ARTHUR L. DAY MEDAL

Presented to
Susan L. Brantley

Susan L. Brantley
Pennsylvania State University

Citation by Lisa L. Stillings and Richard B. Wanty

We are highly honored to give this citation for Dr. Susan Brantley, the 2011 Day Medalist. Although we organized her nomination package, a number of distinguished scientists contributed letters in support. Each letter contained fabulous superlatives: She was described as the "outstanding aqueous geochemist of her generation", as "one of the most impressive earth scientists" with an "enormous global impact", and as the "epitome of a scientific star". We hope to convince you that these are understatements….

As a reminder, the Day medal is awarded for "outstanding distinction in contributing to geologic knowledge through application of physics and chemistry to the solution of geologic problems". It is noteworthy that this award is intended to recognize past accomplishments as well as potential for future research. Sue has been the type example of a Day Medalist from the beginning of her career, with a signature style that combined advanced chemical/physical tools with a seamless integration of field and laboratory methods. She began her research career as an undergraduate, with the study of the geochemistry of a modern marine evaporate in Bocana de Virrila, Peru. In this 1984 study she used Pitzer equations to model the ionic activity coefficients in a late stage brine. At the time this was a cutting edge approach because Harvey and Weare, and Pitzer, were just publishing their work on brines, mineral solubilities, and electrolyte theory.

Sue's research soon focused on quantification of rates of geochemical processes. She, together with students and colleagues, has produced data on rates of dissolution and precipitation reactions for many of the primary, rock forming minerals. These data have been collected with other literature data and summarized in two volumes: "Chemical Weathering Rates of Silicate Minerals, MSA volume 21 published in 1995, and the 2008 volume "Kinetics of Water Rock Interaction", edited by her and Art White. Both volumes quickly became 'must have' references for geochemists. The latter presents, in one place, theory and techniques for measuring and modeling mineral dissolution rates from laboratory experiments and field studies. Its extensive appendix compiles and synthesizes dissolution rate data for many of the major rocsk forming mineral phases, and models these rates over a range of pH with a uniform data-fitting approach.

From work on individual minerals Sue became interested in relating geochemical kinetics to soil forming processes. She and her long-time colleague Art White, along with their students, have worked to develop a quantitative approach to soil profile development. This represents a quantum advance in our understanding of weathering processes. To illustrate, one important contribution was the derivation of a generalized equation to describe chemical depletion profiles in regolith. This relationship is especially powerful because for decades there have been questions on why laboratory dissolution rates differ from field rates. Now, when given an observed elemental weathering profile, the model can estimate a "field" dissolution rate comparable to other values from the literature. This is crucial research for understanding of earth surface processes.

Sue is furthering this approach by working to develop quantitative reactive transport models for soil development. In a simulation of albite weathering to kaolinite, Sue and her students have demonstrated that the thickness of regolith depends upon 1) the dissolution rate, 2) the erosion rate, and 3) the advective velocity of the pore fluid. This approach is a potentially an enormous breakthrough for modeling weathering on a geologic time scale.

Finally, Sue's interests are not limited to physical and chemical processes. She has embarked upon a program to understand the effects of microbial processes on mineral dissolution and soil development. Her interests include of the role of biofilms on weathering, the uptake of metals by bacteria, the effect of bacteria on iron isotope fractionation in weathering reactions, and the use of whole bacterial genomes to infer biogeochemical signatures. This work is truly on the cutting edge of biogeochemistry, widely recognized and pioneering.

This summary illustrates Sue's drive to integrate geochemical kinetics with hydrology and microbiology. Her vision and creativity have given her a leadership role in interdisciplinary, global efforts to understand, quantify, and model processes in the Critical Zone, i.e., the system of coupled chemical, biological, physical, and geologic processes that operate to support life at the Earth's surface. This is research of fundamental importance because Critical Zone processes are the ultimate control on soil production, nutrient availability, and atmospheric CO_2 concentrations on geological time scales. She has led efforts to secure NSF funding to establish the Critical Zone network in the US, and has become a key advisor to European efforts to establish soil observatories.

To conclude we hope we have convinced you that Dr. Susan Brantley is highly deserving of the Day Medal for her pioneering approach to the study of earth surface geochemistry. While this is an award for scientific accomplishment, not teaching, we need to make the point that Sue teaches by example. She has shown her students and colleagues that it is the scientific question that matters, and that we need to use all possible tools, --be it a simple hand auger, NMR imaging of pore volumes in shale, or a chemical engineering approach in the lab. Above all, it's important to have fun while you're doing it. Sue, on behalf of GSA we offer a warm and heartfelt congratulation. Your achievements have set a very high standard for our science, and we're certain you will continue to lead the way, for many years to come.

Response by Susan L. Brantley

When Rich Wanty and Lisa Stillings first tried to reach me to tell me about this award, I was stuck on the tarmac at Philadelphia Airport because a turtle was trying to cross the runway. Really! Eventually I got back to Penn State and talked to Rich. I was flabbergasted and honored when I learned that the Geological Society of America had awarded me this medal.

In many ways I identify with that turtle. I too like to wander around outside. Looking back, I know I love wandering out-of-doors because my mother shooed us outside to play in the mud under our backyard tree—a tree not unlike my own backyard tree today. Outside, my brother and I wandered across the boundaries between backyards and teamed up with peers to do the work that kids do—play. We laughed, got bored, argued, and challenged one another. I am lucky to still be doing those things in my work today.

Along the way, three institutions helped me wander from backyard mud to international science. The first is Princeton University. In 1977, David Crerar, a wonderfully intelligent and thoughtful Princeton professor, became my PhD advisor. At that time, he was crossing into the relatively unknown fields of environmental geochemistry and geomicrobiology. David taught us that geochemistry is really BIOgeochemistry and to understand it we must use fundamental thermodynamics and kinetics. But I was also mentored at Princeton by Brian Evans who taught me that water-rock interaction is not just chemical or biological, but that the processes of cracking, healing, and sintering must also be understood. Likewise, Rob Hargraves and Linc Hollister showed me real rocks. At Princeton, I mostly worked on these problems in the laboratory, where I was guided by another wonderful Princetonian, Maria Borcsik.

The second institution I highlight is the US Geological Survey. I benefitted from two sabbaticals at the USGS at Menlo Park. While at Menlo, Survey scientist Art White and I wandered around and puzzled about why geochemical reactions are faster in the laboratory than in the field. Almost all the work I have pursued can be related to that central puzzle–how can we measure rates in the laboratory and extrapolate them to the field.

I am especially indebted to Art and other USGS scientists who taught me how to auger, make field measurements, and understand water flow through rocks and soils. On one memorable trip to Yosemite, Art and I hammered out the idea of a network of observatories–a rocket ship for scientists to wander together while investigating what we now call the Critical Zone. During a second trip to Yosemite, this time on skis, we figured out how to estimate rates of processes controlling Earth's weathering engine. I have wandered around that problem for about 20 years, looking at it from this and that angle, often not understanding even how to phrase a good question and sometimes not understanding I was working on the same problem over the years.

I could not have wandered around in a better place than the third institution I highlight. We ARE Penn State. At Penn State, Lee Kump challenged me to think more globally. Jim Kubicki and Peter Heaney helped relate dissolution mechanisms to underlying crystal lattices. Don Fisher showed me quartz veins and weathering rinds and we tried to understand how they formed. Ray Fletcher taught me that models are never right but sometimes helpful. Kate Freeman helped me find humor and understanding in a faculty that was, for too long, 30 men and 2 women.

But my biggest influence at Penn State has been my students. To use a football metaphor (after all, I am at Penn State), teaching in graduate school is the ultimate head fake–I start out teaching each student, and then they earn their degree, but I am the one who learns.

In fact, I assume that one day my students, like me, will look back at graduate school and their careers and realize that they learned more from their peers along the way than from the faculty or the books. Friends I made at conferences -- now renowned geochemists, environmental specialists, teachers, department heads, U.S. water specialists, and Deans—helped me cross the boundaries to learn what I needed to know.

But my favorite friend and coauthor is my husband–Andy Nyblade–who himself deserves a daily medal. While my family when I was growing up launched my drive and curiosity, and my family of scientific friends inspired and challenged me along the way, my own family today enables my focused thinking.

Lately I have been wandering around the same observation I assume the Philadelphia turtle made in his wander across the airport runway: it is increasingly hard to find the natural world hidden beneath the built environment. Luckily, laboratory measurements, field observations at Critical Zone Observatories, and computer models are teaching us to decipher the code written in soils–the code that tells us where the water flowed and the organisms lived and why. GSA has long been important because it promotes geologists to decode the record of change written in rocks: now geologists are decoding the record of change in the soil so that we can build models to predict the future. Geological knowledge of soils will let us go back to the future to help ourselves, and the turtle. This is especially important because, as Bruce Wilkinson says, humans are now the dominant geological force on the planet.

In closing, I would like to go back to my own future by speaking to the only two kids that sometimes listen to me: my own. Madeline and Lena, if you read this, please remember to go outside, look at the world and read its signs, and have the courage to cross all the boundaries you find. Thank you for this honor.

View the images from Susan Brantley's Gold Medal Lecture at http://www.geosociety.org/awards/11speeches/GML-Day.pdf