for solution control in a stope. Proceedings Symposium on Application of Geophysics to Engineering and Environmental Problems, Oakbrook, IL, April 26-29, pp. 487-587.

144. **Friedel, M.J.**, M. Jones, P.M., and Schmidt, R.D., 1992, Geostatistical analysis of dynamic transmissivity during in situ copper leaching. Proceedings 23rd International Symposium on Applications of Computers in Mining Industry, April 7-11, pp. 49-61. [INVITED]

145. **Friedel, M.J.**, 1992, Scale-dependence In the hydrologic design of in situ copper leaching operations: Paper presented at Society for Mining, Metallurgy, and Exploration annual meeting, Reno, Nevada, Feb. 18, 1992. (published as Friedel, M.J., 1993, Scale-Dependence in the Hydrologic Design of In Situ Copper Leaching Operations. Society of Mining Engineers Transactions, Vol. 294, pp 1918-1926.)

146. **Friedel, M.J**., Jessop, J.A., and Thill, R.E., 1991, Igneous rock mass fracture delineation using common offset radar reflection. Proceedings 61st Annual International Meeting: Society of Exploration Geophysics, November 10-14, pp. 504-506.

147. Hanson, J.C., Tweeton, D.R., **Friedel, M.J.**, and Dahl, L.J., 1991, A field test of electromagnetic methods for the detection of conductive plumes. Annual International Meeting: Society of Exploration Geophysics, November 10-14, pp. 569-572. (Presented by Hanson)

148. **Friedel, M.J.** and Hanson, J.C., 1990, An integrated geophysical approach to detection of abandoned mine openings. Proceedings 12th Annual National Abandoned Mine Land Conference, Breckenridge, CO, September 15, pp. 57-86. [PRESENTED]

149. **Friedel, M.J.** and Schmidt, R.D., 1991, Effect of an unsaturated setting on the hydrology of in situ opper leaching. Society for Mining, Metallurgy, and Exploration Ann. Mtg., Preprint 91-161, Denver, CO, February 25-28, 11 pp. (published as Friedel, M.J., 1992, Effect of Unsaturated Conditions on the Hydrology of In-Situ Copper Leaching. Society of Mining Engineers Transactions, Vol. 294, pp 1029-1036.)

150. Schmidt, R.D. and **Friedel, M.J.**,. 1991, Application of computers for analysis of in situ leach mining hydrology, Proceedings Indo-U.S. Symposium on Computers in the Mining Industry, Dahnbad, India, November 11-13, pp. 121-135. [INVITED, INTERNATIONAL] (presented by Schmidt)

151. **Friedel, M.J.** and Hanson, J.C., 1990, Assessment of ground penetrating radar for detecting hazardous abandoned mine openings and related features. Proceedings12th Annual National Abandoned Mine Land Conference, Breckenridge, CO, September, pp. 87-55.

152. **Friedel, M.J.,** 1990, Common offset radar profiling for detection of fractures igneous rock. Poster presented at Geophysical Solutions to Geologic Problems of Continental Interiors: A Minnesota Workshop, Minnesota Geologic Survey, Minneapolis, Minnesota, March 4-6, pp 12-15.

153. Schmidt, R.D., **Friedel, M.J.,** and Behnke, K., 1990, Hydrologic considerations of underground in place copper leaching. Society for Mining, Metallurgy, and Exploration Ann. Mtg., Preprint 90-179, Salt Lake City, UT, February 26-March 1, 12 pp. [PRESENTED]

154. Jessop, J.A., R.E. Thill, and **Friedel, M.J.**, 1990, Acoustic site characterization studies for in situ mining. Society for Mining, Metallurgy, and Exploration Annual Meeting, Preprint 90-184, Salt Lake City, UT, February 26-30, 11 pp. [PRESENTED]

155. Thill, R.E., **Friedel, M.J.** and Hanson, J.C., 1990, Mining geophysics: a research perspective. Proceedings International Symposium on Borehole Geophysics in Petroleum, Hydrology, Mining, and Engineering Applications, Tucson, AZ., February 1-3, 5 pp. [INVITED]

156. **Friedel, M.J**., and R.E. Thill, 1990, U.S. Bureau of Mines research on the Kaiser Effect for determining stress in rock. Proceedings in International Joint Meeting, 1st Workshop on AE in Civil Engineering and 2nd Workshop on AE and Rock Fracture Mechanics, Kumamoto City, Japan, Oct. 29-31, pp. 54.

UNIVERSITY TEACHING

Undergraduate

- *Quantitative Hydrogeology*, Dept. of Geology, Colorado College, 2003
- *Unsaturated zone hydrology*, Dept. Environmental Science, University of Colorado, 2004-2008 (guest lecturer - numerical modeling section)
- *Applied Statistics for the Natural Sciences*, Dept. of Environmental Science, University of Colorado, CO, 2009
- *Artificial Adaptive Mathematical Models in Medicine and the Environment*, Dept of Mathematical and Statistical Sciences, University of Colorado, 2013

Post-graduate

- *Modeling Coastal Water Flooding, Mud and Debris Flows*, Central American University, Dept. Energy & Fluid Science, El Salvador, 2003
- *Model Calibration and Predictive Analysis in Earth Science*, Central American University, Dept. Energy & Fluid Science, El Salvador 2004, 2005
- *Assessing and Managing Risks Associated with Hazards in our Environment*, Central American University, Dept. Energy & Fluid Science, El Salvador, 2005
- Advanced Concepts in Watershed Management, Central American University, Dept. Energy & Fluid Science, El Salvador, 2006
- Assessing and Managing Environmental Risks, Central American University, Dept. Energy & Fluid Science, El Salvador, 2006
- *Ecological Risk Assessment*, Dept. Env. Sci., University of Kuopio, Finland, 2007
- *M*ulticomponent reactive transport modeling for mining environments, Dept. of Environmental Science, University of Kuopio, Finland, 2007
- *Model fitting, calibration, uncertainty analyses in the geosciences*, Geosciences Institute, University of Brasilia, Brazil, 2008
- *Model fitting, calibration, uncertainty analyses in the geosciences*, Geosciences Institute, University of Campinas, Brazil, 2008
- *Hydrogeophysics*, Geosciences Institute, University of Brasilia, Brazil, 2008
- *Hydrogeophysics*, Geosciences Institute, University of Campinas, Brazil, 2008
- *Groundwater modeling*, Geosciences Institute, University of Brasilia, Brazil, 2013
- *Multivariate statistics, machine-learning, and hybrid modeling*; Geosciences Institute, University of Brasilia, Brazil, 2013
- *Applied modeling and uncertainty analysis in earth science*, Center for Env. Studies, University of Campinas, Brazil, 2013

UNIVERSITY SERVICE

Post-doctoral
Advisor

Dr. Fabio Iwashita	University of the Andes, CO		2018
Dr. Lucas Moreira	Federal Institute of Education, BR		2016
Dr. Lucas Moreira	University of Brasilia, BR		2015
Dr. Cleyton Carnerio	University of Sao Paulo, BR		2013

Co-Advisor

Dr. Andrea Koga-Vicente	University of Colorado, USA		2014
Dr. Eduardo Vicente	University of Colorado, USA		2014

Graduate Students
Co-Advisor

Daniela Lins	University of Campinas, BR	PhD	In progress
Raul Rechden	Victoria University, NZ	PhD	2014-2017
Lucas P. Moriera	University of Brasilia, BRl	PhD	2010-2013
Fabio Iwashita	University of Campinas, BR	PhD	2009-2011
Andréa Koga Vicente	University of Campinas, BR	PhD	2009-2010
Mark E. Smith	Colorado State University, USA	PhD	2007-withdrew
Akbar Eshfani	University of Colorado, USA	MS	2012-2013
Maria A. Figueroa	University of Colorado, USA	MS	2006-2007
Justin Little	University of Colorado, USA	MS	2006-2007
Maria Stearns	University of Colorado, USA	MS	2003-2004
Chuenamol Sethaputra	University of Colorado, USA	MS	2002-2004
Elizabeth Murphy	University of Illinois, USA	MS	2001-2002

Committee member

Akbar Eshfani	University of Colorado, USA	MS	2013
Erin Wallin	Colorado School of Mines, USA	PhD	2008
Oderson A. De Souza Filho	University of Campinas, BR	PhD	2008

Undergraduate Students

Akbar Eshfani	University of Colorado, USA	BS	2010
Morgan Erlich	University of Colorado, USA	BS	2009

Invited Seminars

Environment Canterbury (NZ), Regional Council, Using SkyTEM data to improve mapping of aquifer characteristics	2019
Ventures Southland and Environment Southland Regional Council (NZ), Using SkyTEM data to improve mapping of aquifer characteristics	2019
Pacific Northwest National Laboratory, Subsurface Science & Technology Group, (USA), Transdisciplinary innovation for knowledge discovery in earth, energy, environment	2019
Beijing University (CN), Machine learning, exploration and new energy sources	2018
Southern University of Science and Technology (CN), Transdisciplinary Innovation and Discovery In Earth and Environmental Sciences	2018

Beijing Technology and Business University, Beijing Key Laboratory of Big Data Technology
For Food Safety (CN), Intelligent landscape classification by Machine Learning & Hyperion Data 2018
University of Andes (CO), Transdisciplinary discovery in geoscience 2017
University of Rosary (CO), Earth-system data science program vision 2017
University of Hawaii (USA), Transdisciplinary solutions in hydrogeology –data2knowledge 2016
Tblisi State University (GA), Role of large earthquakes on aquifer dynamics 2016
University of Colorado (USA), Computationally intelligent solutions in hydrogeology 2015
Tblisi State University (GA), Alternate modeling paradigms in hydrogeology 2015
University of Colorado (USA), Computationally intelligent solutions in hydrogeology 2015
GNS Science (NZ), Computationally intelligent solutions in hydrogeology 2014
Swiss Technical University (CH), New frontiers in experimental hydrogeology 2014
University of Campinas (BR), Forecasting climate change using a hybrid approach 2013
University of Campinas (BR), Climate change – applications of soft and hybrid modeling 2012
University of Brasilia (BR), Numerical modeling strategies in resource assessments 2008
University of Campinas (BR), Overview of hydrogeologic studies at the USGS 2008
Central American University (ES), Simulating hurricane-induced coastal flooding 2006
Central American University (ES), Estimating rainfall in ungauged coastal basins 2006
Hungarian Academy of Sciences (HU), Effects of urbanization on biological integrity 2005
Hohai University (CN), Simulated effects of Sulphur Gulch reservoir operations 2005
Hohai University (CN), Parameter estimation, model calibration, and uncertainty analysis 2005
Hohai University (CN), Predicting effects of urbanization on ecological integrity 2005
Hohai University (CN), Improved estimation of recharge through the vadose zone 2005
University of Colorado (USA), Unsaturated-zone flow and transport modeling 2004
University of Colorado (USA), Coupled-inverse modeling to assess artificial recharge 2004
University of Minnesota (USA), Stochastic simulation and optimization of reservoir parameters 2002
University of Minnesota (USA), Estimating coupled water-heat-solute transport parameters 2002
University of Minnesota (USA), Simulating urbanization effects on ecological integrity 2001
Radford University (USA), Mining applications of seismic tomography 1996
University of California (USA), Dynamic transmissivity during in-situ copper leaching 1992
Columbia University (USA), Geotomographic applications in mining 1992
Michigan Technological University (USA), In-situ mining 1991
University of Wisconsin (USA), Mining applications of geotomography 1991

GRANTS – PI – Principal Investigator, CoI – Co investigator

Funded
1. Department of Energy, National Laboratory Program, Artificial Intelligence and Decision Support for Complex Systems, LAB 20-2321: Innovative Subsurface Learning and Hawaiian Exploration using Advanced Tomography (ISLAND HEAT) (CoI). Funding: 2020 $1.85M, 2021: $1.1M, 2022: 1.1M, FY203 $578k), My PNNL Funding: 0.5 FTE/year; 2021-23).
2. Department of Energy, Pacific Northwest National Laboratory, FY20 Laboratory Directed Research and Development - Physics Informed Machine Learning for Energy and Environment Directorate Applications, Physics-informed learning for reduced-order vadose zone transport modeling of Hanford 300 area, (PI). Funding: 2020, $40k (NF2564).
3. Department of Energy, Pacific Northwest National Laboratory, Deep Vadose Zone Program, Automated Traveltime Picking using Unsupervised Machine Learning (PI). Funding: 2019, $30k (ND5853, NC0426).
4. Ministry for Business, Innovation, and Employment, NZ, 2018 Endeavor Fund Research Program, Unraveling critical for freshwater contamination. (CoI). Funding: 2018-2023, $7.8M (LVLX1802).
5. Environment Southland, Proposal for the design of methodologies to refine the Quaternary in the Southland Leapfrog 3D geological model (CoI). Funding: 2016-2017, $55k (17GW971).
6. Geoscience Australia, Improved groundwater system mapping and characterization workflows using machine-learning and evolutionary techniques II (PI). Funding: 2016-2017, $183k (CMCG4889A/D2017-15889).
7. Geoscience Australia, Improved groundwater system mapping and characterization workflows using machine-learning and evolutionary techniques I (PI). Funding: 2015-2016, $40k (GMCG4889A-001922)
8. GNS Science, Strategic Development Fund, Our rising tide – evaluating the regional impact of sea level change in New Zealand (CoI). Funding: 2016-2017, $150k.
9. Fundação de Amparo à Pesquisa do Estado de São Paulo, Brazil, Hierarchical scenarios of climate change from the perspective of evolutionary landscape dynamics (CoI). Funding: 2013-2014, $35k.
10. Fundação de Amparo à Pesquisa do Estado de São Paulo, Brazil, Evaluation of uncertainty in Amazonian gold occurrence using airborne radiometric data and soft computing (CoI). Funding: 2013, $31k.
11. US Department of Army, Engineer Research Development Center, Reliability of geophysical instrument response to unexploded ordnance, Funding: 2012-2013 (PI). $250k.
12. US Department of Army, Engineer Research Development Center, Near real-time imaging of heterogeneity in a glacial aquifer (Geophysical Remote Sensing – "The Chameleon**")** (PI)**.** Funding: 2012-2013, $68k
13. State of Nebraska, Estimation of Subsurface Attributes Using Hydrogeologic and Geophysical Measurements (Hydrogeologic Framework for Glacial Aquifers) (PI). Funding: 2011, $25k.
14. National Council for Scientific and Technological Development, CNPQ, Improved crustal and upper mantle imaging using disparate geophysical data and joint inverse techniques (CoI). Funding: 2010-2011, $32k.
15. North Atlantic Treaty Organization, Water and environmental security: NATO advanced research workshop: climate-change effects on water resources– issues of national and global security, Izmir, Turkey (CoI). Funding: 2010, $65k.

16. US Geological Survey, Mineral Resource Program Seismic-magnetotelluric joint inversion to improve understanding of sediment-hosted gold deposits (Battle Mountain-Eurkea mineral belt, Carlin-trend), northern Nevada (CoI). Funding: 2014, $150k.

17. US Geological Survey, Mineral Resources Program Joint inversion of disparate data (CoI). Funding: 2013 $175k.

18. World Bank, Technical assistance with water-resource assessment, Mauritania (CoI). Funding: 2011-2012, $100k.

19. US Army, Strategic Environmental Research and Development Program, UXO Discrimination (CoI). Funding: 2010-2011, $40k.

20. Fundação de Amparo à Pesquisa do Estado de São Paulo, Brazil, Joint evaluation and prediction of subsurface attributes from hydrogeologic and airborne geophysical measurements using data mining and knowledge discovery techniques (CoI). Funding: 2009-2010, $50k.

21. Civilian Research & Development Foundation, Evaluation of measures to mitigate groundwater flooding in Bishkek region of Kyrgyzstan (CoI). Funding: 2009-2010, $68k.

22. US Geological Survey, Mineral Resources Program, Stochastic mineral-resource software development (PI). Funding: 2008-2011, $1M.

23. US Geological Survey, Mineral Resources Program Alternate modeling paradigms and methods to evaluate uncertainty (CoI). Funding: 2006-2012, $500k.

24. World Bank, Technical assistance with mineral and water-resource assessment, Mauritania (CoI). Funding: 2006-2008, $1.2M.

25. US Department of State, Technical assistance to Middle East process (CoI). Funding: 2005, $68k.

26. World Bank, Technical assistance with hazards risk mitigation and emergency preparedness, Romania (CoI). Funding: 2005-2007, $900k.

27. US Geological Survey, Mineral Resources Program, National Maps - source/process studies of selected contaminants associated with mineral deposits (CoI). Funding: 2005-2007, $150k.

28. United Nations Development Program, Technical assistance with real time flood warning system, Haiti (CoI). Funding: 2005-2006, $120k.

29. US Department of Army, Strategic Environmental Research and Development Program, Tensor magnetic gradient system (CoI). Funding: 2005-2006, $55k.

30. US Department of Homeland Security, Federal Emergency Management Agency, Post-wildfire flood potential in Willow & Mitchell creek watersheds (CoI). Funding: 2004-2005, $135k.

31. US Department of Health, National Institute of Occupational Health, Development of predictive equations using knowledge discovery techniques (PI). Funding 2003-2004, $37k

32. US Agency for International Development, Office of Federal Disaster Assistance, Technical assistance with coastal flood predictions, El Salvador (CoI). Funding: 2003-2004, $65k.

33. US Geological Survey, Venture Capital Fund, Improvements to conceptual wildfire-induced flood models (PI). Funding: 2003-2004, $35k.

34. US Geological Survey, National Water Quality Assessment Program, Preferential flow and transport in the High Plains aquifer (PI). Funding: 2003-2004, $74k

35. Northern Colorado Water Conservancy District and Denver Water, Stochastic modeling of the effects that Sulphur Gulch reservoir may have on Colorado River near Grand Junction, CO (PI). Funding: 2002-2004, $976k.

36. US Department of Homeland Security, Federal Emergency Management Agency, Post-wildfire technical assistance (PI). Funding: 2002-2004, $550k.

37. US Geological Survey, National Water Quality Assessment Program, Agricultural land-use survey - understanding effect of drought on dry-land wheat farming (PI). Funding: 2001-2002, $150

38. US Geological Survey, Toxics Program Variably-saturated transport in 2-dimensions - VST2D (PI). Funding: 1999, $35k

39. US Geological Survey, National Water Quality Assessment Program, Upper Illinois River Basin study (PI). Funding: 1997-2001, $8M

40. US Department of Agriculture, Agricultural Research Service, Vadose-zone leaching of agricultural chemicals (PI). Funding: 1996, $36k.

41. US Department of Health, National Institute of Occupational Health, Tomographic imaging of deep underground metal mines (PI). Funding: 1996, $48K

42. US Bureau of Mines, Advanced Mining Program In situ leach mining of unsaturated Chalcocite ore (PI). Funding: 1990-1995, $450k

43. US Bureau of Mines, Advanced Mining Program, Characterization and remediation of acid mine drainage from a metal-mine waste impoundment (PI). Funding: 1991-1995, $550k

44. US Bureau of Mines, Abandoned Mine Land Program, Cavity detection using geophysical methods, Funding: Abandoned Mine Land Program (PI). Funding: 1989-1993, $575k

45. US Bureau of Mines, Health and Safety Program, Assessment of damage and integrity of mine structures, Funding: Health and Safety Program (PI). Funding: 1986-1995, $780k

46. US Bureau of Mines, Advanced Mining Program, Geomechanical and geophysical technology for evaluating rock masses for in situ mining (PI). Funding: 1985-1994, $960k

47. Friedel, et al., Annual work plans, Upper Illinois River Basin, USGS: 2001, 110 pp ($1.9M); 2000, 102 pp. ($1.8M); 1999, 193 pp. ($1.7M); 1998, 65 pp. ($1.4M); 1997, 23 pp. ($750K)

Training Courses – Developed and delivered
Short Courses
Big data analytics for groundwater modeling, Beijing Water International/Beijing University, China, 2018
Airborne-electromagnetic resistivity inversion, Geological Survey of Brazil and Campinas University, 2016
Coastal unconfined flooding and debris-flow

Digital signal processing

Ecological risk assessment
Geostatistical analysis
Inverse modeling and genetic programming
Mining applications of seismic tomography

Multivariate geostatistical analysis
Nonlinear parameter estimation and uncertainty analysis
Numerical modeling of flow in the vadose zone
Peak-flood frequency analysis and rainfall-runoff ungauged basins
Quantitative mineral resource modeling
Rainfall-runoff model calibration
Reactive flow and transport
Seismic imaging for spatial imaging of mine-tailings

Stochastic assessment of urbanization of water quality
Unsteady confined and unconfined modeling of coastal water flooding
Unconfined-water and debris-flow modeling
Water-budget modeling and analysis
Watershed model calibration and predictive analysis

CONFERENCES, CONFERENCE SESSIONS, WORKSHOPS ORGANIZED

American Geophysical Union, San Francisco, CA

- *Computationally Intelligent Solutions Resource Questions in Earth Science* (IN016), Earth and Space Science Informatics (Session ID: 24874), 2017
- *Achieving Deep Learning by Systemizing Machine Learning with Big Data Engines I* ORAL (IN11B), Earth and Space Science Informatics (Session ID: 16826), 2016
- *Achieving Deep Learning by Systemizing Machine Learning with Big Data Engines II* Poster (IN14A), Earth and Space Science Informatics (Session ID: 16437), 2016
- *Regional Groundwater Systems: Advances in modeling, characterization, and applications I*, Hydrology session H14E (oral), 2013
- *Regional Groundwater Systems: Advances in modeling, characterization, and applications II*, Hydrology session H13O (oral), 2013
- *Regional Groundwater Systems: Advances in modeling, characterization, and applications II*, Hydrology session H11H (poster), 2013
- *Characterization of Groundwater Systems*, Hydrology oral sessions H11K and H12A (oral), and H13B poster session, 2012
- *Advanced Computational Modeling Paradigms for Hydrologic Systems*, Hydrology poster session H21A, 2012
- *Uncertainty Assessment, Optimization, and Sensitivity Analysis in Integrated Hydrologic Modeling as Applications of Hydroinformatics III*, Hydrology oral session H34D, 2011
- *Computational Intelligence in Earth and Space Systems*, Union poster session U22a, 2011
- *Computational Intelligence in Earth and Space Systems*, Union oral session U22b, 2011
- *Water Resources Science and Strategies for Adaptation to Climate Variability and Change III*, Hydrology oral session H24F, 2010
- *Water Resources Science and Strategies for Adaptation to Climate Variability and Change II*, Hydrology oral session H21G, 2010
- *Water Resources Science and Strategies for Adaptation to Climate Variability and Change I*, Hydrology poster session H21G, 2010
- *Climate Change Effects on Ecosystem Services – Issues of Global Security*, Natural Hazards oral session, H93, 2010
- *Quantitative Resource Assessments – Past, Present, and Future*, Natural Hazards oral session, NH17, 2010
- *Advanced Inverse Strategies for Improved Characterization and Assessment of Groundwater, Mineral, and Petroleum Resources I*, Near Surface geophysics poster session, NS31A, 2009
- *Advanced Inverse Strategies for Improved Characterization and Assessment of Groundwater, Mineral, and Petroleum Resources I*, Near Surface geophysics oral session, NS41A, 2009
- *Relationship of Natural and Anthropogenic Hazards to National and Global Security*, Public Affairs poster session, PA21B, 2009
- *Application of Joint Inverse Methods for Improved Characterization and Assessment of Ground-Water, Mineral, and Petroleum Resources*, Near Surface geophysics poster session, NS31A, 2008
- *Multi-Scale Unsaturated Zone Flow and Contaminant Transport Processes*, Hydrology poster session H13F, 2008
- *Improved Estimation and Prediction in Earth Science Through Integration of Multiple Data Sets and Model Types*, Near surface geophysics oral session, NS43A, 2007

- *Preferential flow and transport in variably saturated porous media*, Hydrology poster session, H33, 2006
- *Spatial Relations Between Plants, Soil, and Water in the Vadose Zone*, Hydrology poster session, H12, 2005
- *Preferential flow and transport in variably saturated porous media*, Hydrology oral session, H13I, 2005
- *Preferential flow and transport in variably saturated porous media*, poster (H33B) and oral (H33A) sessions, 2004
- *Model Calibration, Parameter Nonuniqueness, and Predictive Uncertainty Associated With Flow and Transport in Variably Saturated Media, hydrology poster session*, H12A, 2003

NATO Advanced Research Workshop: Environment and Environmental Security, Izmir, Turkey:

- *Empirical, Numerical, Soft, and Hybrid Modeling*, Climate change Effect on Water Supplies, Issues of National and Global Security, 2010
- *Climate change Effects on Water Resources*, Issues of National and Global Security, 2010

NATO Advanced Study Workshop: Groundwater and Ecosystems, Canakkale, Turkey

- *Water Quality*, 2005

NATO Advanced Research Workshop: Regional Overviews, Baku, Azerbaijan

- *Urban Groundwater Management and Sustainability*, 2004

Methods in Hydrology, Hohai University, Nanjing, China

- *Flood predictions in ungauged basins*, Oral session, International Symposium, 2005

OTHER TECHNICAL ACTIVITIES

WebEx Seminars

Quantitative (stochastic) mineral-resource assessment software

Colorado Water Science Center seminar series

Watershed model calibration and predictive analysis

Model calibration and predictive analysis for watershed models

Simulation of urbanization and its effects on ecological integrity

Stochastic framework for assessing effects of urbanization of water quality

Technical Advisor

Intern advisor to Akbar Eshfani, Volunteer for Science, USGS	2010
Intern advisor to Morgan Erlich, Volunteer for Science, USGS	2009
Advisor to Erin Wallin, Visiting Scientist, USGS	2006-2008

PROFESSIONAL ASSOCIATIONS

American Geophysical Union

European Geosciences Union

International Association of Hydrological Sciences

New Zealand Hydrological Society

Society of Exploration Geophysicists

SCIENTIFIC SERVICE– 2000 to present

- *Editorial board member*, Open Civil Engineering Journal, Bentham Science publishers, 2007-2014
- *Co-editor*, NATO Advanced Research book on Climate Change and its Effect on Water Resources- Issues of National and Global Security, NATO Science for Peace and Security Science Series C. Environmental Security, vol. 3, Springer, Dordrecht, The Netherlands, 318 p., 2013
- *Journal reviewer:* Groundwater Journal, Journal of Hydrology, Vadose Zone Journal, Water Resources Research, Jour Applied Geophysics, Jour Engineering Geology, Journal of Coal Geology
- *Proposal reviewer:* Israel Science Foundation, US Geological Survey, US Environmental Protection Agency, US Bureau of Mines, others

Peer-Review and Expert Panels

- Member, National Hazards Panel, U.S. Geological Survey, 2008
- Member, research grade evaluation panel, U.S. Geological Survey, 2005
- Member, research grade evaluation panel, U.S. Geological Survey, 2004
- Chair, Annual liaison meetings, budget conference calls, project reviews, Upper Illinois River Basin, National Water Quality Assessment Program, U.S. Geological Survey, 1997-2001

Selection and planning committees

- Member, Committee on unsaturated zone for hydrology, American Geophysical Union, discipline, planning, proposal selection: 2004, 2005, 2006, 2007, 2008, 2009, 2010
- Member, Program direction, planning, and technical review committee, senior staff, Colorado Water Science Center U.S. Geological Survey: 2001, 2002, 2003, 2004
- Member, Agricultural flow and transport program committee, direction and long-range planning, National Water Quality Assessment U.S. Geological Survey: 2002, 2003
- Member, Program direction, planning, and technical review committee, Illinois Water Science Center U.S. Geological Survey: 1997, 1998, 1999, 2000, 2001
- Member, Reactive unsaturated zone transport model development program committee, direction and long-range planning, U.S. Geological Survey, National Research Program, 2001
- Member, Characterization of hazardous waste sites using geophysical technology committee, long-range planning, Environmental Technology Program, Bureau of Mines, 1995
- Member, Well-drilling guidelines to reduce liability for groundwater pollution committee, U.S. Bureau of Mines, 1995
- Member, Ground control committee, proposal selection, and funding; Health and Safety program, U.S. Bureau of Mines 1993, 1994, 1995

Government Assistance

- Australia, Geoscience Australia, 2016, 2017
- Brazil, Centro de Pesquisas Meteorológicas e Climáticas, University of Campinas, 2013, 2012
- Brazil, Geosciences Institute, University of Campinas, 2012
- Brazil, Empresa Brasileira de Pesquisa Agropecuária, Campinas, 2012
- Kyrgyzstan, Hydrogeology and Water Economy Problems Laboratory, 2007
- Portugal, European research consortium, 2008
- Georgia, Seismic Monitoring Center and Ministry for Education and Science, 2008
- Brussels, European Union, Mine Waste Directive task group member, 2007
- Mauritania, Ministre du Petrole, de L' Energie et des Mines, 2006
- Romania, Romanian National Agency for Mineral Resources, 2006
- El Salvador, Servicio Nacional Estudious de Territoriales, 2003

REFERENCES

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https://hydrology.pnnl.gov/staff/staff_info.asp?staff_num=2057
https://scholar.google.com/citations?user=1P2RqqYAAAAJ&hl=en

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https://energyenvironment.pnnl.gov/staff/staff_info.asp?staff_num=466

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Geothermal Technologies
National Renewable Energy Laboratory, Golden, CO
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https://www.nrel.gov/research/staff/greg-rhodes.html
PI newly funded project, Innovative Subsurface Learning and Hawaiian Exploration using Advanced
Tomography (ISLAND HEAT), Department of Energy Funding: 2020 $1.85M, 2021: $1.1M, 2022: 1.1M,
FY2023 $578k). **My PNNL funding contribution (0.5 FTE per year: 2021-23) is for geophysical data
inversion and machine learning components**

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Tel: (612) 625-6724, email: nieber@umn.edu
https://www.researchgate.net/profile/John_Nieber

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Tel: (509) 372-4715; E-mail: tj@pnnl.gov
https://www.researchgate.net/profile/Timothy_Johnson13