

BIOGEOCHEMICAL IMPLICATIONS OF CHANGING  
GROUNDWATER AND SURFACE WATER HYDROLOGY AT  
LAKE POWELL, UTAH AND ARIZONA, AND THE  
MERCED RIVER, CALIFORNIA, USA

Thesis by

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In Partial Fulfillment of the Requirements

for the Degree of

Doctor of Philosophy

California Institute of Technology

Pasadena, California

2009

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## Acknowledgements

I must begin by acknowledging my wonderful adviser, Janet Hering. Over the past five years, she has guided my intellectual and professional development with her constant professionalism, outstanding editing, attention to detail, patience, and unrelenting insistence on high standards. While these have all been extremely important to me, perhaps I value her open-mindedness most, for I am extremely grateful for the opportunity to develop and pursue my own ideas at Lake Powell. She found ways to fund projects that were slow to mature, and, in so doing, let me do research that has truly mattered to me. My wish for other graduate students is that they may also wake up each day excited to find the answers to the questions that they have asked, and that they have an adviser as supportive as mine.

I am very grateful to the U.S. National Science Foundation Special Grants for Exploratory Research program, the Alice Tyler Foundation, a gift by William Davidow to Caltech, the U.S. Bureau of Reclamation, Eawag, and the Summer Undergraduate Research Fellowship program at Caltech for funding portions of my research.

If Janet's supervision has been the foundation upon which my development has been built, then Claire Farnsworth, Kate Campbell, and Megan Ferguson have been the main people who helped me grow. Since she arrived at Caltech, Claire has helped in every facet of my research with balanced, thoughtful comments indoors and outstanding field assistance outdoors. Moving to Zürich and understanding the research culture of Switzerland was so much easier because she was there. Kate has been my role model since the first day I met her, teaching me about laboratory measurements, helping me develop my leadership skills, and understanding my daily life as a Caltech graduate

student. Her willingness to pass on her knowledge about porewater sampling has been invaluable. To a young graduate student, wise, “old” Megan was knowledgeable and composed during every experiment she ran and every presentation she gave in group meeting. Years after Kate and Megan answered all my questions in the lab and heard about my latest excitement, I hope I have followed their terrific examples.

Research with Dianne Newman was an outstanding experience. Her patient enthusiasm for discovery was exemplary, and working in her research group was an enlivening, enriching experience. Chad Saltikov taught me microbiology, Jeff Gralnick kept me grounded, and Arash Komeili made sure I always understood my research approach.

Thanks also to my committee members, Jess Adkins, Alex Sessions, and George Rossman, who have helped me see beyond my project and challenged my fundamental assumptions at exactly the right times. They, along with their colleagues, notably Andy Ingersoll, Joe Kirschvink, Paul Wennberg, Jared Leadbetter, Tapio Schneider, John Eiler, Ken Farley, Victoria Orphan, and Michael Hoffmann, have built an Environmental Science and Engineering department at Caltech from which I will be very proud to graduate.

I have been lucky to have been surrounded by excellent non-scientists at Caltech. Fran Matzen is among the most conscientious and reliable people I know, and she taught me that professionalism matters outside of research. Linda Scott’s bubbly, positive attitude was fun on good days and life-saving on the dark ones. Cecilia Gamboa and Dian Buchness can be counted on to support my work well, even from afar. Mike Vondrus is

the epitome of competence and kindness. Humble to a fault, he did let a smile slide across his face when I complimented him on the cleanliness of his workshop.

I simply could not have worked at Eawag without the help of Caroline Stengel, Thomas Rüttimann, and Hermann Mönch. They, along with Michael Berg and Christoph Aeppli, assured me of a soft landing there, which was so important to me in my first extended international experience.

I am so fortunate to have competent collaborators in all of my projects. Joe Domagalski took me out to the Merced River and showed a great deal of patience with an ignorant first-year graduate student. Nathan Dalleska was one of the crucial first few to stoke my excitement for research at Lake Powell, and he followed this with both field assistance and expert advice about all things analytical. His friendship and always-available help have made a big difference in my research experience. Mark Anderson has supported my research at Lake Powell unconditionally. My SURF students, Nathan Chan and Mike Easler, were outstanding, keeping me on my toes and helping me develop my projects in ways that no one else could. The sedimentological and mineralogical expertise of Lincoln Praton and Dennis Eberl, respectively, allows my research to become more interdisciplinary. They both have been exceptionally kind to me, as well. Mike DeLeon and Aurelio LaRotta have gone well out of their way to make sure my XRF data, and consequently, that entire project, turn out as well as possible.

Although I have not written a paper with them (yet!), several other scientists have made sure that my enthusiasm for my work has undergone constant renewal by giving me intellectual support, encouragement, and the examples of their own great work. Bernhard Wehrli, Johny Wüest, René Gächter, and Sharon Walker have been excellent mentors,

and Beat Müller, Flavio Anselmetti, and Michael Brett have given me key pieces of advice at key times. At Lake Powell, Bill Vernieu, Jerry Miller, and Nick Williams have been outstanding in creating opportunities for me and giving me all the resources at their disposal. Perhaps most importantly, Emily Stanley hosted me on a pivotal, mind-broadening visit to the University of Wisconsin.

Although I have never met them, there are a few writers and journalists who have inspired me in important ways. Kirk Johnson and Dean Murray wrote a 2004 article in *The New York Times* that first ignited my interest in studying Lake Powell. Thomas Friedman of *The New York Times* has helped me understand the world outside my scope. Ayn Rand taught me that my mind is my greatest asset. While in graduate school, I have become addicted to National Public Radio, so I must acknowledge Steve Julian and Larry Mantle of KPCC and Renee Montagne and Steve Inskeep of Morning Edition on NPR for their companionship during long days collecting and processing data.

I am grateful for the many friends who have helped in so many ways throughout graduate school. Buck McDaniel was an early partner in crime at Lake Powell, and Erika Anderson provided important balance during my first years. I have been buoyed by Ann Marie Cody's boundless energy, inspired by Drew Keppel's intelligence, and humbled by Lisa Keppel's perspective. Magnus Eek and Natalia Deligne were always up for an adventure, and Mark and Nathalie Vriend have been a huge help as I have visited Caltech since moving away. The Avery class of 2009 was outstanding in so many ways, and Jenni Taylor and Amy Frame of the Environmental Charter High School gave me an important opportunity to reach out to the larger community and understand the challenges facing scientists as we try to communicate to the public.

My best friend, of course, has been my wonderful wife, Zena Harris. Since we met, she has been the best girlfriend and spouse a graduate student could ever hope for, supporting my excitement, demanding clear explanations of why my research matters (e.g., questioning the relevance of a seminal paper on porewater diagenesis, noting that the graphs are “just a bunch of dots”), giving me the time to invest myself in my work, and sharing in all kinds of adventures away from science. I am so excited that she will be there as my career advances!

Before coming to Caltech, my career was shaped in crucial ways. At Yale, Albert Colman taught me proper lab protocol, Lauren Kolowitz took me through my first research project, and Carmela Cuomo taught me that I can be solely responsible for my own work. Bob Berner was an outstanding supervisor and mentor for multiple projects, holding me to high standards and giving me the freedom to pursue projects with my own ideas. I surely would not be the researcher I am without the confidence he gave me.

Before Bob, Janet, Zena, or any of the other many important people I have mentioned here, there was Andy Card, head coach of Yale Lightweight Crew. Andy taught me the value of hard work, perseverance, and single-minded dedication toward one's goals. His professionalism and enthusiasm for his work left a lasting impression on me. He gave me my first clear example of a person who put everything he had into his chosen pursuit, and he showed me that this approach would pay handsomely. He may have thought that he was coaching me to row and compete well, but he ended up teaching me so much more. On so many days during graduate school, I have drawn on the lessons he preached, and it's not an overstatement to say that I would not have enjoyed my research or come close to earning my Ph.D. without his coaching.

## Abstract

This thesis examines some effects of surface water and groundwater hydrology on the mobility of trace elements and phosphorus in natural environments. Three separate field sites are studied: 1) the shoreline of Lake Powell, a large reservoir on the Colorado River in Utah and Arizona where the surface elevation fluctuates on yearly and multi-yearly timescales, 2) the Colorado River inflow region to Lake Powell, where the sediment delta has been exposed due to low water levels, and 3) the lower Merced River, which is located in the San Joaquin Valley, California, amidst extensive agricultural development.

On the shoreline of Lake Powell, depth profiles of manganese and uranium were used to estimate the redox state of sediment porewater. Samples were collected before and after a fluctuation in reservoir level exposed two sampling locations to air and then resubmerged them. Results indicate that reducing conditions are re-established at different rates in two nearby shoreline locations, and that manganese reduction occurs more rapidly than uranium reduction upon resubmergence.

In the Colorado River inflow region of Lake Powell, sediment samples were collected from the lakebed and shoreline. Measurements indicate that particle size anticorrelates with the concentrations of most elements and clay minerals and explains much, but not all, of the variation in trace elements. Spatial trends of particle size imply that low reservoir levels may induce resuspension of fine sediment, a process that may lead to increased primary productivity observed in monitoring data. Sequential extractions performed on these sediment samples suggest that phosphorus, the limiting nutrient in Lake Powell, is primarily associated with calcite and biogenic apatite.



Sorption experiments indicate that fine particles sorb much more phosphorus than coarse particles, and that only a small amount of the sediment-associated phosphorus is desorbed during sediment resuspension. When reservoir levels are low, measurements of dissolved phosphorus suggest that sediment resuspended by the Colorado River may supply phosphorus to the photic zone under specific hydrologic conditions.

Samples of groundwater collected from beneath the Merced River were analyzed for a suite of trace elements. Statistical analyses suggest that hydrologic processes generally influence the transport of trace solutes more than redox chemistry, and results vary between strontium, barium, uranium, and phosphorus.

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