LONQUIST & CO. LLC

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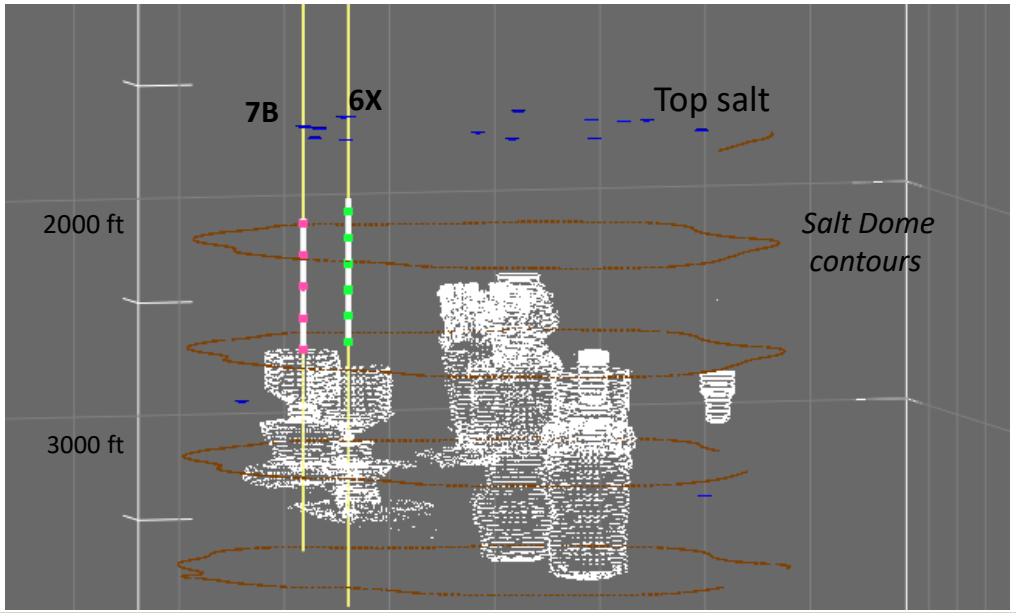
Draft Plan to Monitor Seismic Activity on and around the Sulphur Mines Dome, Louisiana

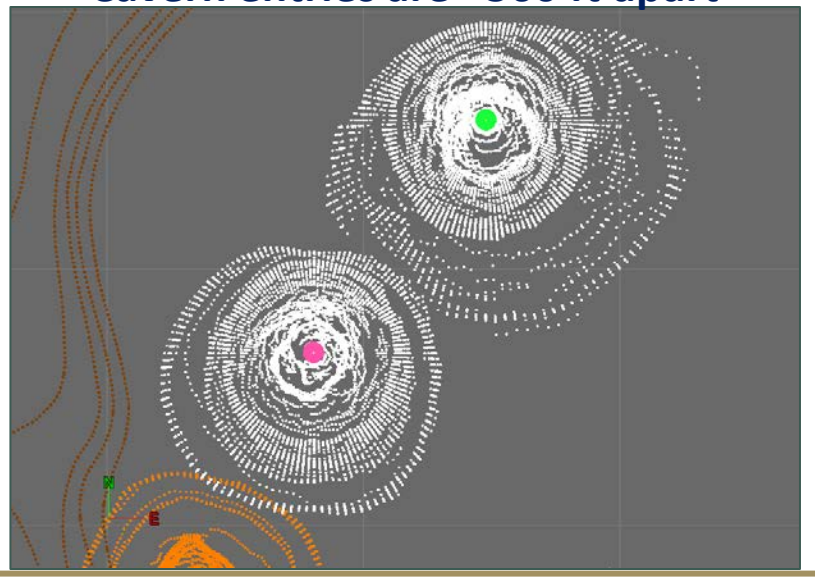
June 13, 2022

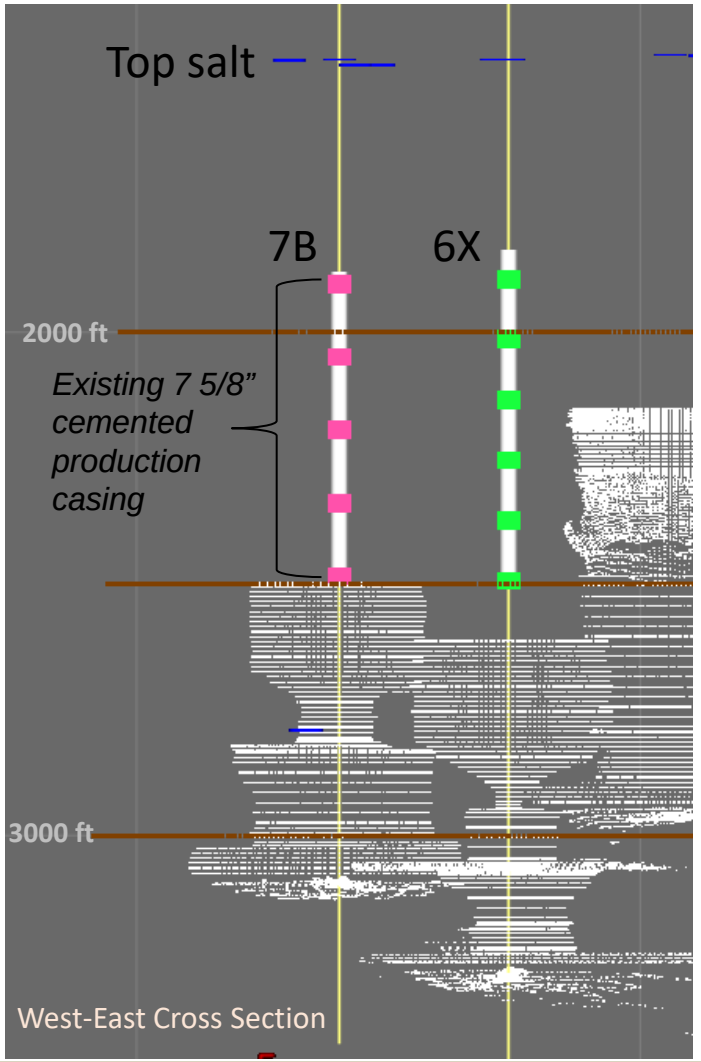
Draft plan for monitoring seismic activity on and around the Sulphur Mines Dome

- Place analog geophones in the existing 7-5/8” cemented production casing on inactive cavern wellbore entries PPG 6X & 7B (operated by Eagle US 2, LLC) to monitor seismicity on and around the the Sulphur Mines salt dome.
  - PPG 6X: Six 3C geophones
  - PPG 7B: Five 3C geophones
  - 600 foot geophone array aperture in each well
  - Top sensors ~1,900 ft depth; bottom sensors ~2,500 ft depth (near the 7 5/8” casing shoe)

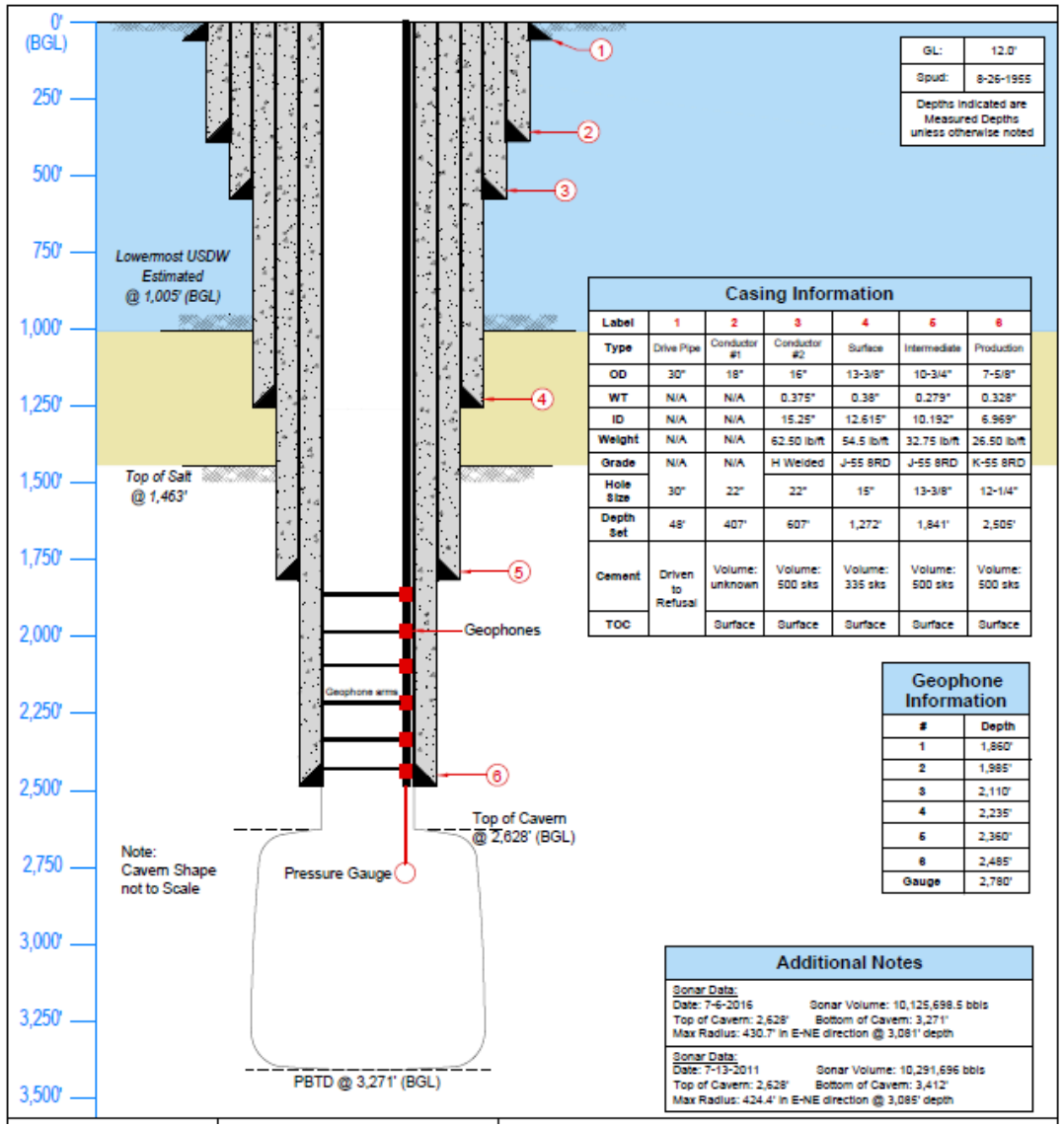


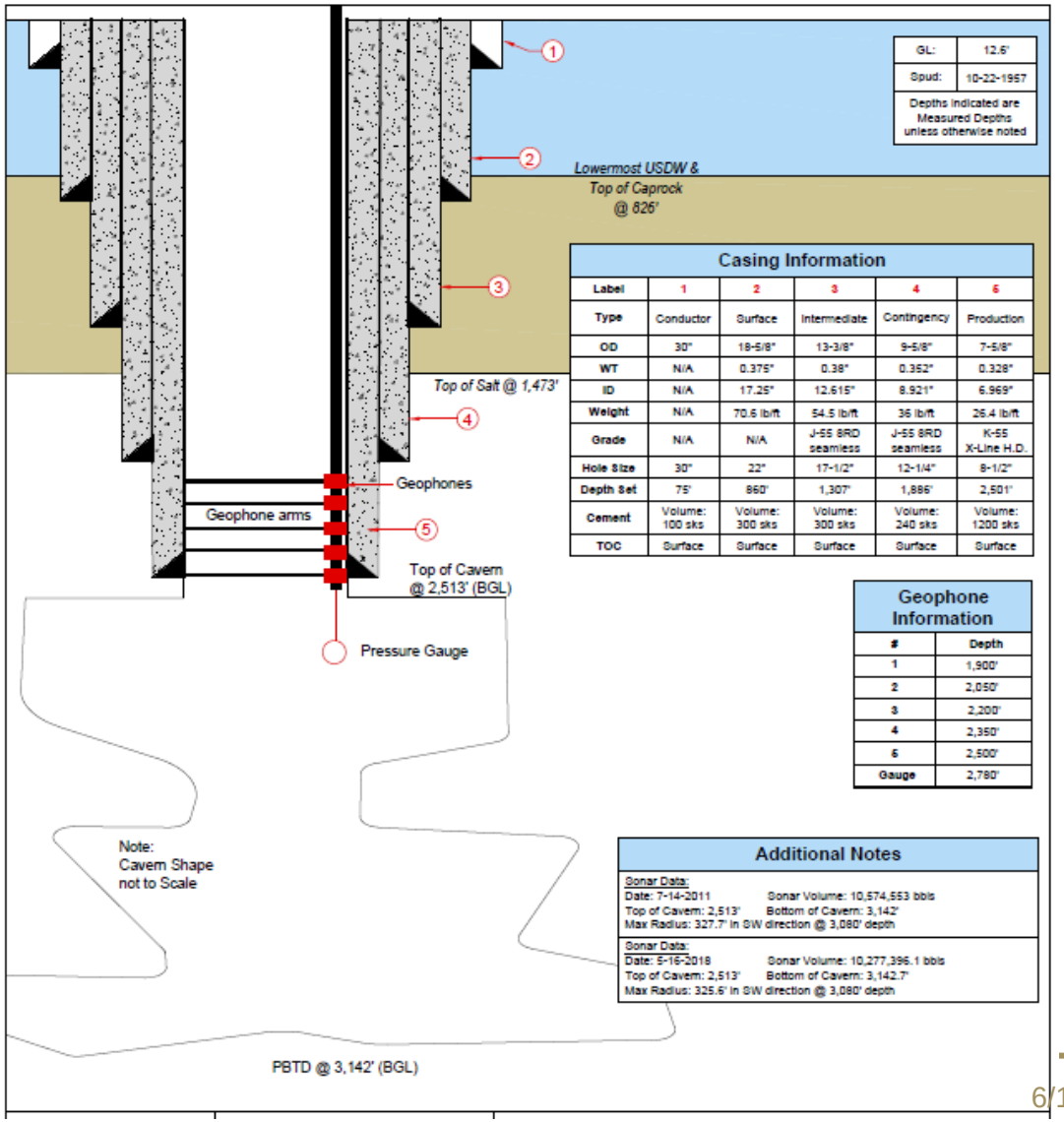
Cavern entries are ~560 ft apart





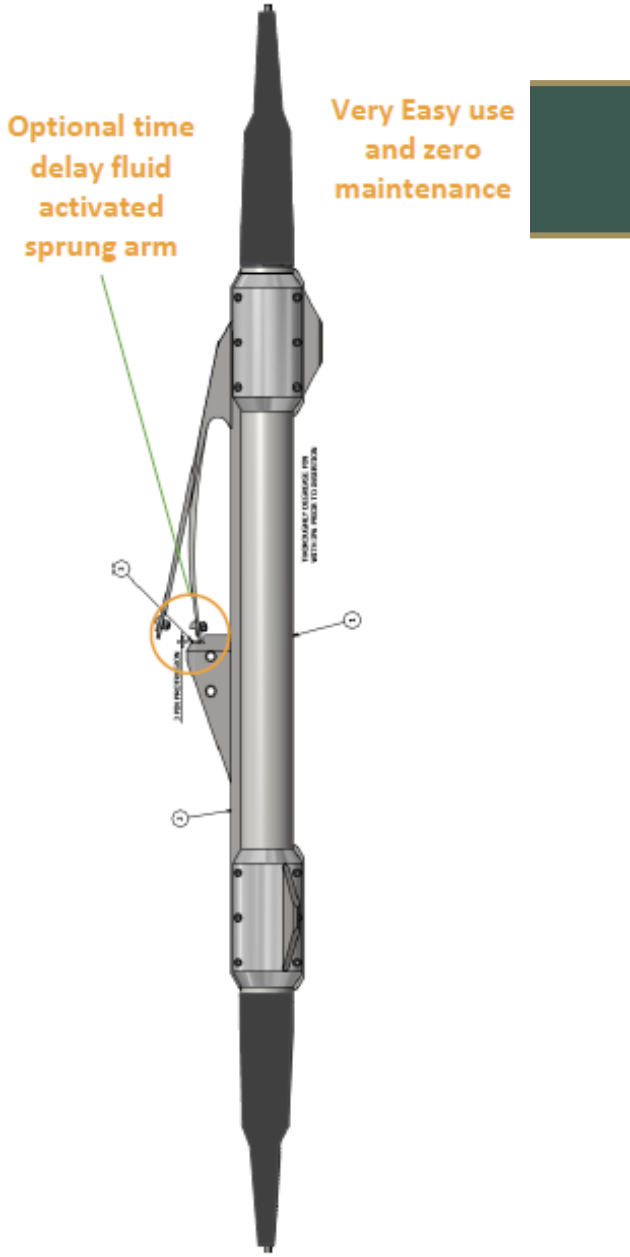
Wellbore Drawings/Geophone Array Placement





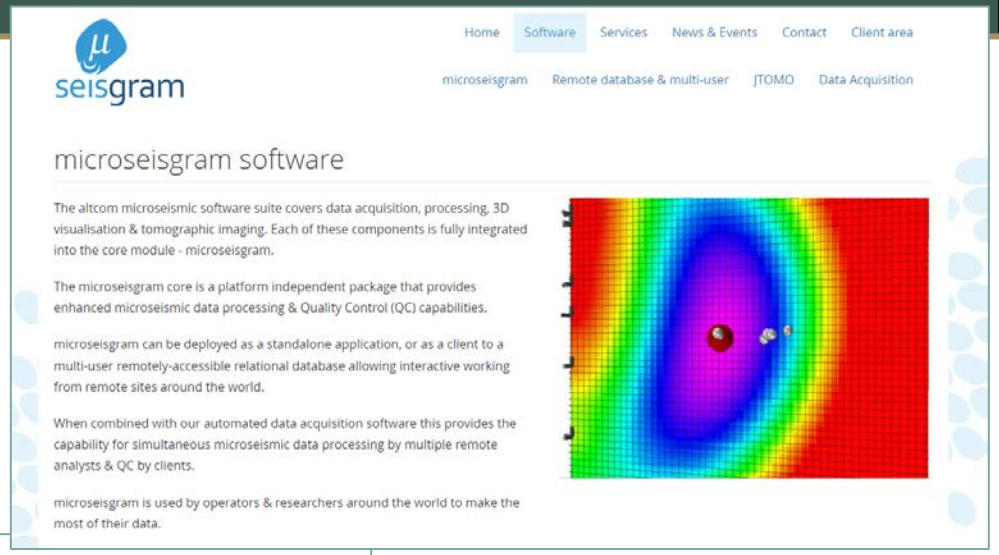
Geophone/Pressure

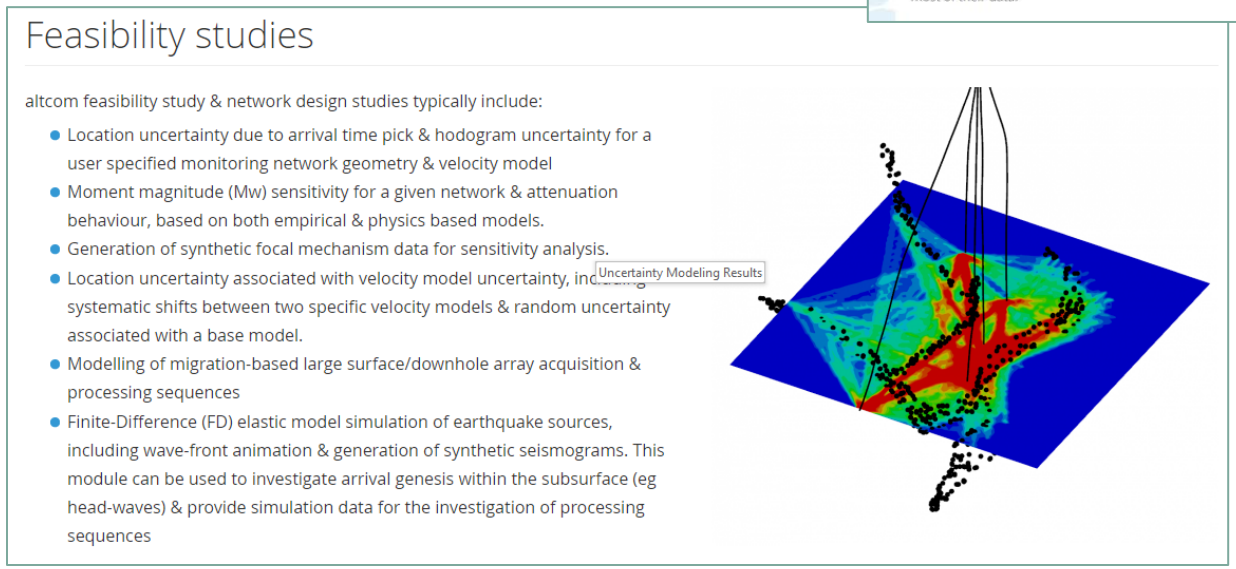
- Custom built analog Avalon geophone array for each well.
  - Geophones have time-release clamping arm.
    - Arm holds each geophone against the 7 5/8” cemented casing
  - Geophone string can be removed for cavern access or sensor maintenance. (tool string is “dragged” up the wellbore)
  - Geophone: 15 Hz, 3 component sensors.
- Pressure Gauge:
  - Incorporated into the same communications cable as the geophones.
  - Set at a depth within the cavern.
- Surface Equipment:
  - Analog/Digital equipment near wellheads to convert signal to digital.
  - Continuous data transmission to onsite computer for microseismic event-detection.
  - Off site vendor for event processing and reporting.
  - Precision GPS timing system.
  - Near real-time detection and location capability if needed.



Array Geometry Microseismic Feasibility Study Performed

- What location accuracy and magnitude detection levels can we expect geophones in the 6X and 7B wellbores?
- A feasibility study was done by “altcom” (Andy Jupe) using the “microseisgram” software package https://microseisgram.com/services
  - Company based in UK
  - Extensive experience in geothermal and oil and gas operations.





Feasibility Study Summary

Geophone Arrays in wells 6x and 7B modeling results:

- **Location Uncertainty Modeling**:
  - Upper 1500 ft of Sulphur Mines dome- <±100 to 150 ft location uncertainty.
  - Mid cavern levels ~4000 to 5000 ft depth, uncertainty about ±200 to 300 feet.
  - Deep 5000-6000 ft, caverns below array ±200-300 ft uncertainty, location resolution drops off at deep >6000 ft near salt flanks.
    - The deep eastern area of dome has larger location uncertainties (> ±500 ft) but events can be detected and located.
  - The effects of “cavern” void spaces on the signal attenuation were not modeled.
  - Background noise levels in the proposed wellbore intervals is unknown at this time.
    - Modeling used ~2x noise level observed at a nearby microseismic observation well in salt.
- **Magnitude Detection Modeling:**
  - Excellent magnitude detectability near the arrays (to magnitude -2.5) and expected to fall off with depth to about magnitude -1.25 below 6000 ft depth.

Modeling suggests geophones placed in 6X and 7B should provide microseismic monitoring coverage over the entire Sulphur Mines salt dome.

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Location Uncertainty Modeling Results

Modeling Assumptions

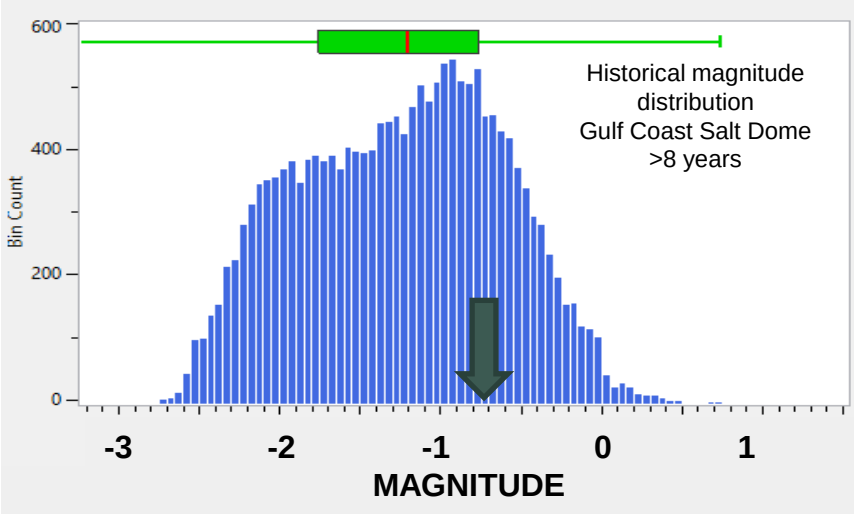
- Uncertainty contours for a **Magnitude -0.75**

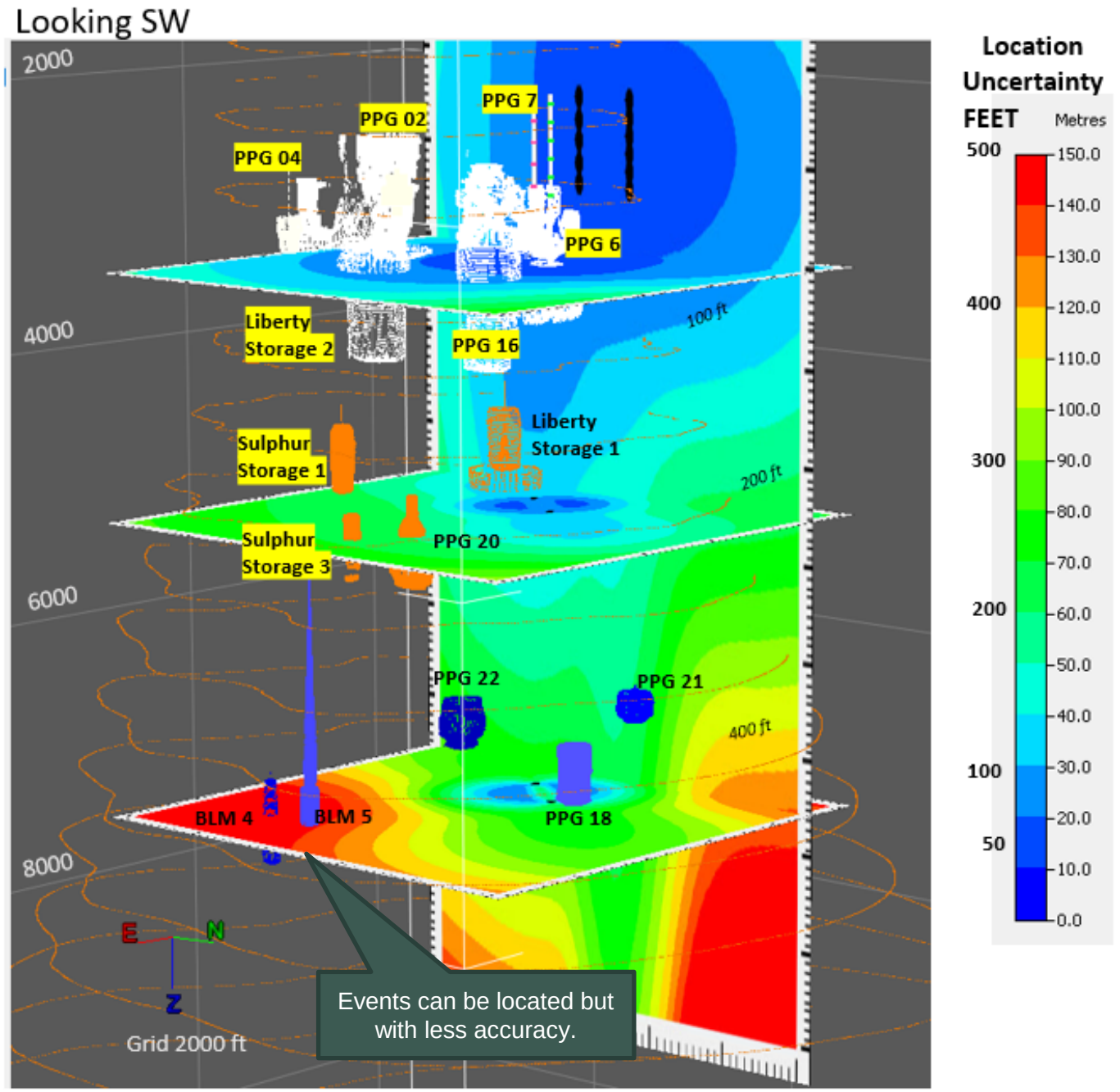
– Background Noise level 20 nm/sec
  - about 2x nearby operator

– Picking uncertainty P wave ± 4 ms

– Picking uncertainty S wave ± 5 ms

– Ave azimuth and inclination uncertainty ±15°





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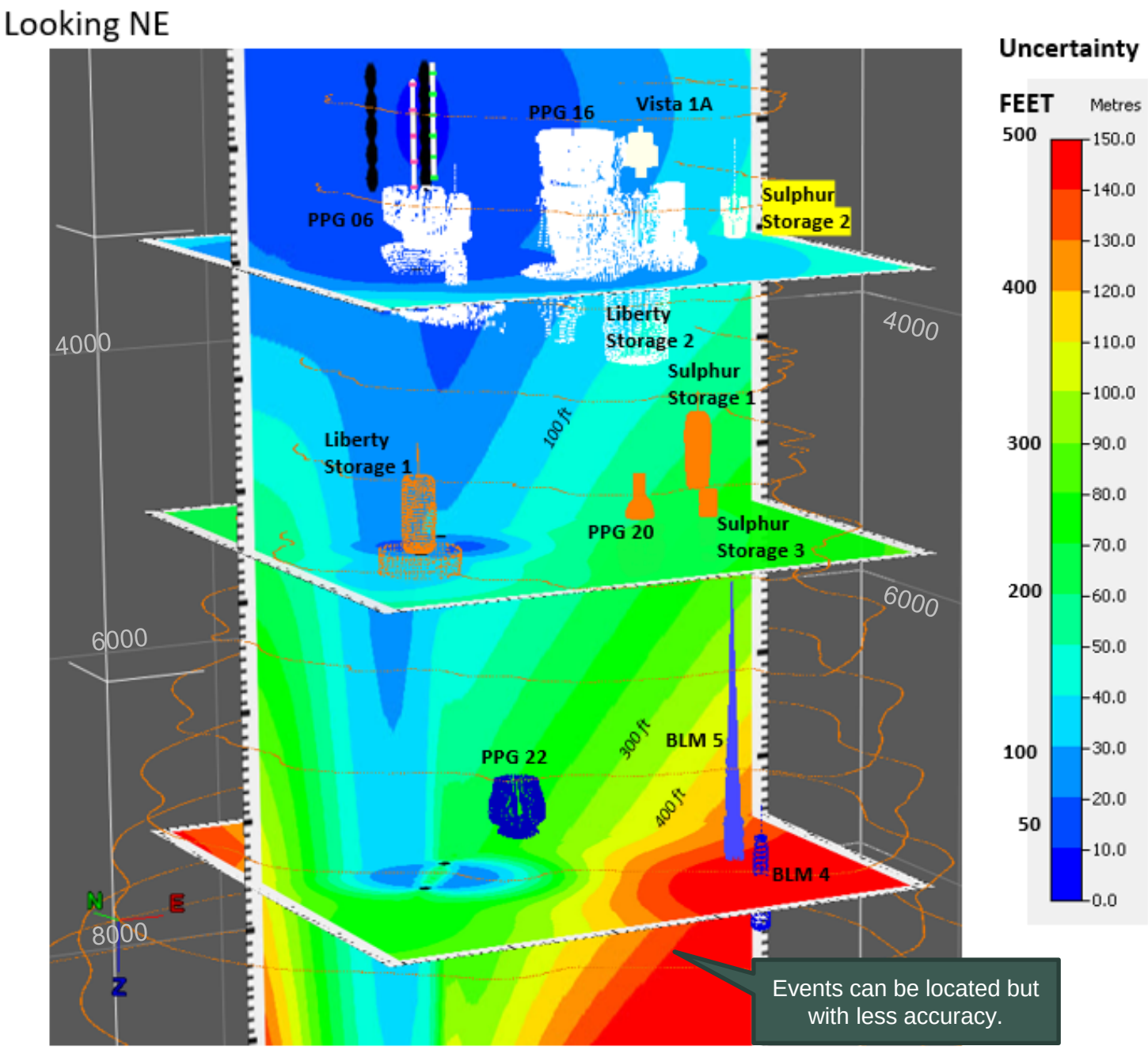
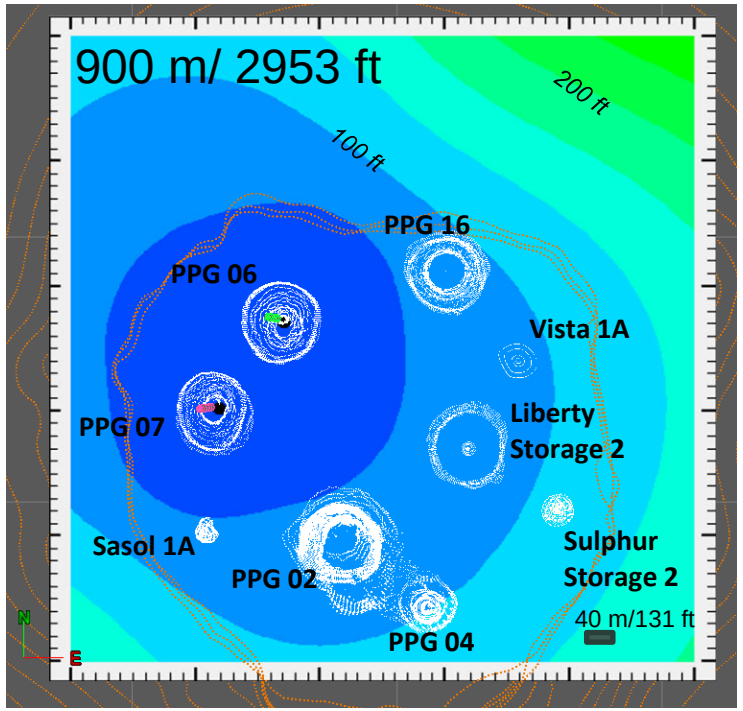


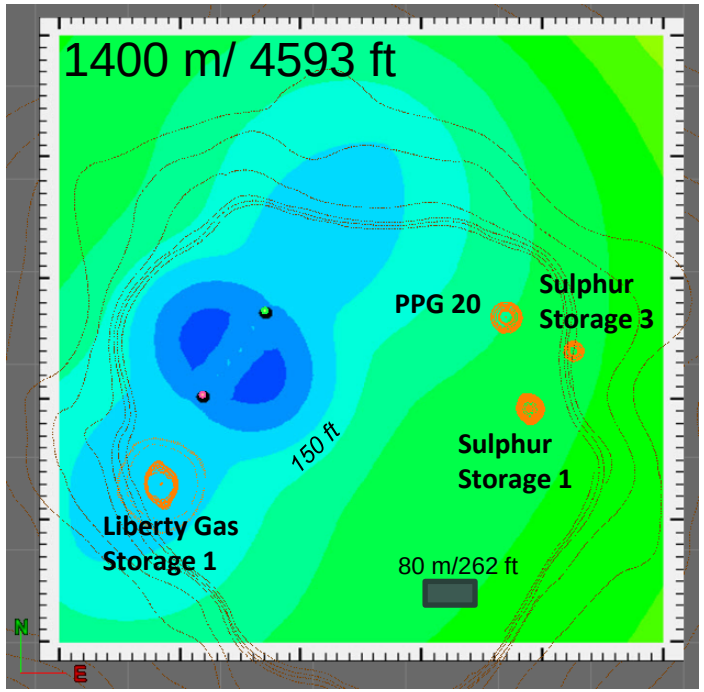
Location Uncertainty Modeling Results

Map view (est. location accuracy at shallow, mid and deep caverns near the depth ranges)

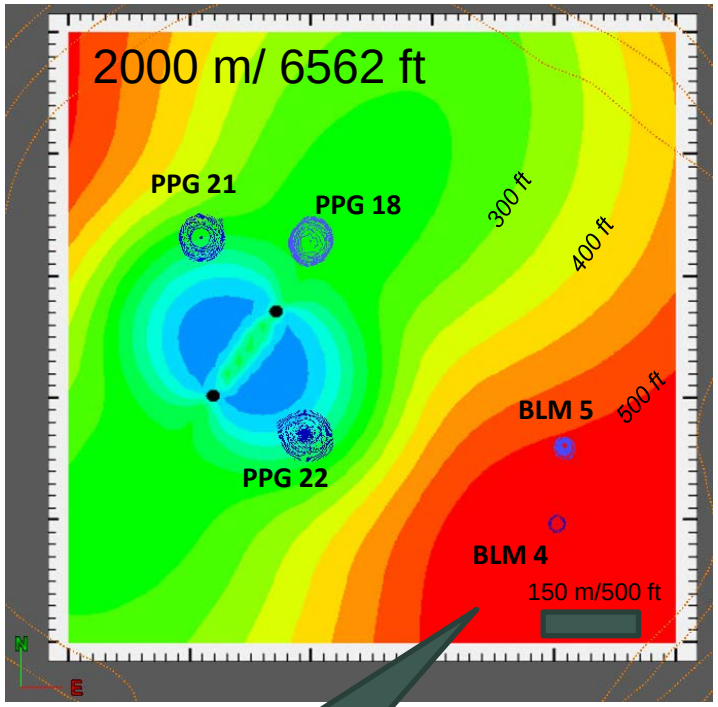
Shallow (~3000 ft)



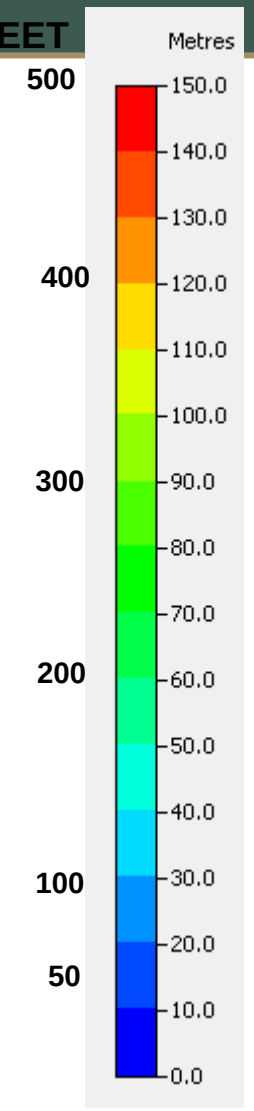
Mid (~4600 ft)



Deep (~6500 ft)



Location Uncertainty



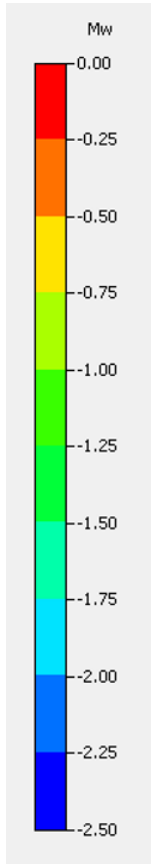
Colored contours of expected location accuracy

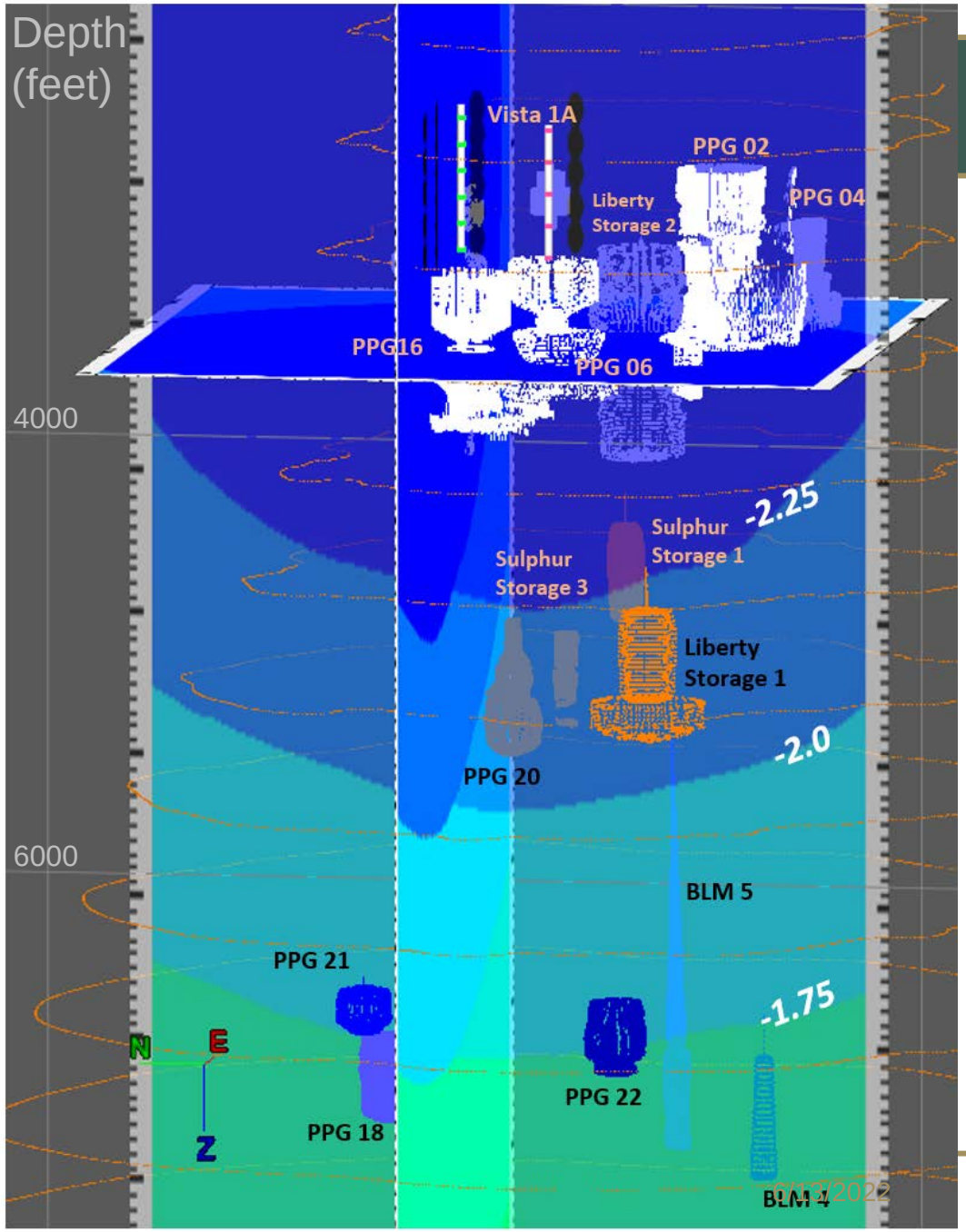
Events can be located but with less accuracy.

Magnitude Sensitivity Modeling Results

- Modeling suggests sensor geometry can detect events magnitude > -1 throughout the dome area and m <-2 near the geophone arrays.
- Median magnitude at nearby seismic salt some monitoring ~magnitude -1.2

~nearby salt monitoring median -1.2

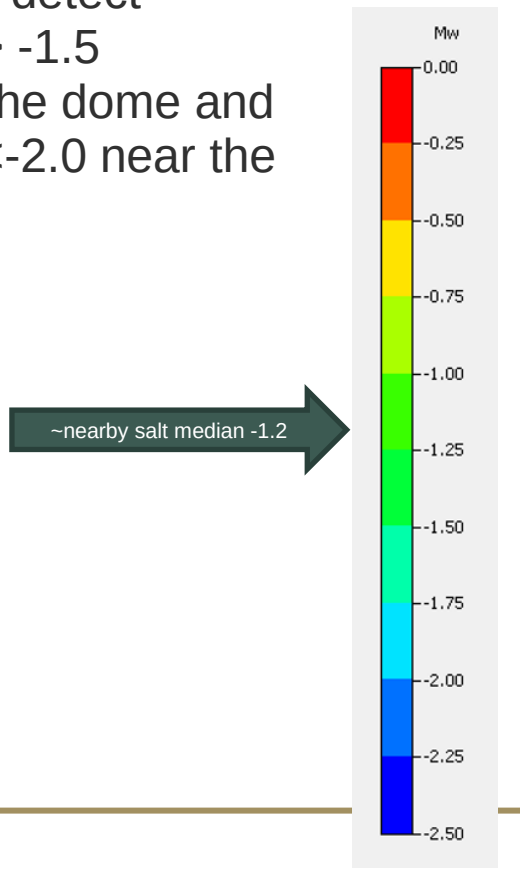


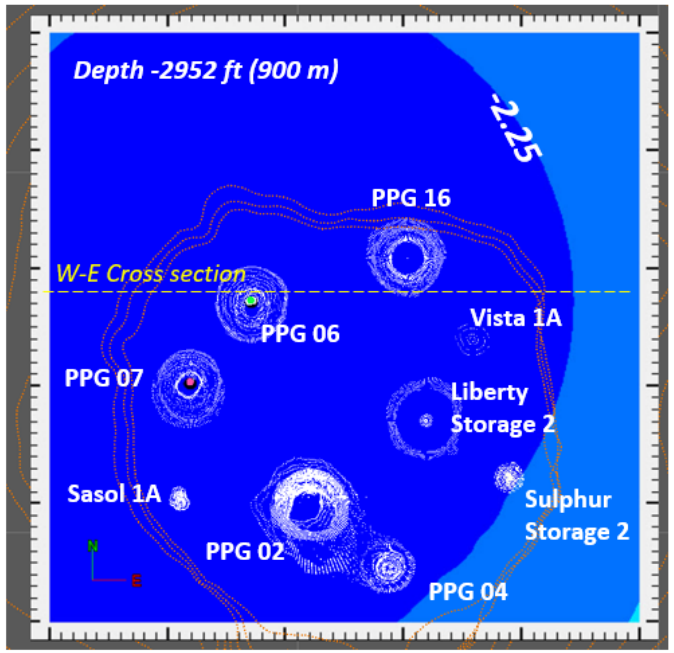


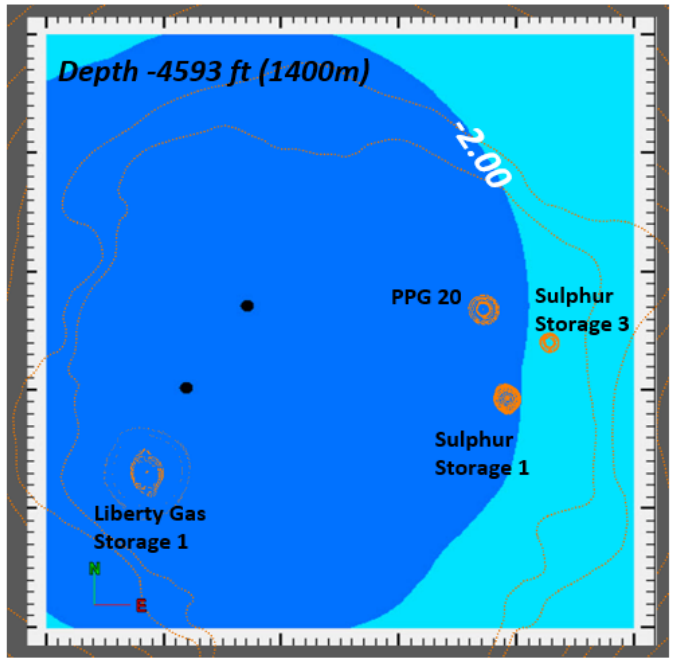
Feasibility Study Results

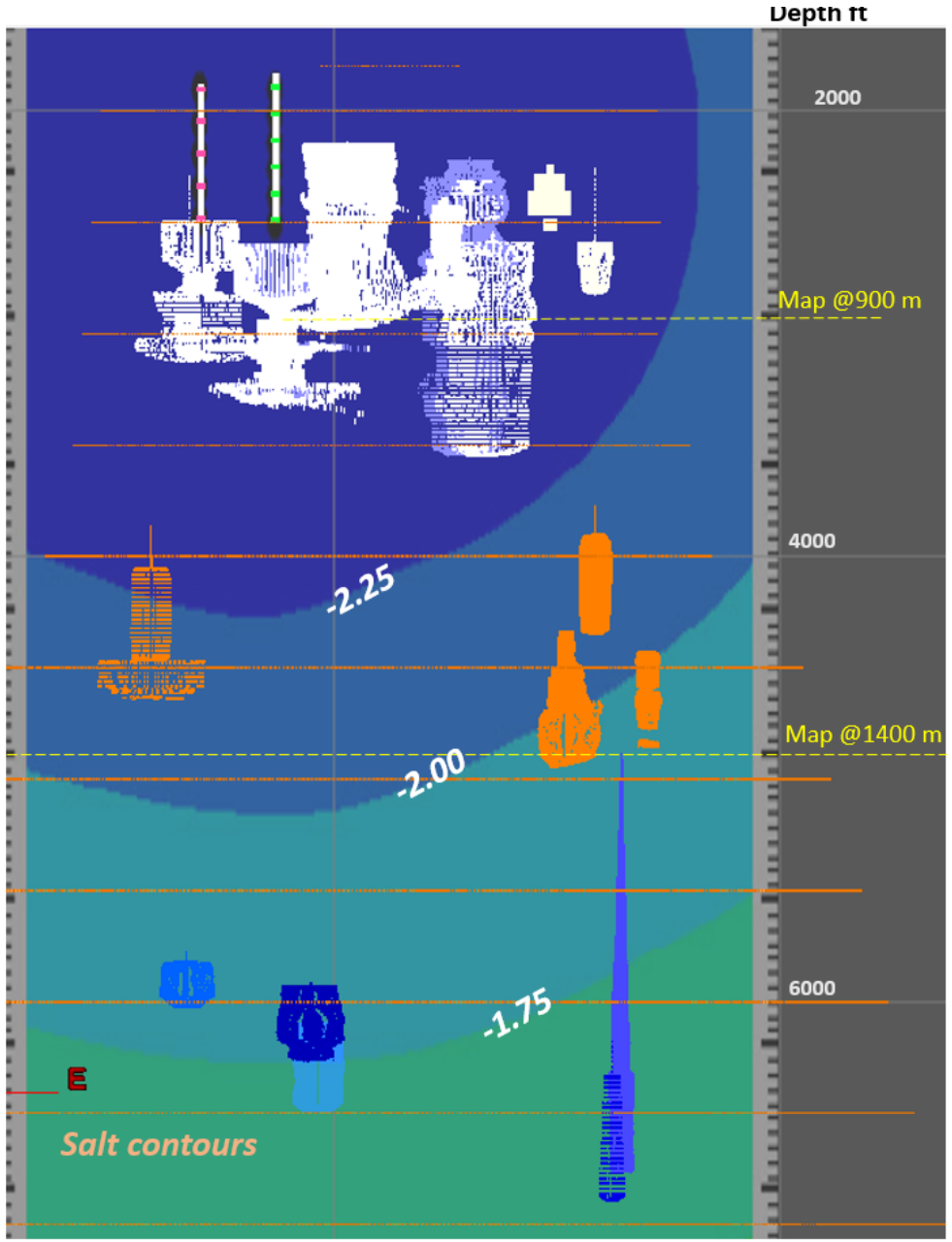
Magnitude Sensitivity Modeling Results

- Modeling suggests network can detect magnitude > -1.5 throughout the dome and magnitude <-2.0 near the arrays.





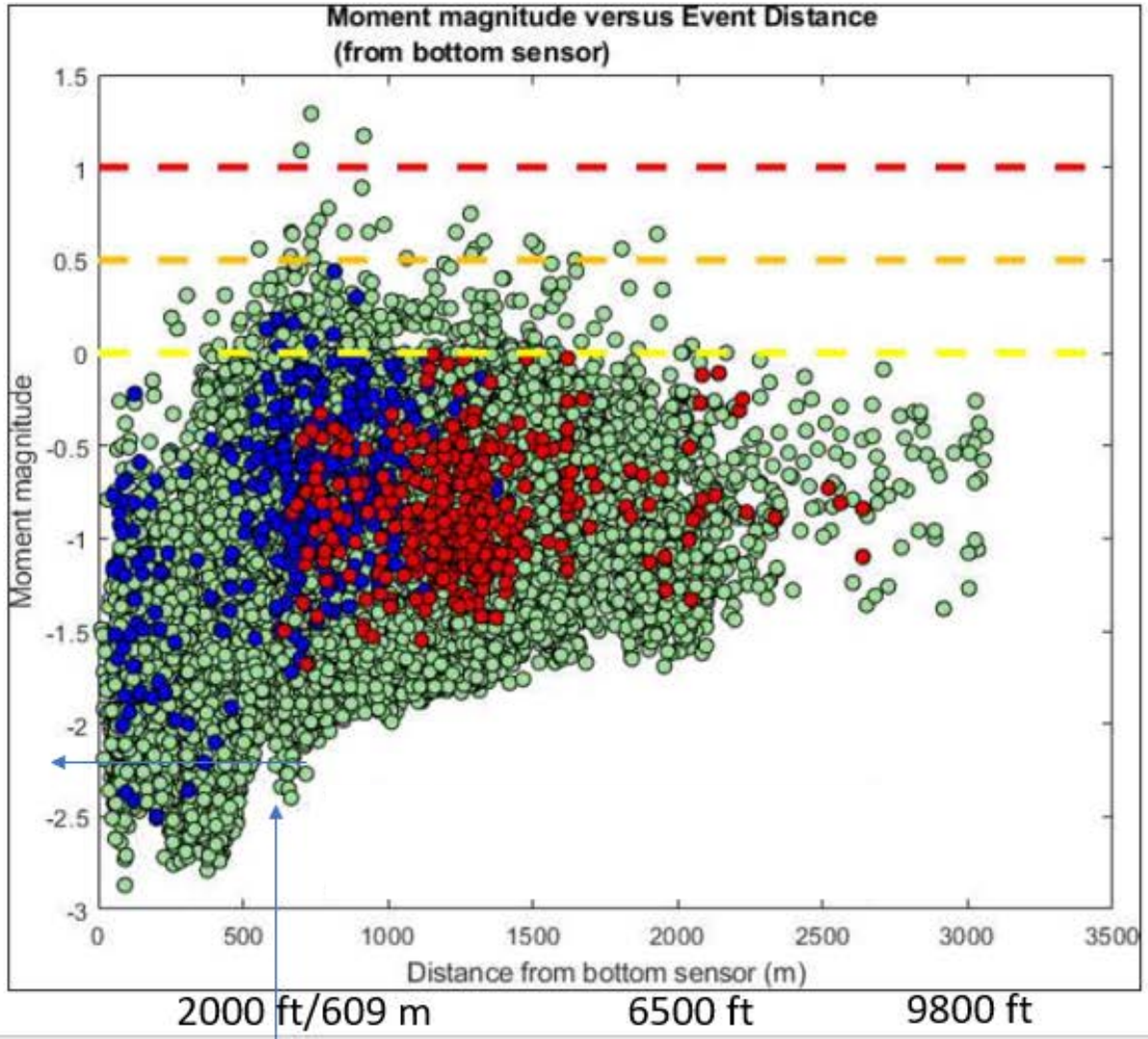


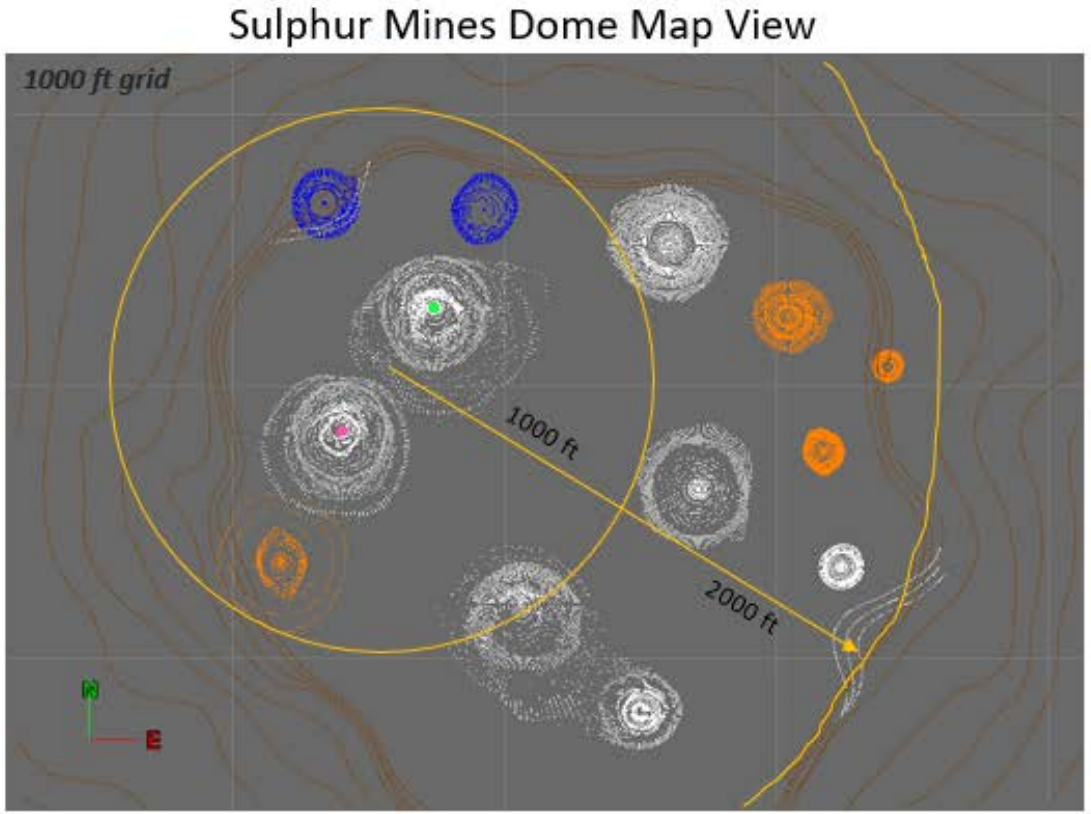


West-East Cross Section

Magnitude "Detectability" observed in a nearby salt dome

- Magnitude vs Distance from Sensors (Gulf Coast Salt Dome)





Based on results form Salt Dome monitoring in Louisiana, Events are located to magnitude <-2 at ~2000 ft distance from sensors.

Draft Plan for Microseismic Monitoring:

Place Two Geophone Arrays: use PPG 6X and PPG 7B wellbores

Location Uncertainty Modeling Results:

- Upper 1500 ft of Sulphur Mines dome- <±100 to 150 ft location uncertainty.
- Mid cavern levels ~4000 to 5000 ft depth, uncertainty about ±200 to 300 feet.
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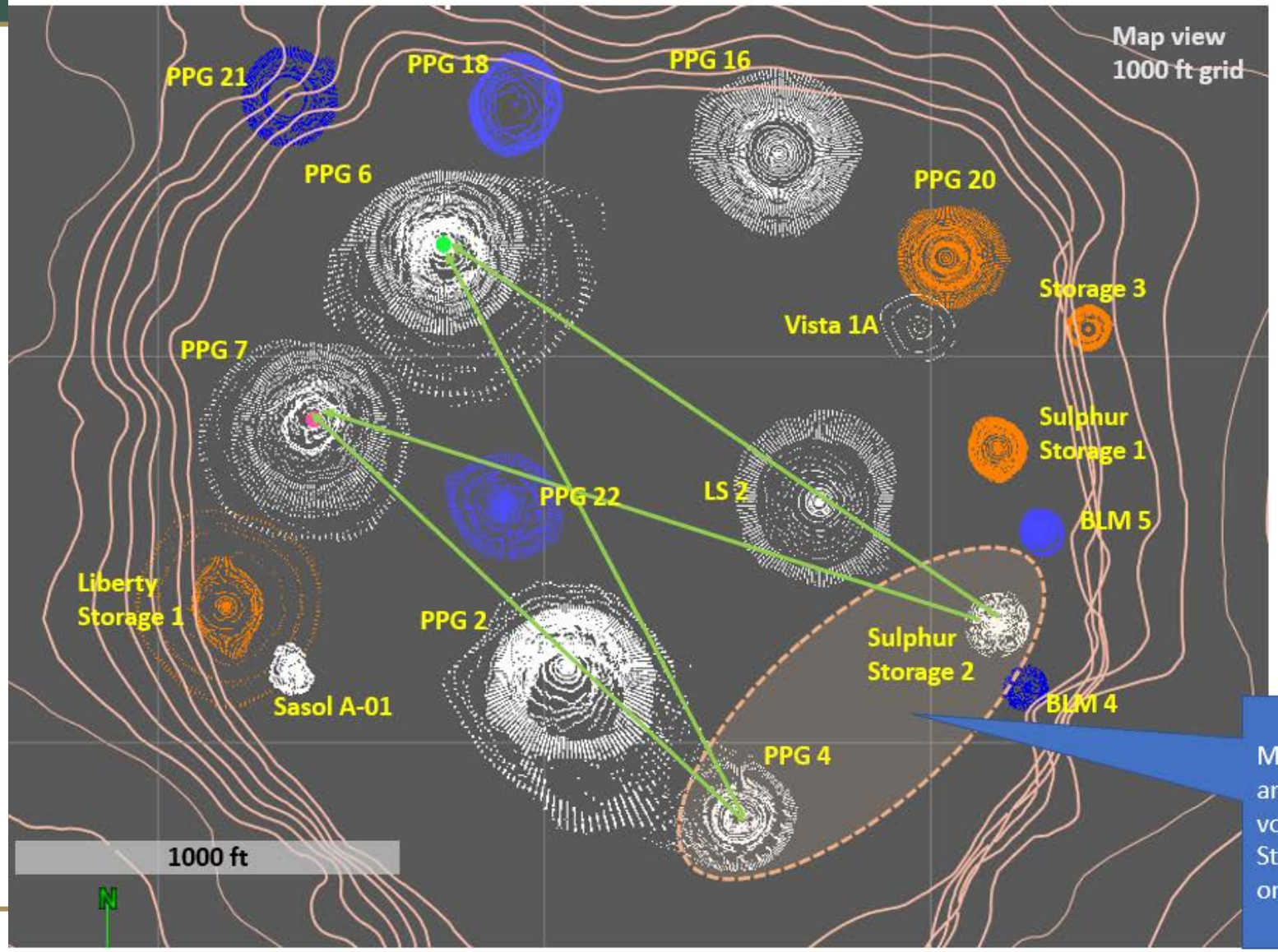
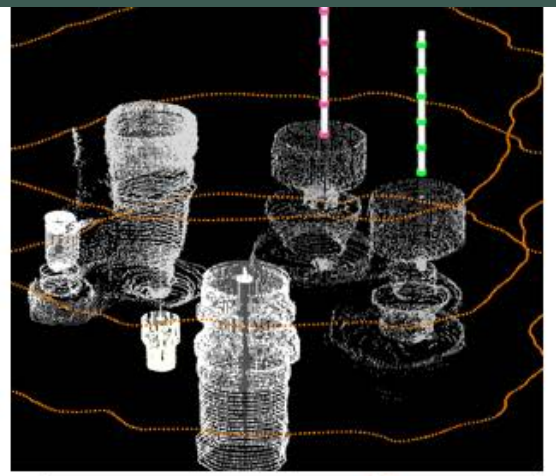
Modeling suggests geophones placed in 6X and 7B should provide microseismic monitoring coverage over the Sulphur Mines salt dome area.

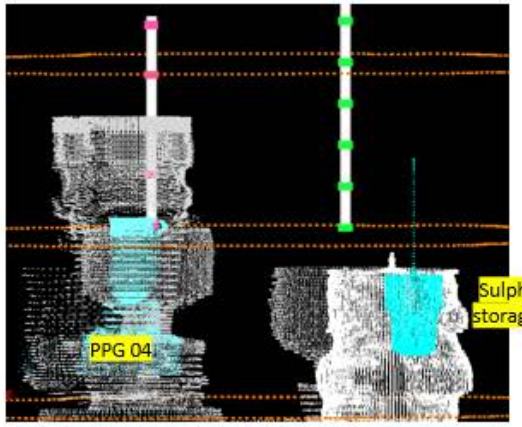
Comments regarding Sulphur Mines microseismic monitoring proposal/modeling, etc.

- The modeling focused on microseismic monitoring within the salt in and around the caverns, which are in the control of the operators.
  - Cap rock events are expected to be detectable and we can locate events above the arrays (not modeled).
    - Nearby dome monitoring able to detect and locate cap rock microseismic activity with array below cap rock.
  - The effects of “cavern” and cap rock void spaces on the signal attenuation were not modeled.
- Deformation in the sediments on the flanks of the Sulphur Mines dome may or may not create detectable microseismic events.
  - Rock “fracturing” must occur to emit a signal for microseismic event detection and location.
  - The Sulphur Mine arrays should pick up seismic activity “off dome” if sediment attenuation, noise levels, etc. are acceptable and the flank formations are actively fracturing.
  - Soft sediment deformation and or slow deformation may not produce microseismic events.
  - The Salt Dome flank- Sediment margin may produce microseismicity.
    - Observed in nearby Gulf Coast Salt Dome and is likely related to growth faults off the salt dome.
- **Background noise levels** in the proposed wellbore intervals is unknown at this time.
  - Modeling used ~2x noise level observed at a nearby microseismic observation well in salt.
  - High background noise can hamper the ability to monitor microseismicity.
    - More difficult to detect small microseismic events.
    - Noise affects quality of the seismic waveforms and the location accuracy worsens.

Cavern “void space” and microseismic monitoring







Microseismic waveform emulating from PPG 04 and Sulphur Storage 2 might be attenuated by void space in caverns PPG 2 and Liberty Gas Storage 2. Each of these cavern likely visible from one of the two arrays, but not both.

Estimated time line for monitoring set up and reporting

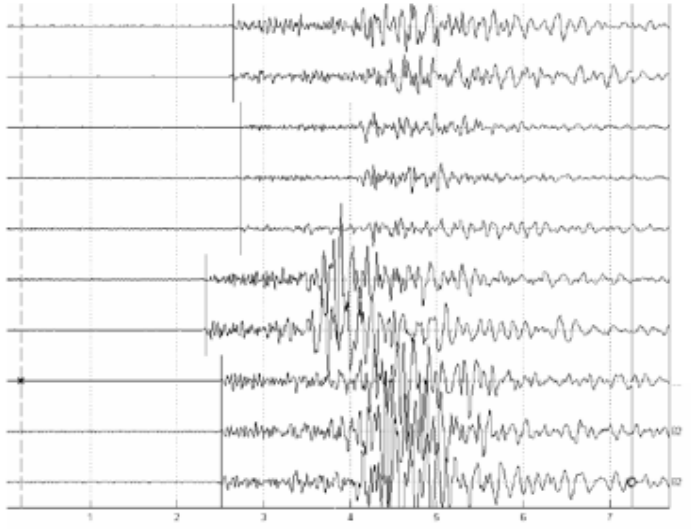
- Currently ~6 month build time for custom seismic arrays.
- Monitoring estimated starting ~ Q1 2023
  - 1-2 months “learning phase” for after monitoring system is operational.
  - Q2 2023 initial reports on status on seismic array, event locations, etc.
    - Set up an tiered “seismic alert system” for Sulphur Mines Dome
      - Call down list, example reporting, etc.
      - Set parameters for the notification time based on seismic alert system
      - Considered an “Initial” alert system
        - » The ability to distinguish normal/anomalous microseismicity will continue over time.
  - Q3 2023 initiate monthly report.
    - Continue monthly reporting to ~Q1 2024 (one year)
    - Continued evaluation of Seismic Alert System.
    - Evaluate seismicity/reporting and the appropriate levels of continued seismic monitoring.
  - Q1 2024 – step down in frequency of reporting: start an annual report

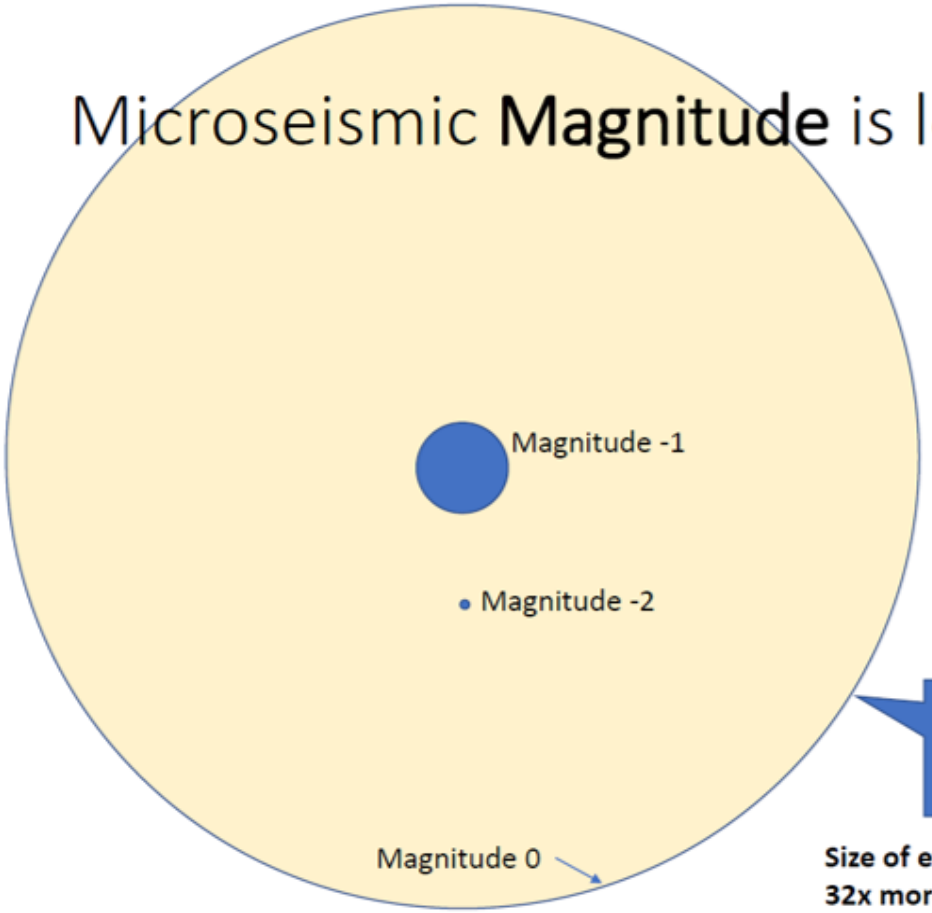
Thank you

QUESTIONS?

Microseismic “Magnitude”

Magnitude is estimated from seismic waveforms





“Energy Equivalents”

Magnitude	Potential Energy
0	minivan dropping 3 feet
-1	bbl oil dropping 3 feet
-2	jug of milk 3 feet

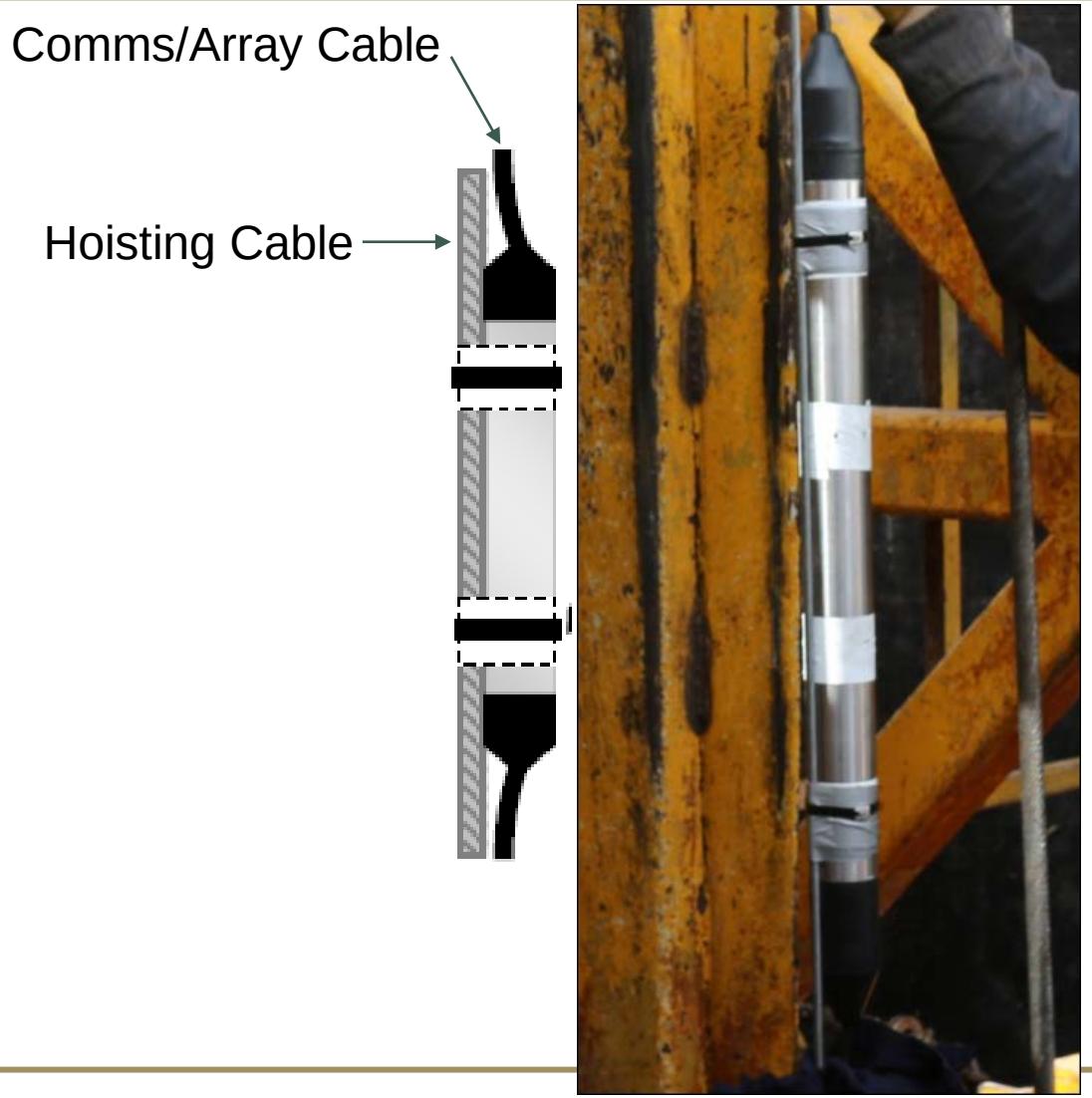
Magnitude	Kinetic Energy
0	Rifle
-1	Pistol
-2	Air rifle

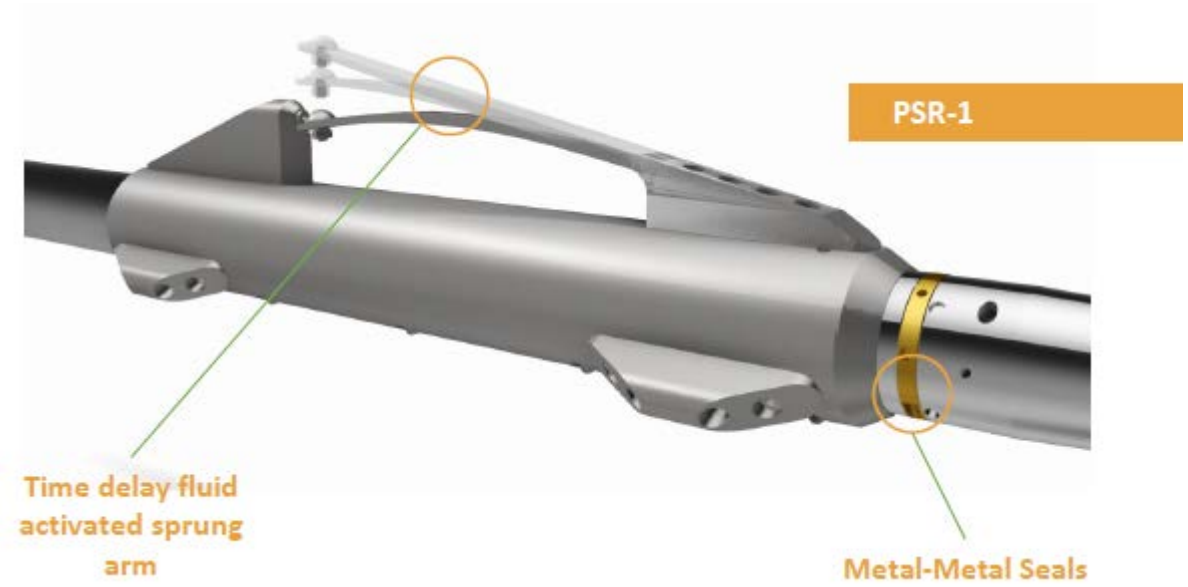
Source for Energy table: Microseismic Imaging of Hydraulic Fracturing: Improved Engineering of Unconventional Shale Reservoirs (Distinguished Instructor Series No. 17), SEG, 2014.

Representative size
0
-1
-2

Size of event 10x larger per magnitude level
32x more energy per magnitude level

Geophone & Cable





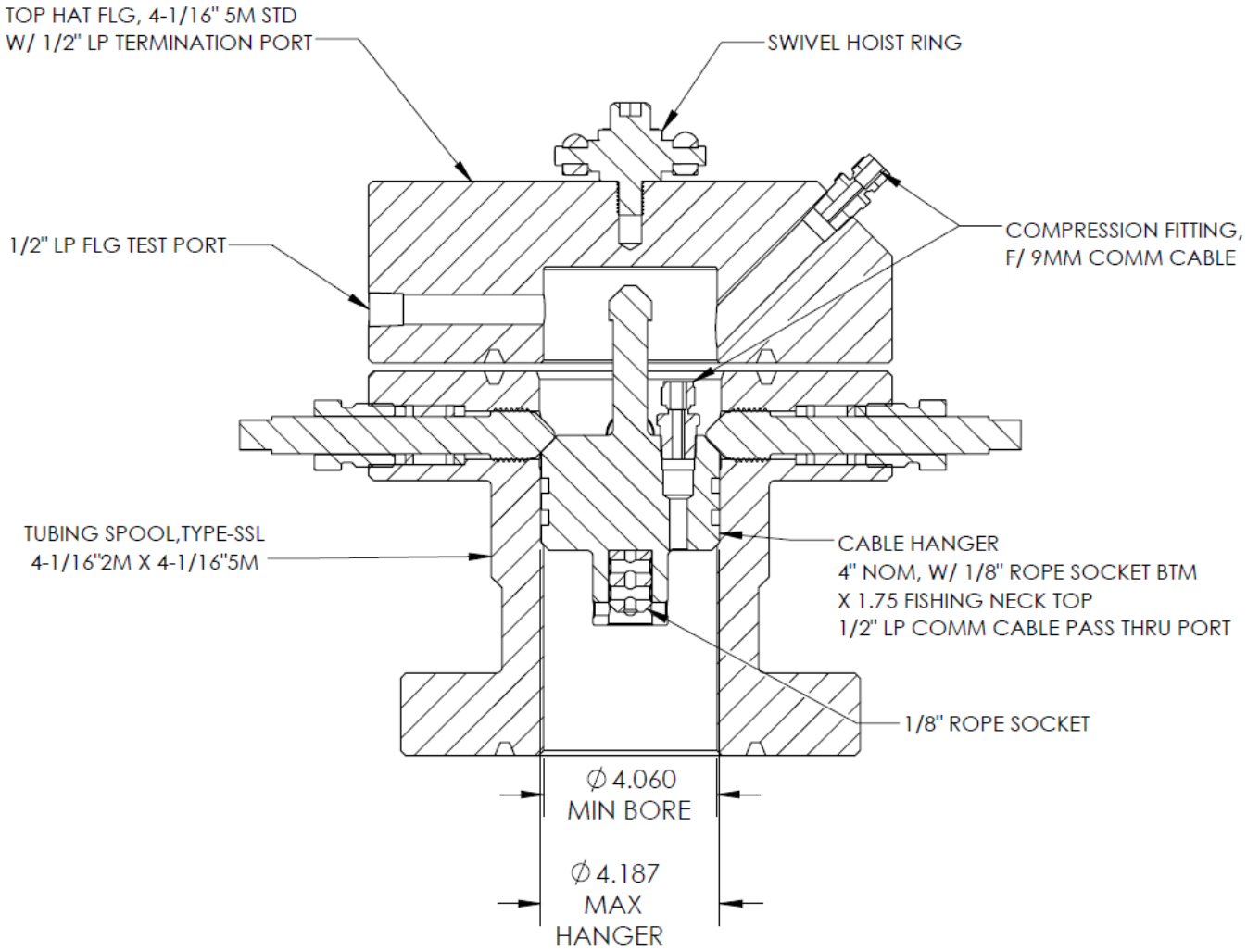
Wellbore Inspection Phase

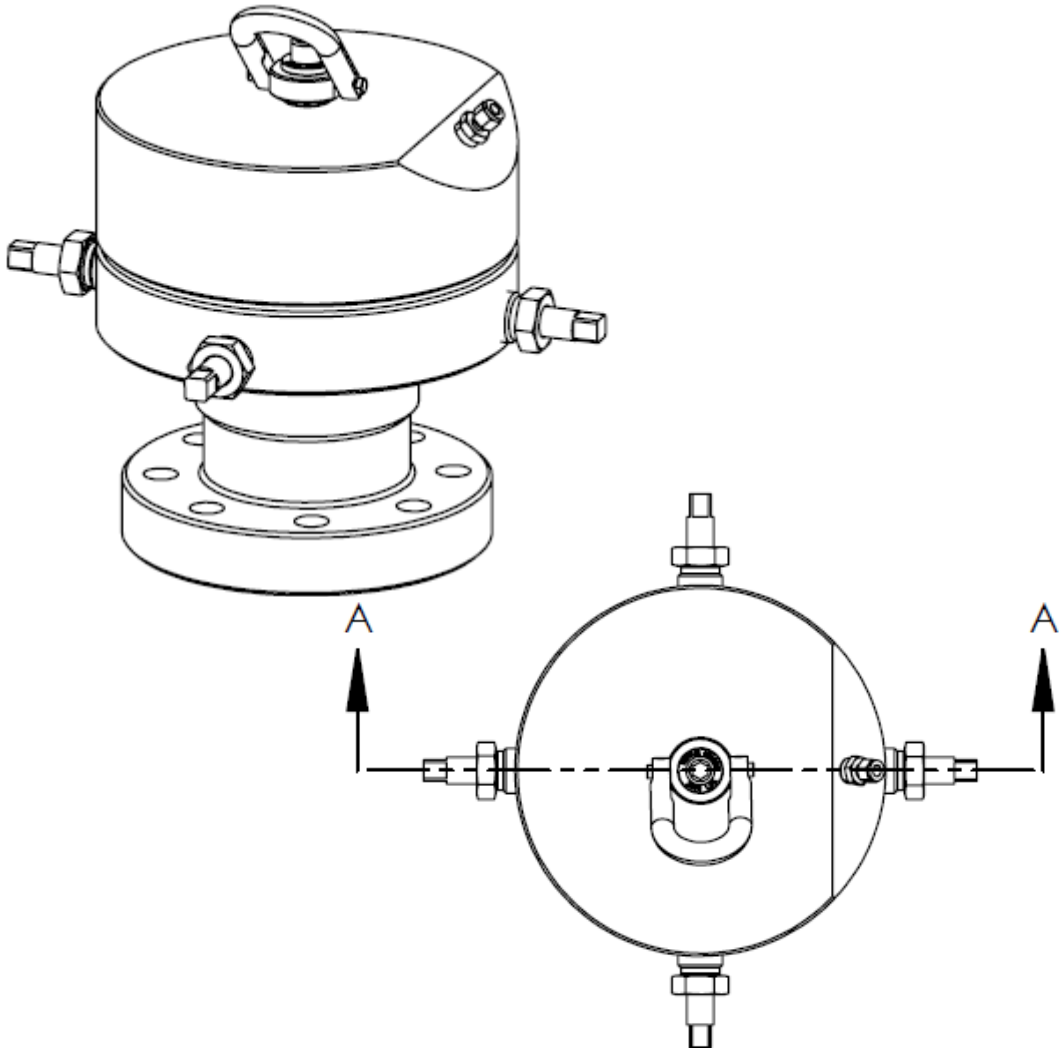
- Move in service rig
- Remove 5-1/2” brine string
- Scraper run on 7 5/8” production casing
- Run casing inspection logs and CBL
  - HiRes Vertilog, 60-Arm Caliper, & SBT
  - Confirm geophone placement depths
    - Sonar Surveys & Nitrogen MIT’s previously performed in March 2022
- Complete the above on both wellbores
- Order geophone equipment (24 week lead time) based upon above results
- Prep surface for equipment installation

Geophone Installation Phase

- Install surface facilities/equipment for data collection and processing
- Run geophones & pressure gauge system to target depth with 1/8” slickline
  - Rigless; via slickline and crane
  - Scaffolding around wellhead to be installed as work floor
- Install new wellhead spool
- Conduct string shot “seismic event” via offset PPG 2 wellbore/cavern
  - Verify orientation of the geophones within 6X & 7B

New Wellhead Spool





New Wellhead Spool

New Spool will go here.