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Borehole DAS recordings of the DAG-1 chemical explosion

PRESENTED BY

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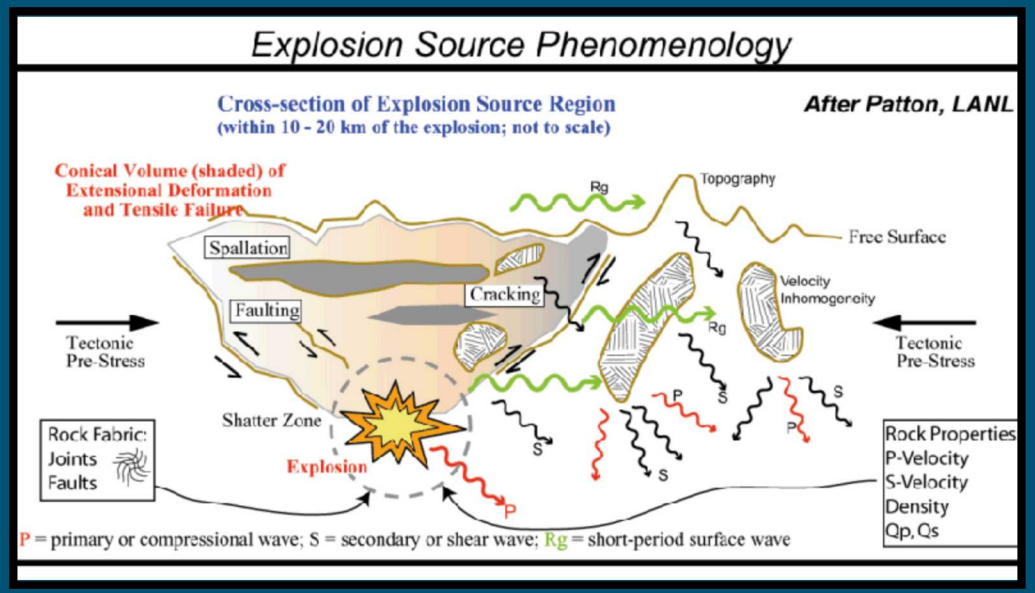
The Source Physics Experiment Phase II, Dry Alluvium Geology

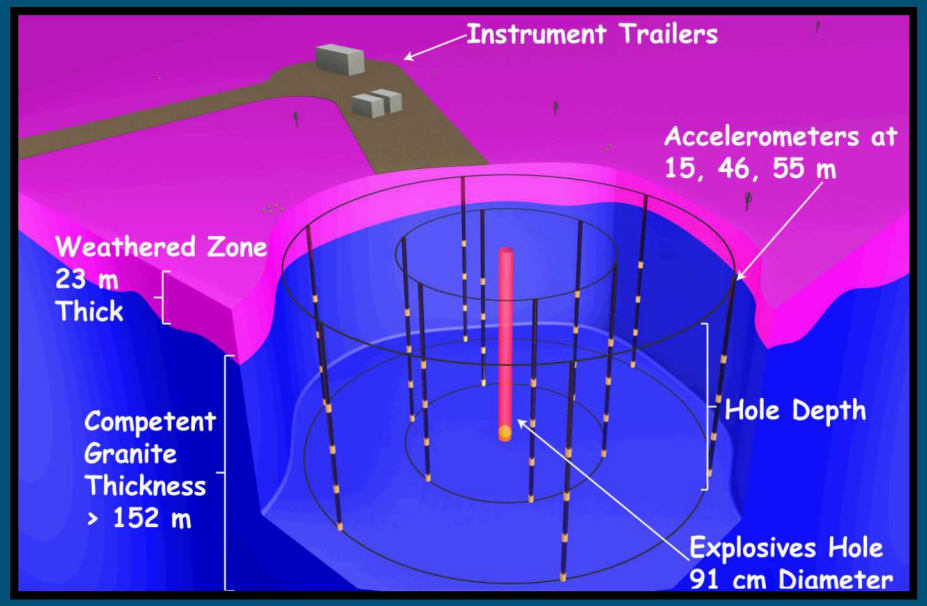
SPE systematically examines the phenomena in the source region of explosions

- The causes of shear-wave creation is of particular interest

Conduct a well-instrumented series of explosions at the Nevada National Security Site (formerly NTS)

Use seismic and other recordings as groundtruth for more physics-based models (as opposed to current empirical models)





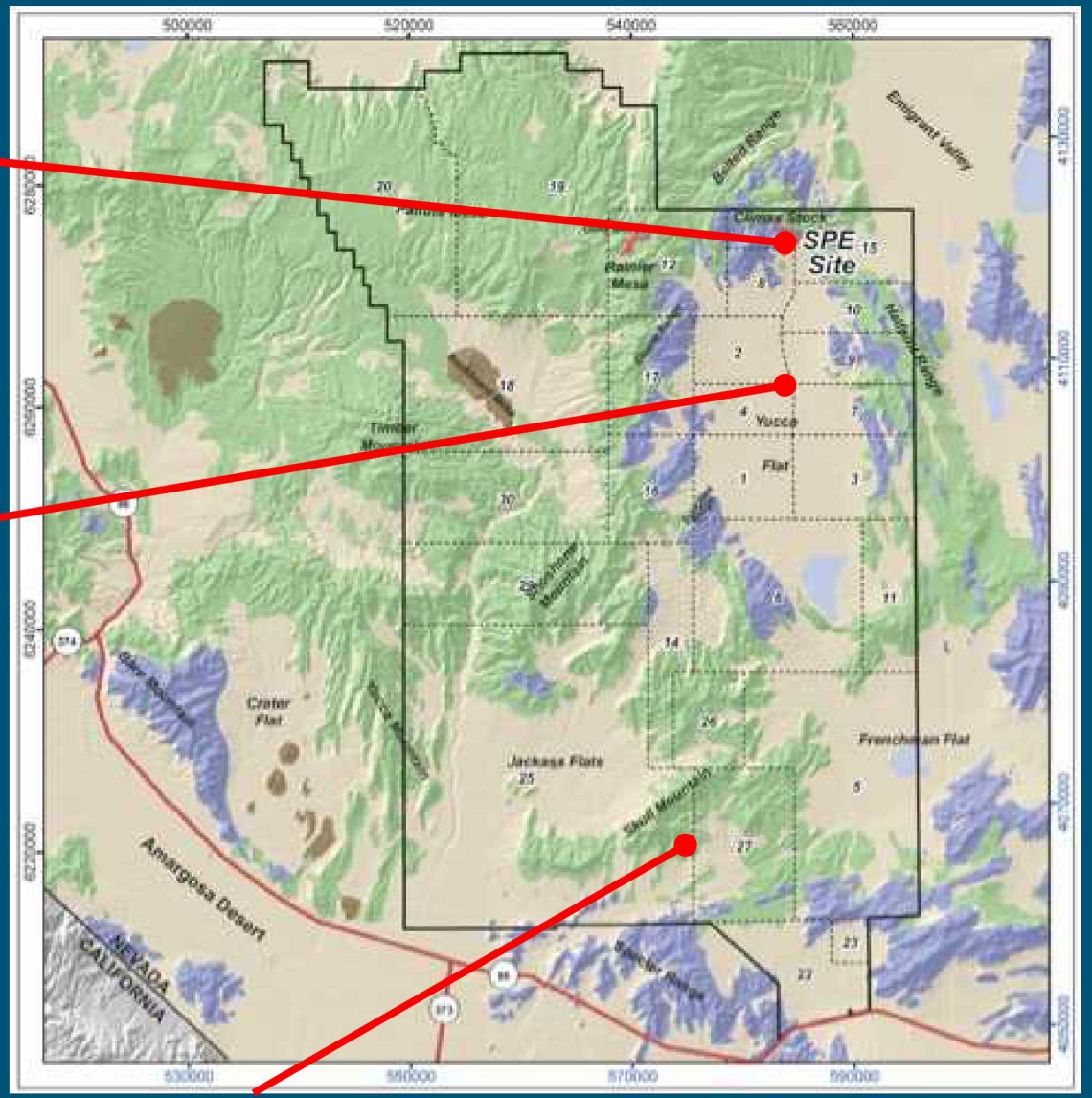
SPE Locations

Phase I (SPE)

- Climax Stock in Area 15
- Location of three nuclear tests
  - HARD HAT
  - PILE DRIVER
  - TINY TOT
- Geology: Granite (hard rock)
- Years: 2010-2016

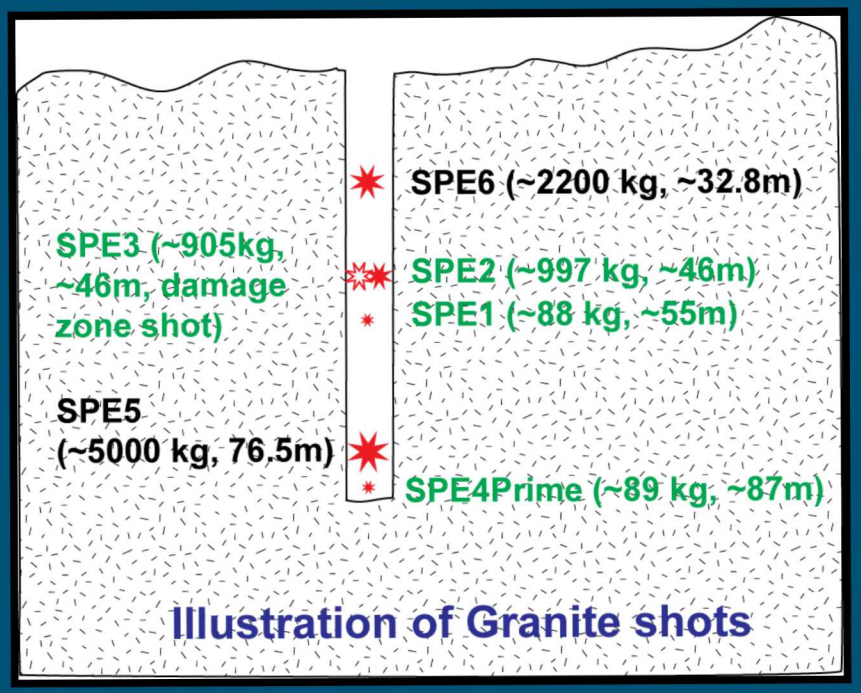
Phase II (DAG)

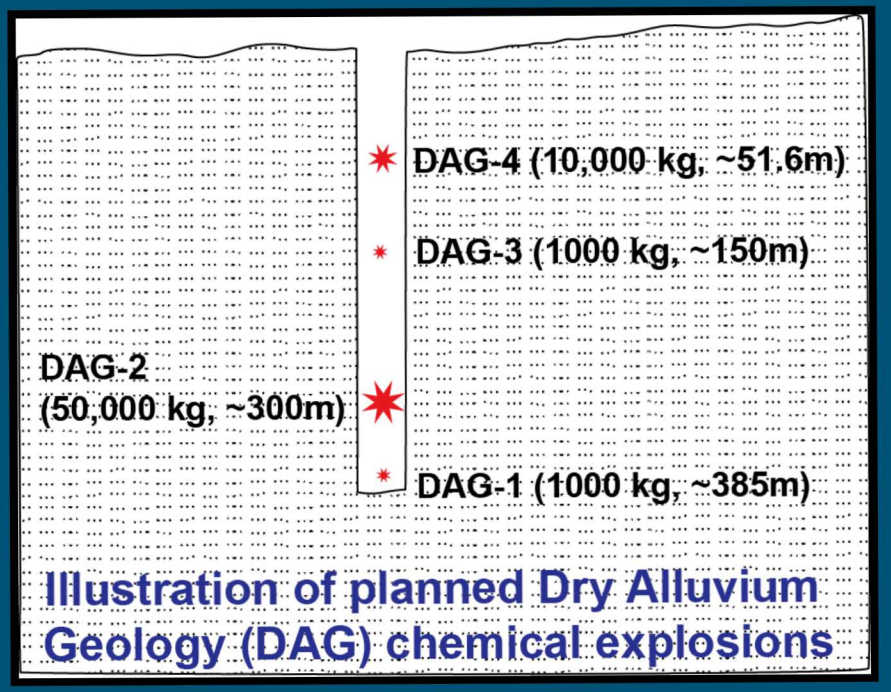
- Location: Yucca Flat
- 9 nearby nuclear tests less than 1 km away
  - FLASK
  - YANNIGAN
  - Others
- Geology: Dry Alluvium Geology (DAG)
- Hole: U2-ez (96" diameter) drilled in 1983
- Dates: FY17-FY19



TBD: Phase III (Rock Valley Direct Comparison)

Completed and Planned SPE Chemical Explosions

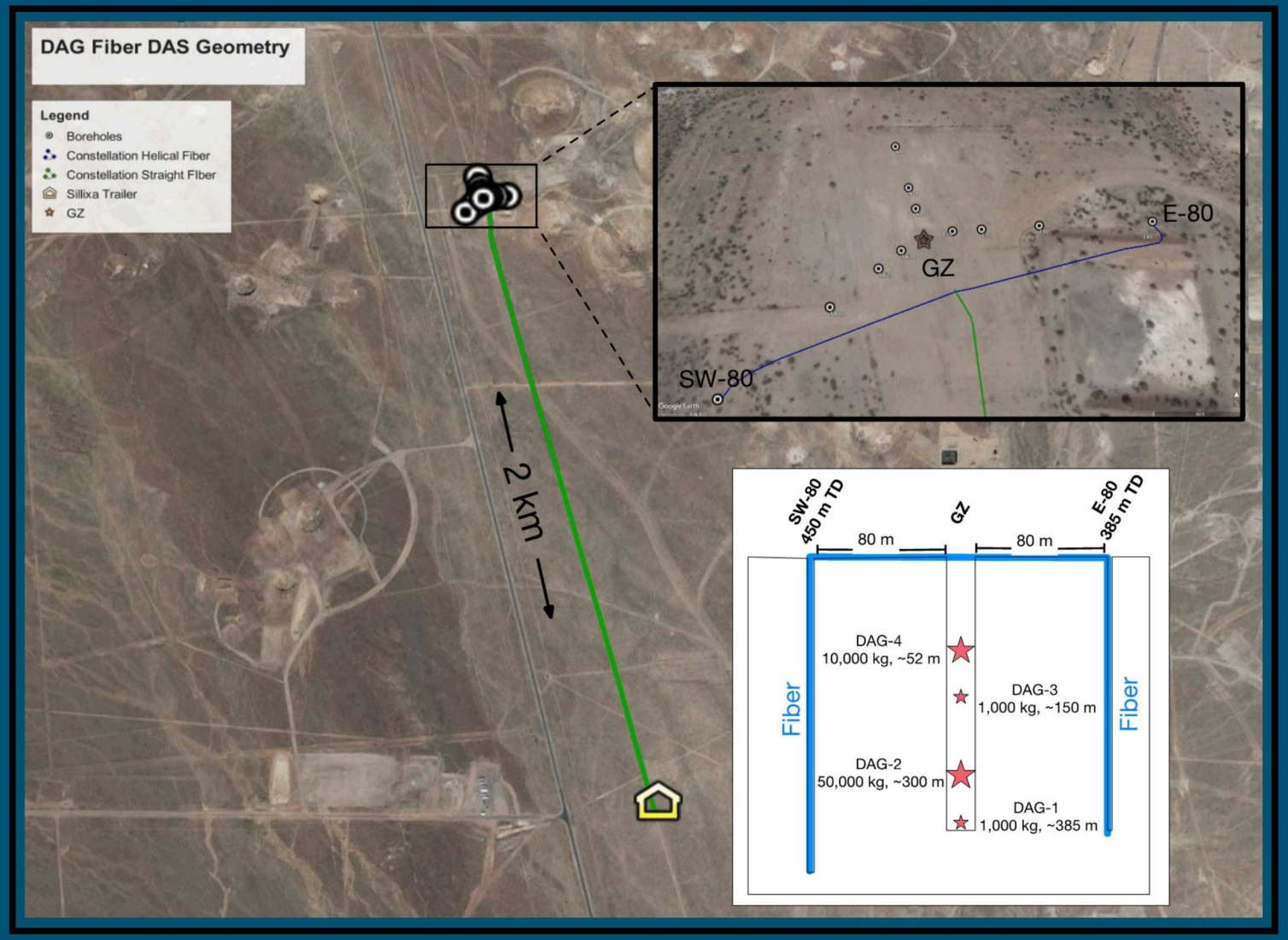




- Phase I is complete
  - Seismo-acoustic data is available for download at Iris
  - No DAS data acquired
- DAG-1 executed July 2018
  - DAS results in this presentation
- DAG-2 scheduled for 1 ½ weeks from today

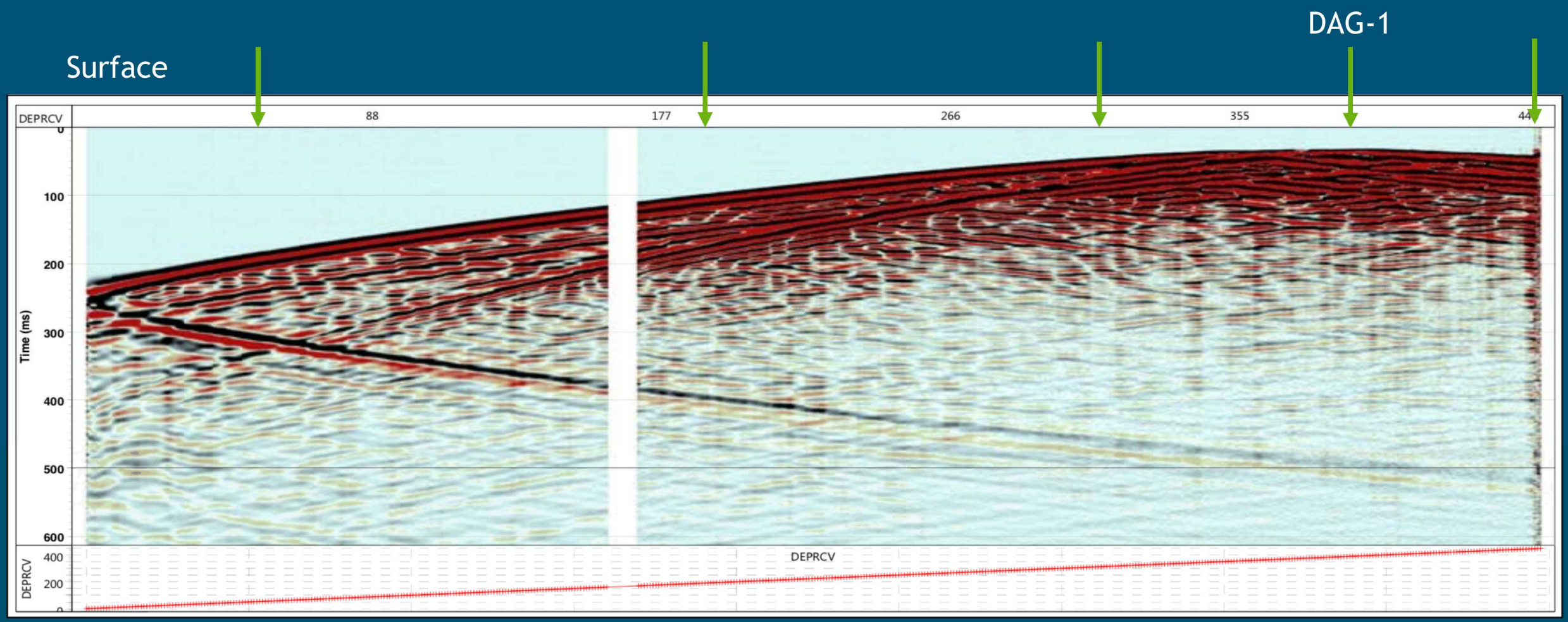
DAG-2 Canister
50,000 kg TNT-equivalent

DAG Fiber DAS Acquisition and Geometry



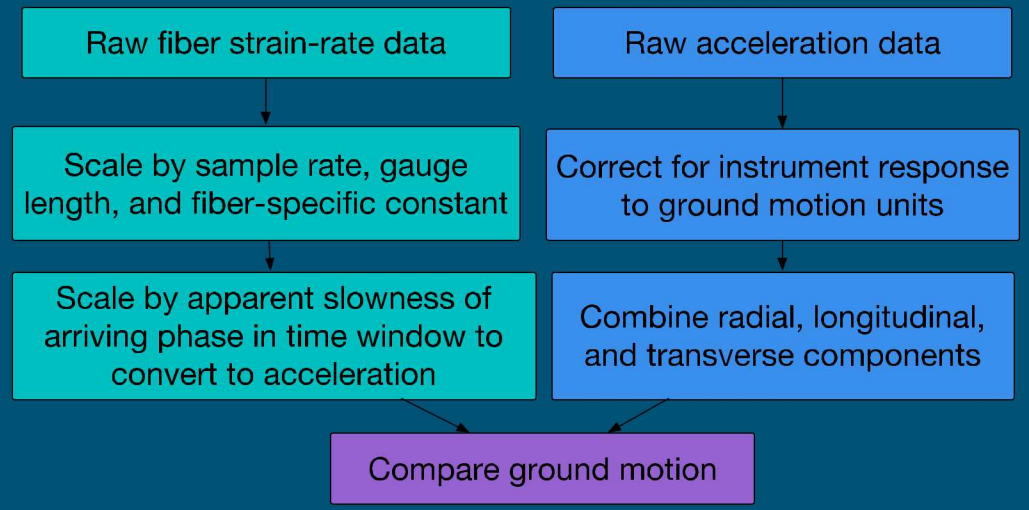
- 1 km of helically wound cable (HWC)
  - HWC cable grouted in two boreholes 80 m from GZ
  - HWC surface-trenched cable between the two boreholes
- 2 km of straight Constellation cable
  - Straight cable run in trench to recording trailer ~ 2 km from GZ
- Triaxial accelerometers at level of each explosion in 12 surrounding boreholes
- Single triaxial geophone

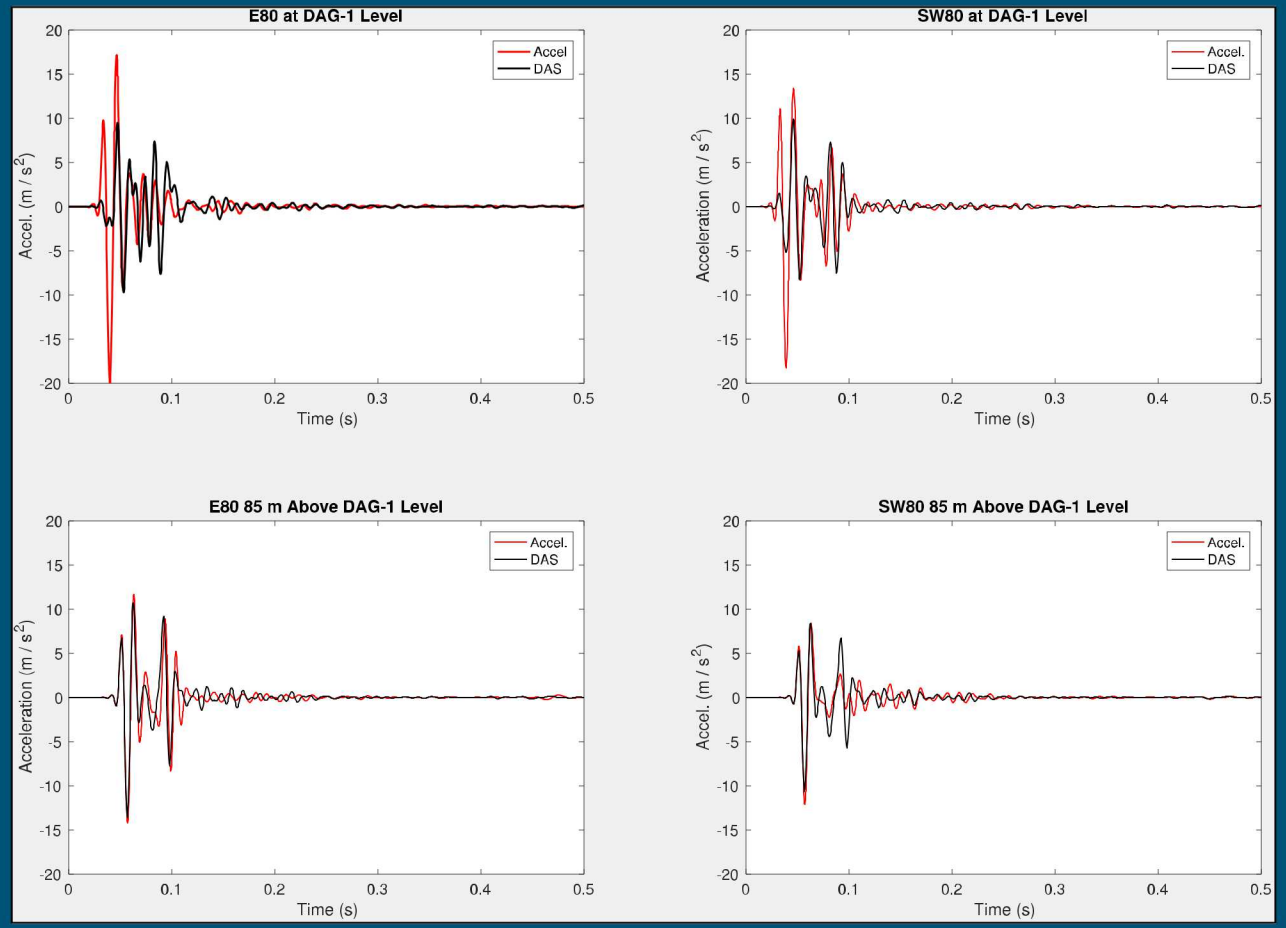
DAS Data in SW-80 Borehole



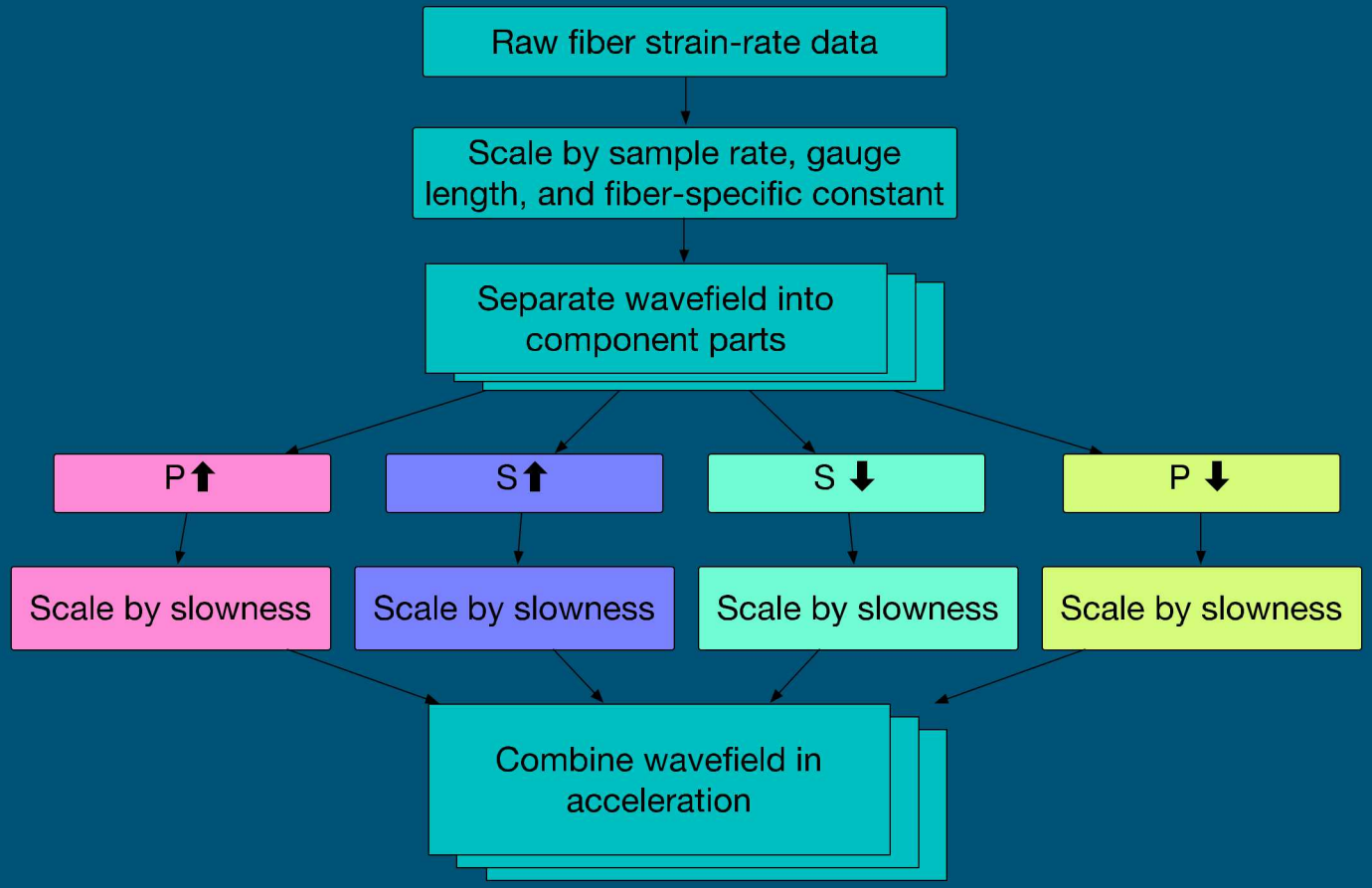
2 m gage length, 2000 SPS
Green Arrows = 3C Accelerometer Depths

Convert Fiber Strain Rate to Acceleration via Simple Scaling

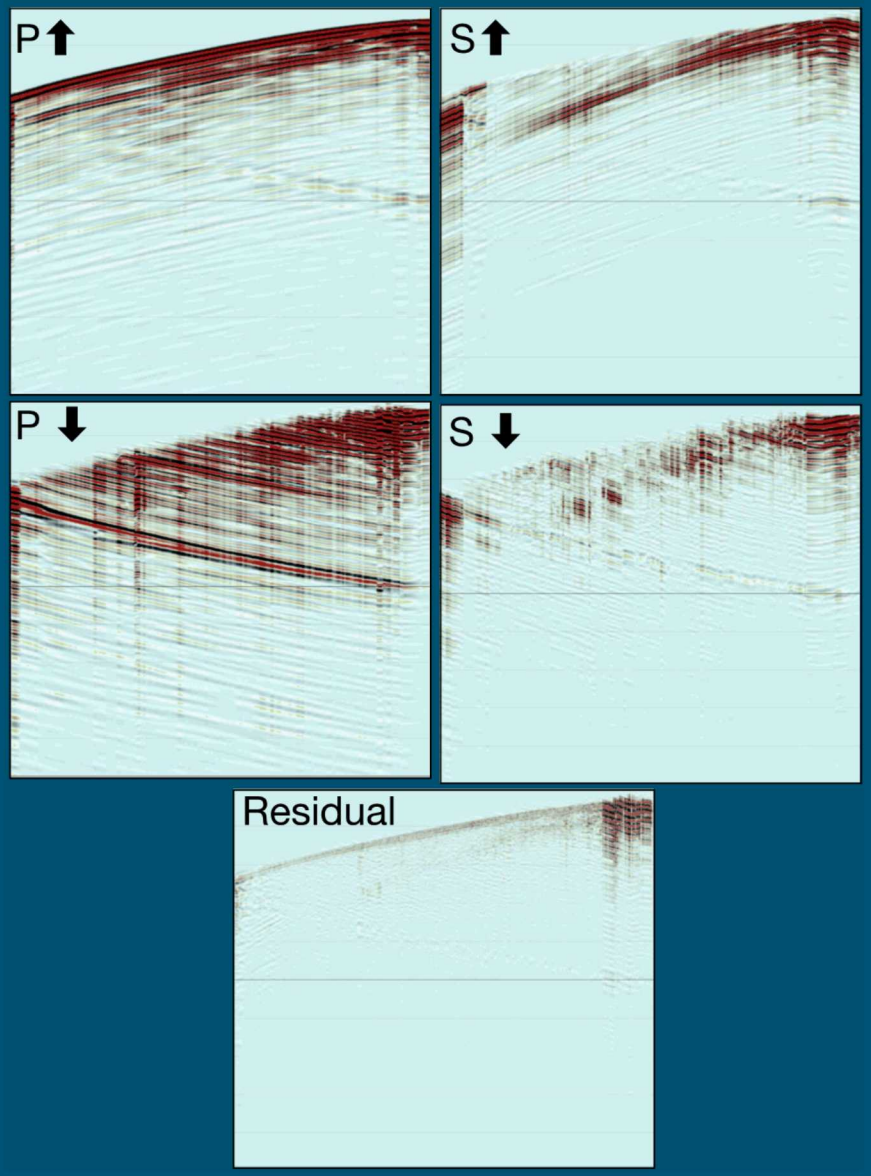




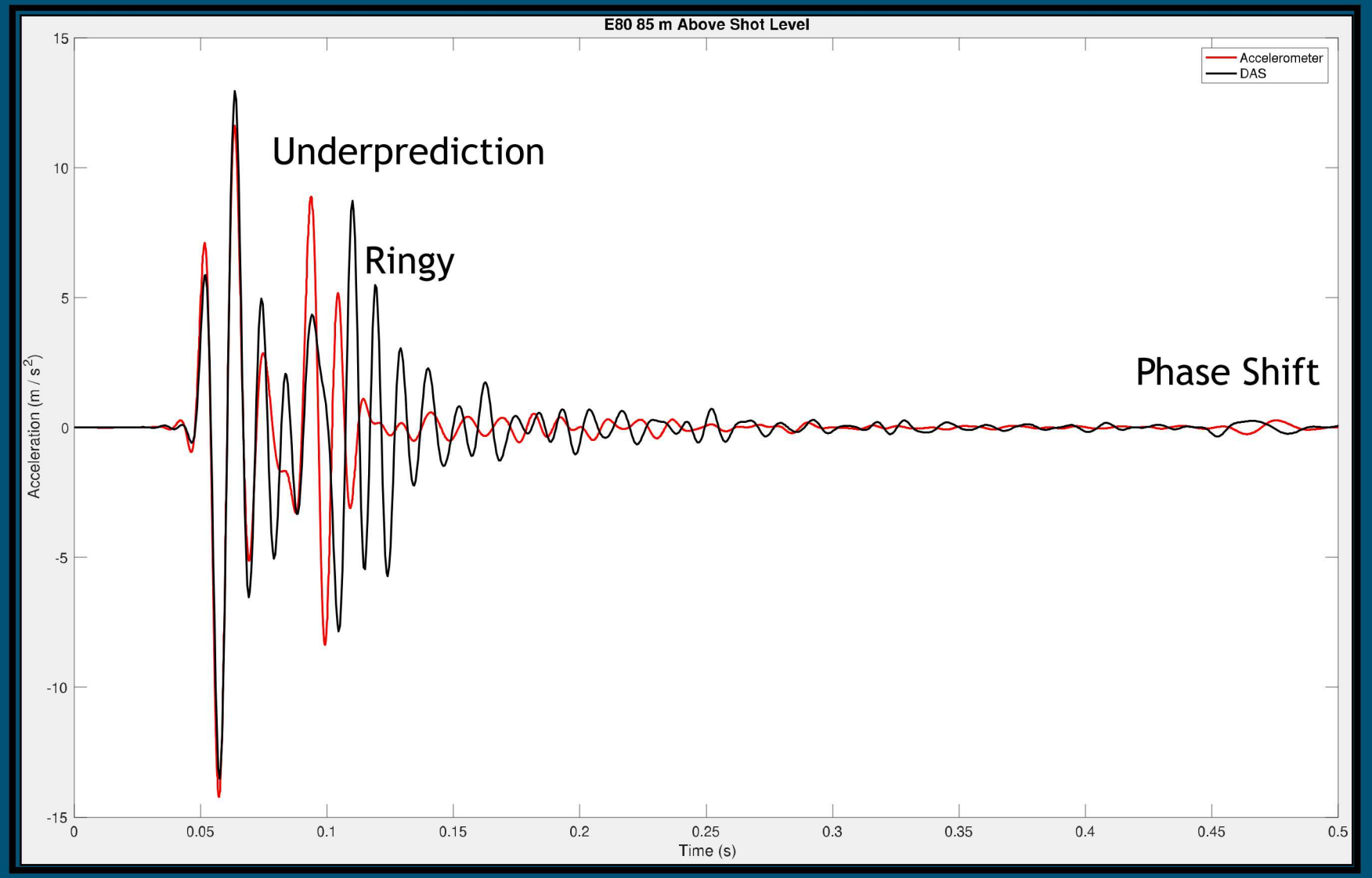
Convert Fiber Strain Rate to Acceleration Wavefield Separation



Preliminary Wavefield Separation

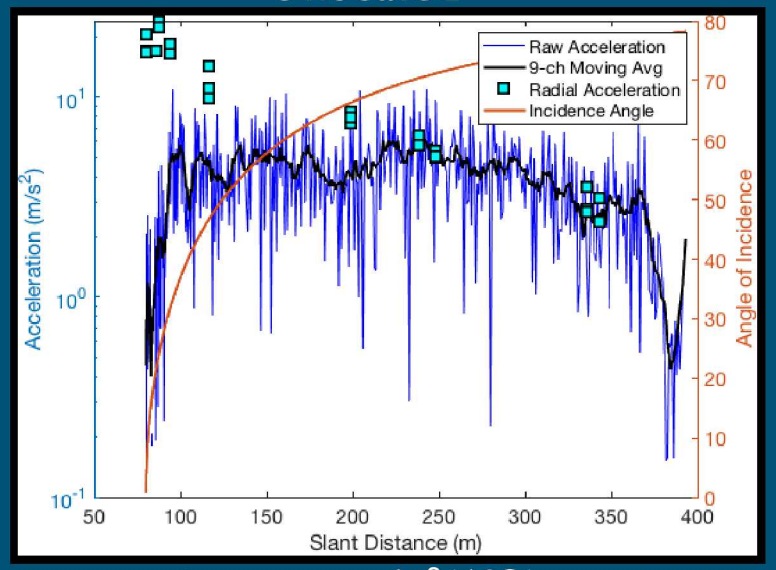


Convert Fiber Strain Rate to Acceleration via Wavefield Separation

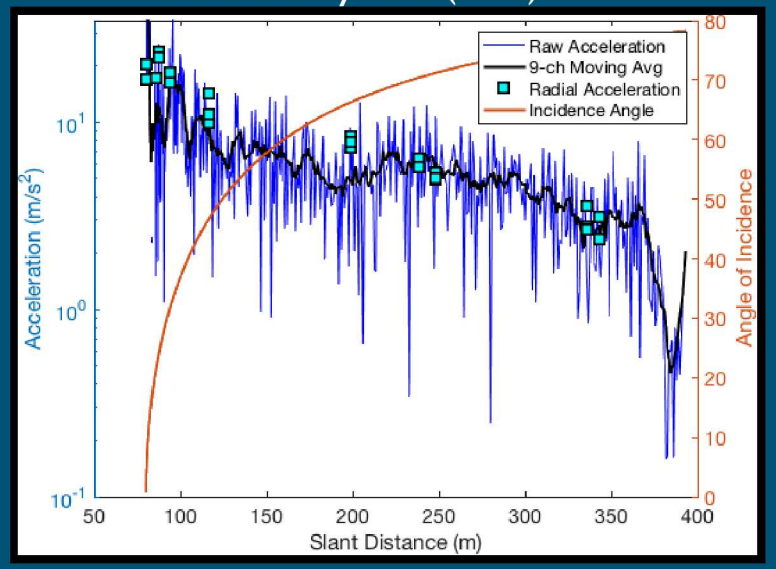


Scaling All First Arrivals by Phase Velocities Show Probable AOI Sensitivity on HWC

Unscaled



Scaled by $\sin^2$(AIO)



- Just the first period of P-wave
- Amplitudes scaled by calculating slope of P-wave travel times and applying same "coupling" factor for all channels
- Radial Acceleration from 3C accelerometers

- Data show clear rollover in amplitudes near shot level where angle-of-incidence is perpendicular to fiber length.
- Scaling by $\sin^2$(AIO) provide reasonable fit, but blows ups near zero AOI

- Curious rollover in amplitudes at shallow depth. Unfortunately no accelerometers for groundtruth at those depths.

Next Steps

- Acquire data for DAG-2, -3, and -4
  - Fill in offsets and angles and explore strain-rate sensitivity
- Process E-80 data the same as SW-80
- Process the 2-km straight cable section
  - DAG-2 will have 75 co-located 3C geophones along the section
- Use existing velocity tomography and receiver geometry to refine apparent phase velocities for use in wave separation