field notes
The Polar Field Services Newsletter

Tunnel Vision – studying the Engabreen Glacier

PolarTREC teacher spent his summer "under this mass of moving ice"

PolarTREC teacher Michael Lampert at the Engabreen Glacier. All photos: Michael Lampert

Buried two hundred meters below Engabreen Glacier, one of a handful of outlet glaciers that drain northern Norway's Svartisen ice cap, is the Svartisen Subglacial Laboratory, one of the world's most unique settings for glaciological research. Just north of the Arctic Circle, the facility came online in conjunction with a new hydro-electric power plant in 1993. An elaborate network of more than 100 km of subglacial tunnels funnels glacial meltwater through the mountain to turbines at the Glumsfjord Kraftverk power station near the glacier base—and allows researchers direct access to the underside of the glacier.

Living quarters and a science lab are housed within barracks-like structures in a tunnel below the surface near the glacier's origin. The only light is the eerie yellow glow emitted from sodium vapor lamps and headlamps affixed to scientists' hardhats.

The Svartisen Subglacial Laboratory houses underground labs and living space.

Michael Lampert, a 2011 PolarTREC teacher* from West Salem High School in Salem, Oregon, who joined PI Neal Iverson (Iowa State University) and team on this year's field expedition, describes his first impression of the lab:

"A helicopter took us up to the top of [the] glacier where we were to enter the tunnel to the Laboratory. I kept looking for a grand entrance, but when we arrived it was just a post with a doorway. We shoveled out a bunch of snow so we could get the door open then walked about 100m through a corrugated pipe that opened into a large room," Lampert explains. "It was a little like being in a sewer – dark, drippy, cold, humid air that is very still. You can always hear water rushing through the tunnels. It's a very odd feeling. There was this unbelievably strange emptiness. I wasn't expecting it."

Svartisen's foyer...

Lampert joined Iverson on the latter's NSF-funded project to understand how, and how fast, Engebreen Glacier moves. During underground stays of up to three weeks at the subglacial lab, the group works at the glacier-bedrock interface, measuring water pressure and microseismicity, tiny earthquakes associated with glacier movement. Data obtained at Svartisen provide fundamental information about variability in glacier movement, information Iverson hopes will translate to long-term predictions about the ice sheets covering Greenland and Antarctica, and their potential contributions to sea-level change.

Lampert mucks out the tunnel.

"The idea here, the overall goal, is to stimulate a rapid glacier movement event by pumping water under the glacier for an hour while measuring the resulting microseismicity," explains Iverson. "We measure water pressure in pump tests and embed accelerometers in the glacier to monitor ice acceleration. We then correlate these motion data to seismicity measured in the tunnel and on the glacier surface. We manipulate the system to try to understand it better. We are trying to calibrate motion in a very large-scale laboratory so we can apply results to other glaciers."

Melting last year's ice.

Donning rubber boots and suits to protect them from mud and water, researchers worked to free instruments left in the glacier ice last summer for maintenance and repairs. To get at the equipment, the team first had to melt free a steel door separating the tunnel from the glacier. Using relatively hot water (sixty degrees) from a fire hose directed at the door for an hour, Lampert , who has a background in physics, got his first up-close glimpse of the Engabreen's underbelly. In a May 2 PolarTREC journal entry he wrote:

"The very bottom of the glacier is a mix of sediment and debris but there is a sudden line of clear glacier ice, often you see lines like this on icebergs that have calved into the ocean. The blue ice has a magical appearance when illuminated with a flood light."

The glacier's base is mixture of ice and sediment.

Next, the team melted horizontal and vertical shafts through the ice to expose boreholes in the rock through which instrumentation, cables, and wiring pass from instruments embedded in the glacier to lab computers. During the year, the holes become clogged with ice that must be removed periodically. It’s a constant fight against moving ice, which can close off passageways at rates of 1-2 meters a day.

“Ice [that is] under 200 meters of pressure oozes like toothpaste. [It’s] not brittle like the ice in your freezer,” explains Lampert. “Once the sensors are in the glacier and we stop melting, the ice moves back in. The glacier is moving so the ice will ooze around you in the course of a day. You can see a difference within an hour. It’s kind of creepy. Sometimes I would sit in a space in the ice and close my eyes. I would think about just exactly where I was – under this mass of moving ice and that really put me in touch with Earth’s geology. That was one of the coolest things ever!”

Enjoying the view from outside the lab entrance.

Instrumentation includes a friction plate, a granite-topped metal disc about a foot in diameter and loaded with sensors that measure the force of the glacier as it slides over bedrock. The plate, the only one of its kind, also contains a water pressure sensor and an acoustic sensor that ‘listens’ to the glacier’s sounds as it moves past. Other sensors include accelerometers in palm-sized capsules that monitor ice motion.

“Some accelerometers have cable tethers that are fed through boreholes in the underlying rock to lab computers. Some transmit wirelessly through the tunnel. Both types have advantages and disadvantages. There is lots of screwing around with electrical stuff in conditions a degree above freezing and 100% humidity,” Iverson says.

Accelerometer maintenance is serious business.

Once instrumentation is tested and reinstalled, the shafts are left alone so that the ice “heals.” Then water is pumped through the tunnel at the base of the glacier and the team waits for data.

“We know for certain that moving ice produces seismicity and the character of our data seem to indicate motion of ice as opposed water, “ explains Iverson. “We are still working out what our data mean. The signals look like we are recording the basal motion of the glacier as it slides over rock, but we are working through the details as the data can be very noisy.”

Other sampling efforts include ice coring, sediment and geologic analyses.

Miriam Jackson takes an ice sample.

As for Lampert, he'll bring lots of stories back to his community and classroom this fall.

"The whole thing was out of the world – so totally surrealistic! These scientists are getting at the real fundamentals of science. I want my students to really understand that applying science in the field is the best part. Then there's the living in a tunnel – there's a psychological effect with it that I didn't expect. When we finally walked out from this place of 24 hours of darkness into the 24-hour day of the polar summer, it was wild…quite a metaphor to walk out of total darkness into light, from nothingness to life."—**Marcy Davis**

PolarTREC (Polar Teachers and Researchers Exploring and Collaborating) is funded by the National Science Foundation's Office of Polar Programs and managed by the Arctic Research Consortium of the United States, or ARCUS. The program aims to give teachers professional development experiences conducting research in the polar regions with career scientists to boost the teachers' content knowledge and to give them hands-on experience in scientific inquiry. ARCUS is accepting applications through the end of September from teachers and researchers interested in participating in the PolarTREC program during the 2012-2013 research season. Visit the ARCUS PolarTREC website for more information: http://www.polartrec.com/

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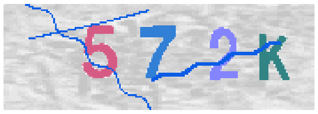

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