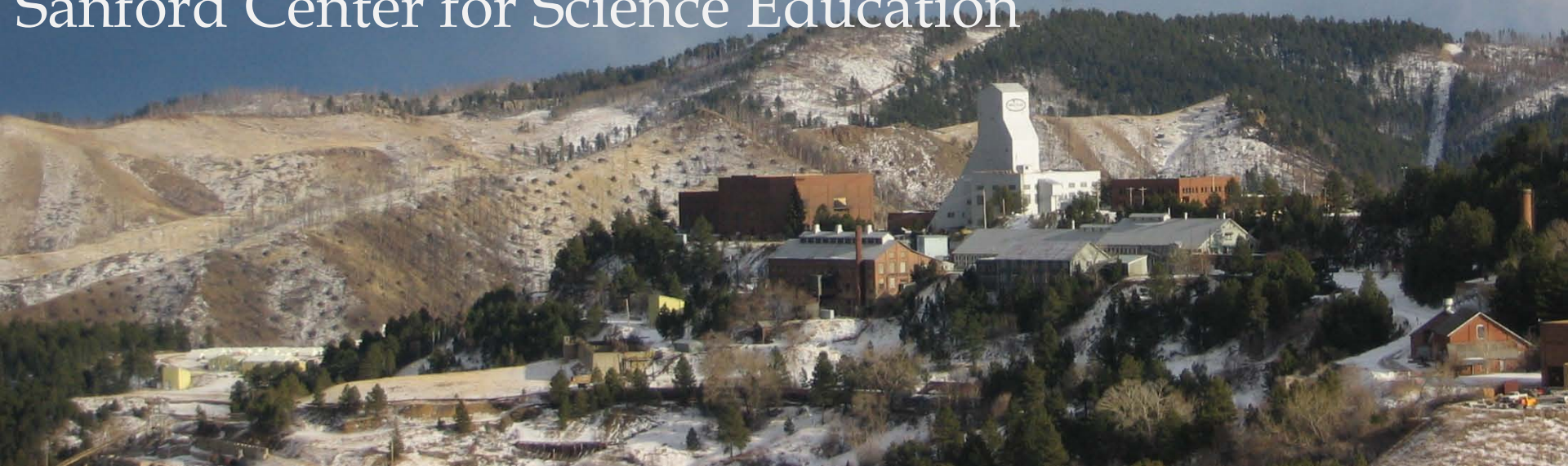
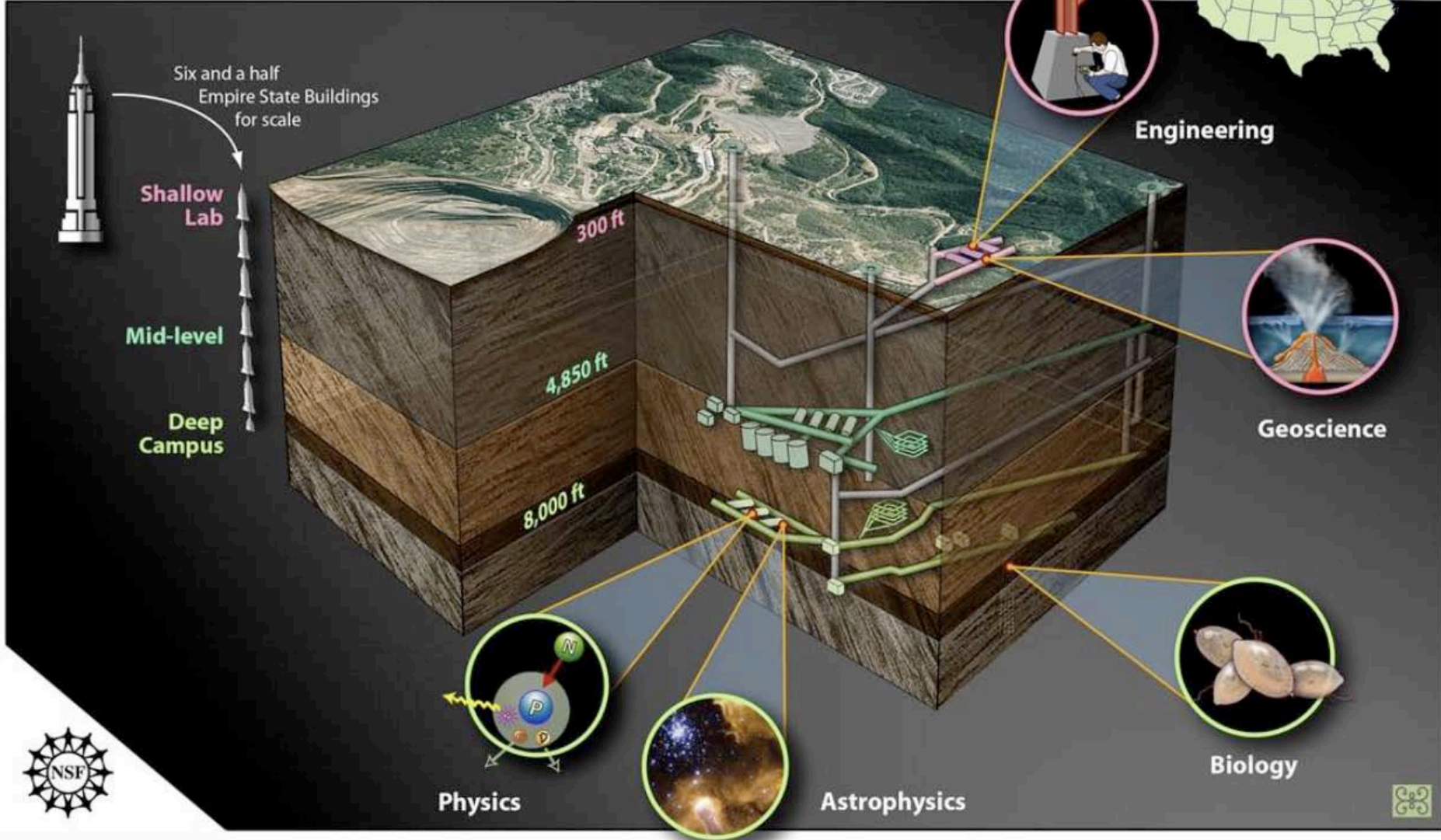


THE DEEP UNDERGROUND SCIENCE AND ENGINEERING LABORATORY (DUSEL): OPPORTUNITIES TO ENGAGE AND INSPIRE

Dr. Peggy Norris,
Black Hills State University,
Sanford Center for Science Education



DUSEL Deep Underground Science and Engineering Laboratory at Homestake, SD



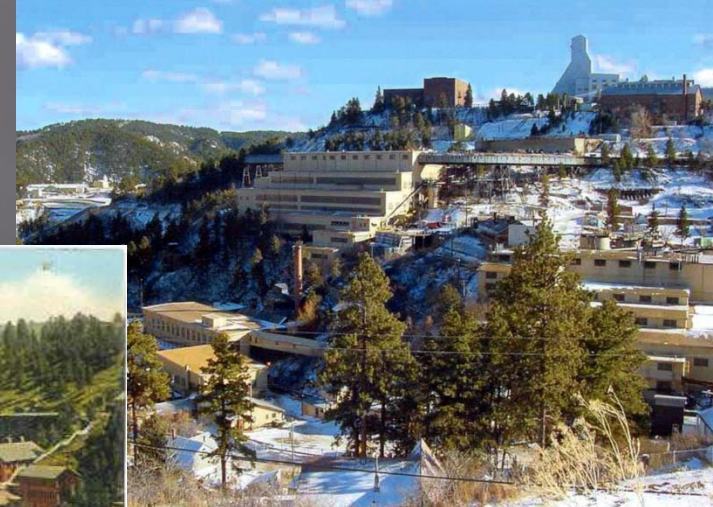
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From Gold Mine to Laboratory

1877



Circa 1930s



Circa 1970s

Feb 2010

Circa 1980



rd
Laboratory



May 2009



Physics and astrophysics: The Underground Universe

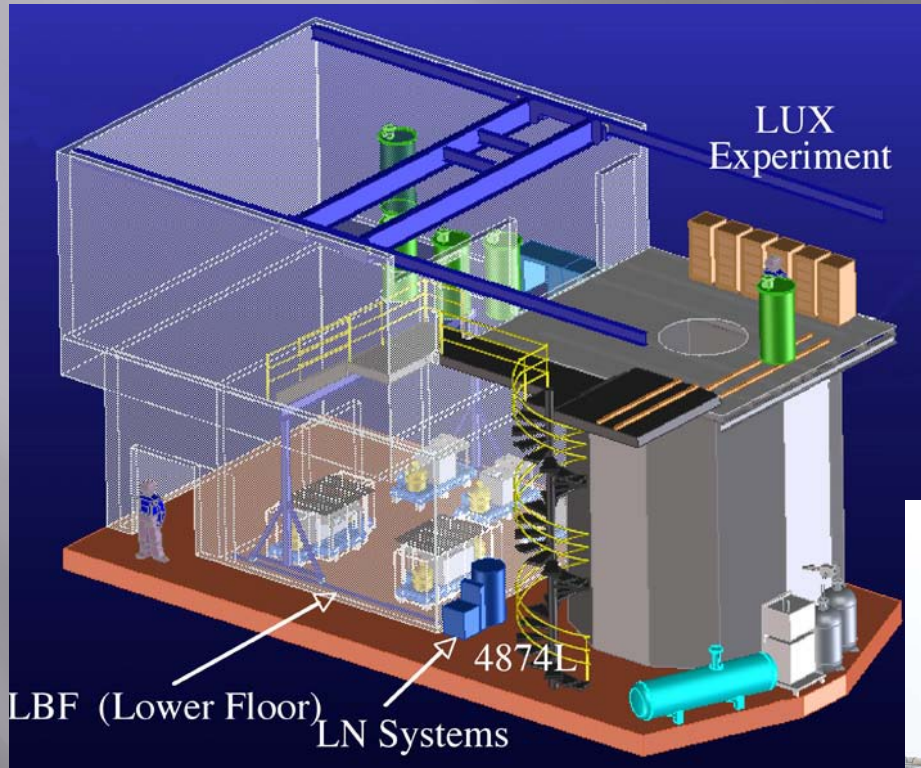
- ▣ What is the universe made of?
- ▣ How did the universe evolve?
- ▣ What happened to antimatter?
- ▣ What is dark matter?
- ▣ What are neutrinos telling us?
- ▣ Are protons unstable?



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Early Physics Experiments



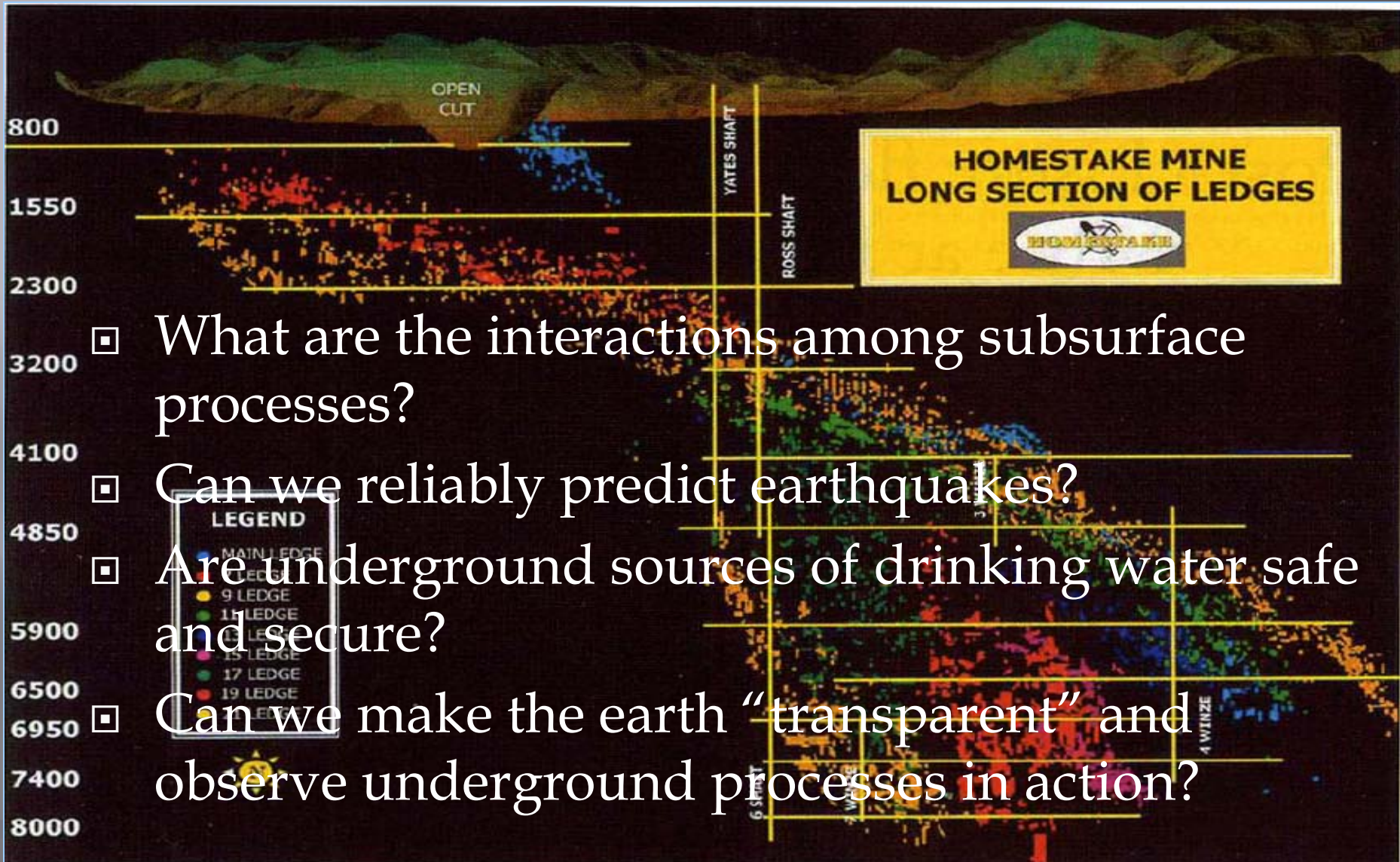
Large Underground Xenon (LUX) – search for dark matter

MAJORANA - neutrinos



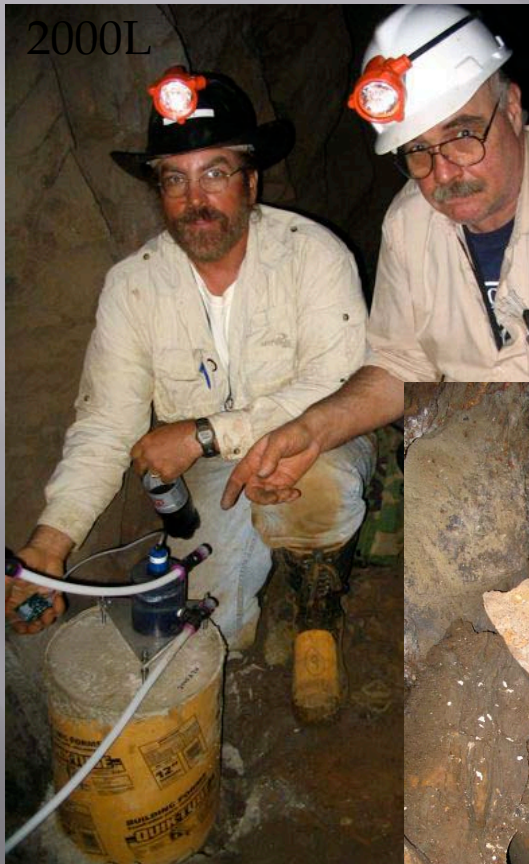
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Geosciences: The Restless Earth



- What are the interactions among subsurface processes?
- Can we reliably predict earthquakes?
- Are underground sources of drinking water safe and secure?
- Can we make the earth “transparent” and observe underground processes in action?

Geology (SDSMT, FNAL, UCB, LBNL, Montana, Wisconsin)



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800L

Biology: Dark Life

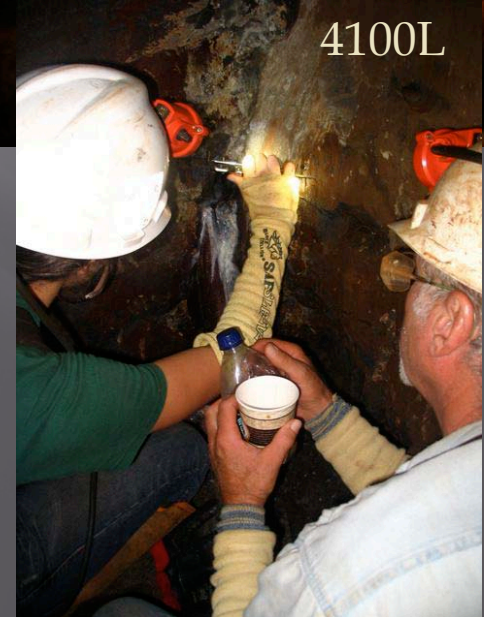
- ▣ How does subsurface microbial life evolve underground?
- ▣ Did life on Earth originate beneath the surface?
- ▣ Is there life underground as we don't know it?
- ▣ How do biology and geology interact to shape the modern world?



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Biology (BHSU, SDSMT, SDSU, Princeton, UTK, ORNL)



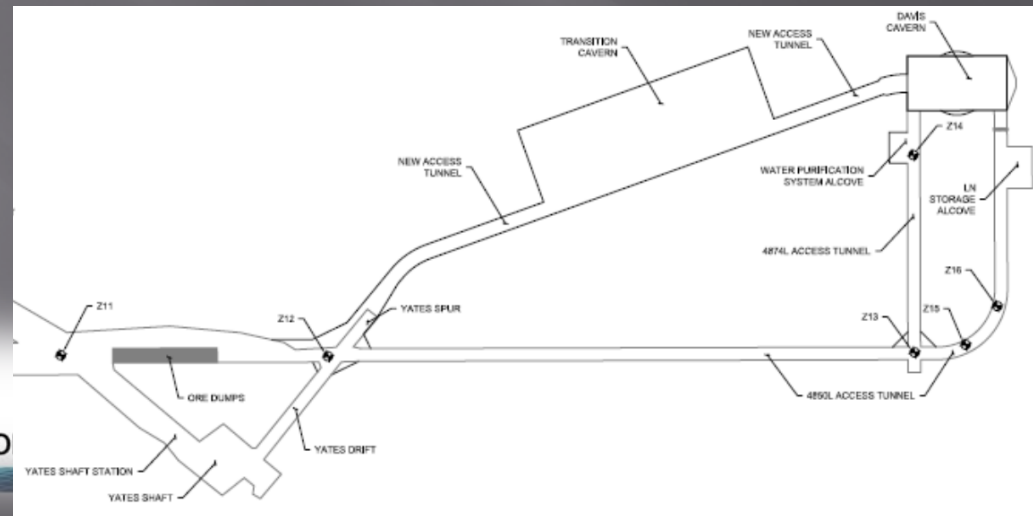
Underground Laboratory at Homestake

Engineering: Ground truth

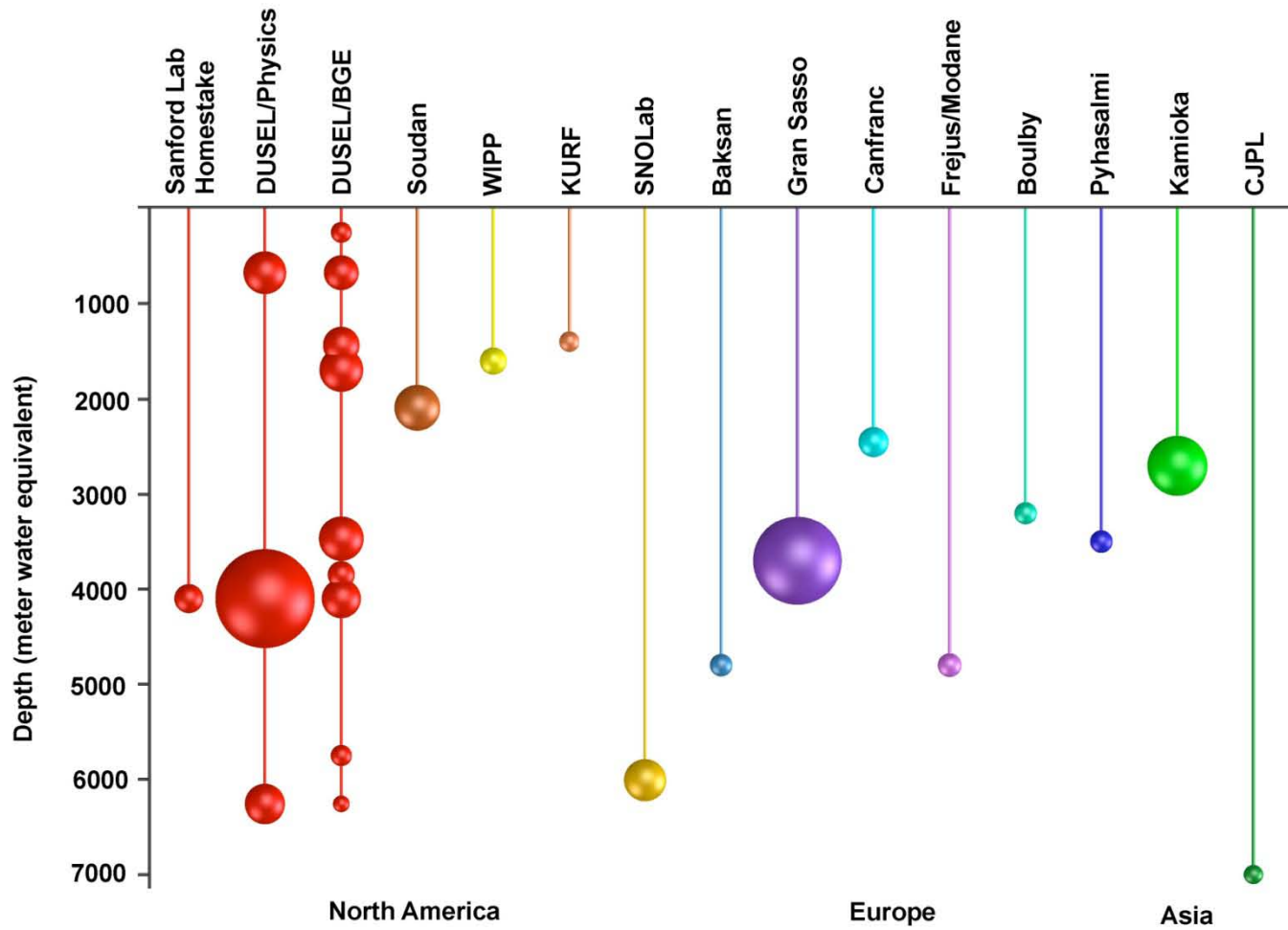
- ▣ What are the mechanical properties of rocks?
- ▣ How can technology lead to a safer underground?
- ▣ How does rock respond to human activity?
- ▣ How does water flow deep underground?
- ▣ What lies beneath the boreholes?



Underground Laboratory at Ho



DUSEL on the world stage

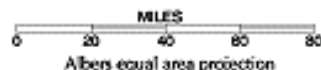




FEDERAL LANDS AND INDIAN RESERVATIONS

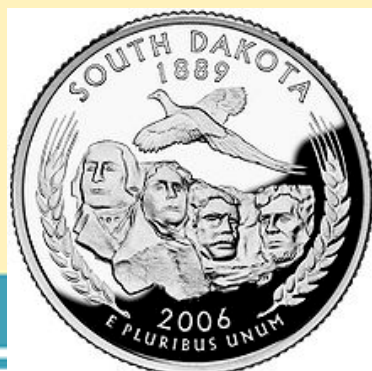
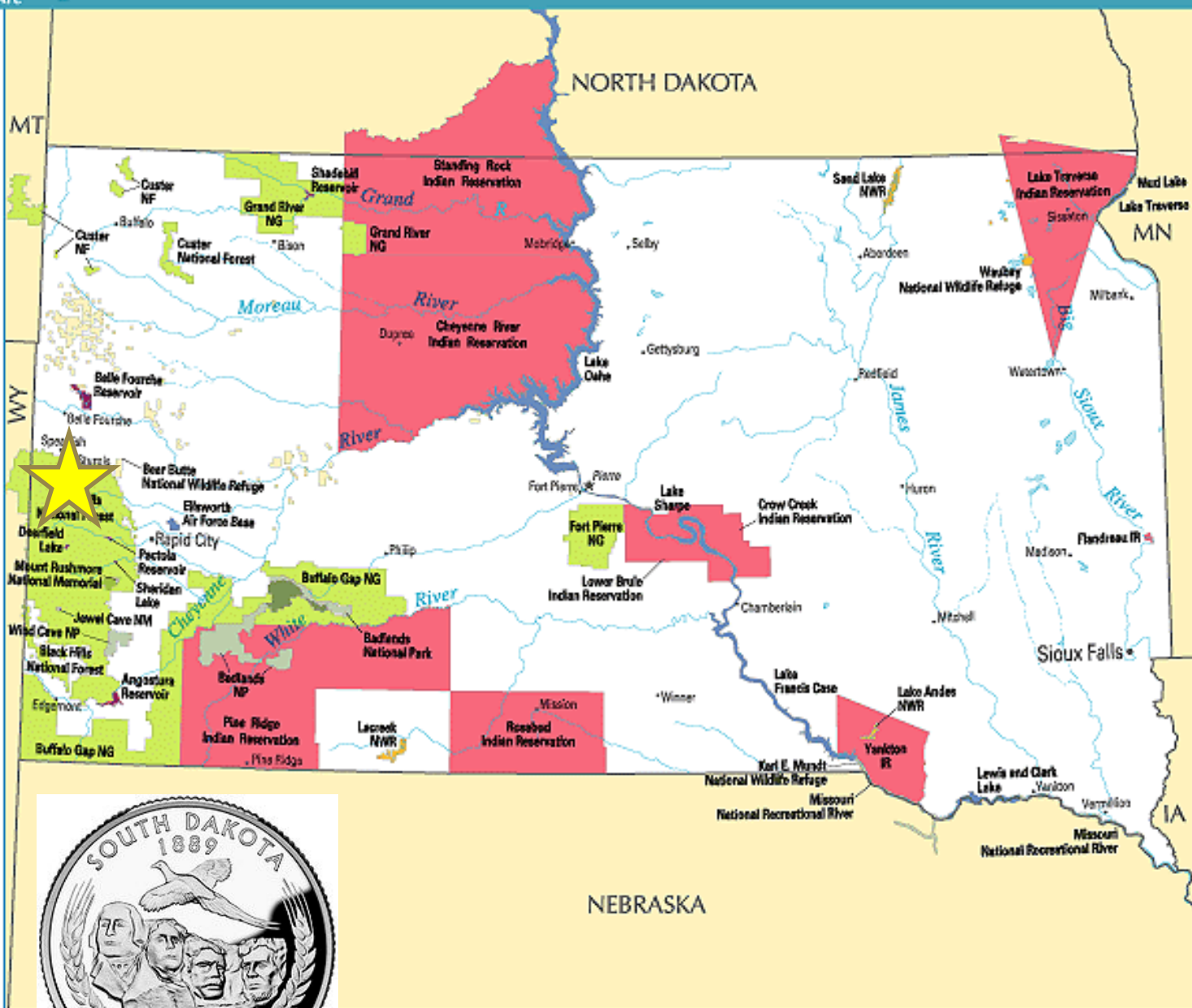
- Bureau of Indian Affairs
- Bureau of Land Management / Wilderness
- Bureau of Reclamation
- Department of Defense (includes Army Corps of Engineers lakes)
- Fish and Wildlife Service / Wilderness
- Forest Service / Wilderness
- National Park Service / Wilderness

Some small sites are not shown, especially in urban areas.



Abbreviations

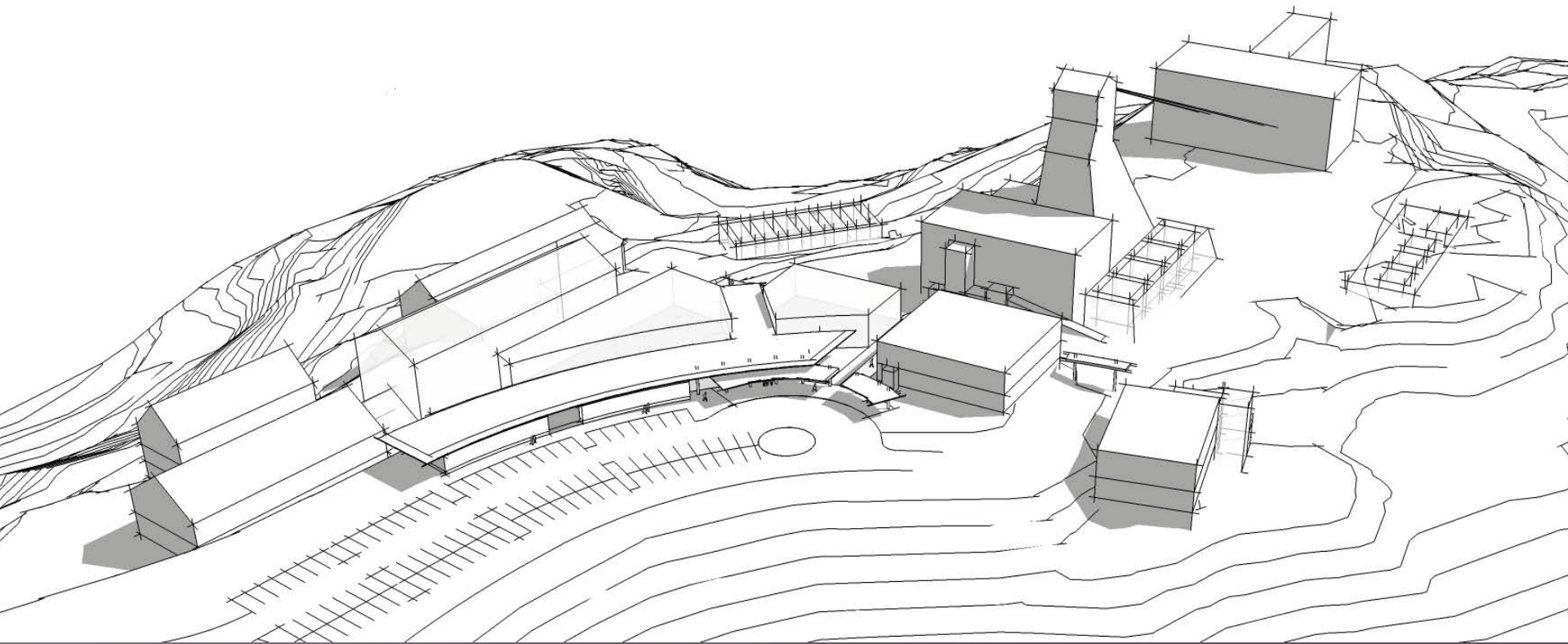
- IR Indian Reservation
- NF National Forest
- NG National Grassland
- NM National Monument
- NP National Park
- NWR National Wildlife Refuge



The Sanford Center for Science Education

The mission of the Sanford Center for Science Education at DUSEL is to draw upon the science and engineering of DUSEL, its human resources, its unique facility, and its setting within the Black Hills to develop and facilitate rich, innovative learning experiences that

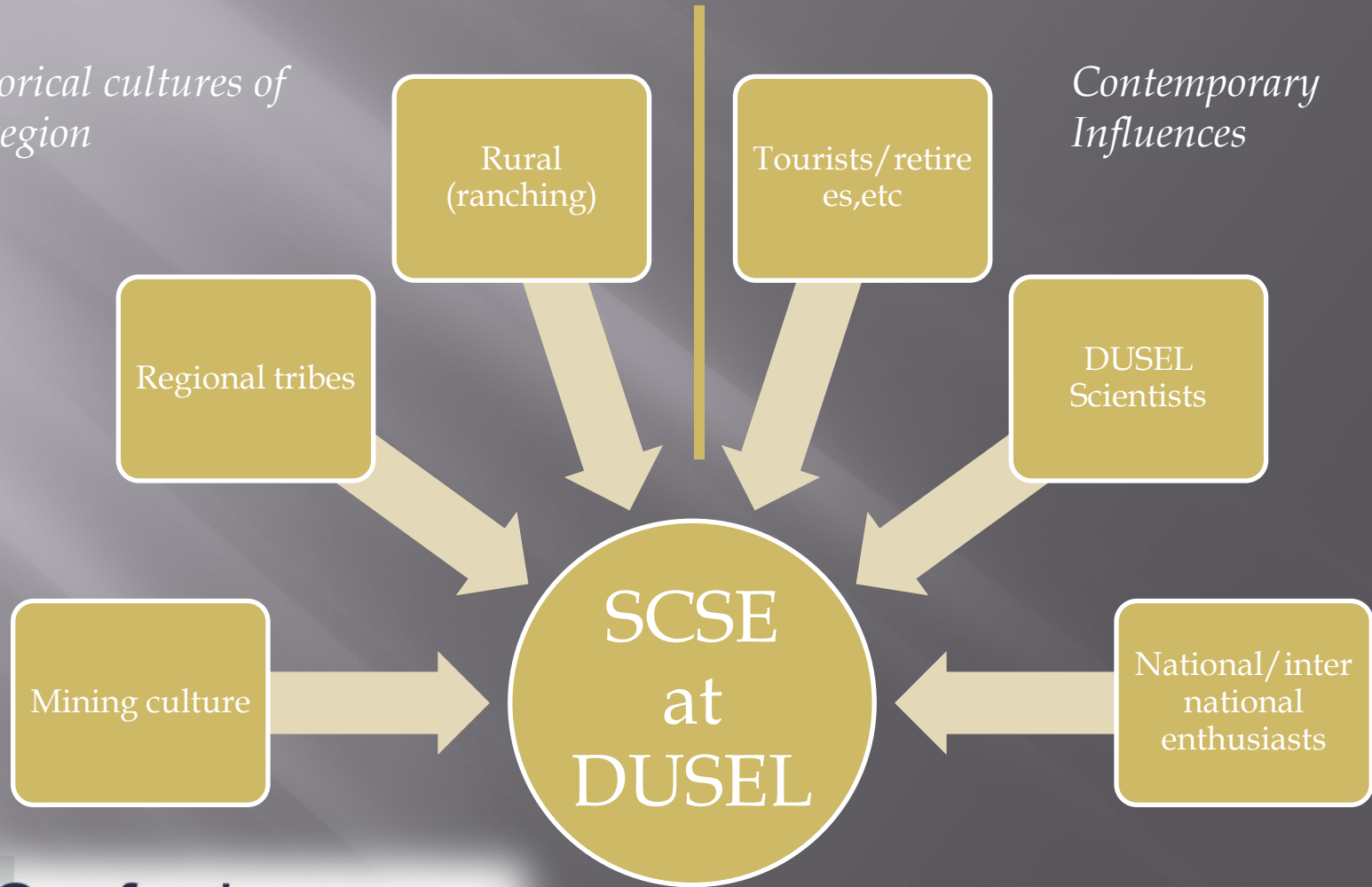
- engage and connect diverse audiences of students, educators, scientists, engineers and the general public,*
- inspire and prepare future generations of scientists, engineers and science educators, and*
- deepen understanding of science and engineering.*



The SCSE in Context

*Historical cultures of
the region*

*Contemporary
Influences*



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Underground Laboratory at Homestake

Challenges and opportunities

1. Creation of a modern, innovative science education/visitor's center while respecting and embracing the history and culture of the region
2. Remoteness of the location (geographically)
3. Remoteness of the science (vertically)

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The Audience for the SCSE

Science aficionados
Teachers as researchers
Undergraduate & Secondary
students as researchers

Committed
engagement

Lifelong learners
Secondary teachers
Secondary students
Scientists as educators

Deeper engagement

Casual visitors/tourists
Primary teachers
Younger students

Casual Engagement with the
Science

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Underground Laboratory at Homestake

Early activities – onsite

Building partnerships, capacity, and prototyping future programs



*Davis-Bahcall Scholars 2009
Undergraduates:
Dave Bozied Interns 2010*



*K-12 Students:
GEAR-UP Freshmen tour WWTP*



*General Public:
Neutrino Day 2010*



*K-12 Educators:
Spearfish science teacher inservice day*



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Underground Laboratory at Home

Early activities – offsite



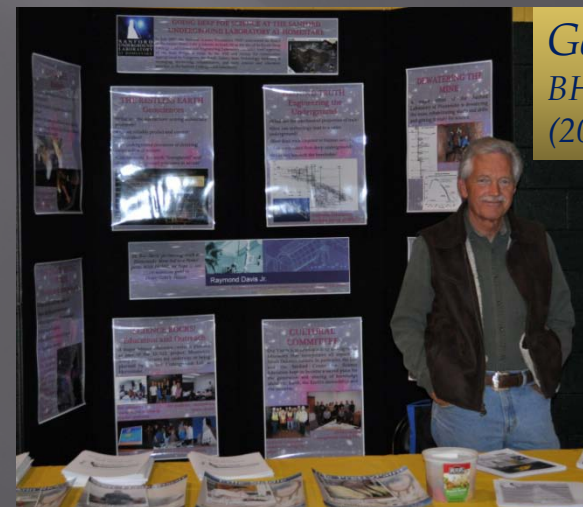
*General Public:
New Sanford Lab Video (2010)*

Building partnerships, capacity, and prototyping future programs



*K-12 Educators:
Physics of Atomic Nuclei workshop in Aberdeen (2010)*

*General Public/Scientists:
Deep Science lecture in Pierre (2010)*



*General Public:
BHSU Pow-wow (2010)*

Early activities – via Internet

vDUSEL demo

All levels:
Virtual DUSEL

Building partnerships, capacity, and prototyping future programs

*K-12 Educators:
Distance learning follow-up to summer PD*



*Scientists/Engineers:
Internet 2 extravaganza – April 2010*



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*K-20:
Remote data access
from underground*



HD Videoconferencing opportunities

- ▣ Connect a classroom with a scientist for a lecture or facilitated activity
- ▣ See science in action underground*
- ▣ Connect teacher workshops to a scientist
- ▣ Connect students to data (e.g. cosmic ray)

* Planning is in progress for an 'Extreme Life' pilot event for Fall 2011.

- travel underground with a scientist looking for micro-organisms
- go into a genomics lab and see how the organisms are analyzed
- implications for life on other planets

Timetable... (approximate)

- 2008 Early Science begins (geo, bio)
- 2009 Mine is dry to 4850' level
- 2010 LUX Surface Lab complete
- 2011 Majorana underground lab complete
- 2012 LUX moves underground
- 2011 NSF approves DUSEL
- 2012 Mine is dry to 8000' level
- 2014 DUSEL construction starts
- 2018 Surface campus/SCSE complete
- 2018 First DUSEL cavern ready for science
- 2019 First Mega-cavern ready for science