Sanford Underground Research Facility

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Deep Thoughts

Notes from the underground by Communications Director Constance Walter

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Building on core knowledge

Long before Sanford Lab became the home to huge physics experiments, it was the Homestake Mine. Over its 126-year history, Homestake delved deeper and deeper to extract precious minerals. Eventually, Homestake's footprint extended 8,000 feet below the surface and included a maze of tunnels, ramps and shafts that, if laid end to end, would measure nearly 370 miles—about the distance from Lead to Sioux Falls.

During that time, Homestake compiled a vast knowledge of the fabric, or character, of the rock. As Sanford Lab prepares to excavate more than 800,000 tons of rock to build the Long-Baseline Neutrino Facility and Deep Underground Neutrino Experiment (LBNF/DUNE), that knowledge is even more precious than gold.

Understanding rock

"Nature abhors a vacuum. When one is created deep underground, it is only natural for the rock to relax and begin to creep into that space," said David Vardiman, geotechnical project engineer at Sanford Lab. Geotechnical engineers study the strengths, weaknesses and stress forces of the rock so they can determine how rock will behave when excavated. Sigma 1, Sigma 2 and Sigma 3 define the orientation and magnitude of these forces, which varies throughout the Earth's crust—and sometimes within a single excavation. The perfect ratio is 1-to-1, which rarely ever happens. However, at Sanford Lab, it's really close at 0.87-to-1. That's nearly ideal for excavating huge caverns.

Core samples

"We know the rock is nearly 2 billion years old," Vardiman said. "The core samples tell us about the strength and geologic composition of the rock and reveal the orientation of folds and other imperfections in the rock mass." The information gleaned from studying core samples, influences the design of tunnels and determines what kind of ground support is needed.

Ground support

Once engineers know the stresses within and the strength of the rock, they begin to design the appropriate ground support. What shape will the caverns take and what is the span of each? How many rock bolts will be needed? How long do the bolts need to be? What kind of shotcrete is required? How much steel mesh is needed?

"Ground support reduces the risk of rock unravelling into work areas," said John Keefner, underground operations engineer. "It pins the rock together in a strong configuration, like a Roman arch, distributing the load and ensuring the opening remains intact." Rock bolts reinforce the rock, while shotcrete and steel mesh keep smaller rocks from popping loose providing a strengthening buttress effect that supports the opening.

Monitoring the earth

Remember, nature abhors a vacuum. The LBNF/DUNE caverns will be 90 feet high, 60 feet wide and up to 600 feet long. That's a lot of empty space. So, in addition to "overwhelming the ground with support," Sanford Lab will monitor the ground, Vardiman said. Extensometers and inclinometers measure movement of the rock, while routine inspections for cracks in shotcreted walls and cement floors reveal stresses in the rock. "Geotechnical investigations help ensure we do things right."

ERT member hangs up her gear

For nine years, Kay Rear was an integral part of the Emergency Response Team at Sanford Lab. She provided CPR training and first aid instruction before becoming a benchman—the person who tests breathing apparatus—for the ERT two years ago.

On March 8, Rear participated in her last training then hung up her PPE for the last time.

"The time is right to retire," Rear said. "There's a good team in place."

Rear, who fought forest fires and served as an EMT and paramedic, plans to continue her service with the Lawrence County Search and Rescue Team.

"Kay is very knowledgeable and is a real leader," said Tom Regan, who works with ESH and is a member of the ERT. "She will be missed very much."