Geology/Geological Engineering Research in Underground Laboratories

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SDSMT

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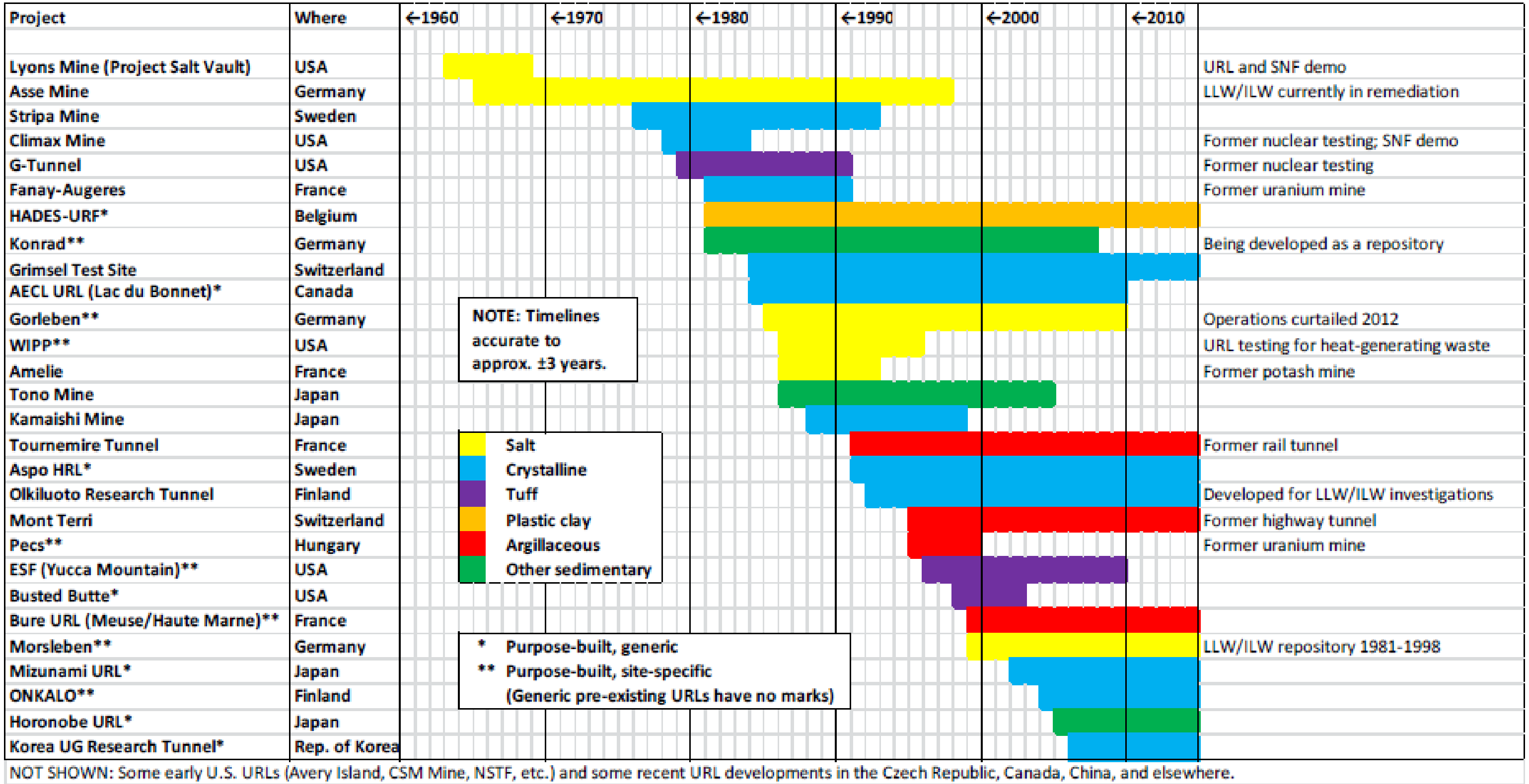
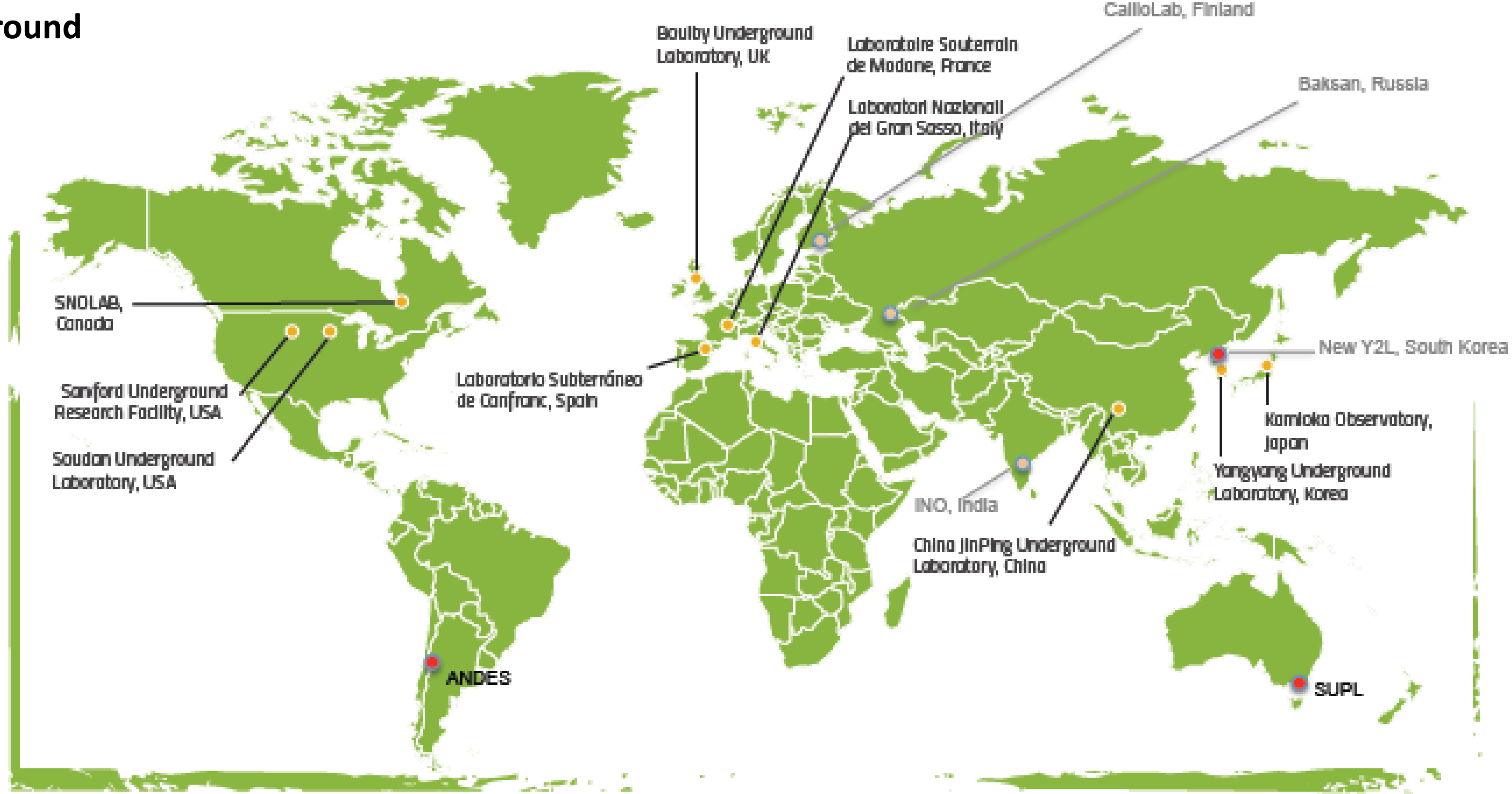
SOUTH DAKOTA MINES



McKinnon, 2015

Deep Underground Laboratories



Established
Future

Anni, 2020

Interests of Geology and Geological Engineering in the deep environment

What makes deep labs special?

- stress
- temperature
- variations in permeability/porosity
- variations in geologic environment/chemistry

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→ *Previous work shows a strong preference for having distributed sites*

An Example:

EGS Collab Project

- Investigating the relationship between **permeability creation, induced seismicity, and heat production** in crystalline rocks for Enhanced Geothermal Systems (EGS).
- Project is testing and verifying computational models that can be used in EGS or the Frontier Observatory for Research in Geothermal Energy (FORGE) EGS field laboratory
- Nine US DOE National Laboratories, seven academic institutions, and three companies

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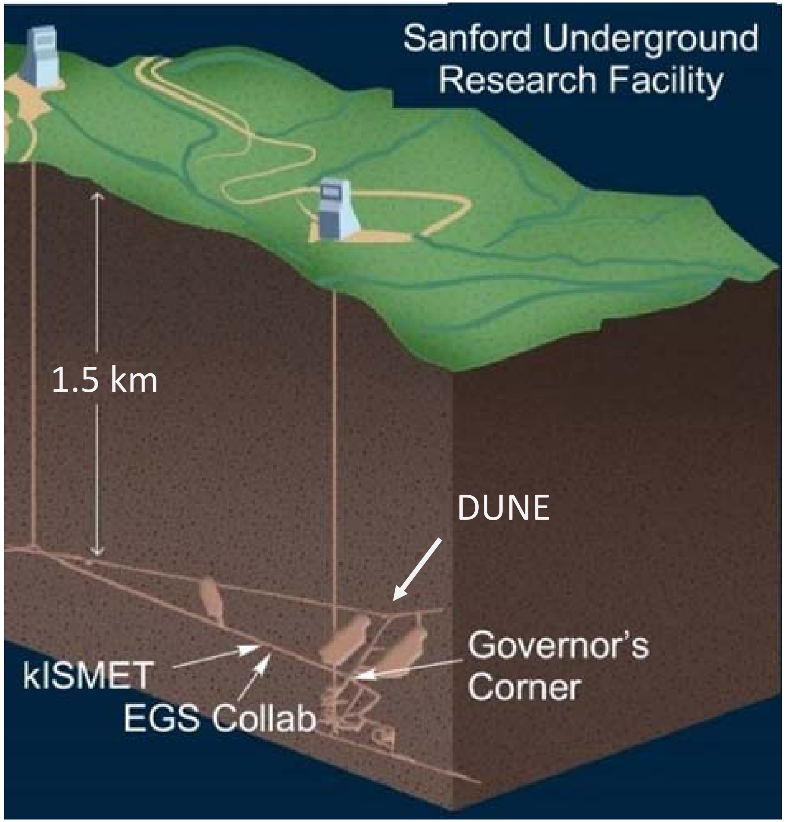
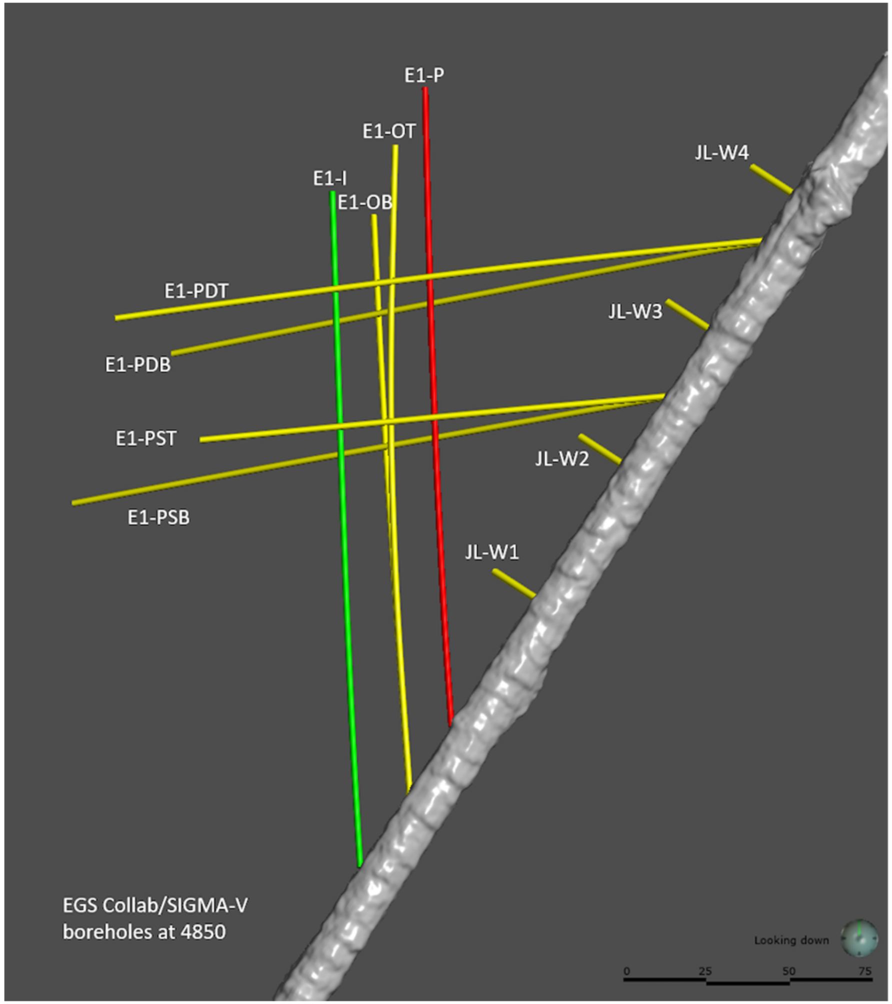
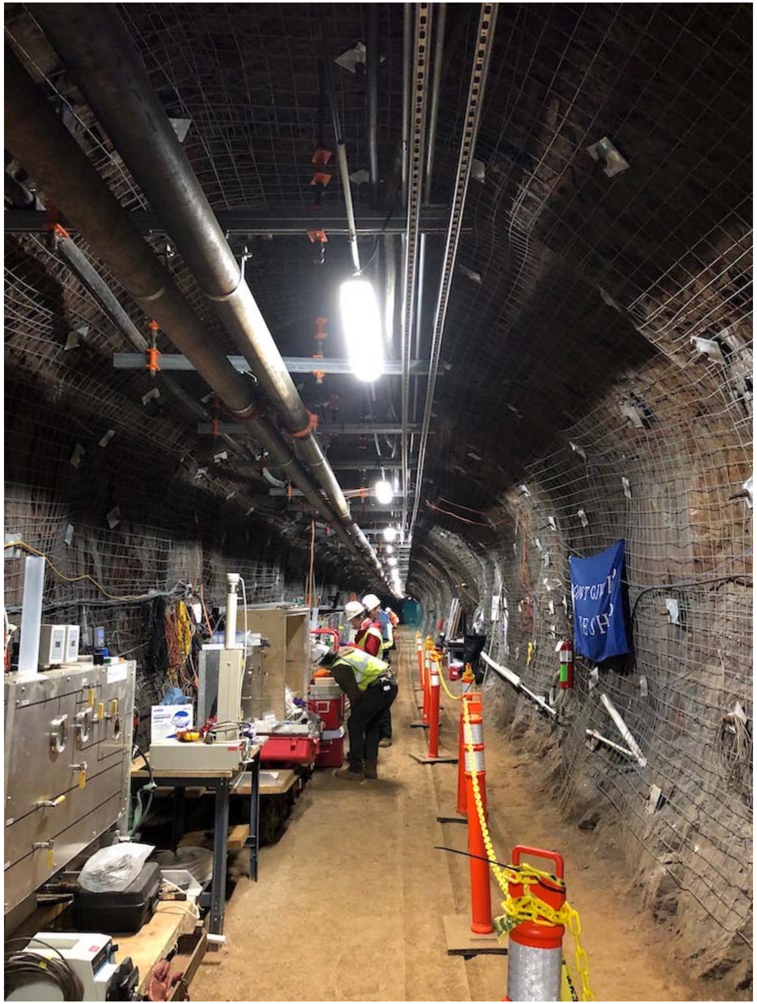


https://eesa.lbl.gov/projects/the-egs-collab-project/
https://gdr.openei.org/egs_collab

EGS Collab Testbed 1
4850 Level SURF





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What was required?

Same as the large physics experiments:

- Power
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- Ventilation
- Ground Support
- Logistical Support from SURF

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→ ***But at much smaller scale and usually in a more remote location***

Commonalities among Geo/Geo Eng. experiment types:

- **May require distributed systems (multiple smaller sites)**

Often should be somewhat isolated due to requirements for:	
• Noise reduction	Passive geophysics; may also be necessary for some active geophysical applications
• Non-interference from other experiments	Reduction in travel through the area; competition for logistical support
• Take advantage of specific geologic features, e.g. faults, fracturing	Experiments are often tied to specific features in the subsurface or to particular formations/chemistries
• If actively interrogating the rock, want to ensure that it does not interfere with other experiments or experimental areas	Necessary to ensure that induced fracturing or fluid injection does not adversely impact other types of experiments

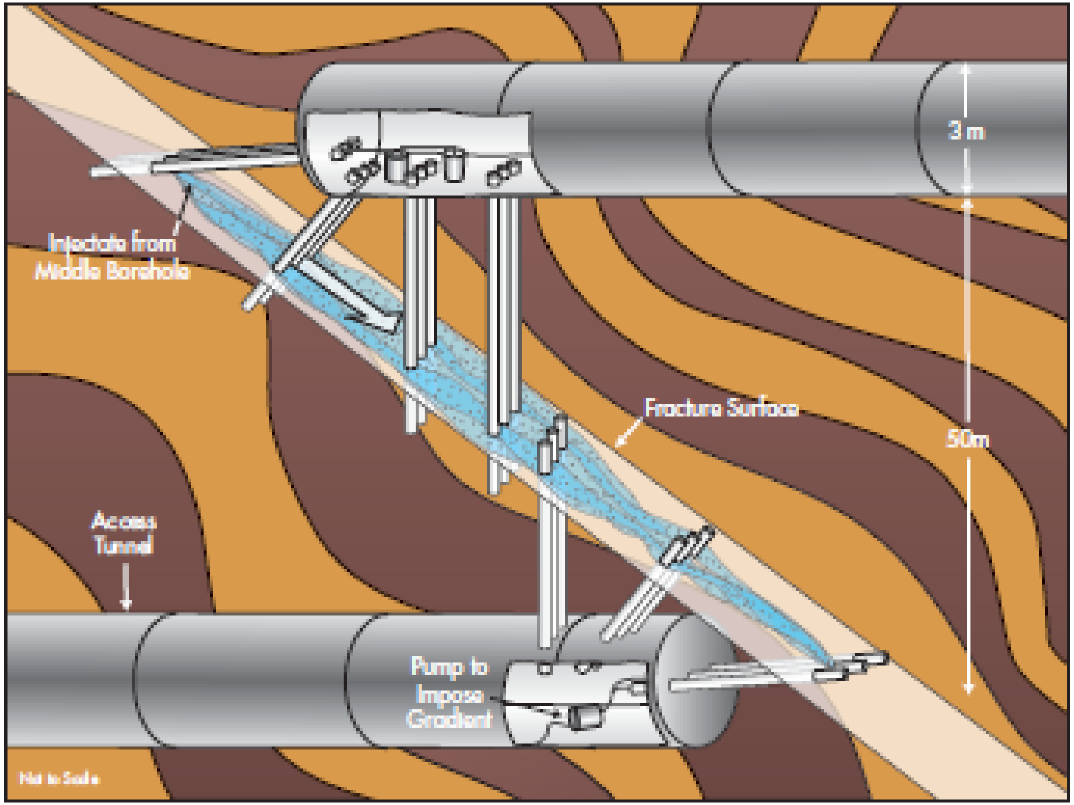
Future Directions:

An Example:

Fluid flow in faults and fractures

Applications:

- Fluid flow in the upper crystalline crust
- Repository integrity
- Geothermal development (flow in both natural and induced fractures)



EarthLab, 2003

Experimental Directions on the Horizon

- Stress determination and effects
- Temperature influence on rock deformation
- Improvements in geophysical techniques
- Improvements in Tomography/Imaging
  - Seismic
  - Electrical resistivity
  - Muon
- Geoneutrinos
- Validation/evaluation construction modeling
- Testing and development of instrumentation, including excavation, ventilation, and ground stabilization

View along the long axis of a horizontal borehole with breakouts showing effects of stress – 4850 Level SURF

http://sanfordlab.org/