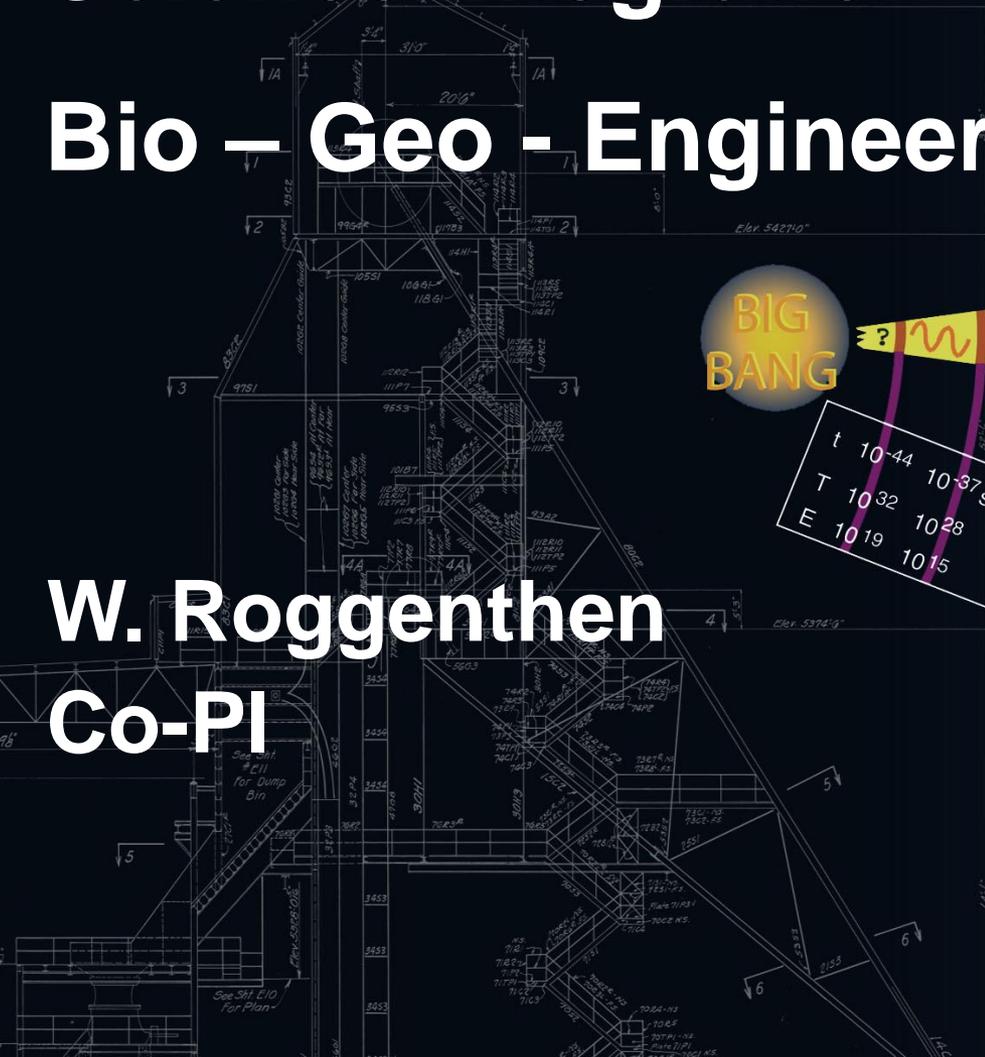
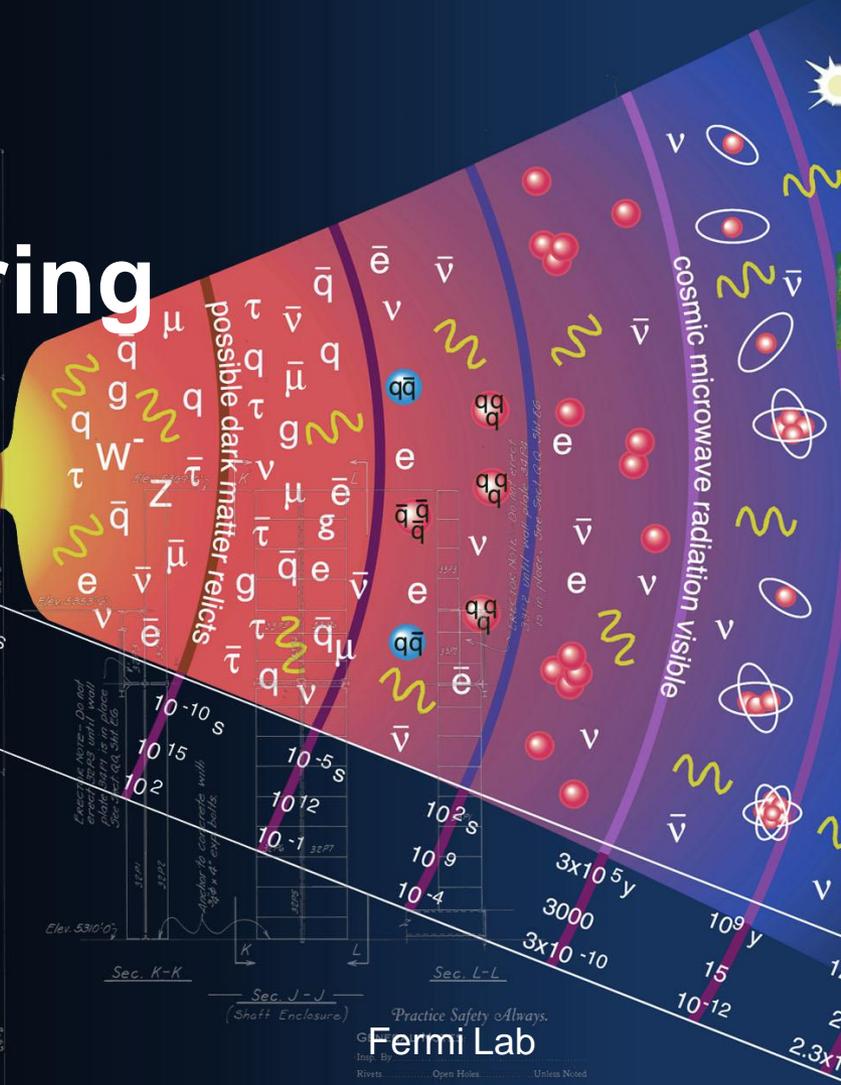


Science Integration Bio – Geo - Engineering

W. Roggenthen
Co-PI



BIG BANG



Considerations

LONGSECTION OF THE HOMESTAKE MINE

- Design of the facility
- Science integration role in facility design
- Overview of biological-geoscience-engineering experiments used to establish facility design requirements
- Status of science integration and facility requirements – present/ongoing characterization
- Connection with Sanford Lab program
- Facility and suite of experiments
- Integration issues and plans for ~2011

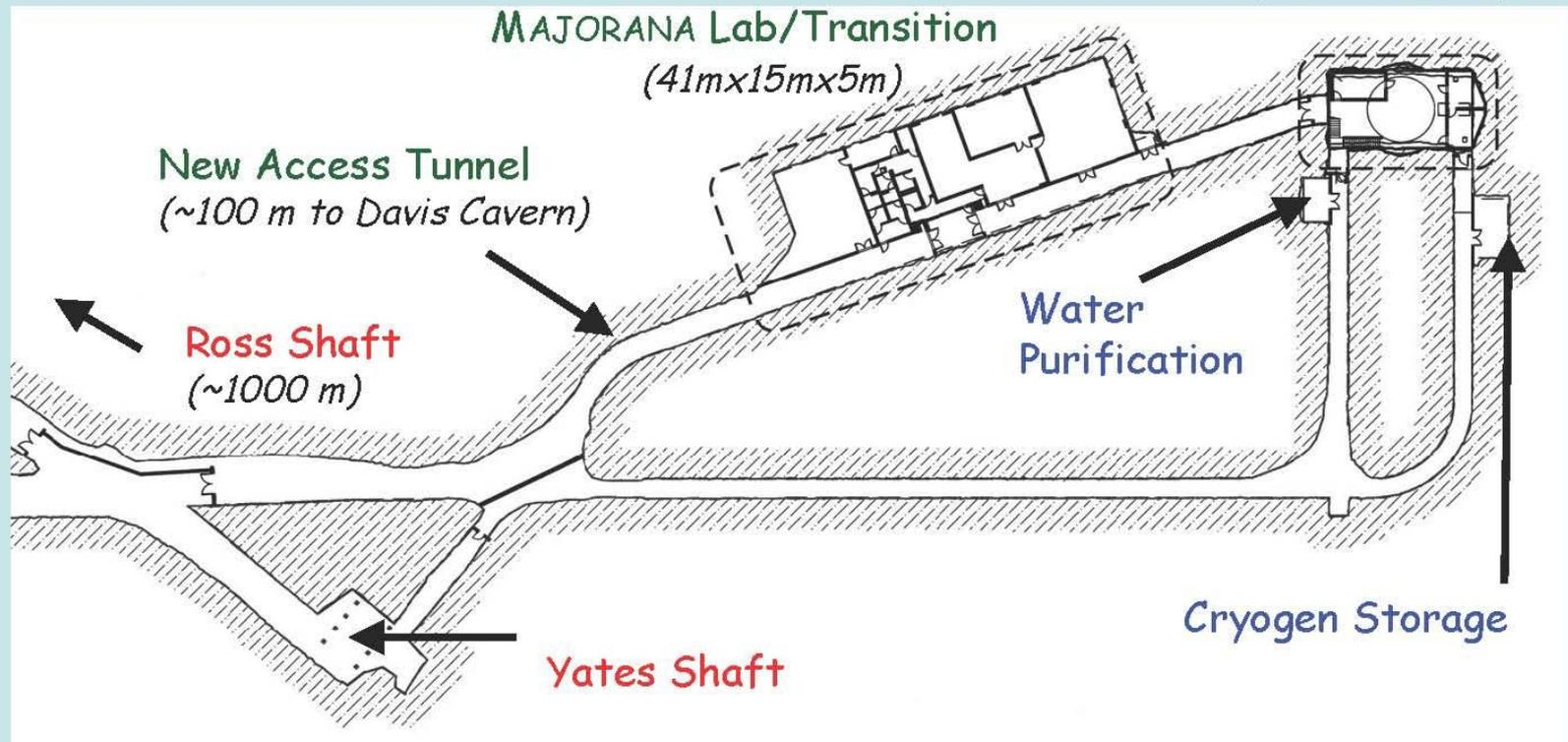
Early BGE Science at the Sanford Underground Laboratory

Experiment	Description	Levels
CO2 Sequestration	Environment characterization	800L, 2000L, 4850L
DUGL	Seismic characterization for gravity wave research	Surface, 300L, 800L, 2000L, 4100L
Fiber Sensors	Extensometers, temperature	4100L
Hydrology/Microclimate	Aquifer characterization, groundwater monitoring	Surface, 1250L, 2000L, 2600L, 4850L
PODS	Core archive and logs, geologic mapping	Surface, 800L
Tiltmeter	Rock deformation	2000L
Transparent Earth	Seismic monitoring	2000L, 4100L
Biology		
SDSMT/BHSU	Microbiology	Surface, 300L, 2000L, 4100L, 4850L
SDSU	Lignocellulose	1700L, 2000L
Princeton/UTK	Manifold Sampling	2000L, 4550L, 4850L
SDSMT	Microbiology/Cellulose	4550L
Engineering		
Signal Propagation	Electromagnetic transmission	300L
Submersible	Autonomous vehicle navigation, magnetic field	1250L

New Laboratory Infrastructure

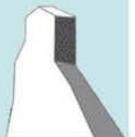
4850L Davis Campus: 745 m² (Total) / 455 m² (Science)

LUX Lab/Davis Cavern
(17m x 9m x 10m)



Sanford Lab at Homestake

Jaret Heise





4850 Level Underground Laboratory progress

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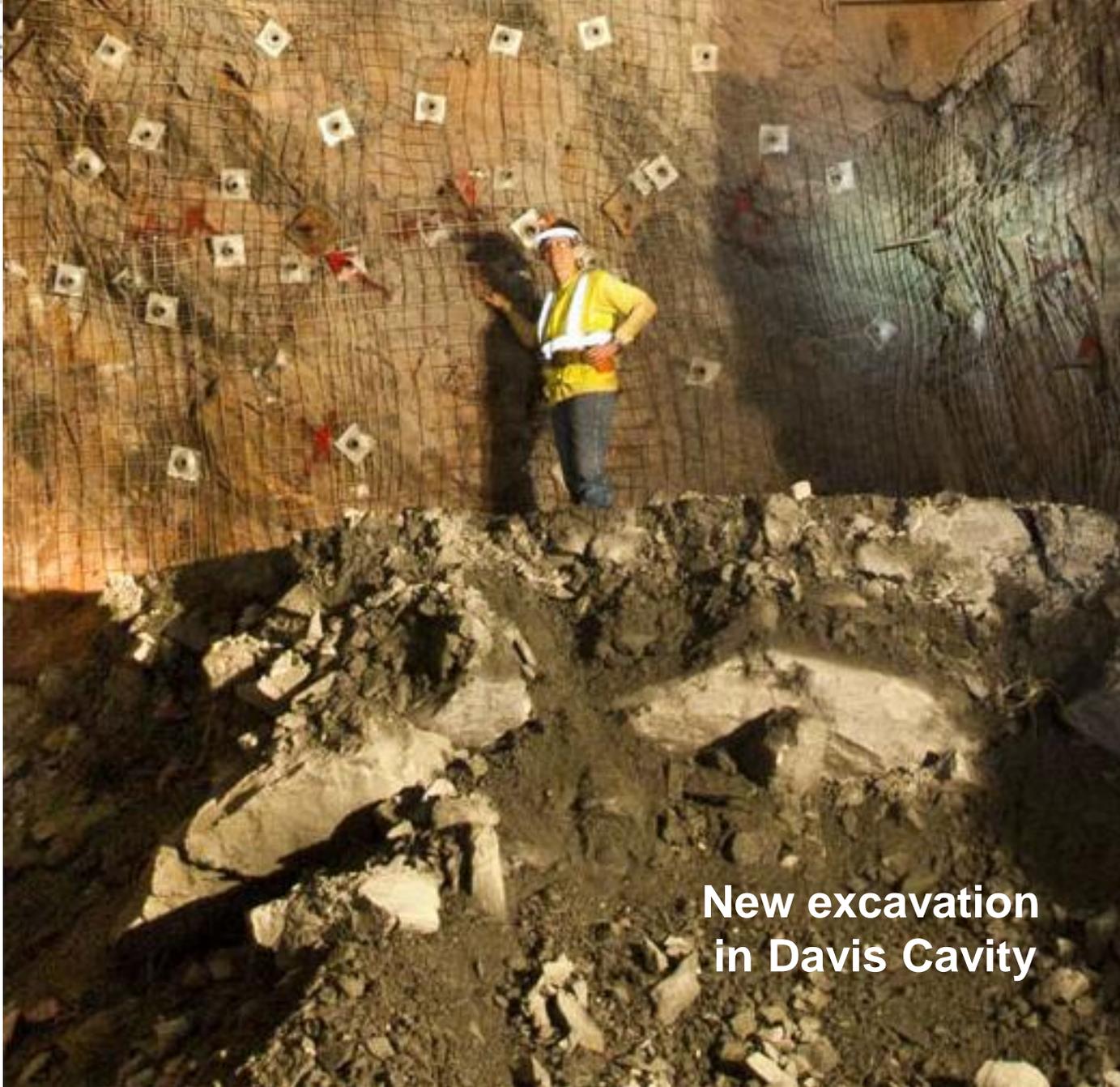
9/7/2010

7

September 2, 2010

Homestake DUSEL

LONGSECTION

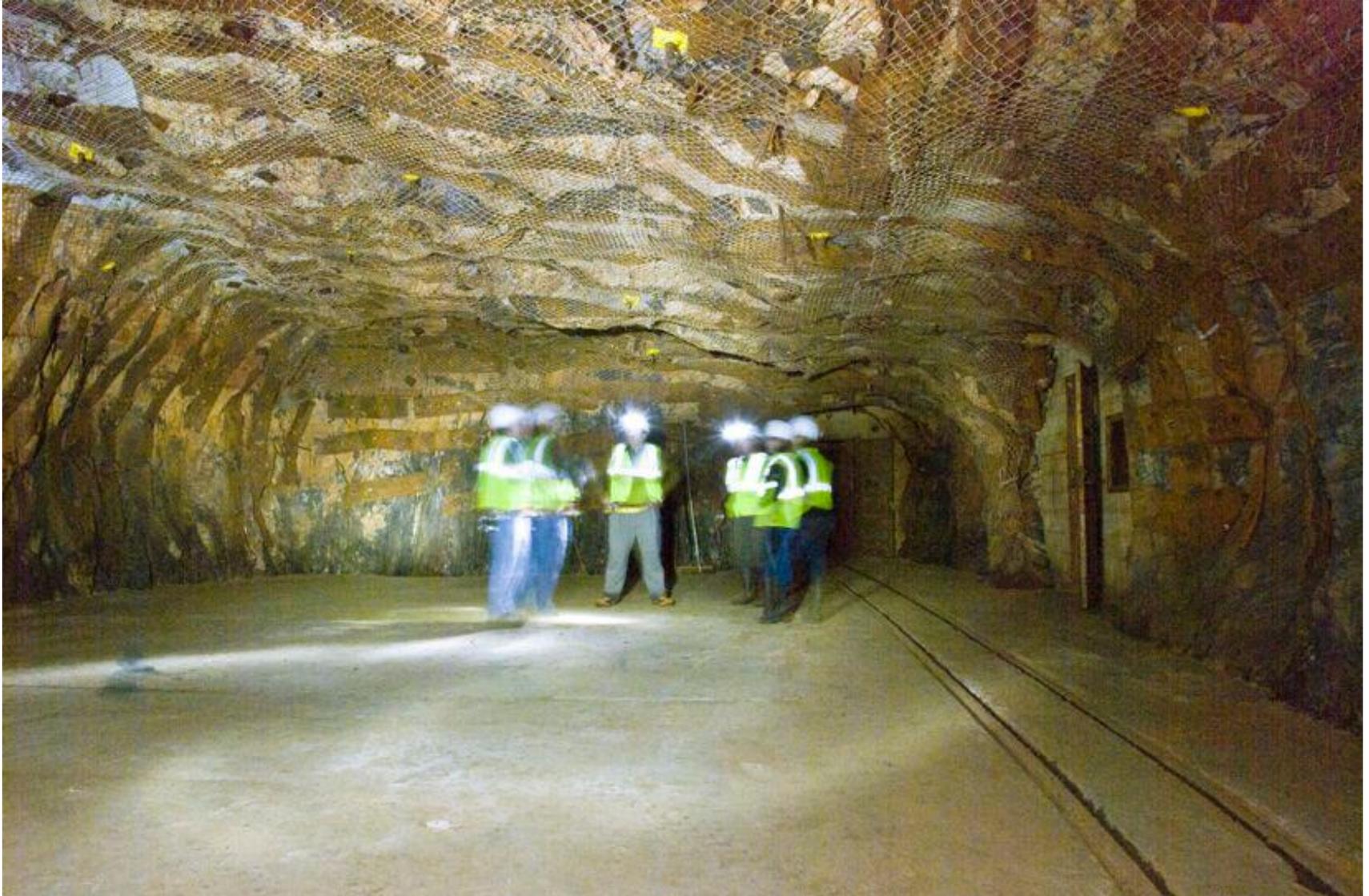


New excavation
in Davis Cavity



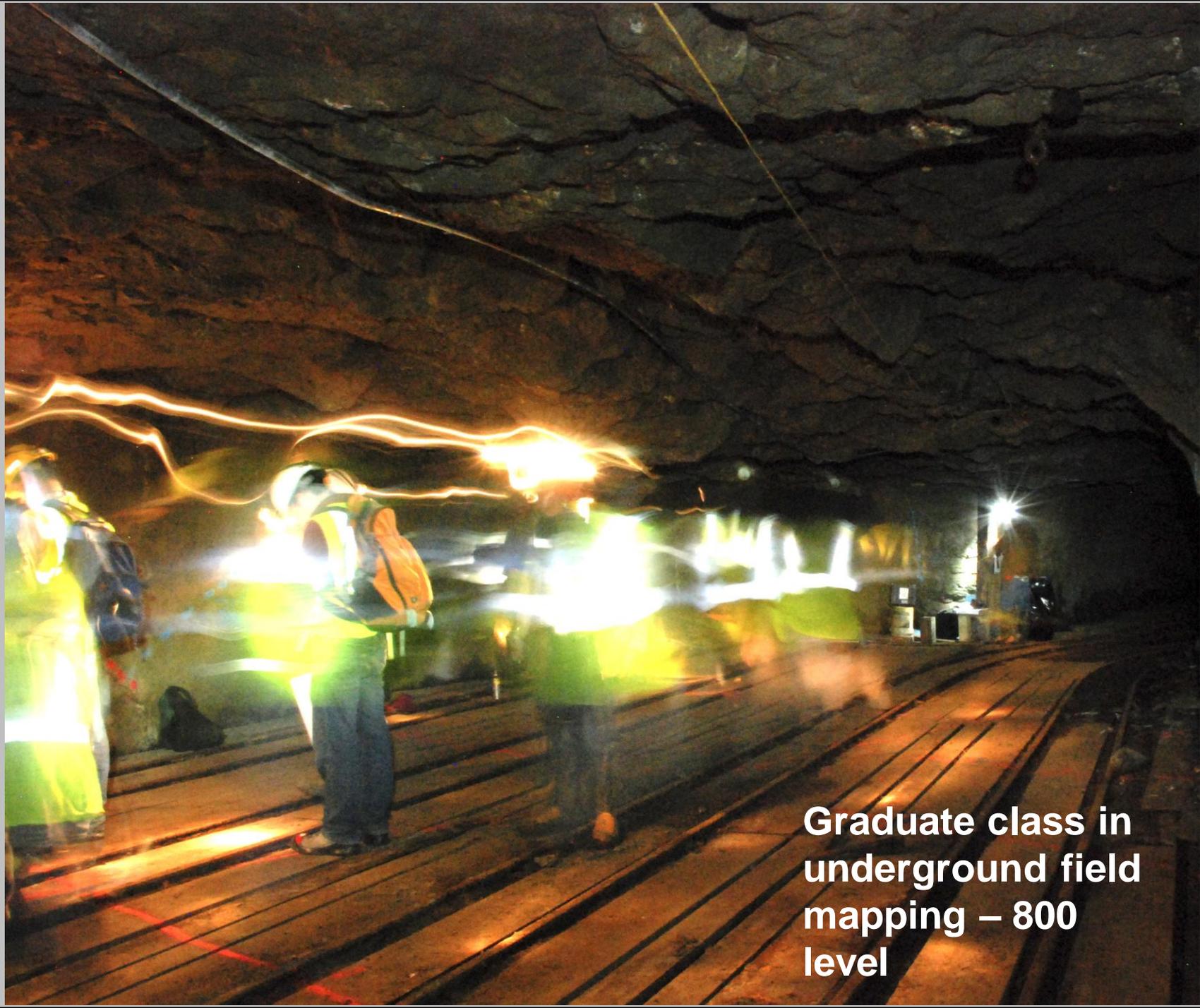
Majorana e-forming Space

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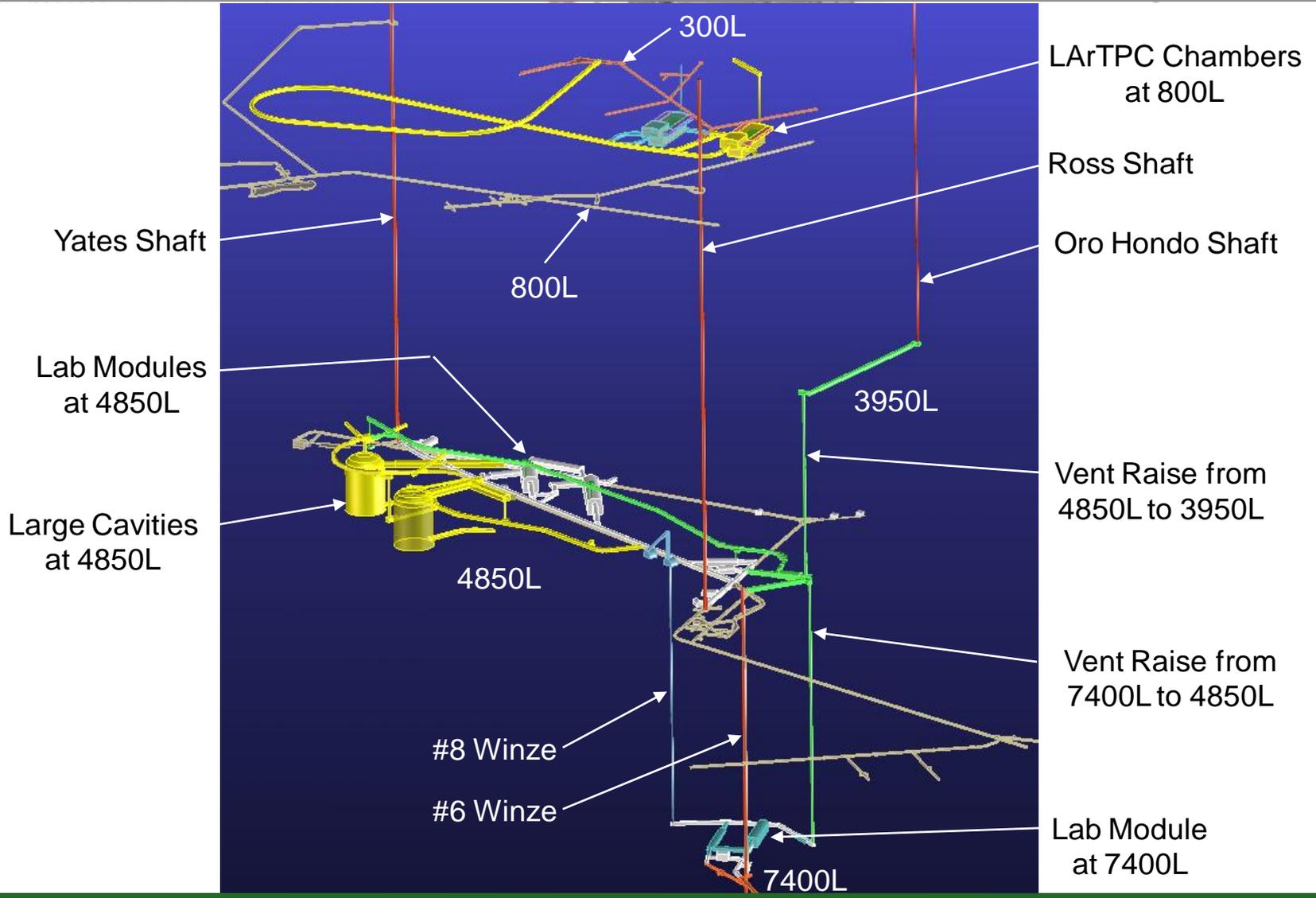
Shotcreted drift



**Graduate class in
underground field
mapping – 800
level**

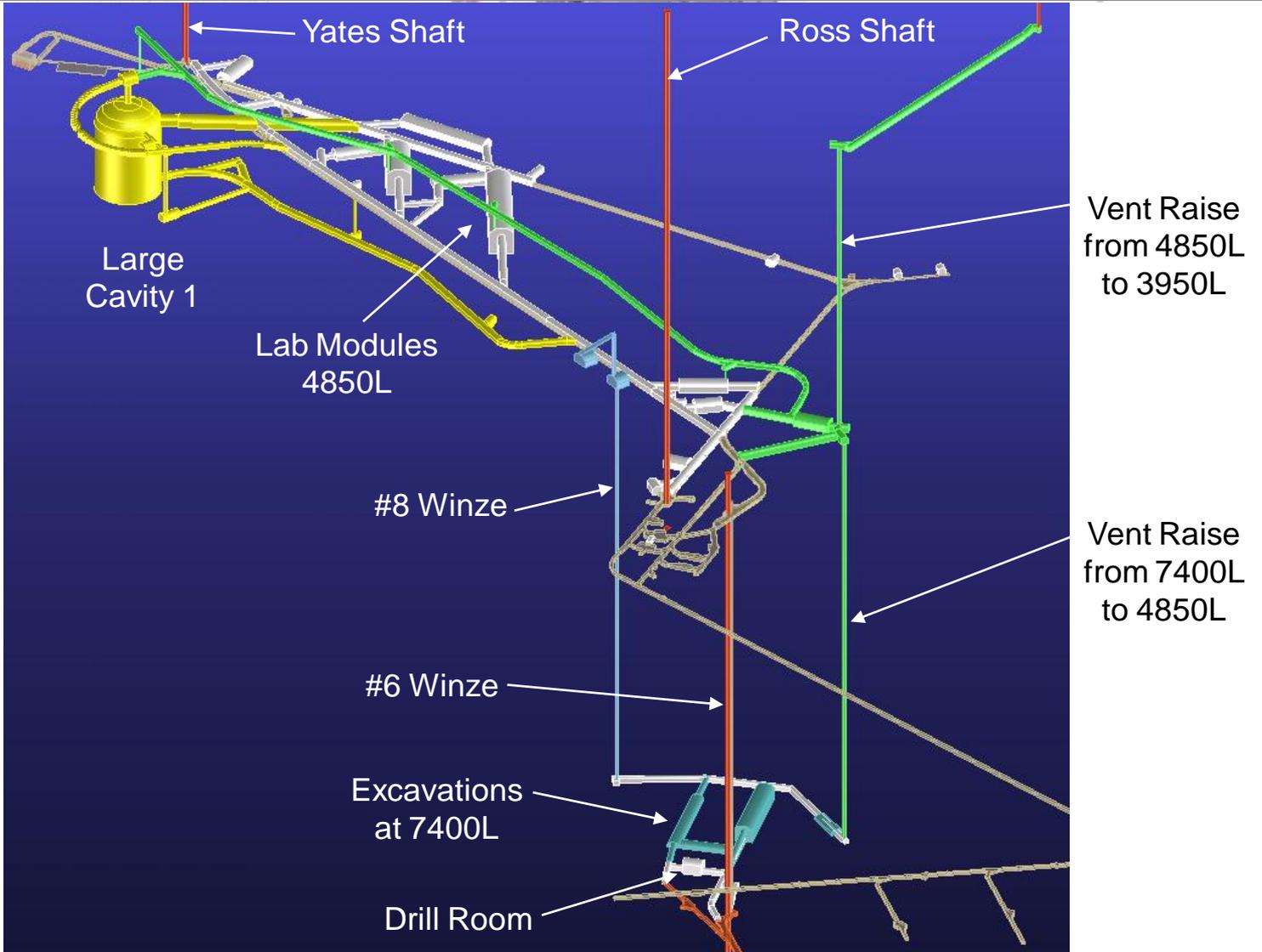
300L to 7400L

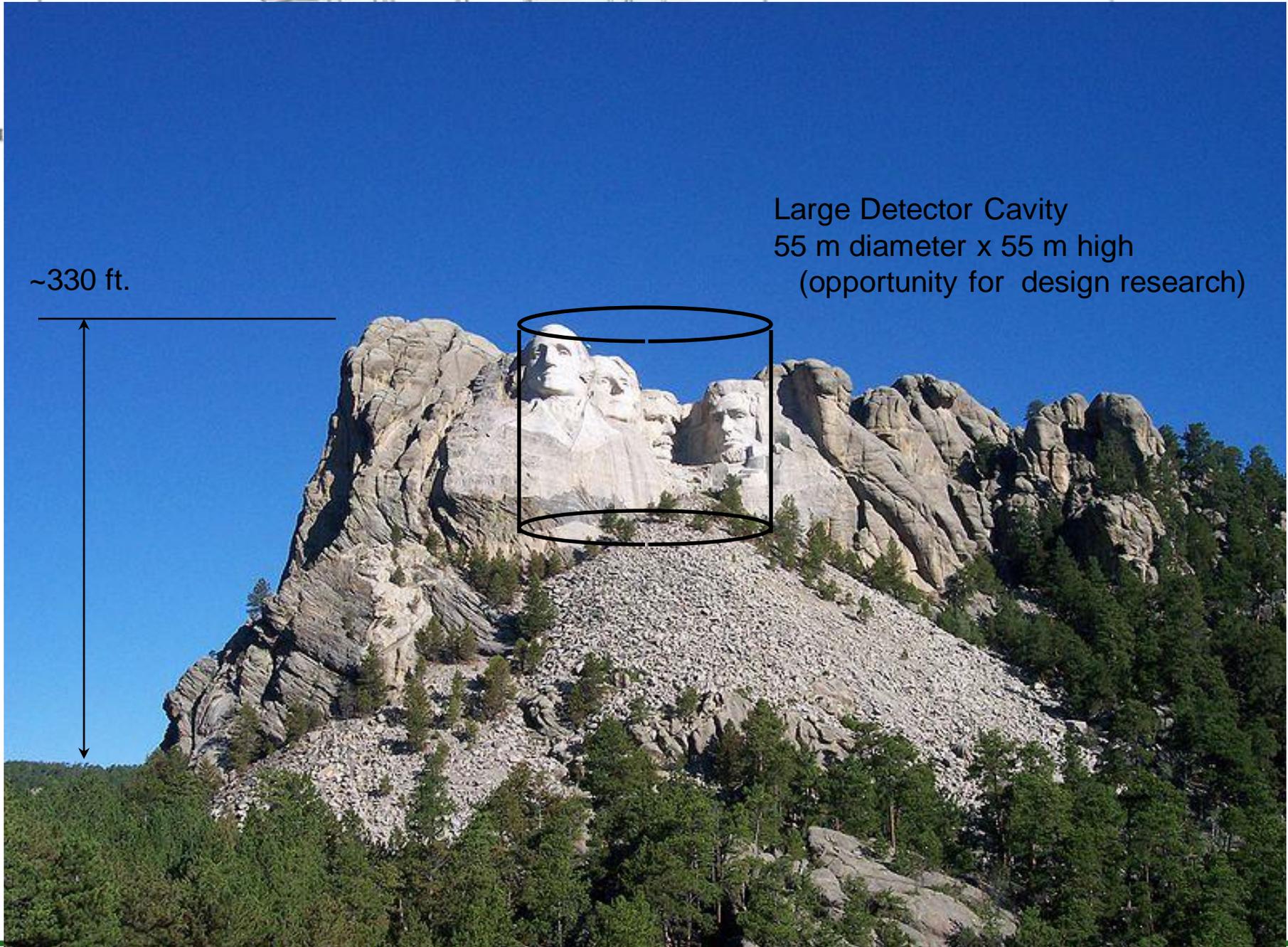
LONGSECTION OF THE HOMESTAKE MINE



4850L - 7400L

LONGSECTION OF THE HOMESTAKE MINE



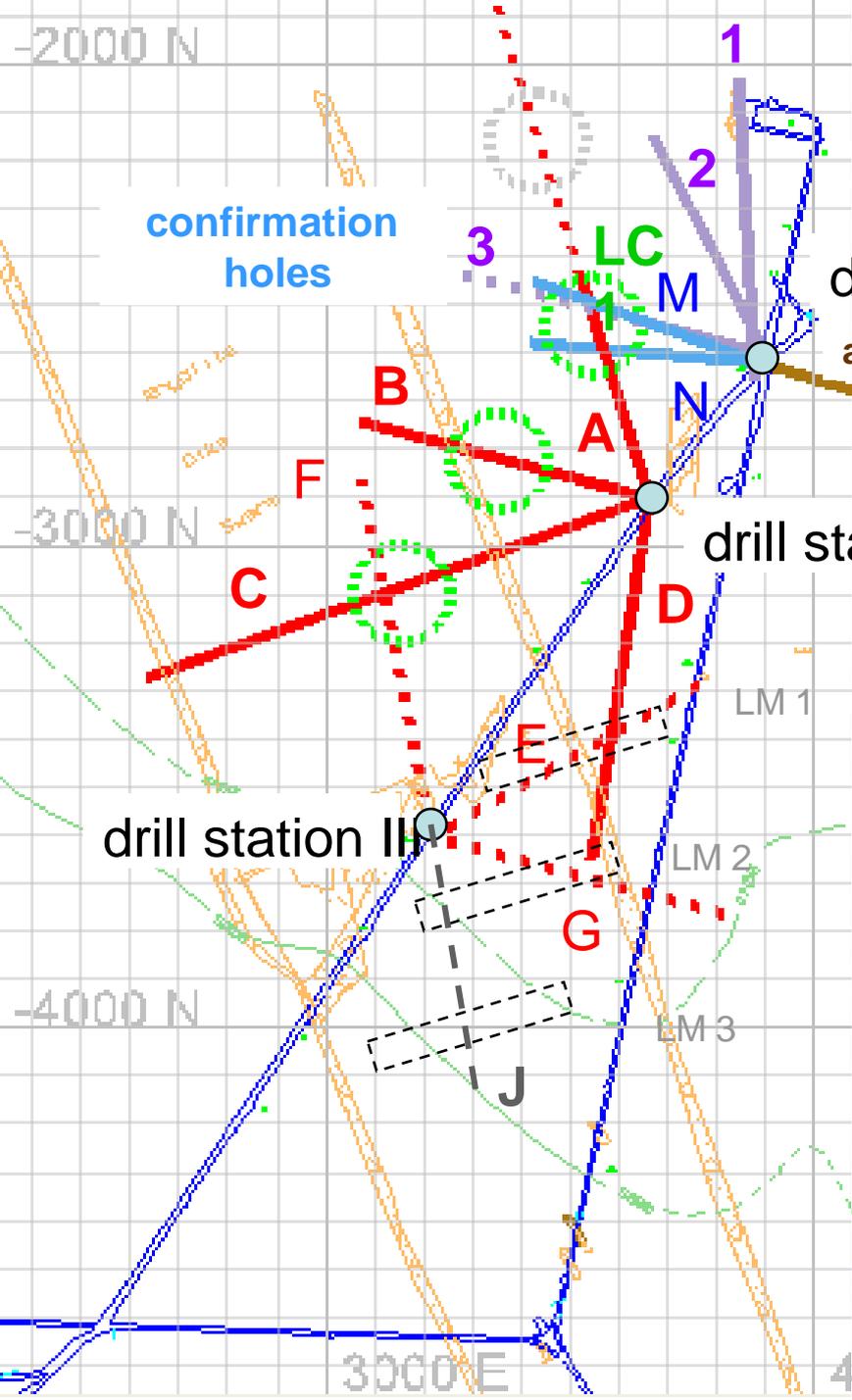


Large Detector Cavity
55 m diameter x 55 m high
(opportunity for design research)

~330 ft.



Geotechnical Characterization



S4 Science Integration Process - Differences

LONGSECTION OF THE HOMESTAKE MINE

- Process similar to that of the Physics groups
- Bio – Geo – Engineering collectively known as “Other Levels and Ramps”
 - may have facilities on 4850 and 7400 Levels as well as other levels
- Key requirements:
 - Safety program
 - Access to selected areas/levels
 - Power
 - on selected levels
 - other areas within the 4850 and 7400 level campuses
 - major constraint
 - Ground control
 - Ventilation
 - Data communications
 - Contractor availability
- Lesser issues:
 - water and compressed air

BGE – S4's

Three main categories:

- 1) Dedicated laboratories
- 2) Distributed laboratories
- 3) Engineering design and rock properties

Seven BGE S4 Collaborations provided input into the PDR requirements

Experimental Input – Bio – Geo - Engineering

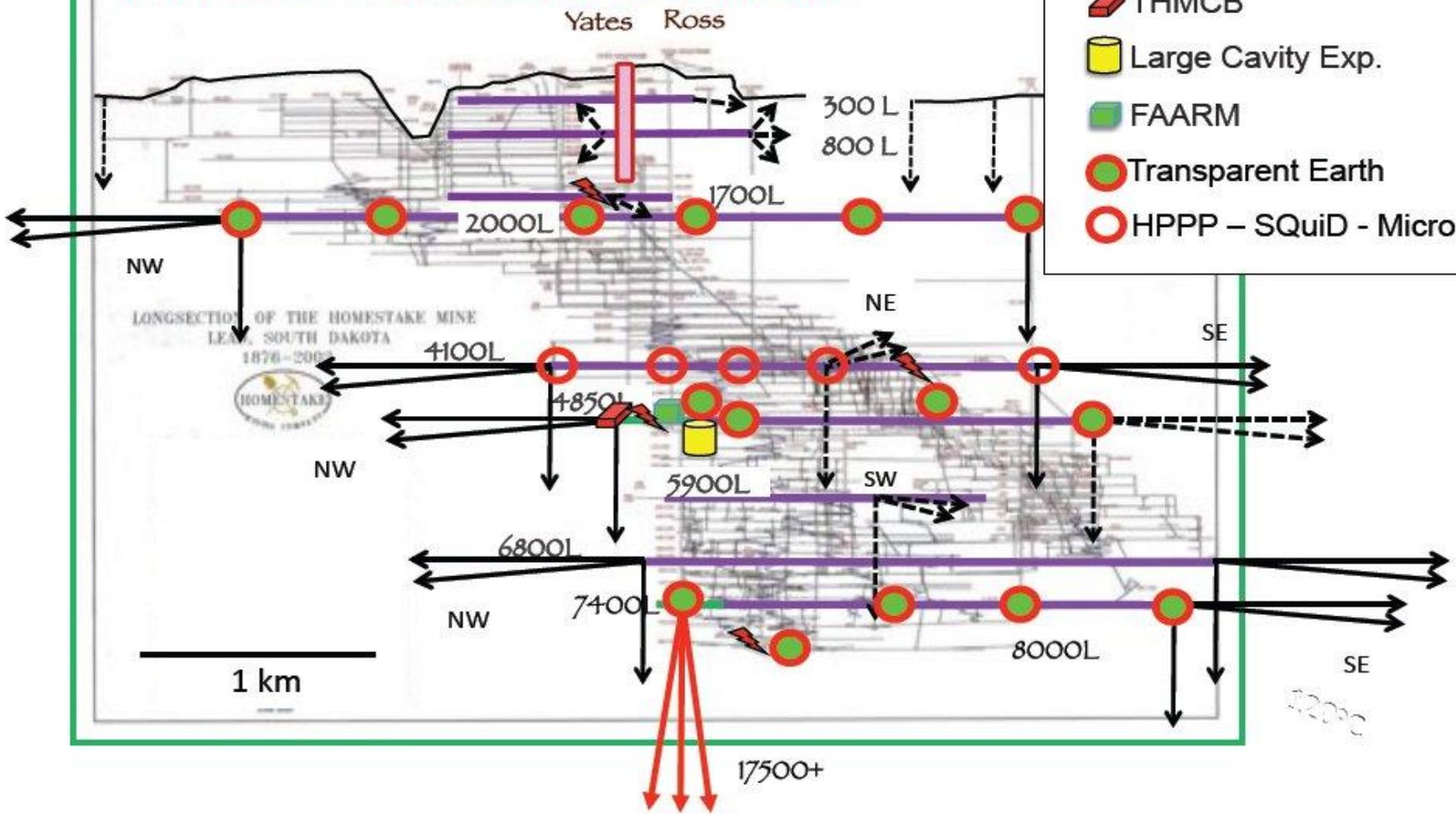
LONGSECTION OF THE HOMESTAKE MINE

<p>Development of a Fracture Processes Facility at DUSEL Homestake PI: Leonid Germanovich</p>	<p>DUSEL CO2 (LUCI) - A Deep Underground Laboratory for Geologic CO2 Sequestration Studies: Design of the Facility and Experiments PI: Catherine Peters</p>	<p>Ecohydrology of Deep Crystalline Rocks at DUSEL Homestake PI: David Boutt</p>
<p>Planning and Design for the Subsurface Imaging and Sensing Experiments at the DUSEL PI: Steve Glaser</p>	<p>Fiber-Optic Strain Monitoring of Rock Masses in Large Underground Facilities PI: Herb Wang</p>	<p><i>Collaborations that are not S4's</i></p>
<p>Coupled Thermal-Hydrological-Mechanical-Chemical-Biological Experimental Facility at DUSEL Homestake PI: Eric Sonnenthal</p>	<p>Cavern Design for the Deep Underground Science and Engineering Laboratory (DUSEL) PI: Herbert Einstein</p>	<p><i>Future experiments that might take advantage of "on ramps" during the life of the laboratory</i></p>

Experimental Layout

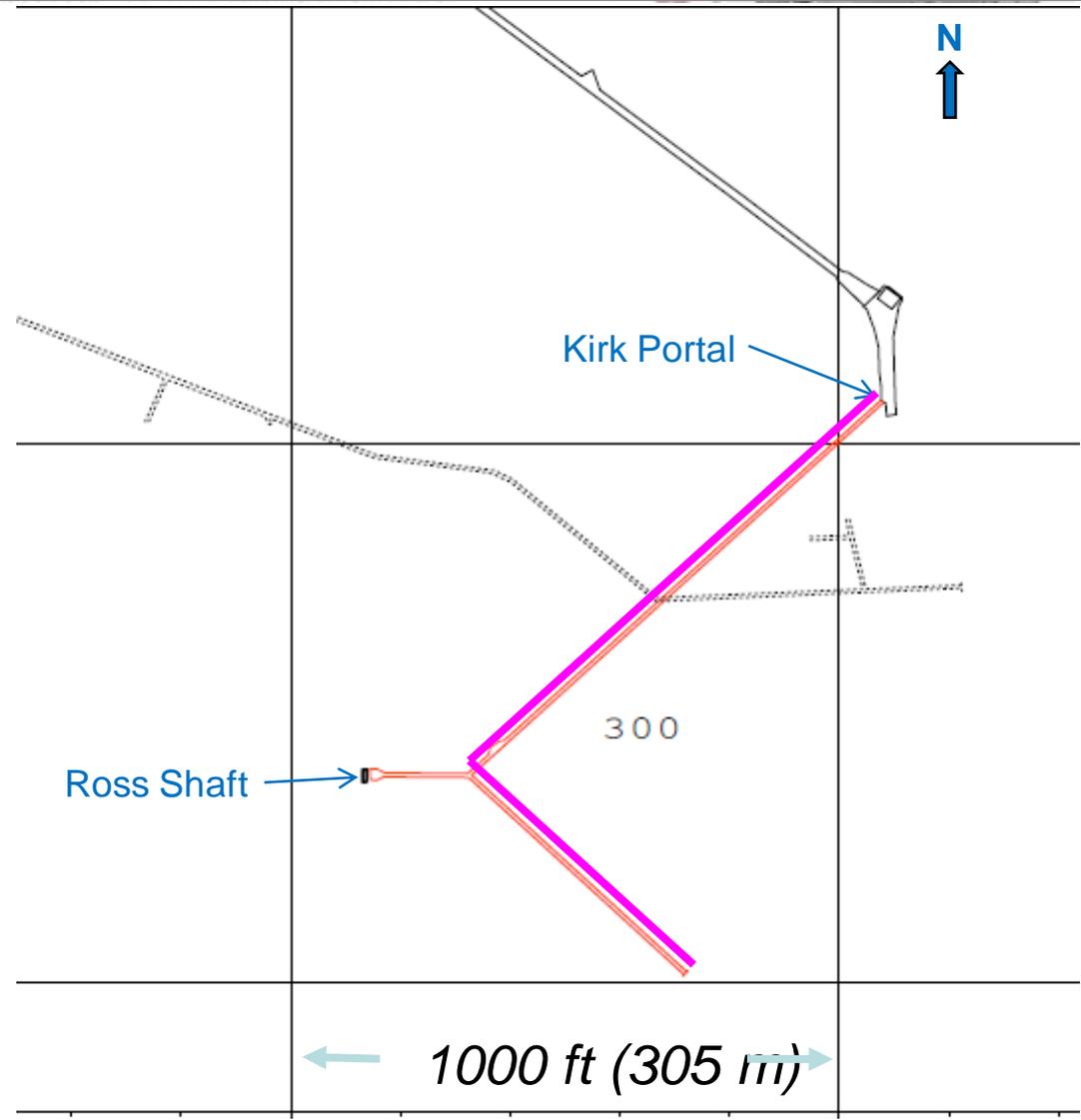
Broad Access at Multiple Levels and Surface Sites

-  Ecohydrology
-  Faulting Processes
-  CO₂ Sequestration
-  THMCB
-  Large Cavity Exp.
-  FAARM
-  Transparent Earth
-  HPPP – SQuiD – MicroG



300 Level, Plan View

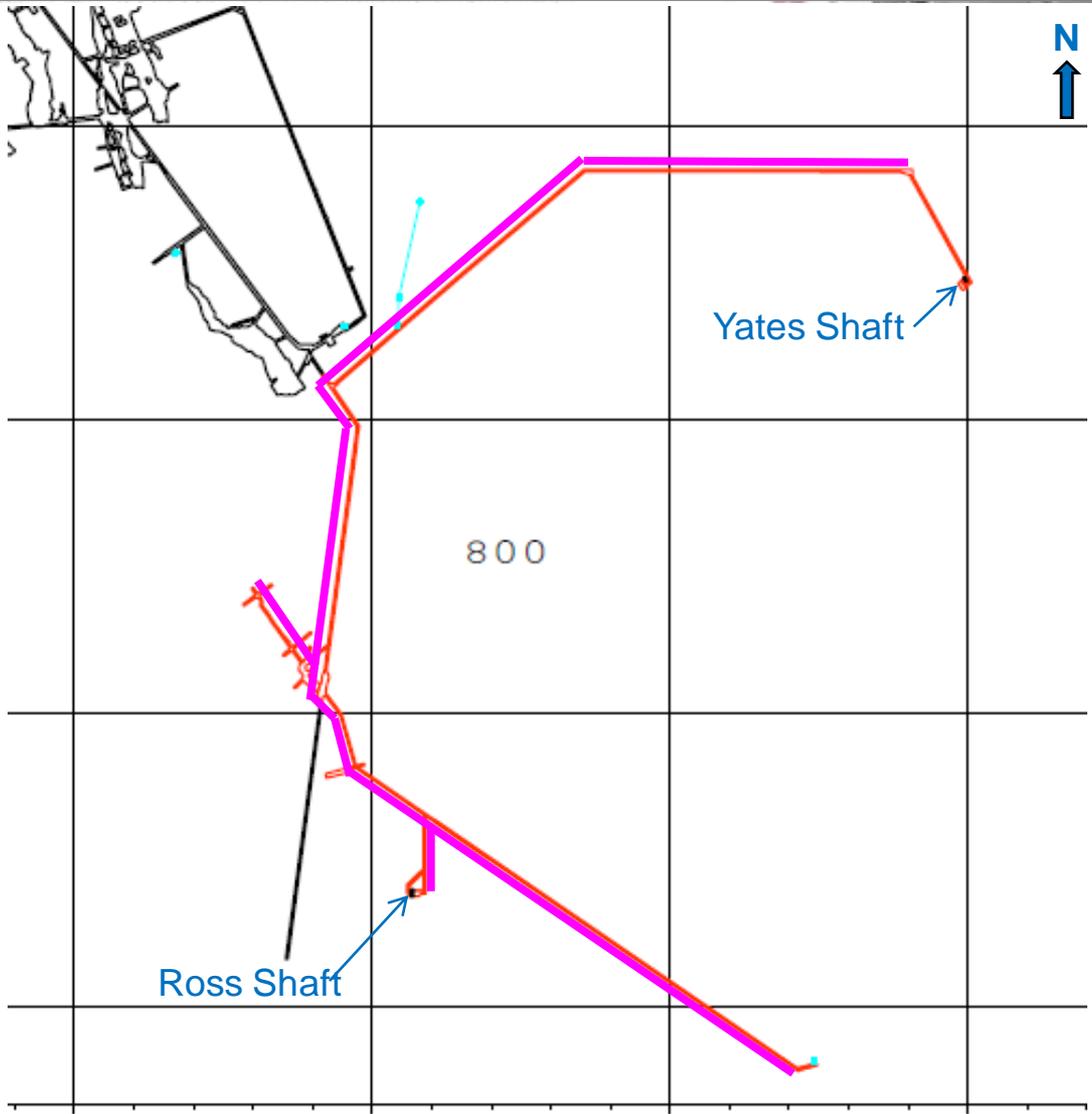
LONGSECTION OF THE HOMESTAKE MINE



— Power (110V) and Data Network
Linear feet of access = 1740

800 Level, Plan View

LONGSECTION OF THE HOMESTAKE MINE

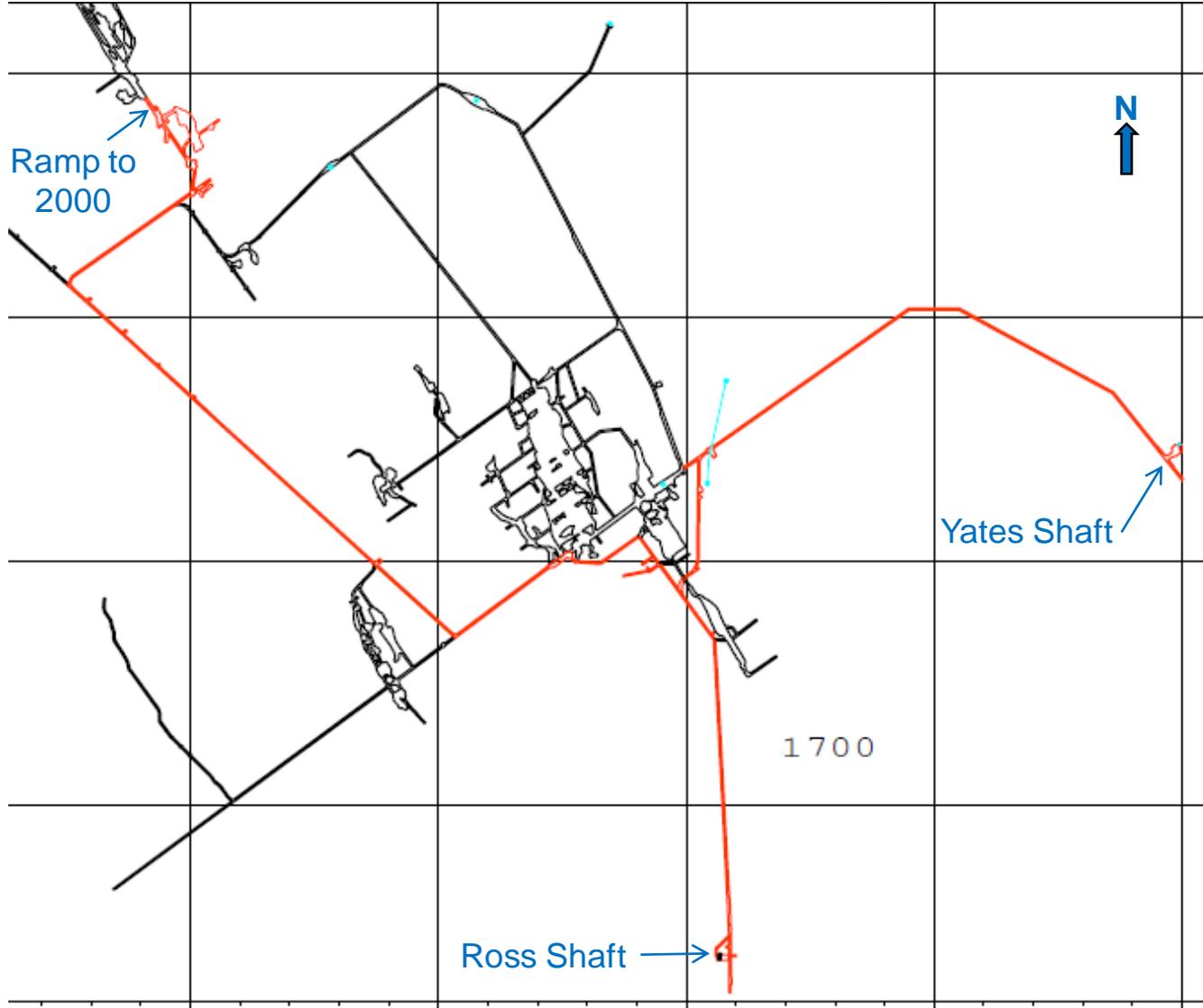


— Power (110V) and Data Network

Linear feet of access = 8010

1700 Level, Plan View

LONGSECTION OF THE HOMESTAKE MINE

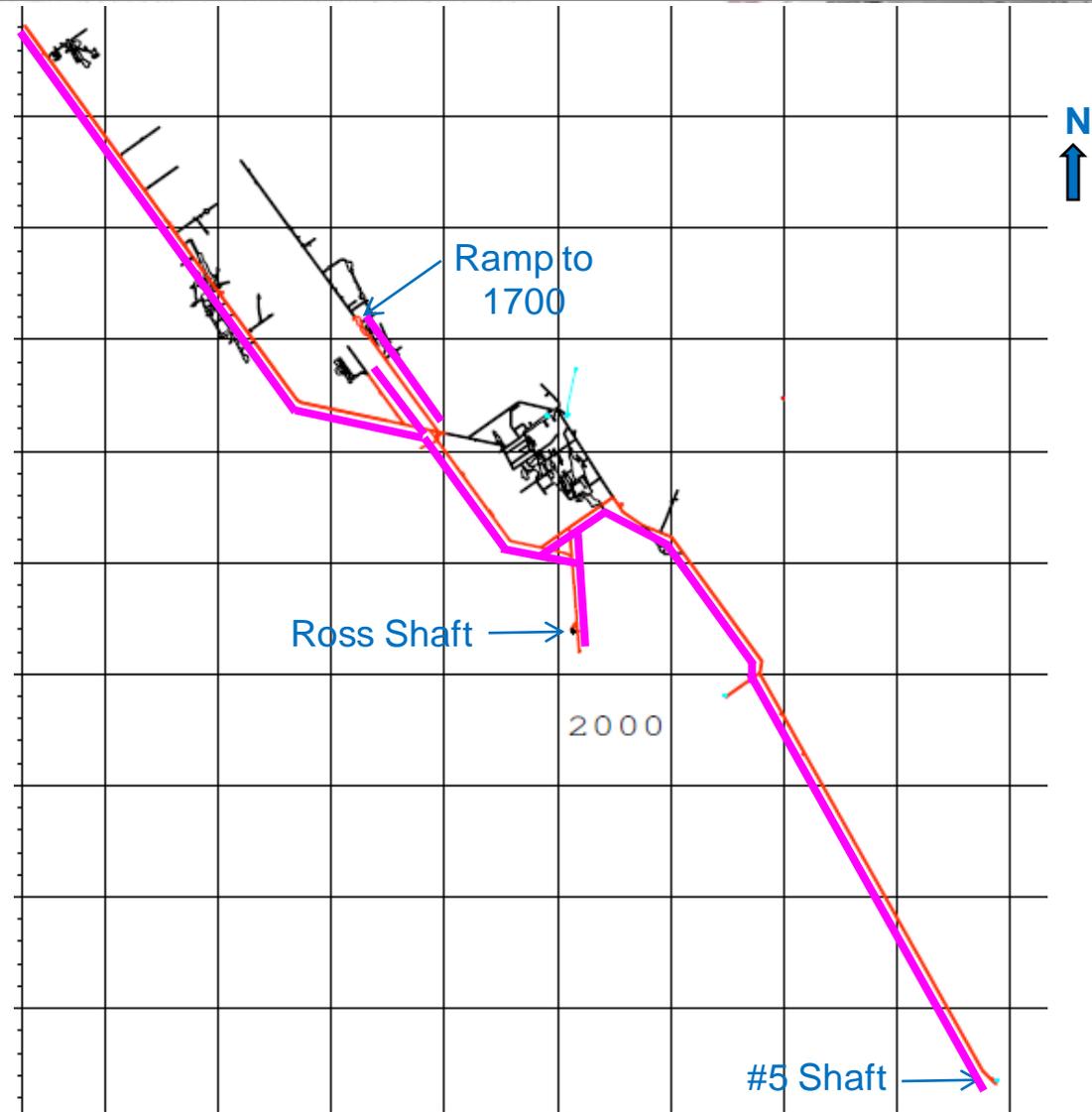


— Power (110V) and Data Network

Linear feet of access = 9190

2000 Level, Plan View

LONGSECTION OF THE HOMESTAKE MINE

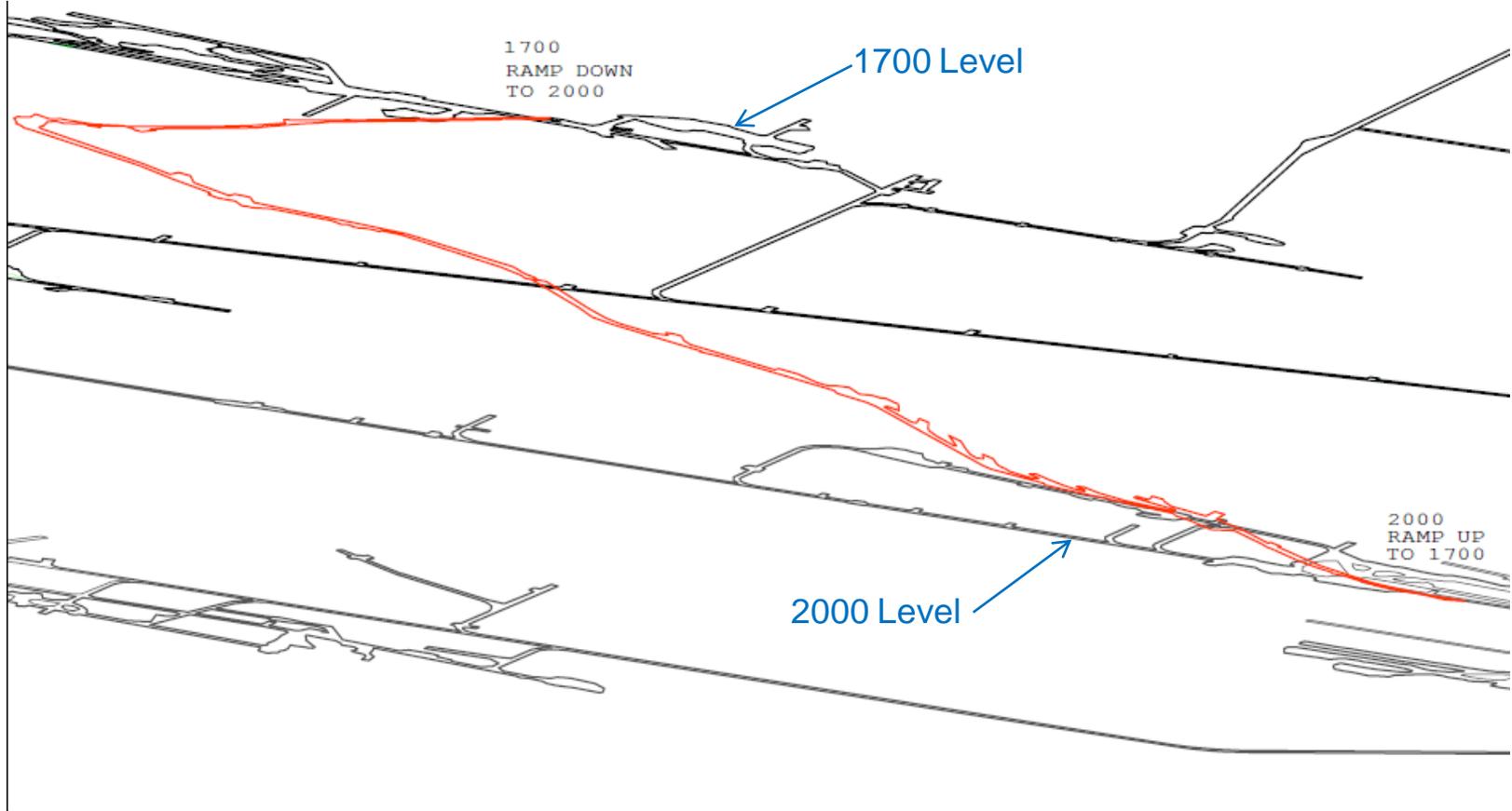


— Power (110V) and Data Network

Linear feet of access = 15,810

Ramp 1700 to 2000 Level

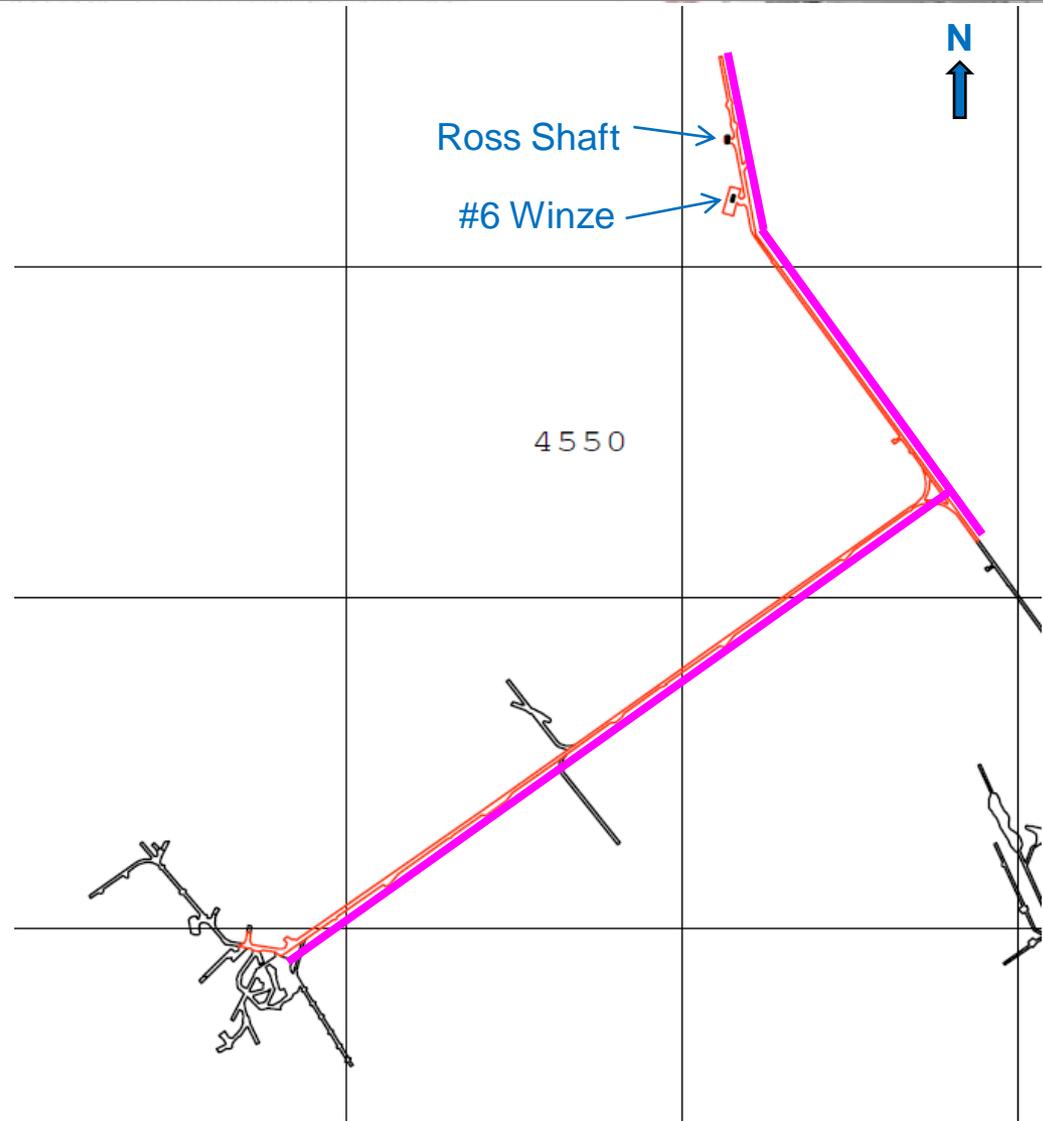
LONGSECTION OF THE HOMESTAKE MINE



Linear feet of access = 2190

4550 Level, Plan View

LONGSECTION OF THE HOMESTAKE MINE

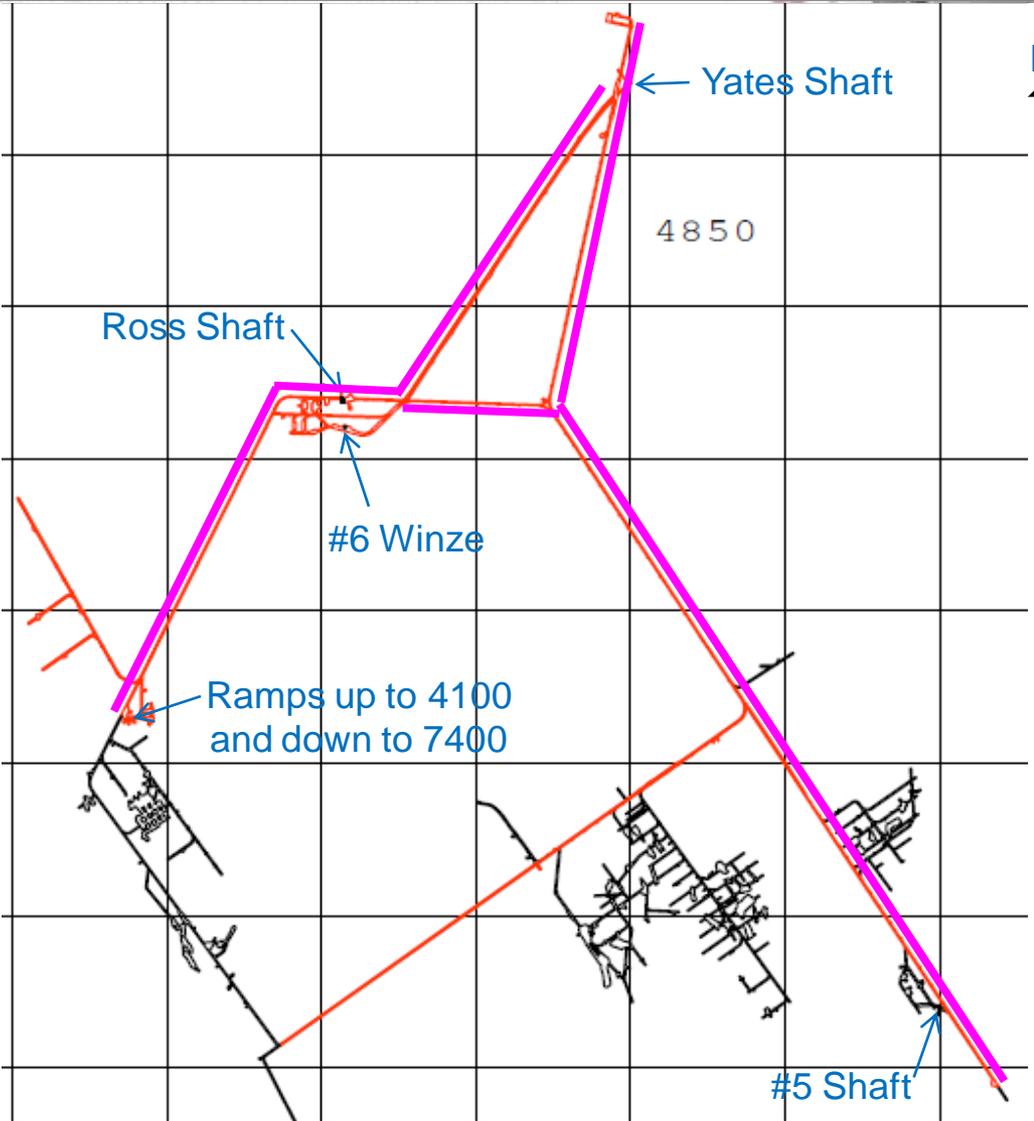


— Power (110V) and Data Network

Linear feet of access = 3770

4850 Level, Plan View

LONGSECTION OF THE HOMESTAKE MINE

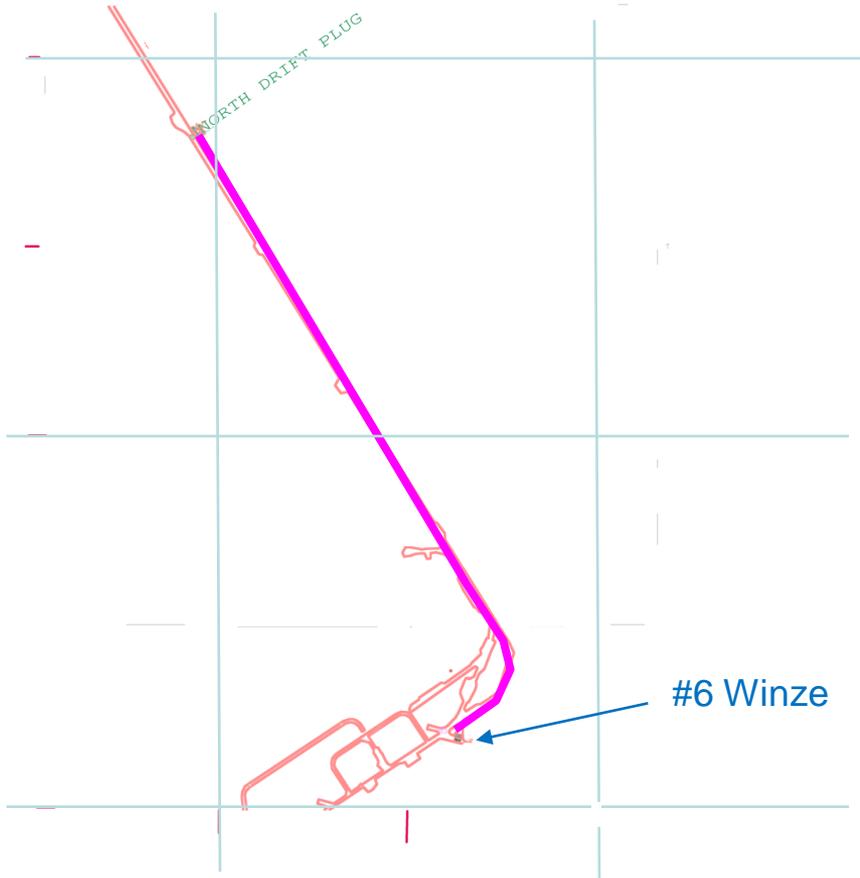


— Power (110V) and Data Network

Linear feet of access = 11,390

6800 Level, Plan View

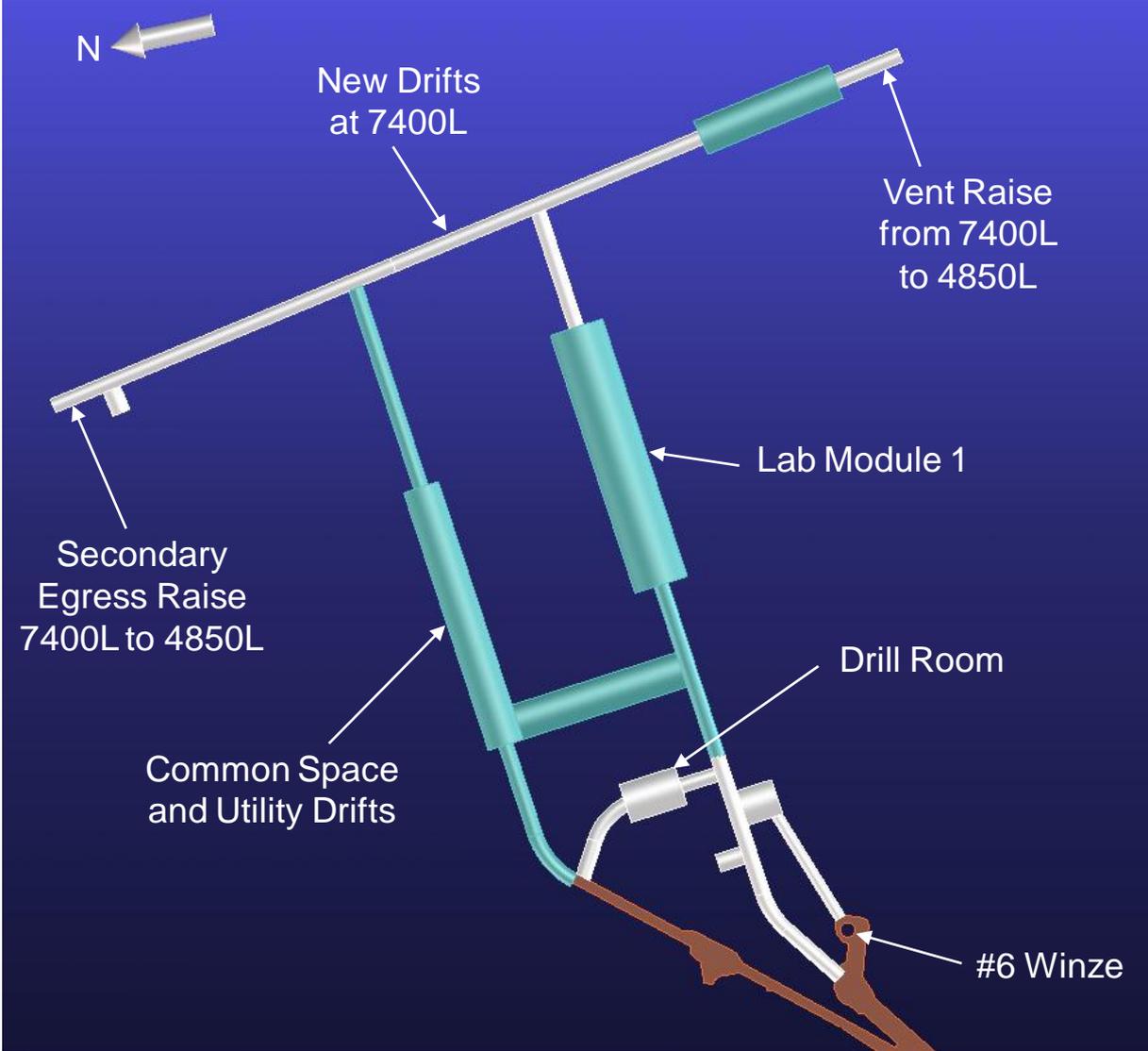
LONGSECTION OF THE HOMESTAKE MINE



— Power (110V) and Data Network

7400L, Phase II, Plan View

LONGSECTION OF THE HOMESTAKE MINE



Facility Design – The Experiments

LONGSECTION OF THE HOMESTAKE MINE

- **The challenge: facility design prior to definition of experiments**
- **Experiment facility requirements defined by:**
 - Obtain envisioned requirements from the S4's (and others) -- iterate
 - Define a general set of requirements based on this input, other underground labs and facility constraints (including cost)
 - Assign requirements(power, water, etc) to specific facility lab modules or areas as needed by for design contractors
- **In the case of the Bio – Geo – Engineering, this could mean that funding would be set aside (saved) until experiments are chosen and scoped**

MREFC Provides

LONGSECTION OF THE HOMESTAKE MINE

- Access to great volume of rock in the subsurface including power, ventilation, communications including:
 - >30 km of drifts
 - safe access to designated laboratories
- Umbrella safety program
- Facilitation for contractor services
- General infrastructure including shafts, hoisting, basic surface laboratories, core archives
- “Funds” for construction of experiments

Recent Developments

LONGSECTION OF THE HOMESTAKE MINE

- PAC meeting in July, 2010
- Bio – Geo – Eng S4 Review August 24-26

Integrating the Suite of Science Experiments into the Facility Design: Program Advisory Committee

Mike Witherell, UCSB

Physics Chair

Mark Zoback, Stanford

Earth Science Chair

Allen Caldwell, *MPI*

Boris Kayser, *FNAL*

Hitoshi Murayama, *IPMU & UCB*

Peter Parker, *Yale*

Michael Ramsey-Musolf,
U. Wisconsin

Heidi Schellman, *Northwestern*

Abe Seiden, *UCSC*

Yoichiro Suzuki, *U. Tokyo*

Don DePaolo, *UCB and LBNL*

Steve Hickman, *USGS*

Art McGarr, *USGS*

Patricia Sobecky, *U. Alabama*

Program Advisory Committee (July, 2010)

(Bio – Geo – Engineering Specific Comments - Posted)

- Good input to the facility for planning to support Bio – Geo – Eng experiments after construction
- Should include the creation of underground work spaces where BGE experiments could be carried out.
 - e.g. bays that open from existing or planned tunnels and shafts where power and telemetry would be available and investigators could set up their instrumentation.
 - particularly valuable for longer-term *in situ* experiments that require monitoring and repeated sampling.

PAC – monitoring recommendations

LONGSECTION OF THE HOMESTAKE MINE

A comprehensive monitoring program should be established

- Monitoring should be independent of individual scientific programs
 - monitor changes during dewatering and underground excavation and construction.
- Establish a permanent three-dimensional broadband seismic network
- Comprehensive geodetic monitoring to monitor both horizontal and vertical deformation
- Monitoring of rock parameters, e.g.
 - Pore pressures
 - Temperature in boreholes
 - Gravity variations due to water level changes
- Microbiological monitoring program
 - R&D into drilling techniques
 - Archive for biological, rock, and fluid samples

The Next Steps ~2011

LONGSECTION OF THE HOMESTAKE MINE

- Coordinate meeting(s) with BGE collaborations to identify areas of overlap, cooperation, and collocation of laboratories
- Coordinate cooperation between BGE collaborations and contractors to enhance research during construction
- Iterate with BGE collaborations to update requirements as their designs mature
- Continue to develop the monitoring program
- Develop a database of baseline hydro-geo-bio-chemical information – historical and current
- Develop a long term management/priority (?) plan for BGE experimental facilities within the framework of DUSEL
- Increase the participation of BGE researchers for the DUSEL

Maximizing DUSEL's Broader Impacts

LONGSECTION OF THE HOMESTAKE MINE

- Comprehensive Education and Outreach Center and efforts spanning multiple scientific disciplines
- Involvement of underrepresented minorities, notably American Indian and rural populations
- Interagency Cooperation on Large Scale Science
- Scientific and Engineering questions of significant societal impact

Surface Facilities at the Yates Shaft Complex

LONGSECTION OF THE HOMESTAKE MINE

