KIRK BRYAN AWARD

Presented to
Neal R. Iverson, Thomas S. Hooyer, Jason F. Thomason, Matthew A. Graesch, and Jacqueline R. Marciulionis (Née Shumway)

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Citation By Scott C. Lundstrom

The Kirk Bryan Award allows us to honor the authors of a recent publication that advances the science of geomorphology and Quaternary Geology. The 2012 award goes to Neal Iverson, Thomas Hooyer, Jason Thomason, Matt Graesch, and Jacqueline Shumway, for their paper, "The experimental basis for interpreting particle and magnetic fabrics of sheared till"—published in *Earth Surface Processes and Landforms* and invited as part of a special issue on "Reconstructing ice-sheet dynamics from subglacial sediments and landforms."

This paper is laudable in several ways, but for the sake of time, I will restrict my citation to two aspects: its importance to subglacial geomorphic processes in our evolving understanding of glaciation, and its illustration of the utility of experimental approaches to geomorphology.

Subglacial deformation of till can activate fast flow of glaciers and ice sheets and contribute to the formation of diverse landforms that develop at glacier beds. Yet, for obvious reasons, direct observations of the complex processes that occur there are very limited, and much of our knowledge is open to question. Thus, the development of new approaches to test models of bed deformation and related subglacial processes is a critical need.

The lead author, Neal Iverson, has been at the forefront of efforts to fill that need with measurements beneath modern glaciers, studies of the sediments and landforms of past ice sheets, and laboratory experiments. A central part of this work has been the construction and application of large custom ring-shear devices in which various materials, including till, are sheared. In the paper being honored, the authors demonstrated the relationship between till shear deformation and the development of till fabric based on preferred particle orientations. Traditional measurements of pebble and sand-grain fabrics and of silt fabrics based on anisotropy of magnetic susceptibility were, for the first time, calibrated to many known states of strain. These results, particularly those based on magnetic anisotropy, provided a quantitative and reproducible framework for inferring patterns and magnitudes of till deformation from the geologic record. Some longstanding models for interpreting field observations, such as models of particle rotation based on viscous fluid flow, were proven incorrect as applied to till and a robust foundation was created for determining how ice sheets move on till beds and affect sediment fabric.

Why study this problem experimentally? I cannot do better answering this question than to read from the final paragraph of the paper being honored:

"Actual subglacial environments are, of course, more complicated than those of our experiments, but that is precisely why experiments are valuable: at the roots of complex geologic phenomena are simple truths that can be obscured in the geologic record but must be understood before claiming basic understanding of that record. These simple truths can be illuminated through experimentation. Unless field workers seeking to interpret fabrics of basal tills reject this well-established philosophy of reductionist science, they need to either let experimentally-derived conclusions help guide their interpretations or demonstrate why such conclusions are wrong."

Whether the glacial geology community has embraced this challenge is still unclear. However, there is little doubt that the extensive body of experimental work presented in this paper is innovative, rigorous, informative, and very significant to understanding the dynamics and subglacial processes of past glaciers and ice sheets. The paper and its authors are richly deserving of the Kirk Bryan Award.

Response By Neal R. Iverson

Thanks Scott, for your generous words. To avoid repetition of responses like the one I'm about to give, I'm going to speak for my co-authors today. Let me take a moment to acknowledge them. When they first considered graduate school, they probably envisioned themselves working on an Alpine moraine, in the high Arctic, or at least in a Midwest gravel pit. I am guessing their plans did not include spending long days in a small room hunched over a peculiar looking piece of experimental equipment, meticulously sampling wet till. Thank you, Tom, Jason, Matt and Jackie for adapting, persevering, and innovating—and for helping to educate me along the way.

When I first thought about building the device that we used in our study, I was a post-doc in the early 1990s at the University of Minnesota struggling to find an academic position. One of my interests was till rheology—a popular topic of the day among glaciologists who had realized that glaciers and parts of ice sheets can ride piggyback on shearing sediments. I was reluctant, however, to sink major effort into building a custom device with future pay-offs that seemed both uncertain and distant. When I raised those doubts with my supervisor, Roger Hooke, his response, delivered after a thoughtful pause, seemed less than sage: "I'd just build it and see what happens." In retrospect, Roger was right on target. Not until the device was built and we had learned that slowly deforming till does not obey a fluid rheology did all sorts of other untested hypotheses become evident to us. One such hypothesis was that till fabric could be used to quantitatively characterize the style and magnitude of glacier-bed deformation.

The subject of untested hypotheses brings me back to the point of that somewhat didactic paragraph that Scott just read from the end of our paper. In our field, as we all know, community-wide consensus can become mistaken for fact, and models can drift from one textbook to the next, unanchored to data. Compelling ideas and models seem plentiful; hypothesis tests that leave us with definitive knowledge seem rare. Experiments, of course, can provide a concrete reality check that complements field studies—but only if a chunk of the natural system is bitten off that is small enough to be chewed and swallowed. And there's the rub: the limited scopes, tightly drawn objectives, and baby steps forward that characterize most experimental work can seem out of step with a modern science culture that emphasizes "Earth systems," "grand challenges," and "transformative research." Tennyson's famous verse stating that "Science moves, but slowly, slowly, creeping on from point to point" is still true, but it would be unlikely to fly in an NSF proposal. Against this backdrop, experimental reductionism can seem a bit old-fashioned.

For this reason my co-authors and I are especially indebted to Scott for his nomination, to those who wrote letters on our behalf, and to the awards committee. Thank you for finding value in playing with mud in the laboratory and honoring our small step forward.