

## **OPPORTUNITIES AND CHALLENGES: EXPERIENCES IN PERFORMING RESEARCH AT THE SANFORD UNDERGROUND LABORATORY AT HOMESTAKE**

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### ABSTRACT

The former Homestake mine in Lead, SD, has been chosen by the NSF as the location for the proposed Deep Underground Science and Engineering Laboratory (DUSEL). Prior to the establishment of the federally-funded facility, an interim early science program is being facilitated by the South Dakota Science and Technology Authority, which currently operates the Sanford Laboratory. Many unique opportunities are associated with early access to the Lab site as well as a number of challenges, including access to services such as power and communications and reconciling desired experiment locations with the approved safely-accessible laboratory areas. Experience gained from observing and participating in research has led to an understanding of best practices for safely and effectively utilizing the Sanford Laboratory area and resources.

### Keywords

DUSEL, Homestake, South Dakota Science and Technology Authority, Sanford Laboratory

### INTRODUCTION

The art and science of gold mining were studied by geologists and miners for 125 years at the Homestake mine in Lead, SD, until the mine was generously transferred by Barrick Gold Corporation to the state of South Dakota for the development of an underground laboratory. The recent conversion of the mine into a deep underground science laboratory has brought a new generation of miners to Lead—physicists, engineers, biologists, and geologists—seeking to uncover details about the nature of the universe, the earth, and the limits of life.

The South Dakota Science and Technology Authority (SDSTA) provides oversight to researchers so they are able to safely conduct experiments and collect data within the mine. Currently, approximately 18 groups are actively conducting science experiments on the surface and at 11 separate levels as part of the Sanford Laboratory Early Science Program. At the present time, the DUSEL effort supported by the National Science Foundation is directed toward preparing the engineering design for the larger federally-funded project, which is the ultimate goal for the facility.

*Early Science Access*—Groups interested in conducting research at the Sanford Laboratory first contact the Science Liaison Director, who collects information about the proposed experiments, the equipment to be used and the associated Laboratory infrastructure requirements. Science Liaison department staff then use that information to identify suitable candidate locations, relying on existing maps, past experience, and dedicated underground investigations. In some cases a site-selection visit with the research team is necessary to ensure a particular location is acceptable. Advice from other Laboratory departments such as Engineering and Environment, Health & Safety may also influence the choice of location.

Once a site (or sites) is identified, the process of planning an underground trip to perform work begins. As part of the planning process, the research team provides documents detailing activities, personnel and procedures, work planning steps as well as an analysis of the job hazards. Depending on the nature of the work, certain training may be required in addition to the standard site-specific training. Those researchers expecting to be on-site for more than 40 hours per year are currently required to take a 10-hour OSHA training class, scheduled sessions of which are offered for free by the Laboratory.)

As soon as possible in the planning process, paperwork is circulated internally alerting Laboratory personnel of the proposed trip to determine if there will be any scheduling conflicts. Afterward, an “Action Plan” is submitted on behalf of the research group that provides specific details about the trip, including the start time and expected duration as well as listing the required personal protective equipment and any other relevant considerations such as contact information.

*Performing Early Science*—Early science research at the Sanford Laboratory takes several forms. Some groups install instruments in defined areas while other groups, such as those performing biological and hydrological experiments, require more flexibility to collect samples from multiple locations within the accessible underground volume. Studies requiring fixed installations must provide greater detail in planning to ensure safe execution of the work and to ensure that data can be gathered effectively.

Ground motion and water level monitoring in the mine requires specialty installation, power, network and occasional access. Equipment installation, fine tuning, and troubleshooting can take days or weeks. The lifetime of each installation is expected to be months to years. For example, an ideal location for a ground-motion monitoring site selected by one of the groups was located at a distance from sources of anthropogenic noise (shafts, pumps, ventilation drifts,

walkways, other experiments) on a main level 1250 meters (4100 feet) below the surface. However the location fell well outside the safety footprint of the laboratory and was not equipped with 110V power or fiber-optic network connectivity. Although a review by safety personnel and installation of ventilation, ground control, power, and network connectivity could have made this site usable, this location would greatly increase the financial and time costs associated with the experiment. A second location was selected by focusing on areas within the safety footprint and within 100 meters of existing utilities. Noise levels were sacrificed in order to benefit from a more reasonable completion schedule and budget. After the site had been selected and confirmed by the SDSTA, a site visit was conducted to plan the installation and coordinate with SDSTA personnel on requirements and expectations. A second installation trip was planned and scheduled, and the necessary paperwork and safety training was completed. The installation was accomplished without any major problems.

*On-site Visit*—A first-time researcher visiting the Sanford Laboratory to go underground first registers with reception at the main Administration building and then is directed to their contact person or the Safety Department for the required safety training. Completion of the safety training is documented and archived on-site for future visits. Before going underground the visitor is equipped with personal protective equipment and transported to the headframe to board the “cage”. The cage is used as primary access and egress to the underground for equipment and personnel. The current Laboratory access policy calls for each research team to be escorted by qualified Laboratory staff (the ratio of Lab staff to scientists depending on the destination). Laboratory staff members are there to ensure the safety of the science team and help teams with logistics and coordination. Upon completion of the underground activities, the team returns to the Administration building to return personal protective equipment and generate a shift report detailing the events of the trip.

*Early Science Challenges and Opportunities*—Installations, experiments, and sample collections that go smoothly have several attributes in common: communication, adequate preparation, well-understood action plans, and backup plans. Active research groups require constant communication with the Safety and Science departments of the SDSTA. Installations and underground visits typically require initial communication >1 month before the intended visitation date with occasional communication thereafter to establish expectations and fulfill safety obligations. Job hazard analyses and other paperwork typically require several revisions and are expected to be in place before the visit date. It is important for science groups to realize that a significant amount of time and effort is required both on- and off-site prior to any installation of equipment underground. When planning for a relatively complex experiment, some groups have found it beneficial to send a subset of the entire team in advance to assemble equipment and supplies, scout the location of interest, and prepare for installation.

A document database is currently hosting information associated with Sanford Laboratory early science, DUSEL design and materials relevant to contractors. To enhance the effectiveness of early science at the Sanford Lab, we will add

to a publicly-accessible server previous research data, archived Homestake mine documents, safety procedures and forms, geologic maps, and diamond drill core archive information. Moreover, new data generated from early science will be added to a public database, the availability of which will make the planning process more effective and efficient. New underground infrastructure will improve water removal, ground control, ventilation, networking, and power to increase the safety footprint of the Sanford Underground Laboratory.