# KEIR SODERBERG

Associate

## AREAS OF EXPERTISE

- Isotope Hydrology
- Biogeochemistry
- Ecohydrology
- Field Instrumentation
- Analytical Chemistry
- Environmental Forensics

## SUMMARY OF QUALIFICATIONS

Dr. Soderberg's expertise covers isotope hydrology, environmental geochemistry, ecohydrology, and human impacts on ecosystems. His experience, including five years in sub-Saharan Africa, has involved project development, field and laboratory chemistry, analysis of satellite imagery, geochemical modeling, and management of large datasets. Through the combination of rapid *in situ* measurements of water vapor isotopes and eddy covariance flux technology, Dr. Soderberg has helped advance the understanding of evapotranspiration dynamics in semi-arid lands. He has also utilized multiple stable and radiogenic isotope tracers to determine the impacts of atmospheric inputs on ecosystem functioning. Dr. Soderberg is a member of the Urban Geochemistry Working Group of the International Association of Geochemistry.

**YEARS OF EXPERIENCE: 15+**

### EDUCATION

**PhD –** Environmental Sciences, University of Virginia, 2010
**MS –** Environmental Geochemistry, University of Cape Town, 2003
**BSE –** Civil and Environmental Engineering, Princeton University, 2000

### PROFESSIONAL HISTORY

**S.S. Papadopulos & Associates, Inc.,** Associate, 2018 to present
Senior Scientist, 2016–2018; Senior Project Geochemist, 2013–2016; Project Geochemist, 2012–2013; Staff Geochemist, 2003–2007; Intern, 2000.

**Princeton University,** Postdoctoral Research Associate, Dept. Civil and Environmental Engineering, 2010–2012.

**University of Virginia,** Teaching and Research Assistant, Dept. of Environmental Sciences, 2006–2009.

**Desert Research Foundation of Namibia,** Fulbright Scholar, 2007.

**University of Cape Town,** Princeton-in-Africa Fellow, Assistant Lecturer, Dept. of Mathematics and Applied Mathematics, 2001–2002.

## REPRESENTATIVE EXPERIENCE

**S.S. Papadopulos & Associates, Inc.,** Bethesda, MD

### ENVIRONMENTAL FORENSICS AND ALLOCATION

- **Private Client,** Union City, Indiana — Used geochemical signatures in soils and river sediments for polychlorinated biphenyl (PCB) source allocation considering both calibrated and raw analytical data. This analysis involved automated extraction and processing of raw data for all quantitated chromatographic peaks, as well as working directly with the laboratory to discuss changes in operating conditions and to run specialized standards.
- **Private Client,** New Mexico **—** Provided an analysis of geochemical signatures relating to uranium mining activities to evaluate the impacts of both underground mining and surface activities such as the management of exploratory borehole cuttings and mill tailings storage.
- **Private Client,** Elmira, Ontario — Assisted in the development and evaluation of geochemical models using stable isotopes and major ion chemistry. The models were used for the allocation of ammonia loading to two potential source areas.
- **Private Client,** Louisiana — Used stable isotopes ($\delta^{13}C$, $\delta^{18}O$, and $\delta^{2}H$) of dissolved carbon dioxide and methane to help interpret patterns and processes relating to methane in shallow groundwater before and after the excavation of petroleum-impacted soil.
- **U.S. Department of Justice,** Georgia — Evaluated the residual impact of a recycling operation that handled solvent-impacted materials.

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- **City of Portland,** Oregon – Used PCB patterns and the presence of associated chlorinated compounds in soil and sediment samples for the identification of likely sources of PCBs to the Willamette River.
- **Private Client,** South Carolina — Interpreted noble gas isotope results for age-dating of groundwater. Worked with a university laboratory to design an appropriate sampling protocol, arrange for analyses, and discuss the results.

### REMEDIAL DESIGN AND EVALUATION

- **Private Client,** Illinois **—** Delivered testimony commenting on the coal ash management rules proposed by the Illinois EPA.
- **U.S. Department of Justice,** Idaho — Provided an analysis of herbicide transport and degradation rates in agricultural soils.
- **Private Client,** Pensacola, Florida— Provided statistical analysis of trends in chemical data, and evaluated radionuclide analytical data quality for an agrichemical facility.
- **Private Client,** Mississippi — Helped select and evaluate devices for obtaining samples of groundwater with high concentrations of methane in a deep aquifer.
- **Private Client,** Oklahoma — Evaluated background perchlorate concentrations, determined the extent of site-related perchlorate in groundwater, and helped develop remedial actions at a former spent missile processing facility.
- **U.S. Department of Justice,** Maine — Evaluated the remediation of sludge drying lagoons associated with a chrome tanning operation.

**Princeton University,** Princeton, New Jersey

During two years at Professor Kelly Caylor's Ecohydrology Laboratory at Mpala Research Center in Kenya, managed a stable isotope laboratory, an eddy covariance flux tower, and field monitoring activities. This work used stable isotopes of water to investigate evapotranspiration dynamics, and ultimately to measure water-use efficiency at the landscape scale. A unique aspect of this work is the continuous (1 Hz) measurement of water vapor isotopes in the field. Hired and trained four Kenyan research assistants, and mentored several undergraduate student interns.

**University of Virginia,** Charlottesville, Virginia

PhD research on the water relations and geochemistry of desert ecosystems in the Central Namib Desert, Namibia. Stable isotopes were used to investigate nutrient cycling, fog-dust interactions, and the amount of fog water used by various species including the floristically unique *Welwitschia mirabilis*. Served as Teaching Assistant on several courses at the University of Virginia including GIS Methods, Engineering in Community Settings, and the study abroad course *People, Culture and Environment of Southern Africa*.

**University of Cape Town,** Cape Town, South Africa

Studied the geochemistry of fynbos ecosystems in the Cape Floristic Region biodiversity hotspot. The research focused on the cycling and origin of minor and micro-nutrients for the vegetation in a poorly buffered, acidic environment. Isotopes of lead and strontium were a useful complement to differentiate urban, terrestrial and marine inputs.

## AWARDS AND HONORS

**AGU Citation for Excellence in Reviewing**, JGR-Biogeosciences, 2018

**Buckner W. Clay Dissertation Year Fellowship**, University of Virginia, Graduate School of Arts and Sciences, 2009

**G.A. Harris Fellowship**, Decagon Devices, Inc., 2009

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**Michael Garstang Award for Interdisciplinary Research in Atmospheric Sciences**, University of Virginia, Department of Environmental Sciences, 2008

**Huskey Research Symposium Award**, University of Virginia, 2008

**Fulbright Scholarship,** Desert Research Foundation of Namibia, 2006

## PROFESSIONAL SOCIETIES

International Association of Geochemistry, 2011 to present
Geological Society of America, 2009 to present
American Geophysical Union, 2003 to present

## APPOINTMENTS

Reviewer for *Journal of Hydrology*
Reviewer for *Journal of Geophysical Research – Atmospheres*
Reviewer for *Journal of Geophysical Research – Biogeosciences*
Reviewer for *Hydrological Processes*
Reviewer for *Ecohydrology*
Reviewer for *Geophysical Research Letters*
Reviewer for *Geoderma*
Proposal Reviewer for the *National Science Foundation, Hydrologic Sciences*

## PUBLICATIONS AND PRESENTATIONS (* peer reviewed journal)

* Henschel, J. R., T. D. Wassenaar, A. Kanandjembo, M. K. Louw, G. Neef, T. Shuuya, K. Soderberg, *Accepted* 2018. Roots point to water sources of *Welwitschia mirabilis* in a hyperarid desert. *Ecohydrology.*

*Li, S., N.E. Levin, K. Soderberg, K.J. Dennis, and K.K. Caylor, 2017. Triple Oxygen Isotope Composition of Leaf Water in Mpala, central Kenya. *Earth and Planetary Science Letters:* 468, 38-50. doi:10.1016/j.epsl.2017.02.015

*Chambers, L.G., et al., 2016. Developing the Scientific Framework for Urban Geochemistry. *Applied Geochemistry*, v. 67, pp. 1-20.

Soderberg, K., D.P. McCarthy and R.J-C. Hennet, 2015. Volatilization of Polychlorinated Biphenyls: Implication for their Distribution, Forensics and Toxicity in Urban Environments. Presentation at the Geological Society of America Annual Meeting, November 1-4, 2015, Baltimore, MD.

Hennet, R.J-C. and K. Soderberg, 2015. Pharmaceutical Fingerprinting as a Dating Tool for Recent Sediments. *Contaminated Sediments: Environmental Chemistry, Ecotoxicology and Engineering.* Ascona, Switzerland, March 8-13, 2015.

*Soderberg, K., J. Henschel, R.J. Swap, and S.A. Macko, 2014. Sulphur Isotopes in the Central Namib Desert Ecosystem. *Transactions of the Royal Society of South Africa,* v. 69, no.3, pp. 217-223. doi: 10.1080/0035919X.2014.976778

*Good, S.P., K. Soderberg, K. Guan, E.G. King, T. Scanlon, and K.K. Caylor, 2014. $\delta^2$H Isotopic Flux Partitioning of Evapotranspiration over a Grass Field Following a Water Pulse and Subsequent Dry Down. *Water Resources Research,* v. 50, no. 2, pp. 1410-1432. doi: 10.1002/2013WR014333.

Soderberg, K., and R. J-C. Hennet, 2014. Using Raw Chromatographic Data for PCB Source Allocation. Presentation at the IAGC Urban Geochemistry Working Group Meeting, August 5-6, 2014, Columbus, OH.

Dennis, K.J., K.K. Caylor, K. Soderberg, S. Li, N. Levin, T. Cerling, and M. Bende, 2014. Reconstructing Terrestrial Environments Using Oxygen Isotopes in Biogenic Apatite: A Modern Case Study from Mpala and Tsavo, Kenya. Presentation at the Goldschmidt Conference, Sacramento, CA.

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Soderberg, K. and R.J-C. Hennet. 2014. Detection of Pharmaceuticals in the Environment: History of use as a Forensic Tool. in Goldstein, W. ed., *Pharmaceutical Accumulation the Environment: Prevention, Control, Health Effects and Economic Impact*. CRC Press: Boca Raton, FL. 262 pp.

Mihm, K., K. Soderberg, M. Nelson, S. Britt, 2014. Passive Grab Sampling for Dissolved Methane at Depth with the Sealed in-situ Snap Sampler Device. Presentation at the National Ground Water Association*, Groundwater Summit*, Denver, CO.

*Soderberg, K., Good, S P., L. Wang, M. O'Connor, K. Ryan, and K K. Caylor, 2013. Using Atmospheric Trajectories to Model the Isotopic Composition of Rainfall in Central Kenya. *Ecosphere,* v. 4, art. 33.

*Wang, L., S. Niu, S.P. Good, K. Soderberg, X. Zhou, J. Xia, R.A. Sherry, Y. Luo, K K. Caylor, and M.F. McCabe, 2013. The Effect of Warming on Grassland Evapotranspiration Partitioning Using Laser-based Isotope Monitoring Techniques. *Geochimica et Cosmochimica Acta,* v. 111, pp. 28-38.

Soderberg, K., C. Gerlein, P.C. Kemeney, and K.K. Caylor, 2013. Isotopic Equilibrium Between Precipitation and Water Vapor: Evidence from Continential Rains in Central Kenya. Presentation at the American Geophysical Union (AGU) Fall Meeting, Abstract GC13A-1057.

Li, S., N. Levin, K. Soderberg, K.J. Dennis, and K.K. Caylor, 2013. The Triple Oxygen Isotope Composition of Leaf Waters in Mpala, Central Kenya. Presentation at the American Geophysical Union (AGU) Fall Meeting, Abstract PP23C-1976.

Gerlein, C., K. Soderberg, P.C. Kemeney, and K.K. Caylor, 2013. Rain-Vapor Isotopic Equilibrium in Central Kenya. Presentation at the First International Workshop on Advances in Observations, Models and Measurement Techniques of Atmospheric Water Vapor Isotopes. October 17, 2013. CNRS, France.

Good, S., M. O'Connor, K. Soderberg, L. Wang, and K. Caylor, 2013. Analysis of the Distribution of the Isotopic Composition of Evapotranspiration Flux in a Semi-arid Savanna. Presentation at the EGU General Assembly, Vienna, Austria. Abstract EGU2013-9991.

*Soderberg, K., S.P. Good, L. Wang, and K.K. Caylo, 2012. Stable Isotopes of Water Vapor in the Vadose Zone: A Review of Measurement and Modeling Techniques. *Vadose Zone Journal*, v. 11, no. 3.

*Good, S.P., K. Soderberg, L. Wang, and K.K. Caylor, 2012. Uncertainties in the Assessment of the Isotopic Composition of Surface Fluxes: A Direct Comparison of Techniques Using Laser-based Water Vapor Isotope Analyzers. *Journal of Geophysical Research – Atmospheres*. v. 117, D15301.

*Eckardt, F., K. Soderberg, L.J. Coop, A. Muller, K.J. Vickery, R.D. Grandin, C. Jack, T.S. Kapalanga, and J. Henschel, 2012. The Nature of Moisture at Gobabeb in the Central Namib Desert. *Journal of Arid Environments*. doi: 10.1016/j.jaridenv.2012.01.011

Soderberg, K., J.M. Gitonga, and K.K. Caylor, 2012. Establishing a Water Isotope Framework for Investigating Ecosystem Functioning and Agricultural Water Use in Central Kenya. Presentation at the Presentation at the American Geophysical Union (AGU) Fall Meeting, Abstract H34B-04.

Evans, T., M. Cox, P. McCord, K.K. Caylor, C. Washington-Ottombre, K. Soderberg, and S. Sadri, 2012. Water Governance, Agricultural Development and Community-level Resilience to Climate Change. Presentation at the American Geophysical Union (AGU) Fall Meeting, Abstract H14F-02.

Soderberg, K., S.P. Good, L. Wang, and K.K. Caylor, 2012. Soil Water Vapor Isotopes as a Tool for Understanding Ecohydrological Processes. Presentation at the 22nd V. M. Goldschmidt Conference, Montreal, Canada

Soderberg, K., S.P. Good, M. O'Connor, E.G. King, and K.K. Caylor, 2012. Evapotranspiration Partitioning in a Semi-arid African Savanna Using Stable Isotopes of Water Vapor. *Geophysical Research Abstracts*, EGU2012.

Caylor, K.K., S.P. Good, K. Soderberg, and E. King, 2011. Isotope Based Landscape-scale Transpiration Measurements. Presentation at the American Geophysical Union (AGU) Fall Meeting, Abstract B23E-07.

Good, S.P., K. Soderberg, L. Wang, and K.K. Caylor, 2011, Uncertainty in Measurements of dET. Presentation at the American Geophysical Union (AGU) Fall Meeting, Abstract B24B-02.

Soderberg, K., J. Henschel, and S.A. Macko, 2011. Using Stable Isotopes to Understand Survival Strategies of the Living Fossil, *Welwitschia Mirabilis*. Presentation at the American Geophysical Union (AGU) Fall Meeting, Abstract V13A-2579.

Good, S.P., K. Soderberg, L. Wang, K. Ryan, M. O'Connor and K.K. Caylor, 2011. Air Mass Trajectory Influence on East African Rainfall Isotopic Composition. Presentation at *Isoscapes 2011*, Purdue University, Indiana.

Good, S.P., K. Soderberg, L. Wang, and K.K. Caylo, 2011. A Direct Comparison of Stable Isotope Evapotranspiration Flux Measurement Techniques with Closed Path Water Vapor Isotope Analysers. Presentation at the 9th International Symposium on Applied Isotope Geochemistry, Tarragona, Spain.

Soderberg, K., S.P. Good, L. Wang, and K.K. Caylor, 2011. Soil Water Vapor Isotopes: Combining Continuous Field Measurements with Experimental and Modeling Approaches in a Semi-Arid Ecosystem. Presentation at the 9th International Symposium on Applied Isotope Geochemistry, Tarragona, Spain.

Soderberg, K., S.P. Good, L. Wang, and K.K. Caylor. 2011. Using the Stable Isotopes of Water in the Soil-Plant-Atmosphere Continuum as a Basis for Understanding Ecosystem Functioning in a Semi-Arid African Savanna. Presentation at the symposium: Hydrogen Isotopes as Environmental Recorders, Orleans, France.

Soderberg, K., L. Wang, S. Good, and K.K. Caylor, 2011. Measurement of Soil Water Vapor Isotopes for Evapotranspiration Partitioning. *Geophysical Research Abstracts*, v. 13, EGU2011.

Soderberg, K., J. Henschel, R. Swap, and S. Macko, 2011. Environmental Controls on C, N and S Cycling in Plants of the Namib Desert. *Geophysical Research Abstracts*, v. 13, EGU2011.

Good, S.P., K. Soderberg, G. Kaiyu, E.G. King, and K.K. Caylor, 2011. Savanna Grassland Transpiration Fluxes After Water Pulses Assessed Using Stable Isotope and Eddy Covariance Techniques. Presentation at the Conference on the Roles of Stable Isotopes in Water Cycle Research. Keystone, CO.

Caylor, K.K., L. Wang, S. Good, and K. Soderberg, 2011. Evapotranspiration Dynamics in a Semi-Arid Savanna Using Continuous Water Vapor Isotopes from the Eddy Covariance Flux Tower at Mpala Research Centre, Kenya. Presentation at the *9th Annual Savanna Science Network Meeting*, Skukuza, South Africa.

Soderberg, K., J. Henschel, K. Billmark, R.J. Swap, and S.A. Macko, 2010. Multiple Stable Isotope Tracers of Fog Use by Namib Desert Plants. *Geophysical Research Abstracts*, v. 12, EGU2010.

Soderberg, K., 2010. The Role of Fog in the Ecohydrology and Biogeochemistry of the Namib Desert. PhD Dissertation, Department of Environmental Sciences, University of Virginia.

Soderberg, K., R.J. Swap, and S.A. Macko, 2009. Fog-Aerosol Interactions in the Coastal Namib Desert. *Eos Transactions,* v. 90, no. 52, Fall Meeting Supplement. Abstract A51D-0138.

Macko, S.A., K. Soderberg, J. Henschel, K. Billmark, and R.J. Swap, 2009. Linking Fog Water Use by Plants in the Coastal Namib Desert to Carbon and Nitrogen Cycles along Aridity Gradients. *Eos Transactions,* v. 90, no. 52, Fall Meeting Supplement. Abstract B51A-0291.

Soderberg, K., J. Henschel, K. Billmark, and S.A. Macko, 2009. Fog as a Supplemental Water Source for Plants in the Central Namib Desert. *Geological Society of America Abstracts with Programs*, v. 41, no. 7, p. 464.

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Soderberg, K., J. Henschel, and S.A. Macko, 2008. Aridity and Fog Deposition as Controls on C3/CAM Photosynthesis and N-cycling in *Welwitschia mirabilis*. *Eos Transactions,* v. 89, no. 53, Fall Meeting Supplement. Abstract B23C-0439.

Soderberg, K., J. Henschel, and S.A. Macko, 2008. WaterRrelations of a *Welwitschia mirabilis* Community Threatened by Mining in the Namib-Naukluft National Park, Namibia. Presentation at the Society for Conservation Biology 22nd Annual Meeting, Chattanooga, TN.

*Soderberg, K., and J. Compton, 2007. Dust as a Nutrient Source for Fynbos Ecosystems, South Africa. *Ecosystems,* v. 10, no. 4, pp. 550-561. doi:10.1007/s10021-007-9032-0

*Soderberg, K., and R.J-C. Hennet, 2007. Uncertainty and Trend Analysis—Radium in Groundwater and Drinking Water. *Groundwater Monitoring and Remediation,* v. 27, no. 4, pp. 122-129. . doi: 10.1111/j.1745-6592.2007.00167.x

Soderberg, K., 2007. Fog Interactions with Surface Ecosystems of the Central Namib Desert and Potential Fog-Aerosol Feedbacks: Initial Ideas. in Benito G, Todd S, eds., Book of Abstracts: *Groundwater Recharge in Ephemeral Rivers of Southern Africa: Implications for Water Management.* Cape Town, South Africa. p 22.

Soderberg, K., R.J-C. Hennet, and C. Muffels, 2005. Uncertainty and Trend Analysis for Radium in Groundwater and Drinking Water. Presentation at the 2005 NGWA Naturally Occurring Contaminants Conference*: Arsenic, Radium, Radon, and Uranium*, Charleston, SC. pp.30-44.

Soderberg, K., 2003. Geochemistry of the Fynbos Ecosystem in a Table Mountain Group Sub-Catchment of the Olifants River, Western Cape, South Africa. *MS Thesis*. University of Cape Town, South Africa.

Compton, J.S., and K. Soderberg, 2003. Water Quality and Geochemistry of the Mountain Fynbos Ecosystem in the Vicinity of Citrusdal, South Africa. *Eos Transactions,* v. 84, no. 46, Fall Meeting Supplement. Abstract H41D-1038.

Soderberg, K., and J.S. Compton, 2003. Dust Deposition as a Nutrient Source for Fynbos Ecosystems, South Africa. *Eos Transactions,* v. 84, no. 46, Fall Meeting Supplement. Abstract B21F-0781.

Soderberg, K.S., and J.S. Compton, 2002. Chemical Interactions Between Groundwater and Surface Ecosystems: An Example from the Table Mountain Group in the Olifants River Valley. *Proceedings of the Geological Society of South Africa Regional Groundwater Conference*, Somerset West, South Africa.

Soderberg, K., 2000. Sustainable Water Resource Development in North-Central Namibia. *Proceedings of the American Water Works Association Section Meeting*, Atlantic City, NJ.

Soderberg, K., 2000. Approaches to the Study of Water Resources in North-Central Namibia. BSE Thesis: Dept. of Civil and Environmental Engineering. Princeton University, Princeton, NJ.

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## DEPOSITION AND TESTIMONY EXPERIENCE

*TESTIMONY*

2018 Tethyan Copper Company Pty Limited (TTC) v. The Islamic Republic of Pakistan. ICC Case No. 18347/VRO/AGF/ZF/AYZ. Expert Report filed July 24. London, UK.

2018 Cuppels v. Mountaire Corporation. Case No. S18C-06-009 ESB. Expert Report filed June.

2018 Tethyan Copper Company Pty Limited (TTC) v. The Islamic Republic of Pakistan. ICSID Case No. ARB/12/11. Expert Report filed April 30. In-person testimony May 19. London, UK.

2014 Before the Illinois Pollution Control Board. R14-10 (Rulemaking – Water). Coal Combustion Waste (CCW) Ash Ponds and Surface Impoundments at Power Generating Facilities. Proposed New 35 Ill. Adm. Code 841. Pre-filed testimony April 9. In-person testimony May 14-15 and July 24. Chicago, IL.

*DEPOSITION*

2017 State of Minnesota v. 3M. 27-CV-10-28862. Expert Report filed September. Deposition October 4. Washington, D.C.