The Rock Valley Direct Comparison: Deep Core Drilling in an Unconstrained Fault Zone and Seismometer Emplacement

C.N. Pennington[1], W. R. Walter[1], C. M. Snelson[2], R.E. Abbott[3], C. Stanciu[3], A. Miller[4], J. Pine[4], C. Freimuth[4], K. Gaynor[4], I. Whittaker[4], C. Carr[2], J. Falliner[3], C. Jewell[4], E. Alger[1], M. Dietel[4], J. Bonner[1], K. Smith[4] and M. Pyle[1]

Lawrence Livermore National Laboratory[1], Los Alamos National Laboratory[2], Sandia National Laboratories[3], Nevada National Security Sites[4]

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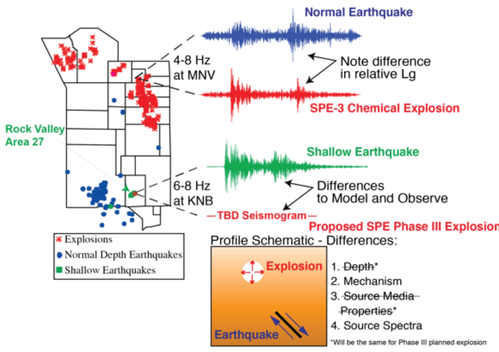
The Plan

Key Science Questions:

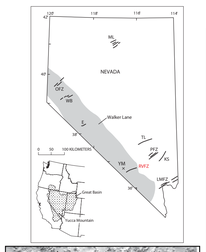
- What are the fundamental signature differences between explosions and earthquakes?
- In a region without prior explosions, how do we robustly use earthquakes and geophysical knowledge to predict explosion signatures?
- Through direct sampling and measurement, can we improve the physical understanding of earthquakes and explain why are there shallow (< 3km) earthquakes in some regions but not others?



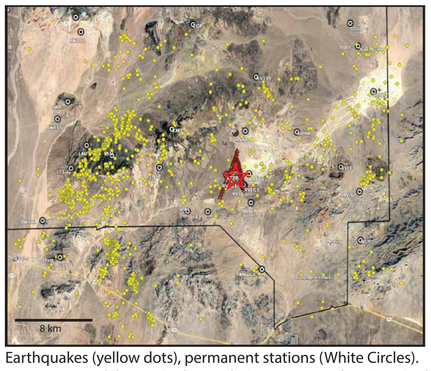
RV/DC

What is the Rock Valley Direct Comparison Experiment (RV/DC)?

- We will directly compare an explosion at the same location as a prior shallow earthquake.
- Rock Valley Nevada is chosen since it is an area of active shallow and normal depth earthquake occurrence.



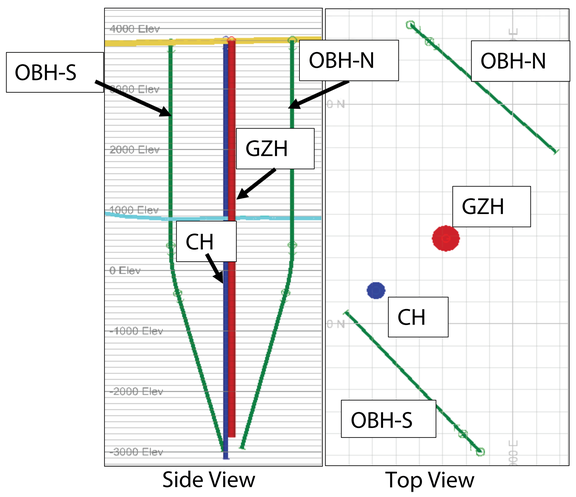
From O'Leary (2000)



Earthquakes (yellow dots), permanent stations (White Circles). Temporary nodal array (red triangles). Experiment location. (red star)

- Step 1: Drill a corehole (CH) to allow for the characterization of the geology in the flower structure and understand hazard
- Step 2: Drill two observatory holes (OBH-N OBH-S) for the experiment.
- Step 3: Drill a hole to contain explosive (GZH) the size of which will match a 1.5-2.5 magnitude event.

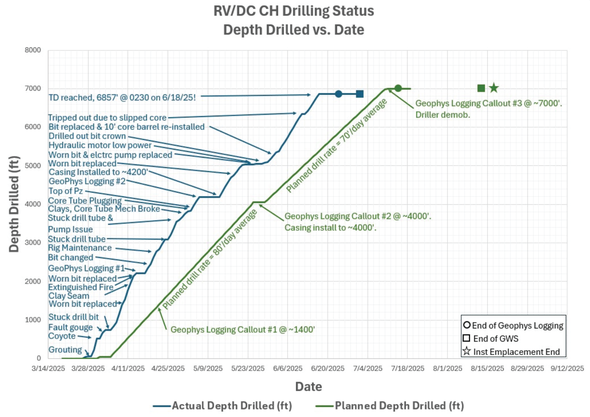
Plan is to drill 4 deep boreholes



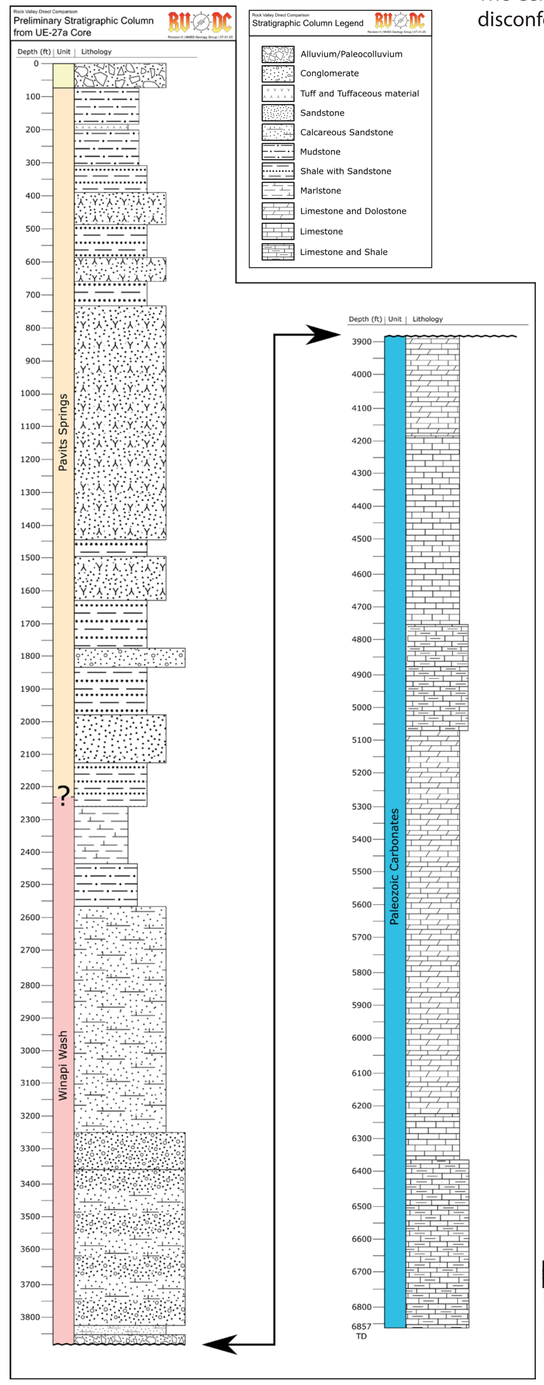
Deep Core Drilling

Deep Core Drilling

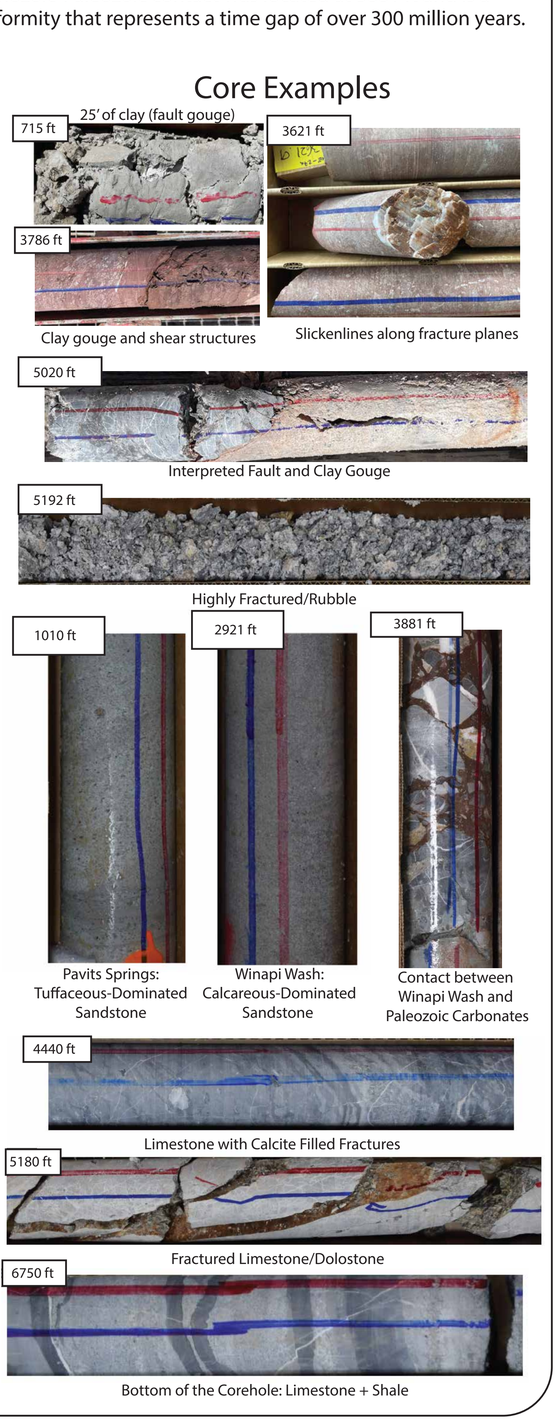
- Drilling started on 3/17/25 and ended on 6/21/25
- Elevation of Drill site is 1151.56'
- Total Drilled: 6857' (2090 m)
- Total Recovered Core: 6735.2' (2053 m)
- Total Recovery Percent: 98.2%
- Total Sound Core: 5484.3' (1672 m)
- Total Sound Percent: 80.0%
- Water Table 1,406' (427 m) from ground level



- Drilled through a flower structure to reach the location of shallow seismicity.
- Crossed through at least 3 main geologic units with more to be interpreted with further analysis.
- Crossed a number of faults. Some shallow at 700 ft (213 m) and others at 5000 ft (1524 m) deep.
- Shallow fault exhibited sub-vertical fracturing that transitioned to small-scale shear and fault planes, and eventually fault gouge.
- The Cenozoic-Paleozoic contact was located at 3881 ft and is a disconformity that represents a time gap of over 300 million years.



Core Examples



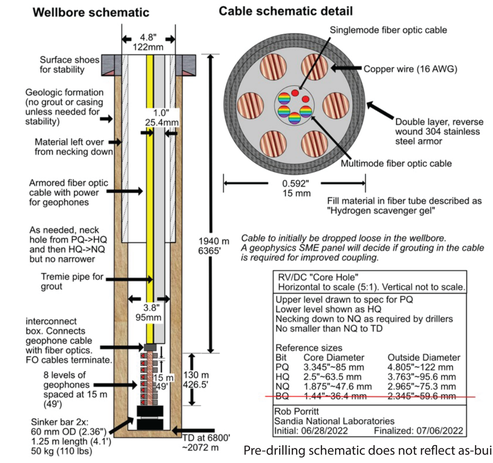
Seismometer Emplacement

DFOS (Distributed Fiber Optic Sensing) Array

- Distributed Acoustic Sensing (DAS): 30 m gauge length and channels every 1 m with a 500 Hz sampling rate. Producing a total of 3000 sensing locations (2000 in CH).
- Distributed Temperature Sensing (DTS): Channel spacing is 0.508m and averaging timing is 30 min.

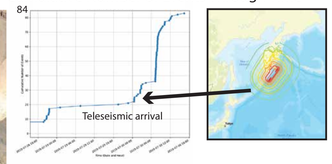
Seismometer Array

- 8x3 channel Geophones with sampling rate of 4 kHz with a 24 dB gain



Pre-drilling schematic does not reflect as-built dimensions

Observations

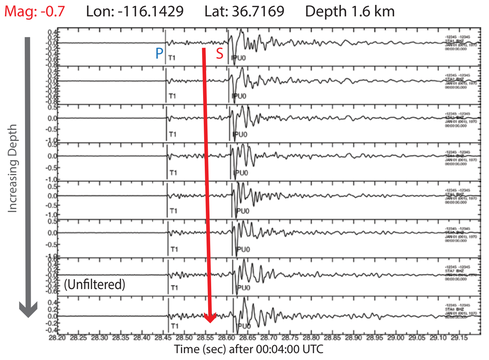


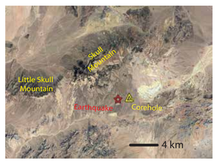
- The M8.8 in Kamchatka appears to have produced a large increase in events at Little Skull Mountain
- We are observing events shallower than the borehole array

Example Shallow Event

2025-07-09 00:04:27.92871 UTC

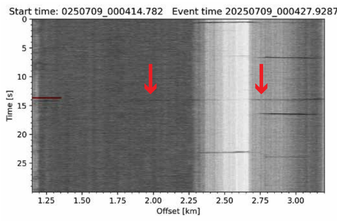
Mag: -0.7 Lon: -116.1429 Lat: 36.7169 Depth 1.6 km





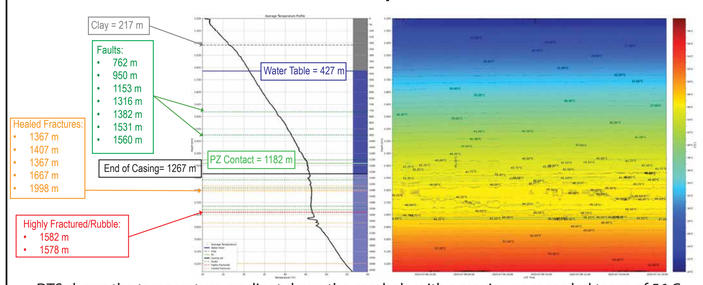
Depth (m)	P (s)	S (s)
2065	28.455	28.604
2080	28.457	28.605
2095	28.458	28.607
2110	28.459	28.609
2125	28.460	28.612
2140	28.461	28.613
2155	28.462	28.614
2170	28.463	28.616

DAS



- DAS records seismicity, but is less sensitive than the seismometer array. Sensitivity improves below the ground water level.
- Sensitivity issues are likely due to coupling issues with the borehole wall.

DTS: Corehole Temperature Profile



DTS shows the temperature gradient down the corehole with a maximum recorded temp of 56 C. Temperature fluctuations often occur around areas of fractured rock.

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