EARLY HYDROLOGY AND GROUND MOTION STUDIES AT HOMESTAKE DUSEL

DUSEL MREFC Workshop
Lead, SD

Thursday
Oct. 1, 2009

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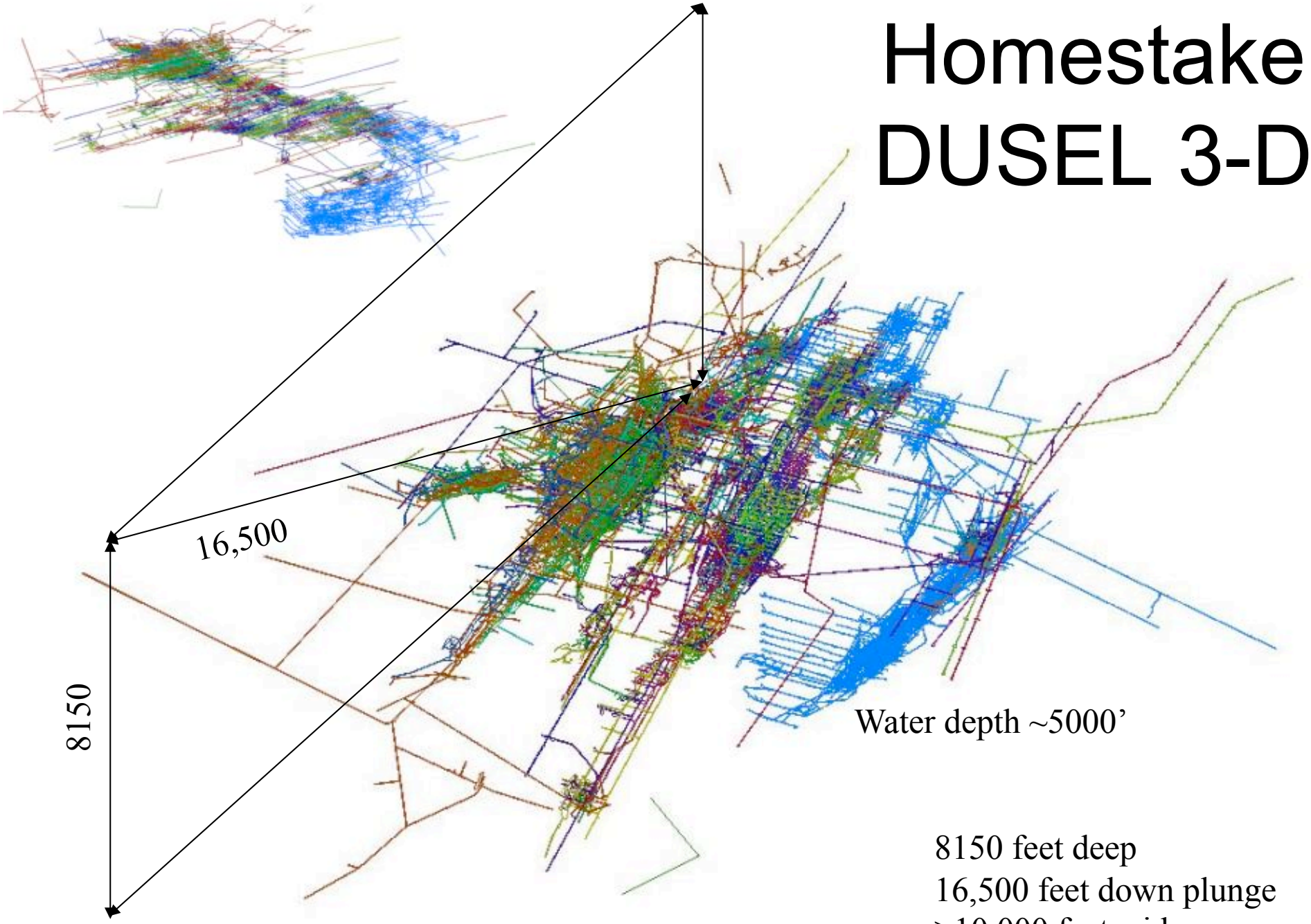
SD School of Mines & Technology

Sponsored by
National Science Foundation
In Cooperation with
SDSTA, SDSMT, Fermilab
and LBNL

Homestake DUSEL 3-D



8150 feet deep
16,500 feet down plunge
>10,000 feet wide

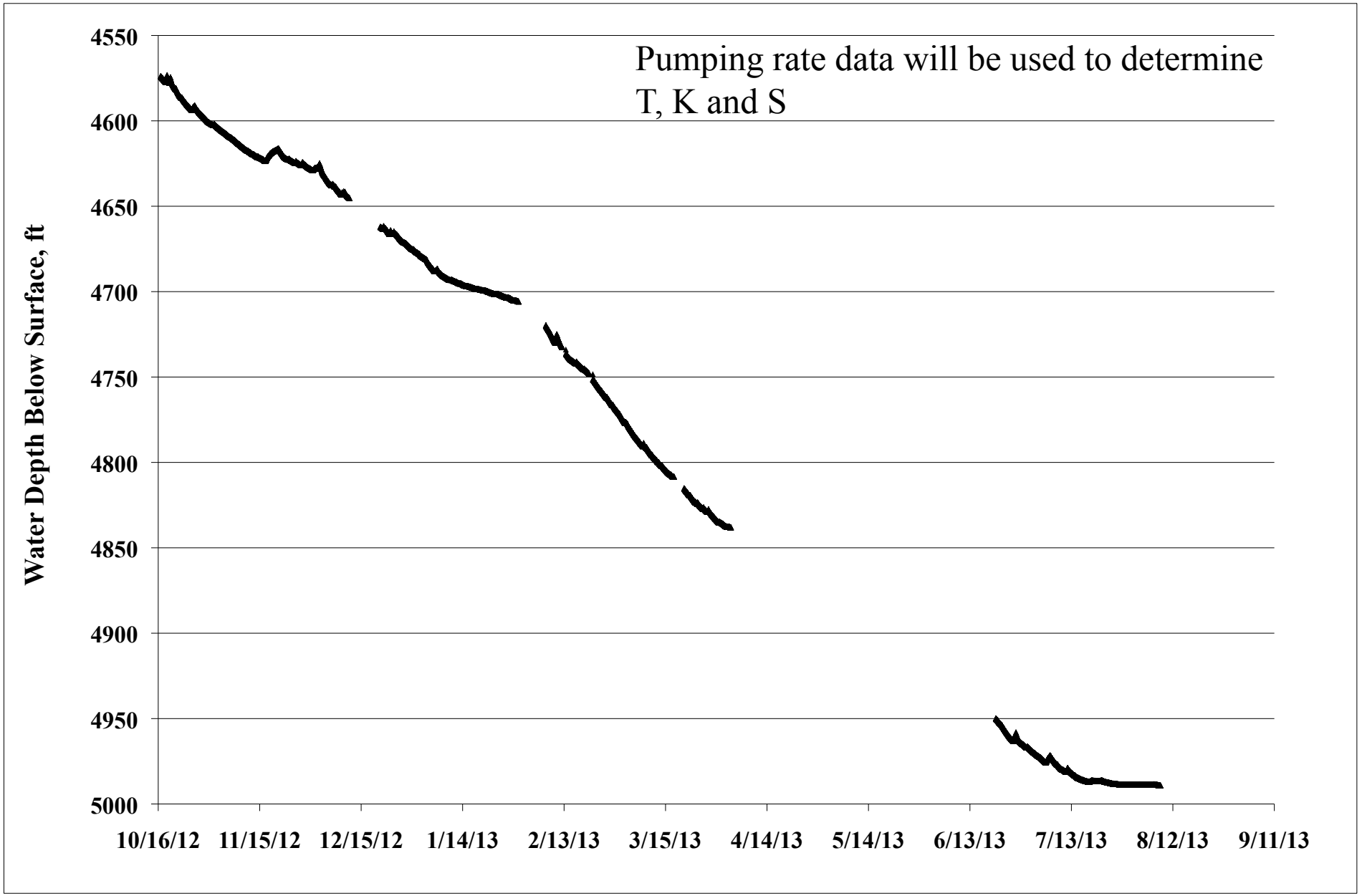
Dewatering Instrumentation

Max water level: 4529 ft
Drop point on the 4850-ft level
Pressure transducer at 5192 feet

350 foot data cable

	Depth
Air temperature/relative humidity Barometric pressure	4850
Water temperature	4970 5090
Level Logger pressure transducer Specific Conductance Water temperature	5192

Water Reduction Data



Next Steps

- Student is now organizing data for modeling
- Vibrating wire transducer lowered to 8000’
  - Intent to monitor #5 winze to 7400’
- Connect to Ethernet for data readout at surface
- New boreholes on 4850 have flowing water
- Packers will be utilized to isolate the flow and pressure buildup and drawdown tests will be performed

Ground Motion

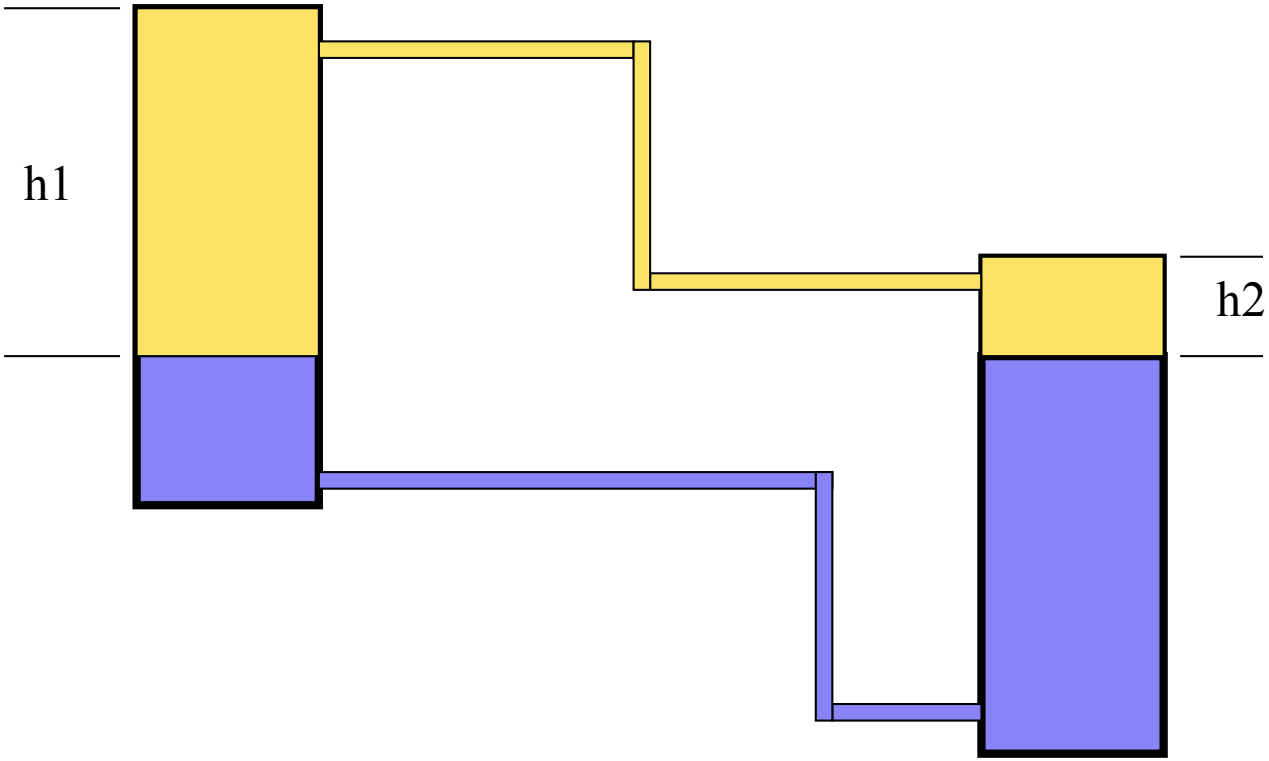
Instruments on the 2000-ft level

2 Accelerometers in sand holes

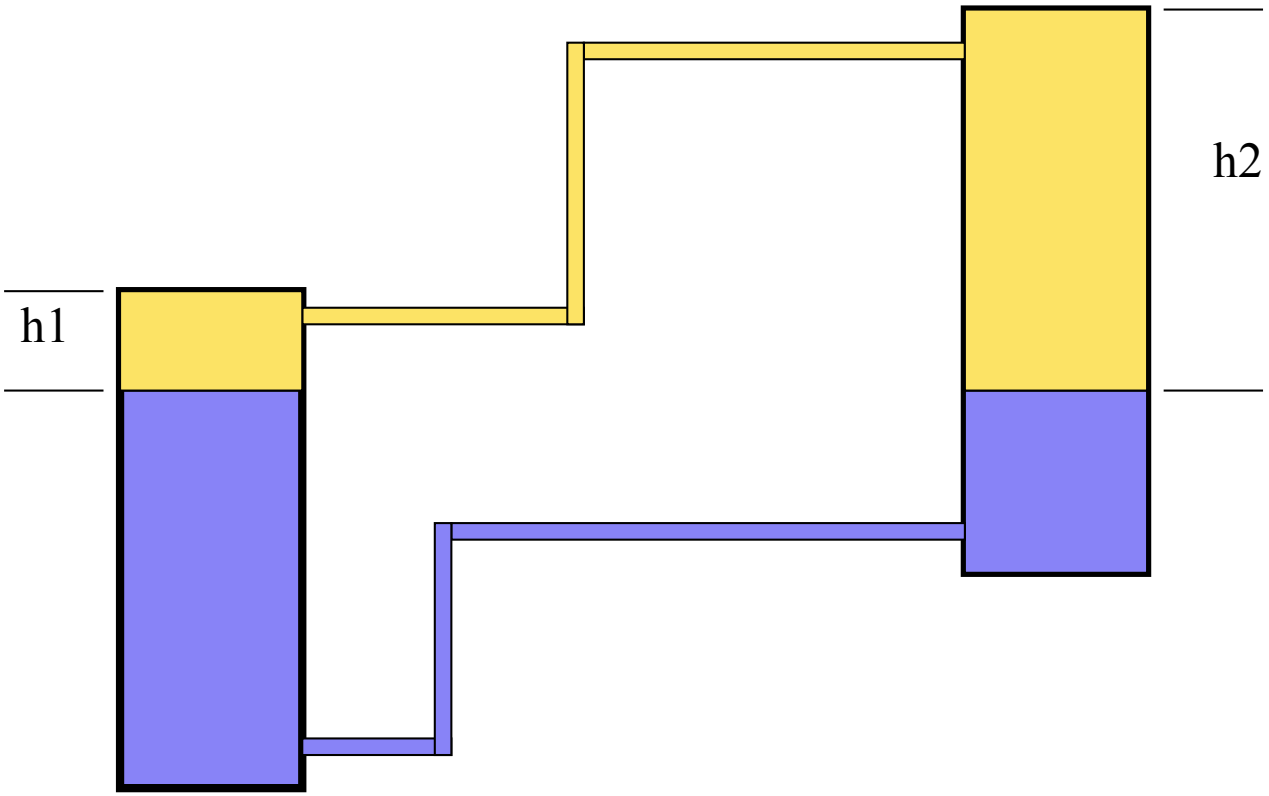
2 Bubble-type tiltmeters, ηm resolution

12 Fermilab water level sensors in 2 arrays

Simple HLS system

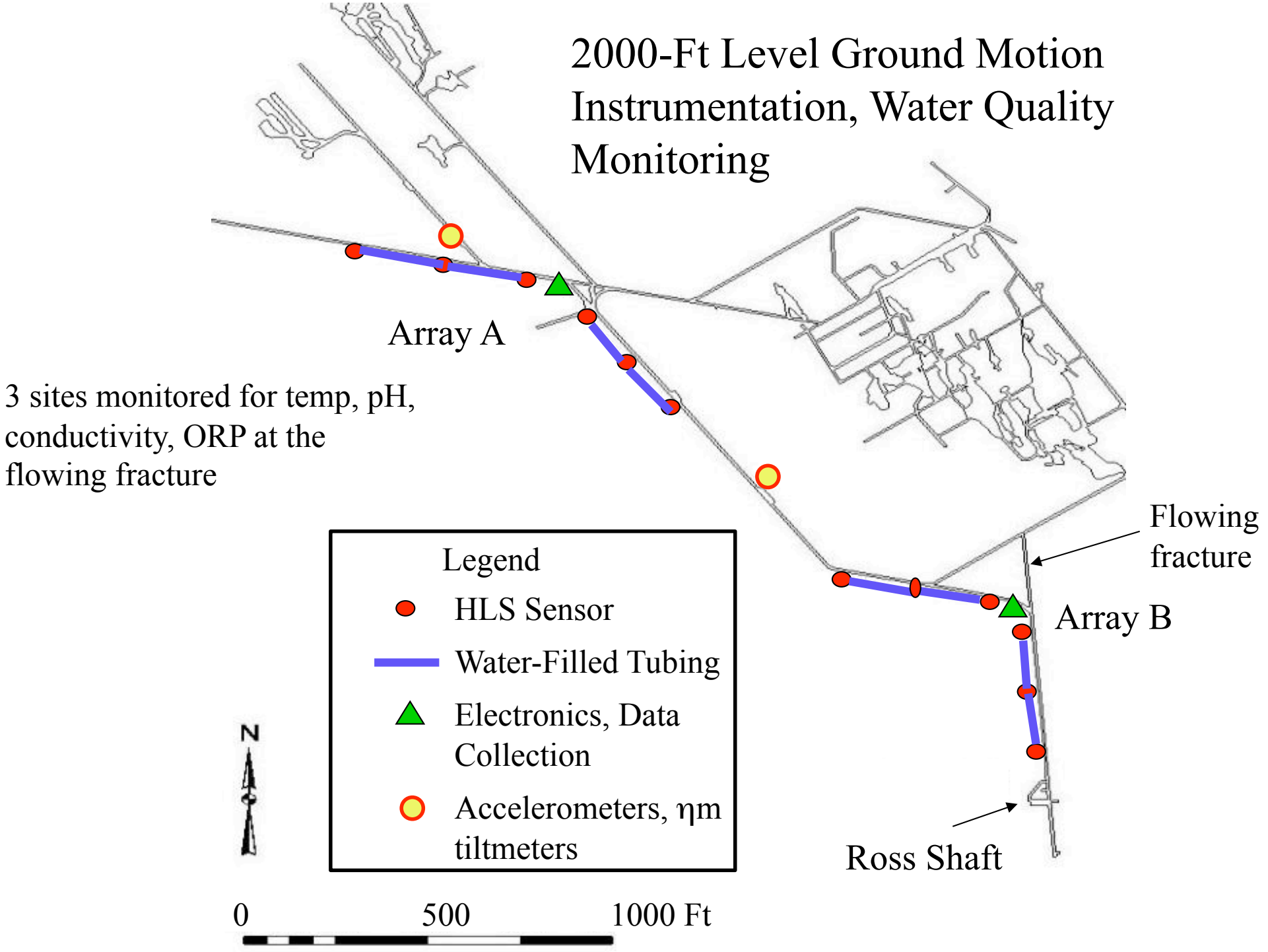


Simple HLS system



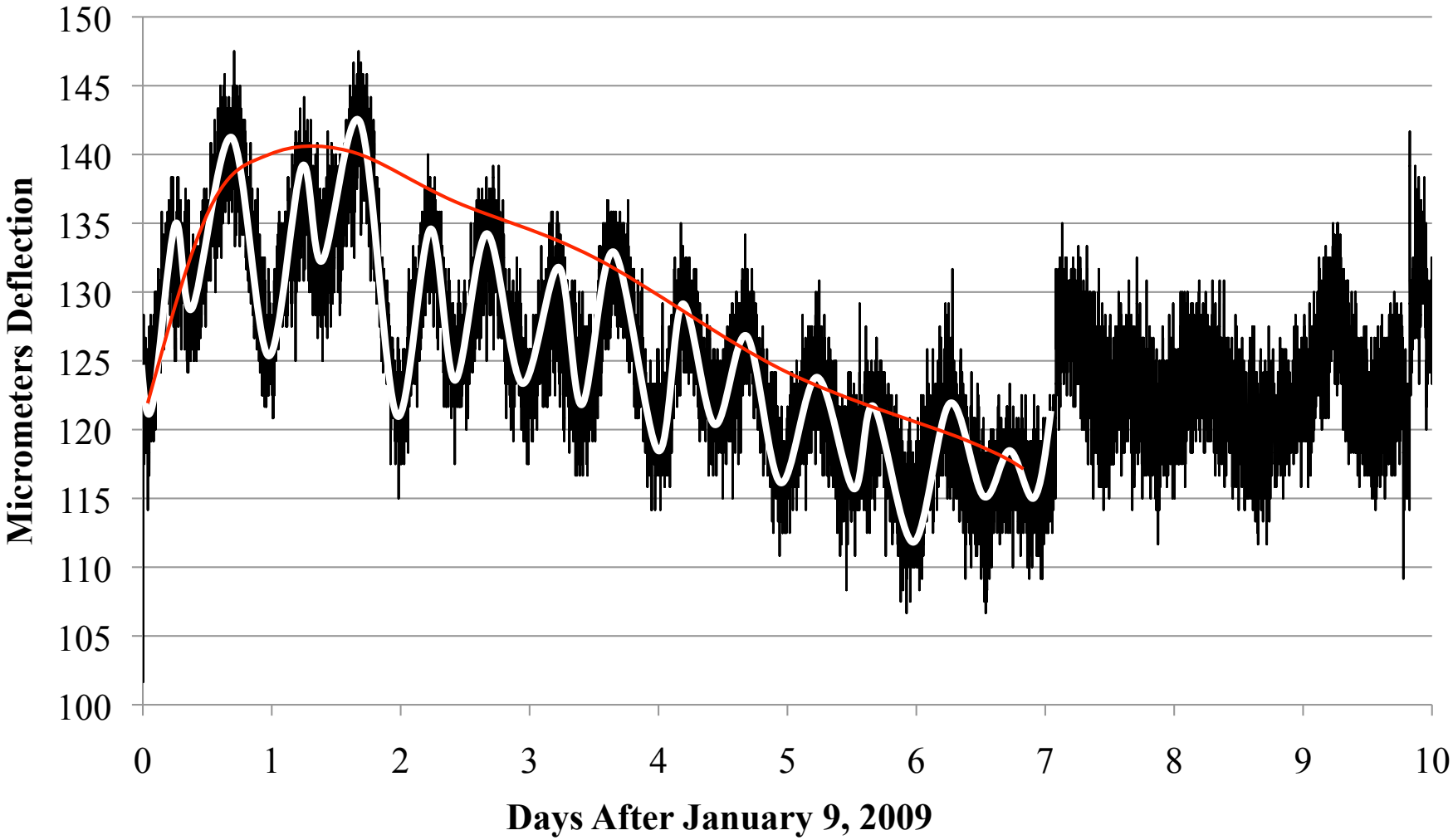
Tiltmeter Installation

2000-Ft Level Ground Motion Instrumentation, Water Quality Monitoring



3 sites monitored for temp, pH, conductivity, ORP at the flowing fracture

N-S Leg, Array A



White line = diurnal tidal cycle
Red line = spring and neap tidal cycle

Frequency Analysis of Tiltmeter Data

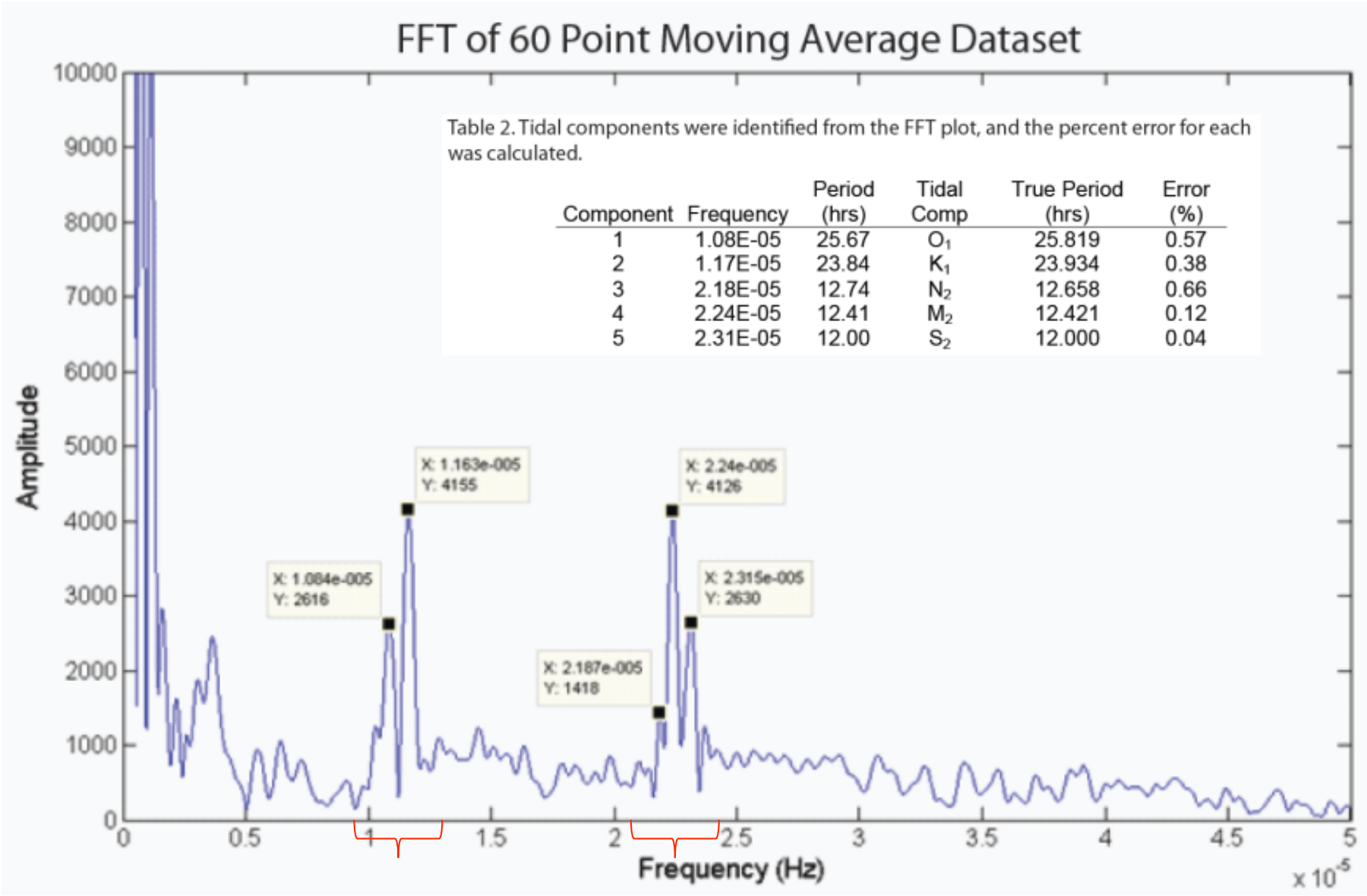


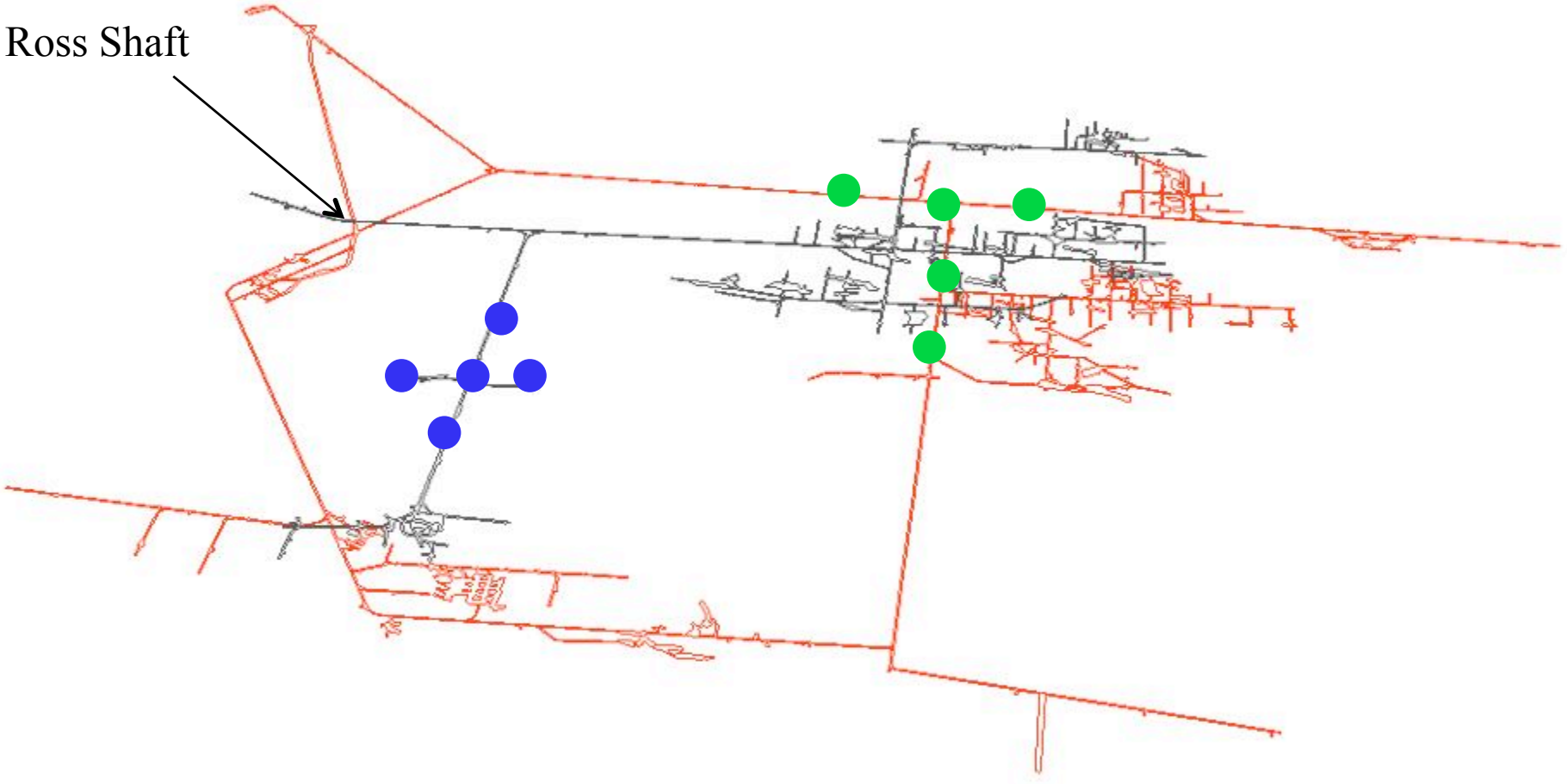
Table 2. Tidal components were identified from the FFT plot, and the percent error for each was calculated.

Component	Frequency	Period (hrs)	Tidal Comp	True Period (hrs)	Error (%)
1	1.08E-05	25.67	O_1	25.819	0.57
2	1.17E-05	23.84	K_1	23.934	0.38
3	2.18E-05	12.74	N_2	12.658	0.66
4	2.24E-05	12.41	M_2	12.421	0.12
5	2.31E-05	12.00	S_2	12.000	0.04

Diurnal

Semi-diurnal

Future Tiltmeter Installations



Black: 4550
Red: 4850

Experiment w/rib installation on 2000-ft level

Davis, et al., 2009.
Mining Engineering,
61(3):43-47

Post-closure flooding of the Homestake Mine at Lead, South Dakota

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Abstract

The historic Homestake Gold Mine at Lead, SD, was closed in December of 2001 after 125 years of operation. Since closure, the mine was selected by the National Science Foundation as the proposed host site for the Deep Underground Science and Engineering Laboratory. Pumps in the 2,480-m- (8,150-ft-) deep mine were shut off on June 10, 2003. Post-closure flooding of the mine has resulted in rising water levels that reached the 1,524 m (5,000 ft) level in July of 2007. The rate of water inflow into the mine is about 47 L/s (750 gpm). A plot of water level vs. time shows that the rise has not followed an exponential decay curve. When the pumps are turned on for dewatering, the rate of water-level decline will be monitored. Water in the Homestake mine contains arsenic derived from arsenopyrite. In samples of mine water, the median concentration of arsenic was 0.012 mg/L, which is below South Dakota's surface-water aquatic life standard of 0.15 mg/L for beneficial use.

Introduction

Homestake Mine. One hundred twenty-five years after discovery of the original lode in 1876, mining ceased in December 2001 at the Homestake Gold Mine in Lead, South Dakota. During the mine's lifetime, it supplied more than 40 million oz of gold, or about 10% of the nation's total gold production to that date (Rahn and Roggenthen, 2002).

Homestake was predominantly an underground mine, although it included surface operations at the Open Cut in Lead. Mining operations over the 125 years resulted in 63 levels and about 515 km (320 miles) of underground workings. The deepest workings are about 2,480 m (8,150 ft) beneath the surface.

The rock in the Homestake Mine is mainly Precambrian phyllite. The Homestake Formation, which contains the ore body, is a complexly folded iron formation that consists of grunerite-siderite schist and chert. The underlying Poorman Formation is a sericite-biotite carbonate phyllite, and the overlying Ellison Formation includes interbedded quartzite in sericite-biotite phyllite and schist (Bachman and Caddey, 1990).

Initial neutrino experiments in the Homestake Mine. Initial neutrino experiments began in 1965 at the Homestake Mine when Raymond Davis, Jr., and his colleagues set up a 380-m³ (100,000-gal) tank of perchloroethylene. When neutrinos interacted with chlorine atoms in the perchloroethylene, they occasionally produced a radioactive isotope of argon. Detection of neutrinos in the experiment was announced in 1968 (Bahcall, 2000). Raymond Davis, Jr., received the Nobel Prize for physics in 2002.

Deep Underground Science and Engineering Laboratory (DUSEL)

The end of mining operations at the Homestake Mine caused concerns about the continuation of neutrino experiments at the 1,480-m (4,850-ft) level and led to proposals to expand the types of experiments at deeper levels. The Homestake Mine (Fig. 1) is in a relatively stable area geologically and is in a seismically quiet region. The large volume of rock over the detectors, at deeper levels, would shield the experiment from cosmic-ray background radiation. Figure 2 shows the advantages of the Homestake site in reducing background radiation.

The proposed expansion of neutrino experiments at Homestake generated interest in the creation of a Deep Underground Science and Engineering Laboratory (DUSEL) with a broader focus that could accommodate additional research in rock mechanics, groundwater flow, the microbiology of extreme environments, and other fields. In 2007, the National Science Foundation selected Homestake as the host site for the deep underground laboratory. Development of the site will occur in two phases. Phase 1 is the establishment of an interim facility at the 1,480-m (4,850-ft) level (the site of previous neutrino experiments), funded by Federal, State and private sources. The South Dakota Science and Technology Authority was set up by the state to administer the interim site. Phase 2 will involve construction of the deep laboratory at the 2,260-m (7,400-ft) level and deeper. It is anticipated that Phase 2 will begin around 2010-2011. The Yates shaft (Fig. 1) will be used for access to the laboratories.

Mining Engineering, in press

Instrumentation of the Homestake Underground Laboratory for Drawdown Measurements During Dewatering

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ABSTRACT

The former Homestake gold mine at Lead, South Dakota, has been selected by the National Science Foundation as the proposed host site for the Deep Underground Science and Engineering Laboratory. The deep laboratory and associated research campus will be developed at approximately the 7700-ft level. Plans also include the development of the Sanford Underground Science and Engineering Laboratory at the 4850-ft level. After the mine's pumps were shut off in June, 2003, water levels rose to approximately the 4650-ft level by early 2008. Pumps in the 8150-ft deep mine were turned on again for dewatering in April, 2008. Instrumentation is being installed in the mine to measure water-level declines during pumping, for later analysis of permeability and related hydraulic properties of the formation. Pressure-sensitive transducers and data loggers will provide real-time information on water levels that will be available to interested parties. Quality of the water also will be monitored as it is pumped from the mine.

1996; DeWitt and Duke, 1996) intruded into the folded and fractured rock and is considered at least one of the proposed gold mineralization events (Paterson, 1996).

The Homestake site was selected as the Deep Underground Science and Engineering Laboratory in part because of its geologic and structural complexity and because such a large volume of crust is accessible for scientific and engineering experiments. Development of the site will occur in two phases. Phase 1 is the establishment of the Sanford Underground Science and Engineering Laboratory at the 4850-ft level, constructed with Federal, State, and private funds. Phase 2 involves construction of the DUSEL at the 7700-ft level and will be funded by Federal grants. It is anticipated Phase 2 will begin in 2010 or 2011. The South Dakota Science and Technology Authority (SDSTA) will administer the site.

Water Levels in the Homestake Mine

After mining ceased, pumps in the mine were shut off on June 10, 2003. Sensors were installed every 600-ft depth and have provided the crude data used to

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Molecular Analysis of Prokaryotic Diversity in the Deep Subsurface of the former Homestake Gold Mine, South Dakota, USA

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A culture-independent molecular phylogenetic analysis was carried out to study the prokaryotic diversity in two soil samples collected from the subsurface (1.34 km depth) of the former Homestake gold mine, Lead, South Dakota, USA at two sites, the Ross shaft and No. 6 winze. Microbial community analyses were performed by cloning and sequencing of 16S rRNA genes retrieved directly from soil samples. Geochemical characterization of soils revealed high amount of toxic metals such as As, Cd, Co, Cr, Cu, Ni, Pb, Zn, and U at both the sites. Phylogenetic analyses showed that soil samples were predominantly composed of phylotypes related to phylum *Proteobacteria*.Other phyla detected in libraries were *Acidobacteria*,*Actinobacteria*, *Bacteroidetes*, *Chloroflexi*, *Chlorobi*, *Firmicutes*, *Gemmatimonadetes*, *Nitrospirae*, *Planctomycetes*, *Verrucomicrobia*, and candidate divisions OP10 and TM7. The majority (>95%) of the phylotypes retrieved in the libraries were most closely related to environmental sequences from yet-uncultured bacteria representing a hitherto unidentified diversity. The archaeal communities at both the sites exhibited lower diversity and were most closely affiliated to uncultivated species within the *Crenarchaeota*. Results showed the existence of diverse microbial populations in deep subsurface environment of the Homestake gold mine. Statistical analyses demonstrated that each site harbored phylogenetically distinct microbial populations that were more diverse at Ross site compare to winze site.

Keywords: Homestake, DUSEL, gold mine, microbial diversity

Data will be made available on a website at some future point

Questions?

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