Defense Nuclear Nonproliferation Research & Development

Nuclear Explosion Monitoring Program Review
NEM2021

Rock Valley Earthquake Relocation

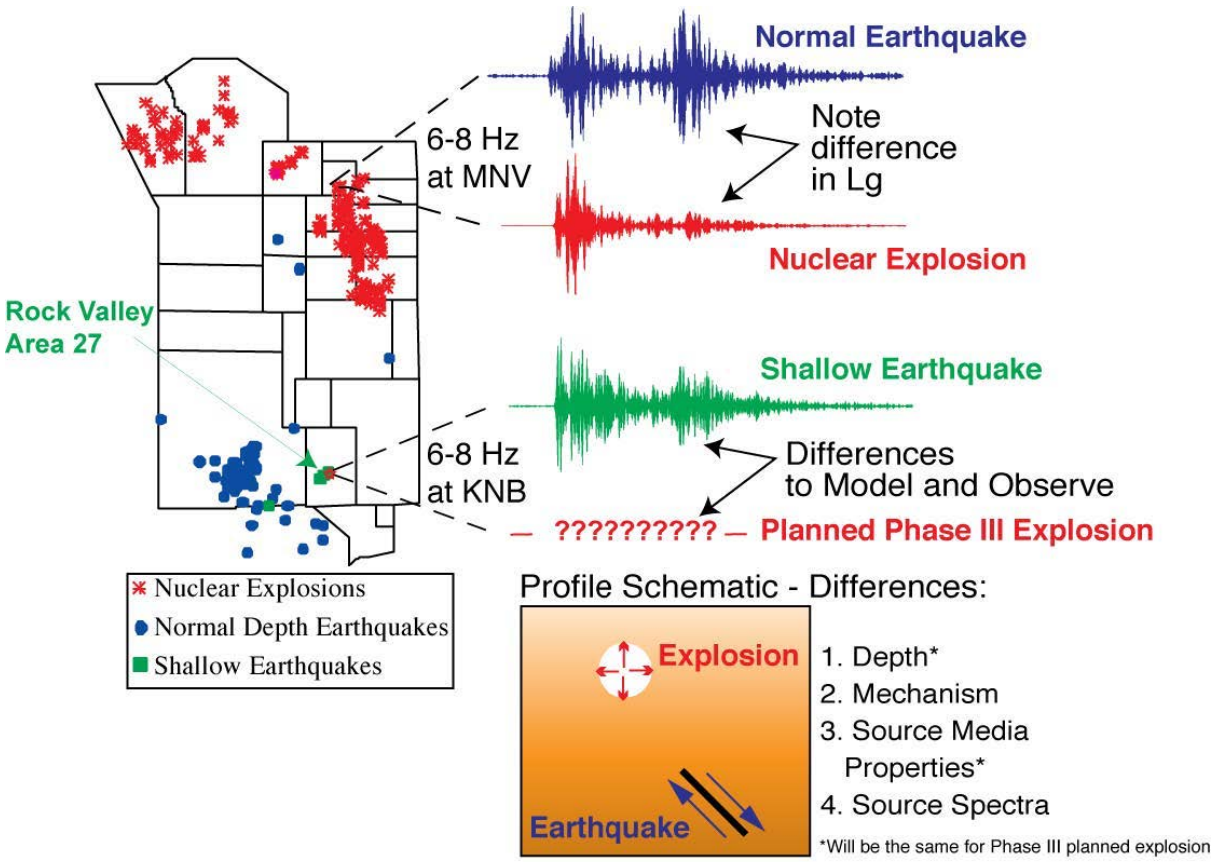
Michelle (Dunn) Scalise, Cleat Zeiler, Lance Prothro
NNSS
Seismic Support from Bob White and Kale McLin (NNSS)

1x March 2021

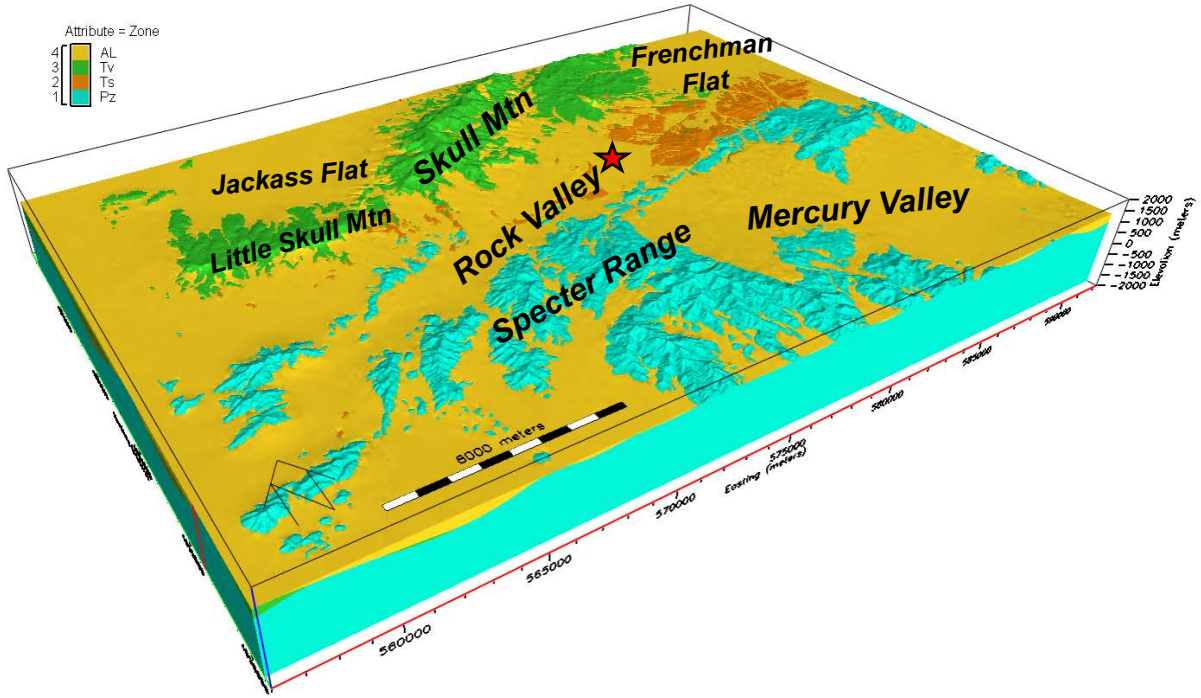
This work was done by Mission Support and Test Services, LLC, under Contract No. DE-NA0003624 with the U.S. Department of Energy. DOE/NV/03624--1011.

Motivation

- **Refine earthquake locations**
  - **Minimize depth uncertainty**

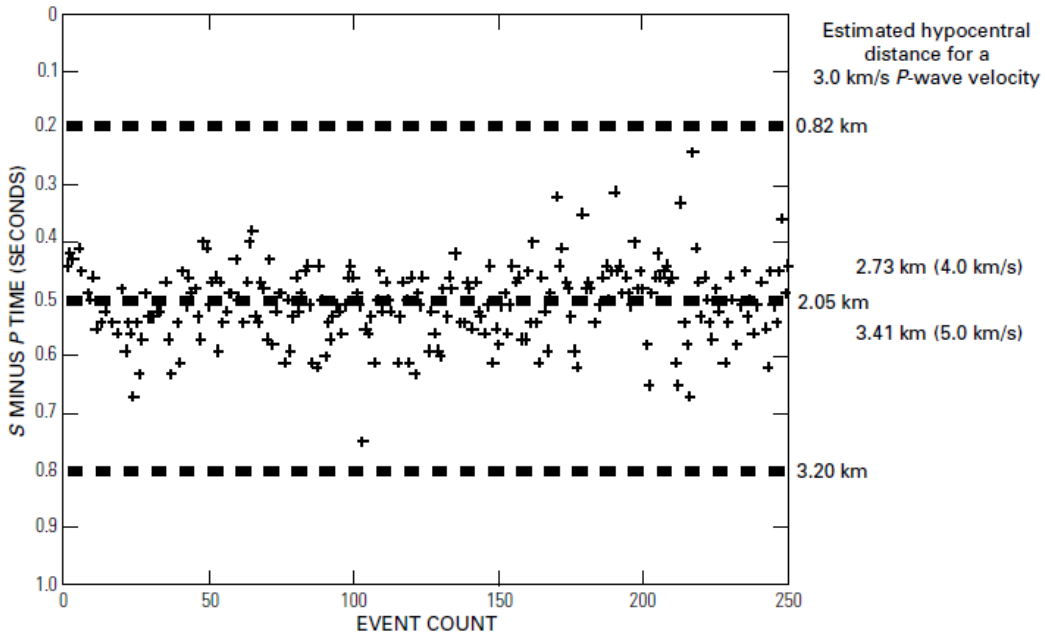


- **Inform and refine GFM**
  - **Image subsurface fault geometry**

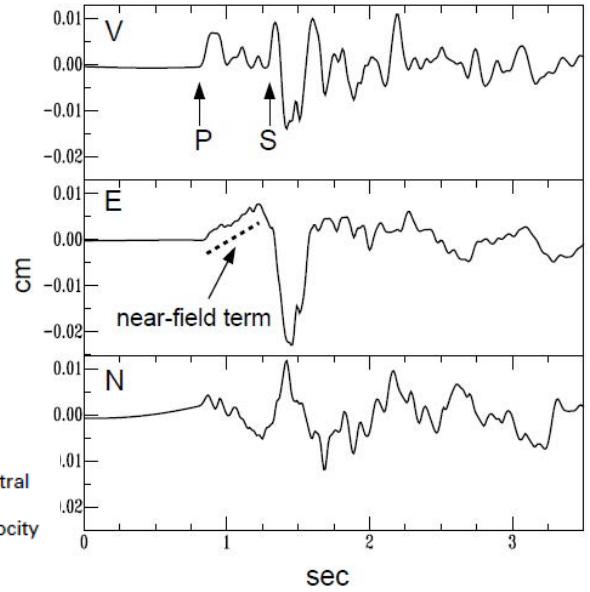


Previous Work

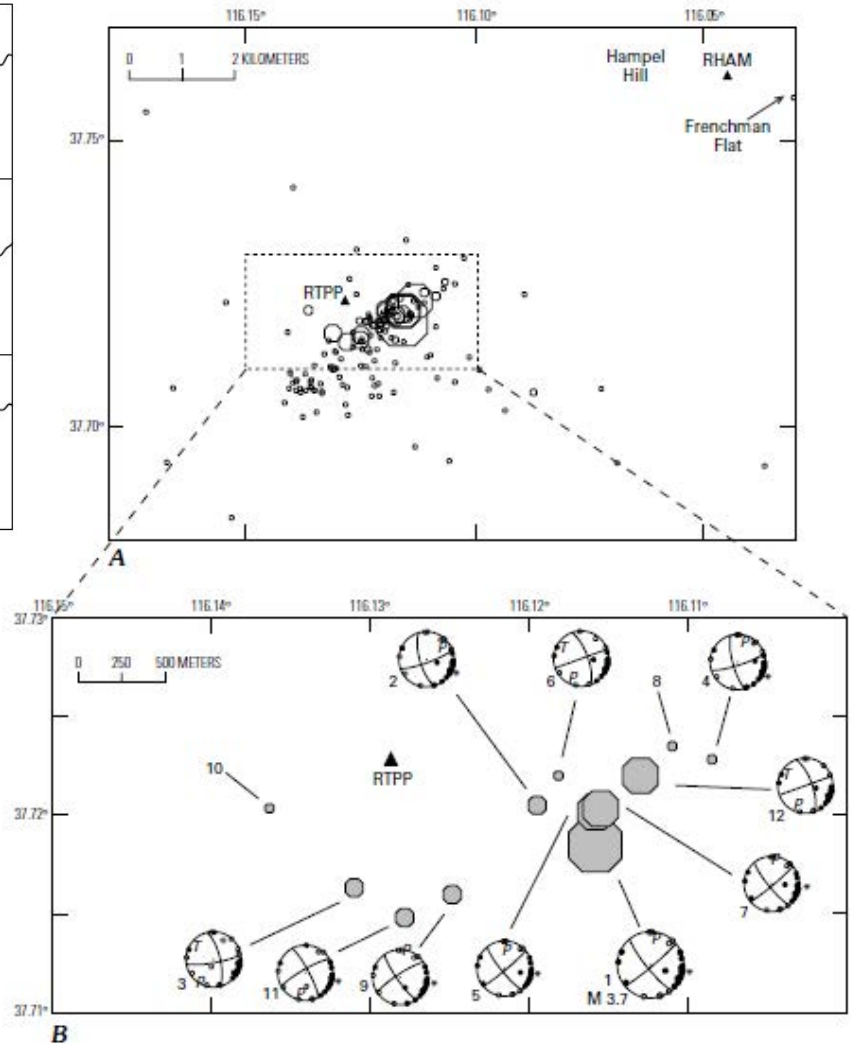
- 1993 Rock Valley Sequence
- Shallow earthquakes (< 3 km)
  - Short S-P times
- ML 3.7 event on May 30, 1993
- ~500 events in 5 months



Smith *et al,*. 1993



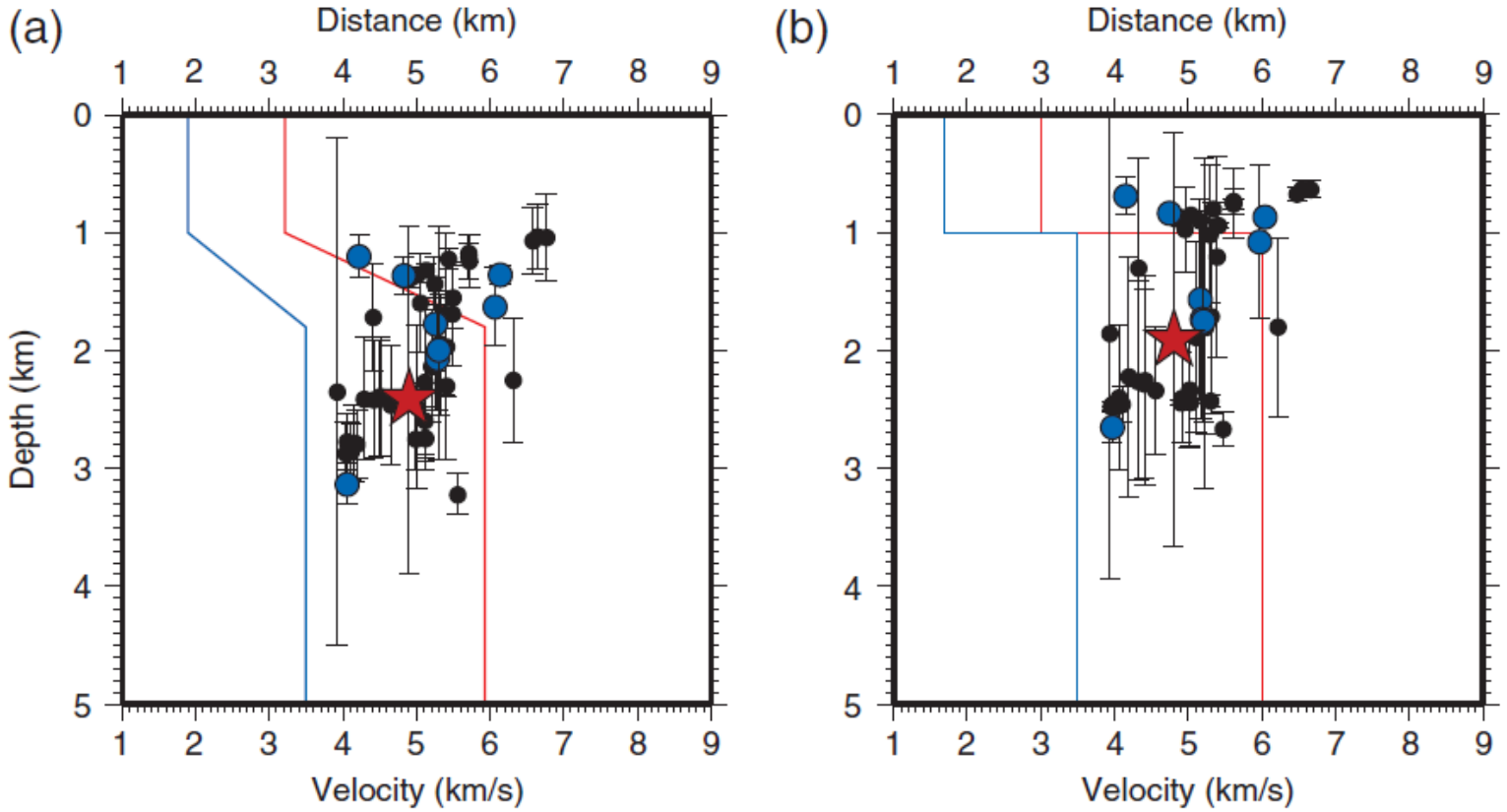
Shields, 1999



Smith *et al.,* 1993

Previous Work

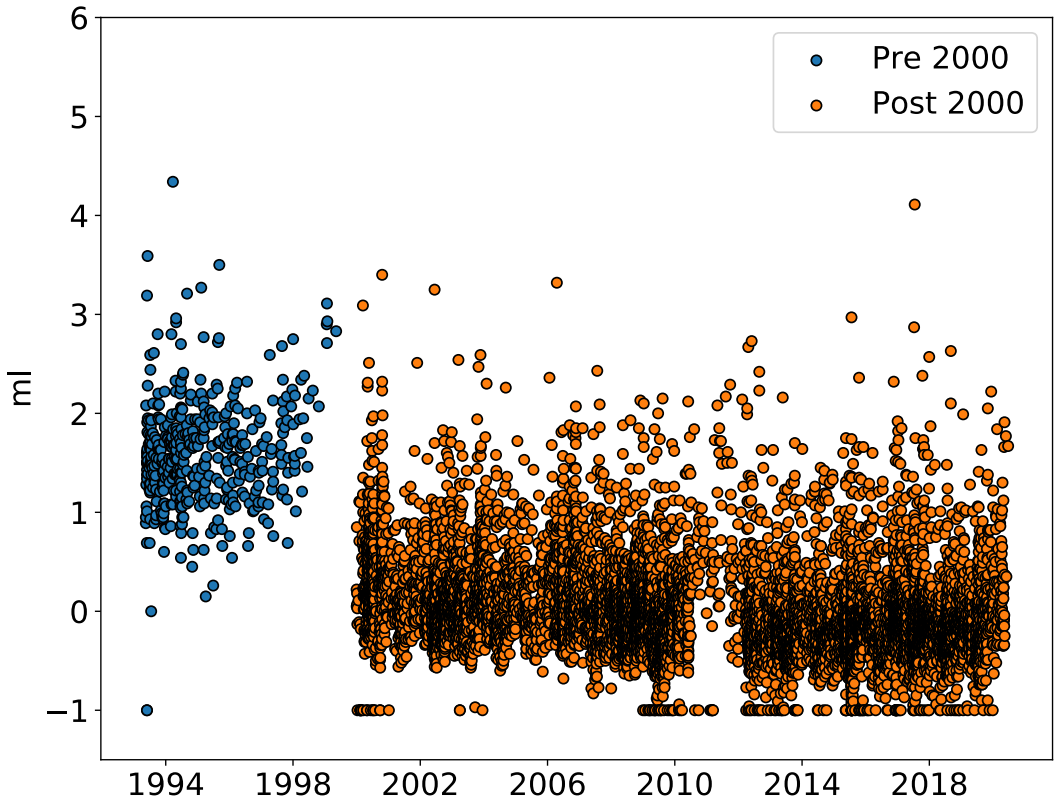
- **Absolute relocations**
  - **LLNL developed Bayesloc multiple-event algorithm**
  - **Past nuclear tests in Yucca Flat provide accuracy and uncertainty estimates**
  - **Depth uncertainty predominantly attributed to uncertainty in velocity model**



Pyle *et al.,* 2015; Red star represents mainshock, and blue circles represent largest aftershocks. Cross section showing event depths for the Rock Valley earthquakes using (a) the LLNL velocity model and (b) the MOONHOF velocity model.

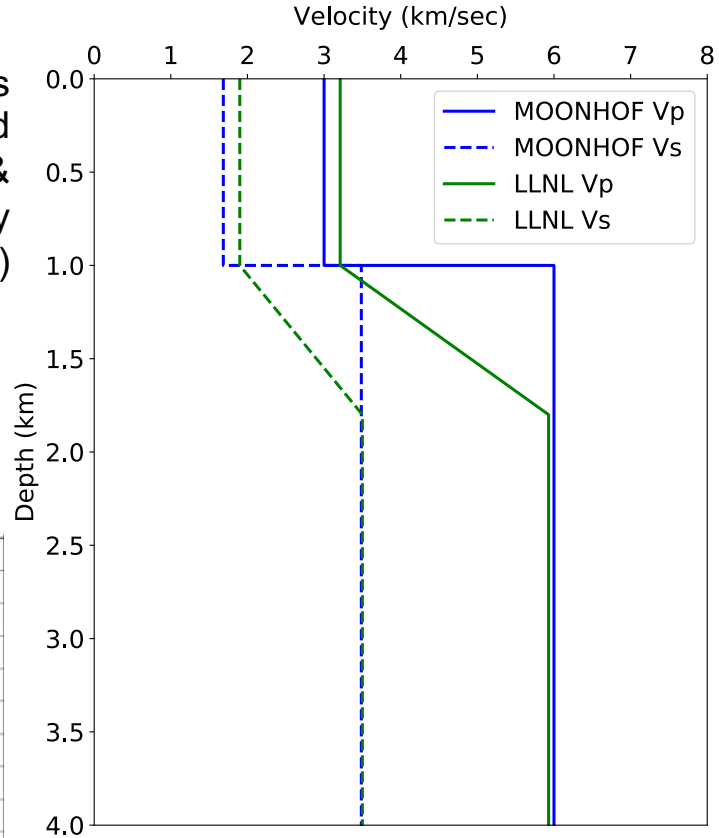
Technical Approach

- **Relocate earthquakes 1993-2020**
  - **Pre 2000 Data is converted analog**

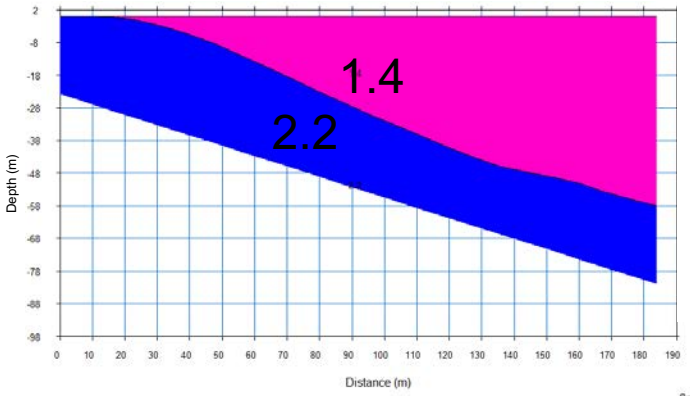


- **Address uncertainty in velocity model with seismic survey**

NNSS velocity models from Anderson and Myers (2010) & Hoffman and Mooney (1983)



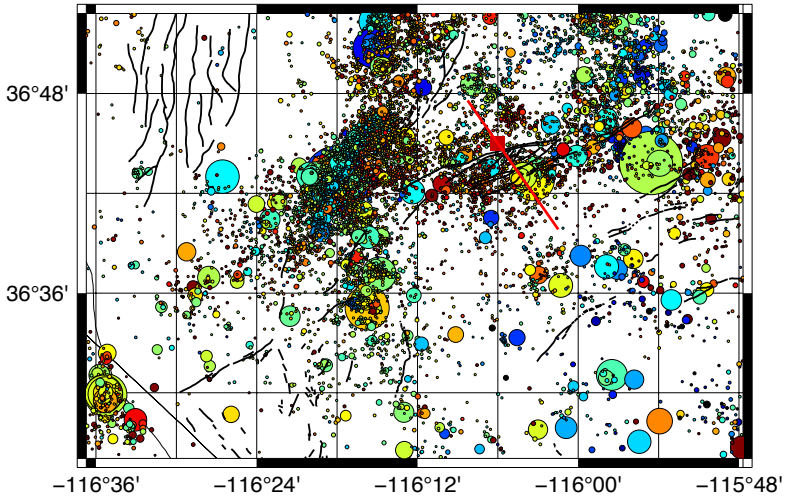
Preliminary AWD refraction results

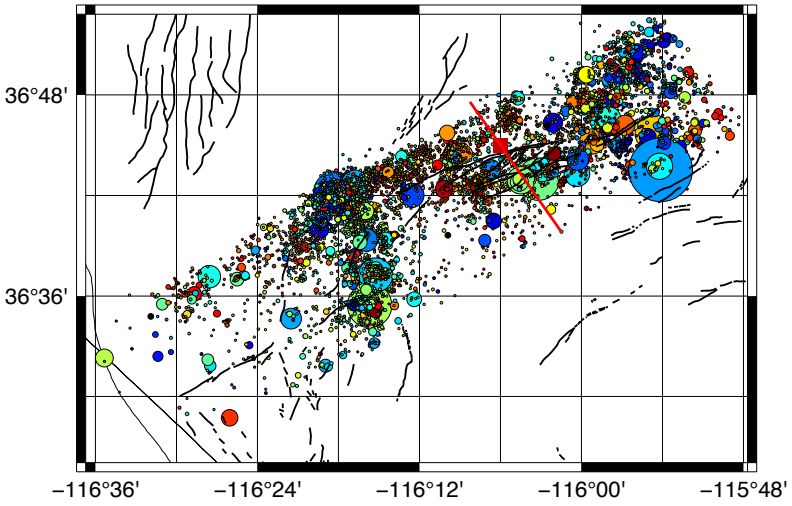


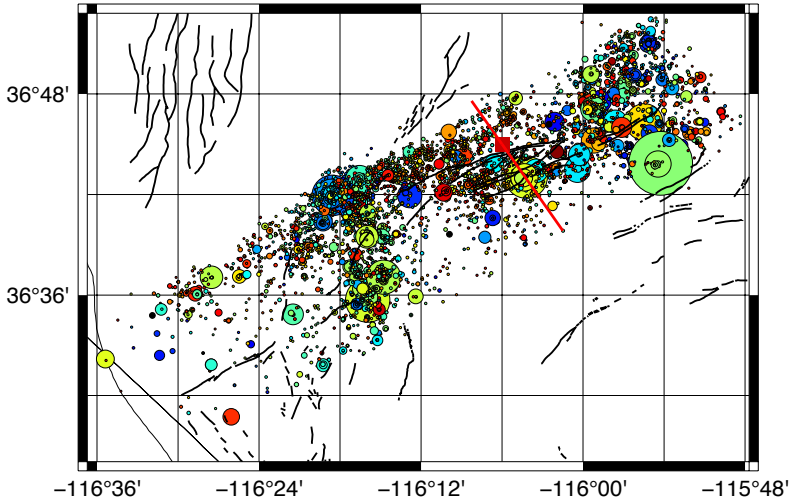
*Depth down to ~80 m from a 180 m horizontal line

Technical Approach

Catalog → Absolute Relocation: HypoInverse → Relative Relocation: Growclust



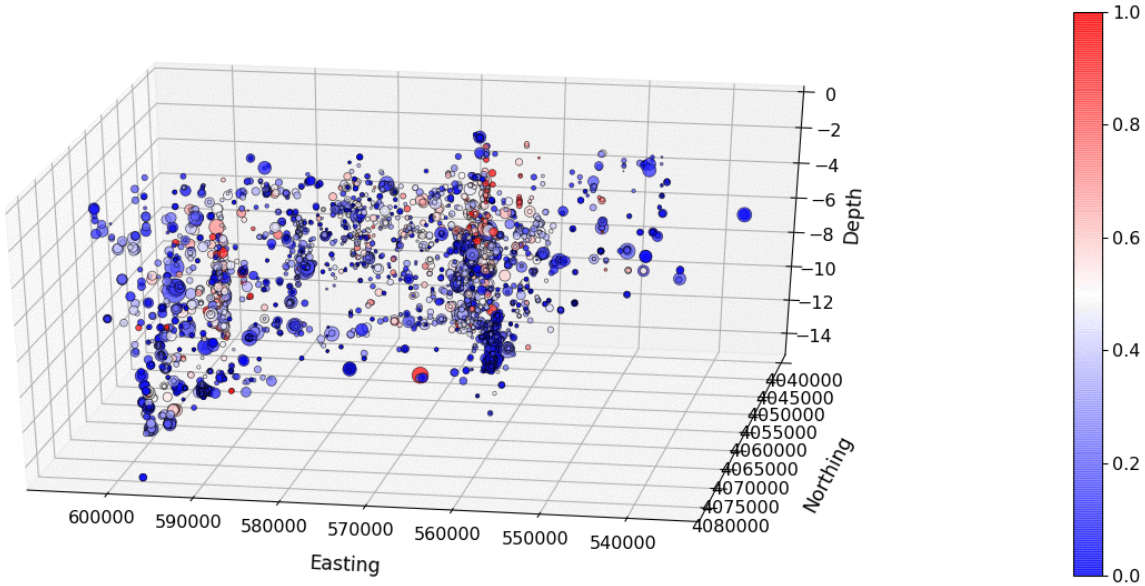




Initial Results

- **Error estimates**
  - **HypoInverse Results for RTPP:**
    - **P-wave: 0.008 sec**
    - **S-wave: 0.002 sec**
  - **Growclust:**
    - **Mean vertical error: 0.18 km**
    - **Median vertical error: 0.096 km**

- **Correlation with GFM faults**
  - **Relocated earthquakes correlate with mapped faults**
  - **Relocated events will be used to refine subsurface projection of faults in the GFM of Rock Valley**



Next Steps…

- Seismic Survey
- 3D Velocity Analysis
- GFM Integration
- Test Bed Location
- Prepare for SPE Phase III