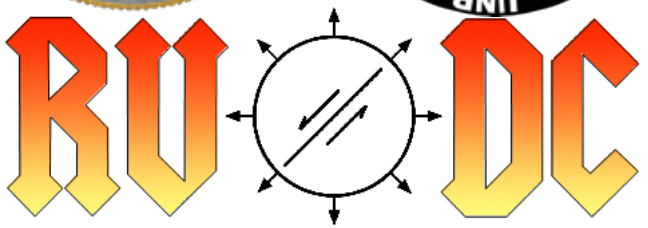
SAND2023-02780C

How Good is Your Location?

Comparing and Understanding the Uncertainties in Locations of a Sequence of Events in Nevada



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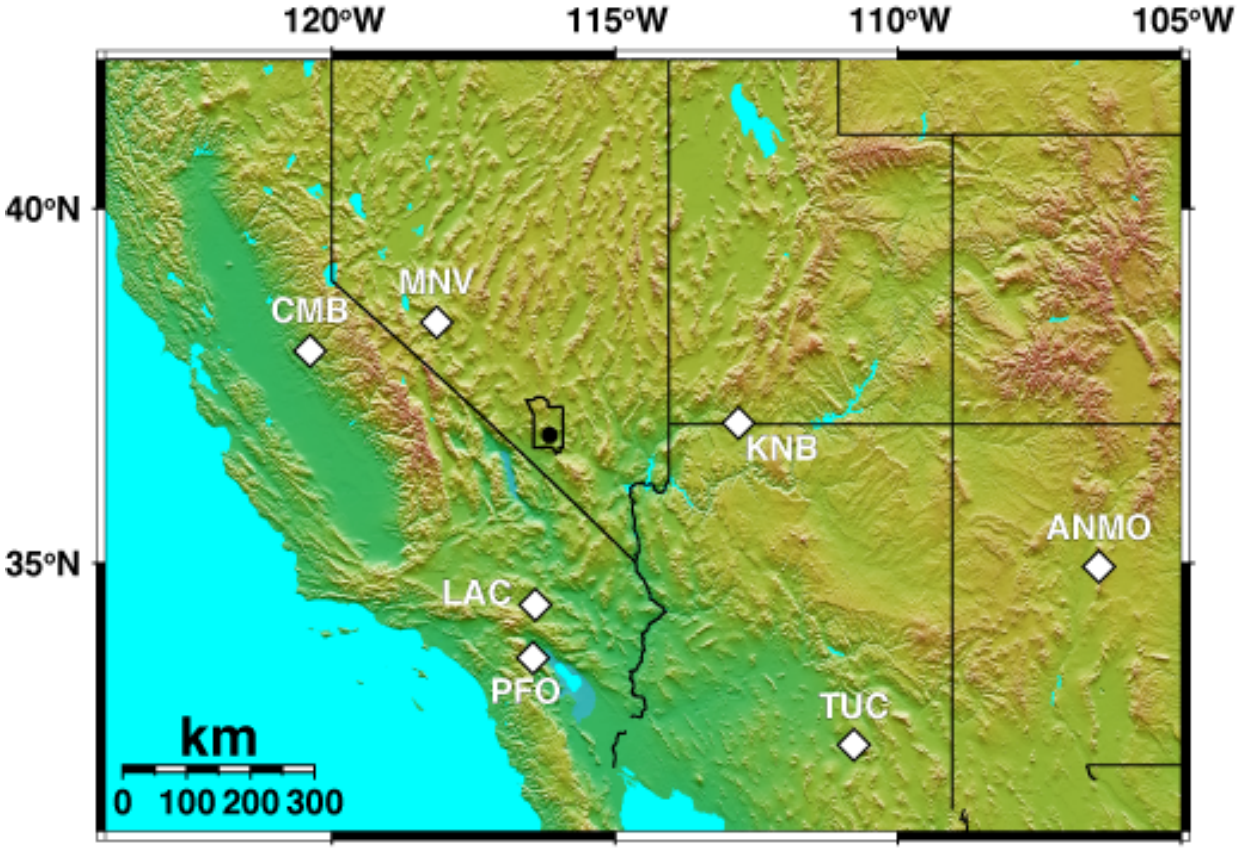
In 1993 a series of unusually shallow earthquakes happened at the former Nevada Test Site (now Nevada National Security Site – NNSS)



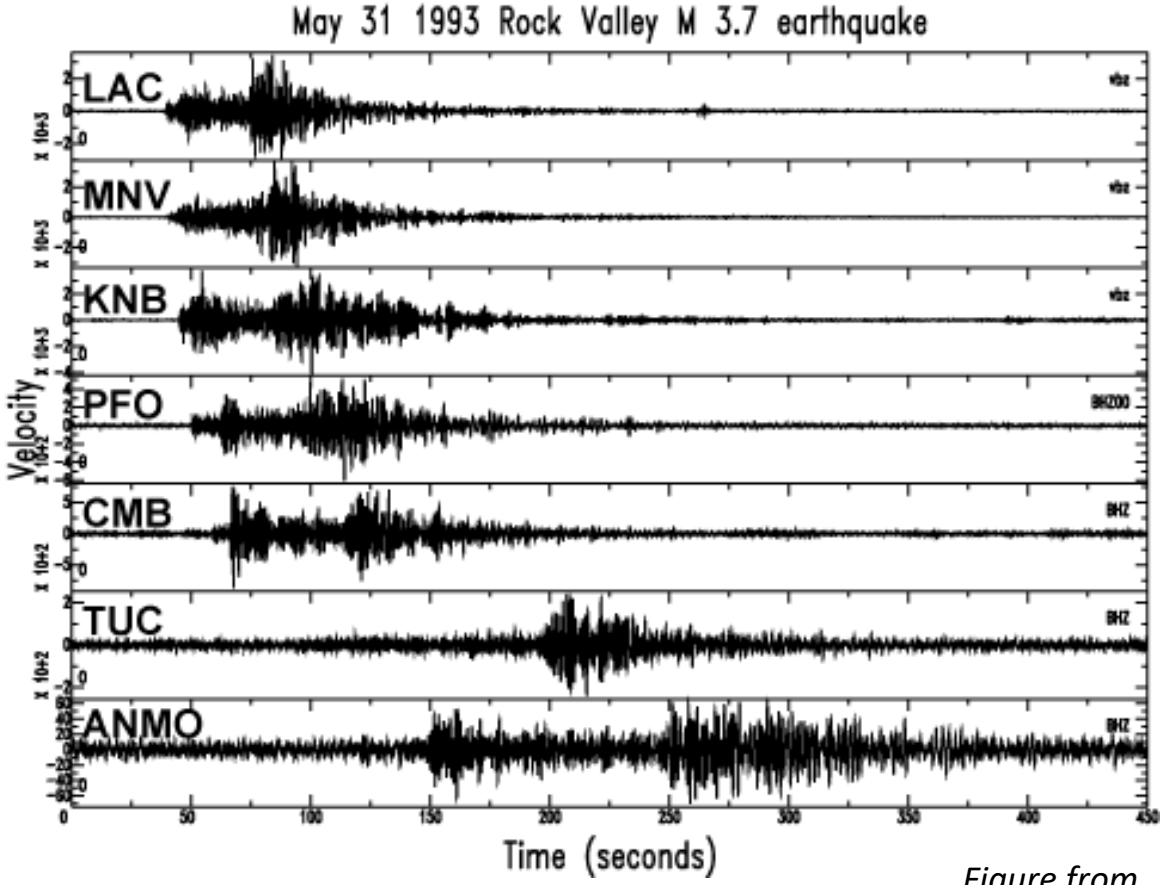


Figure from Bill Walter

There were 12 events with $M_L > 2$ that were well recorded at local and regional distances

The shallow depth was well constrained by a temporary seismic deployment by University of Nevada Reno

Waveforms at RTPP

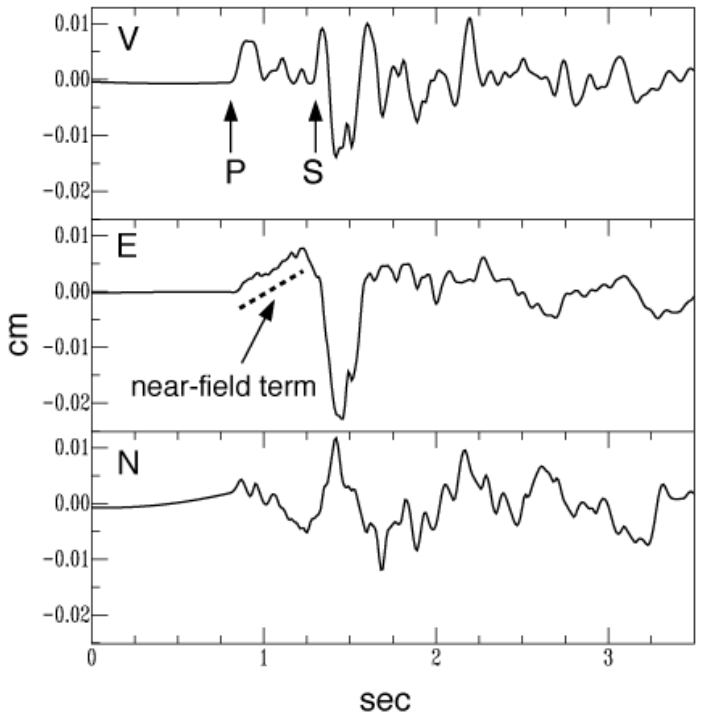


Fig 0.2 from Shields, 1999 UNR Master Thesis

Depth cross-section

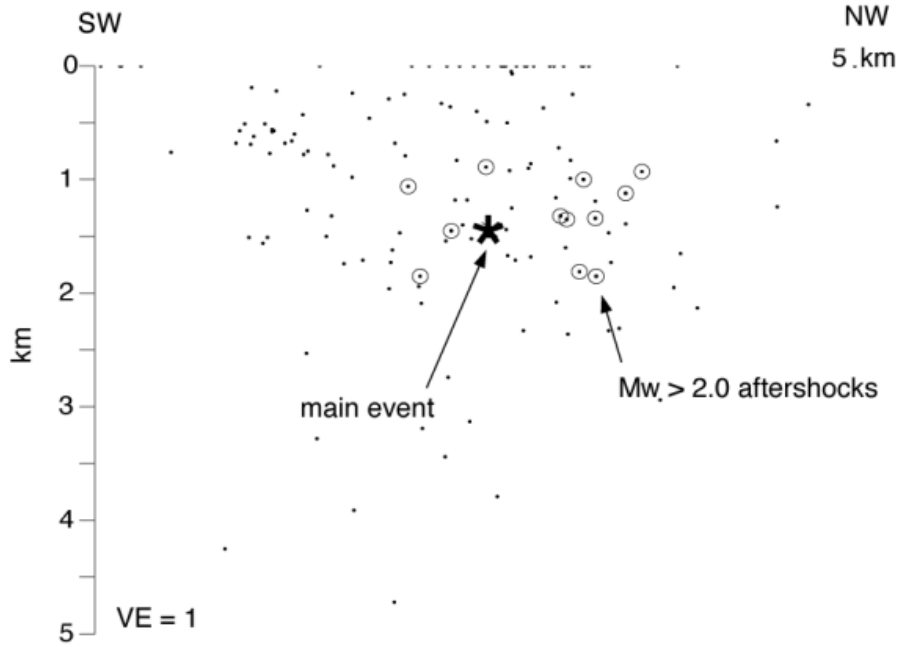


Fig 0.4 from Shields, 1999 UNR Master Thesis

Re-located Rock Valley events

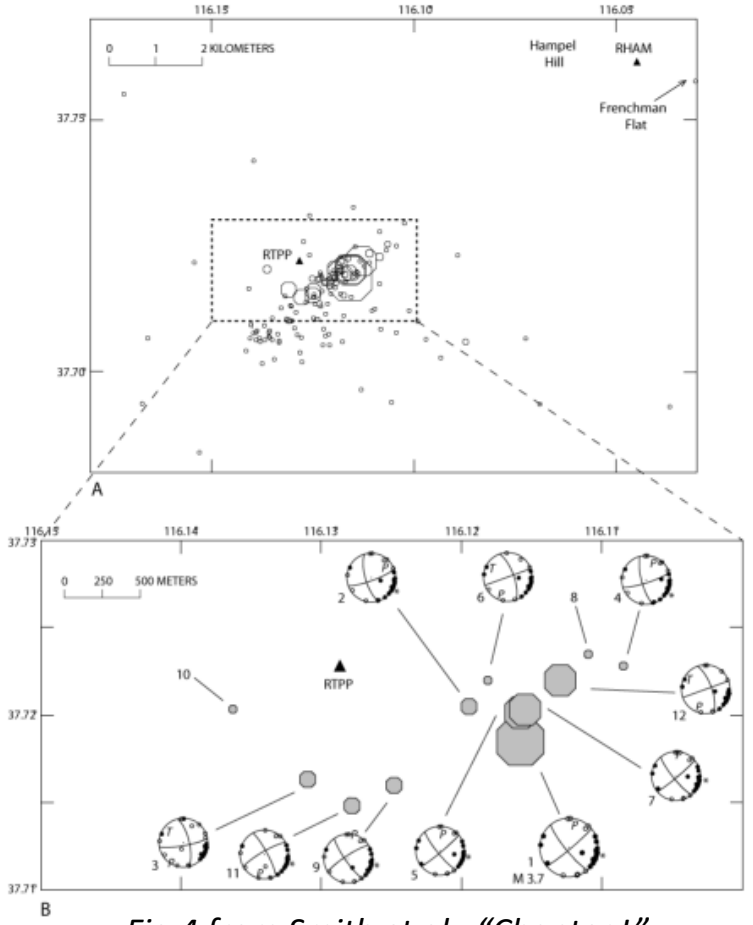
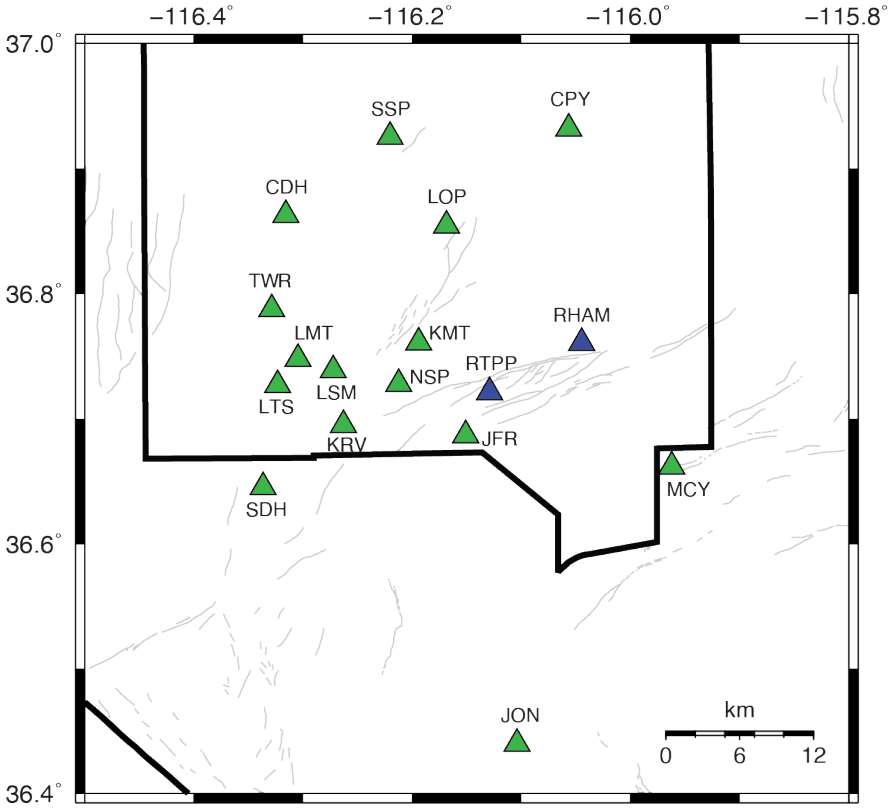


Fig 4 from Smith et al., "Chapter L"

We relocated the historic Rock Valley earthquakes while considering variations of a number of different factors

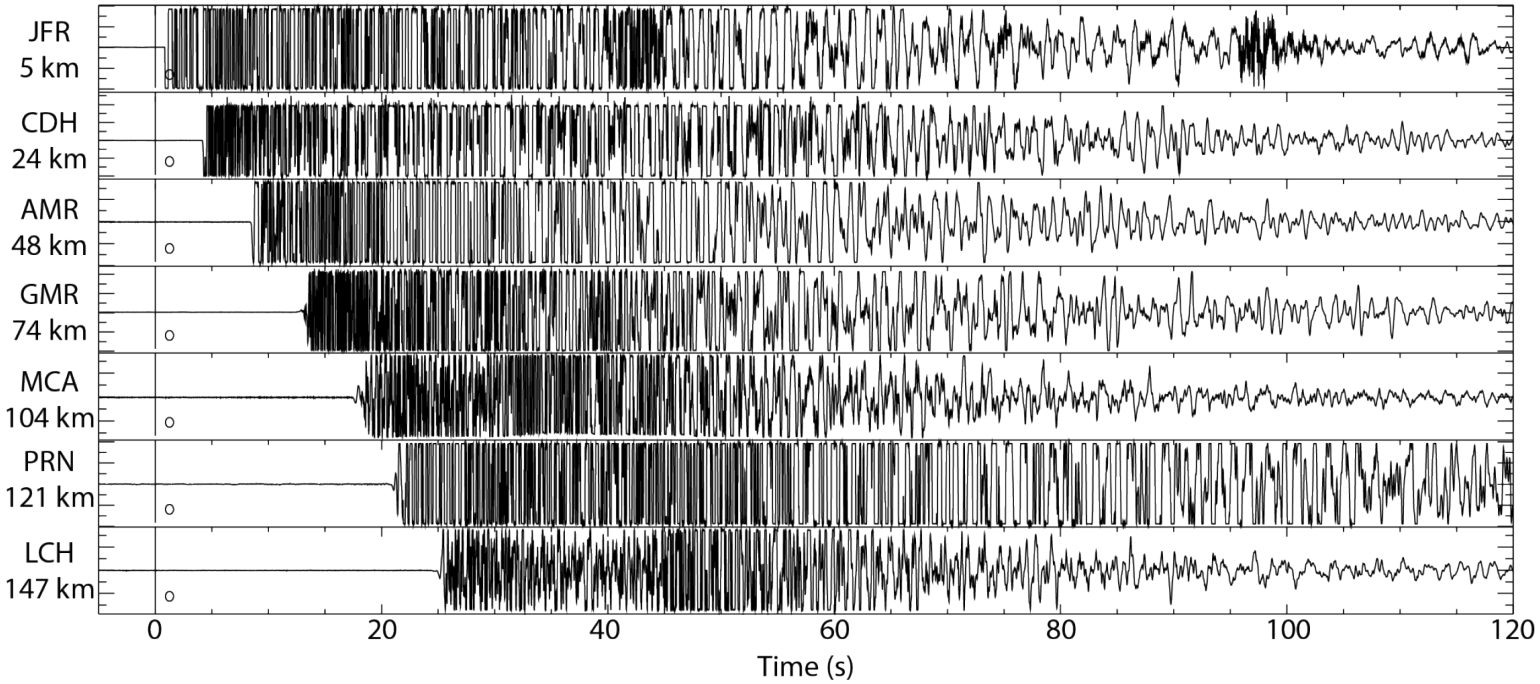
- Station Constellation
  - Constant across all comparisons of velocity models and algorithms
  - Best azimuthal coverage/distance of stations to include
- Sets of Phase Arrivals
  - 8 total sets of P and S arrivals
- Velocity Models
  - 9 total models 1D models and 2 versions of a 3D model
  - 4 pre-existing regional models
  - 5 models that have shallow, localized structure near station RTPP
- Algorithms
  - 4 different algorithms including Hypoinverse, Bayesloc, Elocate, and Tomog

Station Constellation and Data

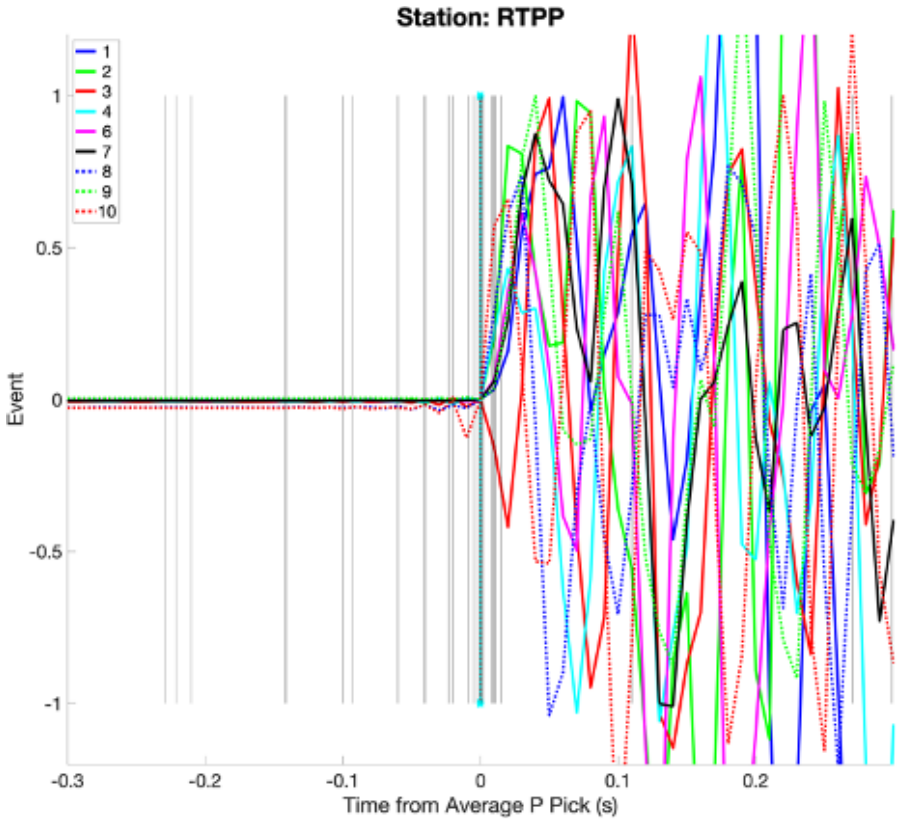


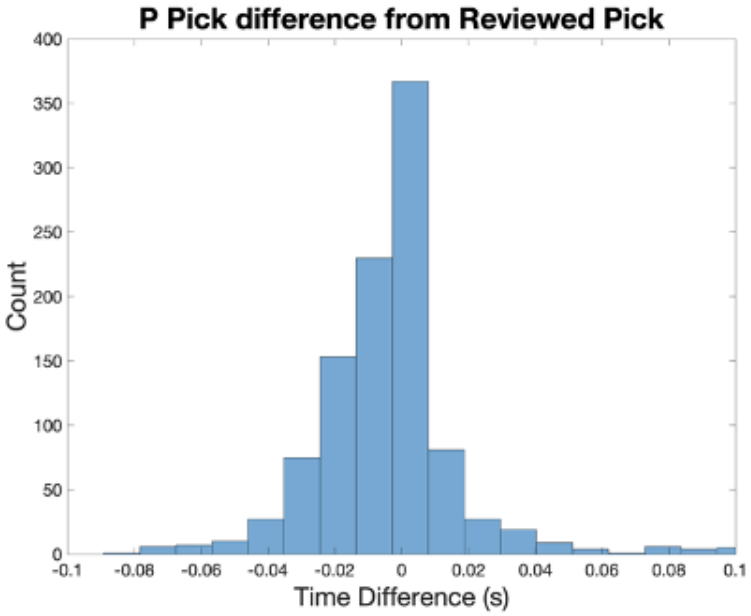
Stations used in relocation – blue triangles denote temporary 3 component stations

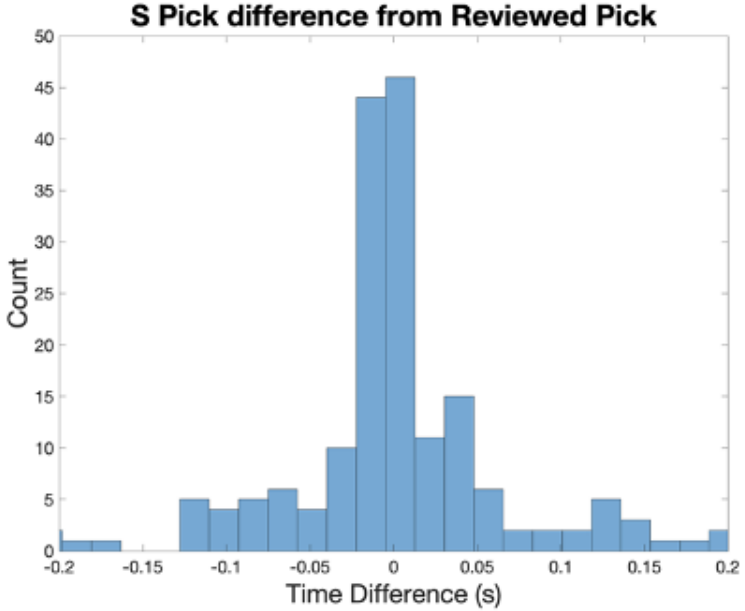
One of the many data challenges included heavily clipped waveforms as far away as ~150 km



Picking the Phase Arrivals



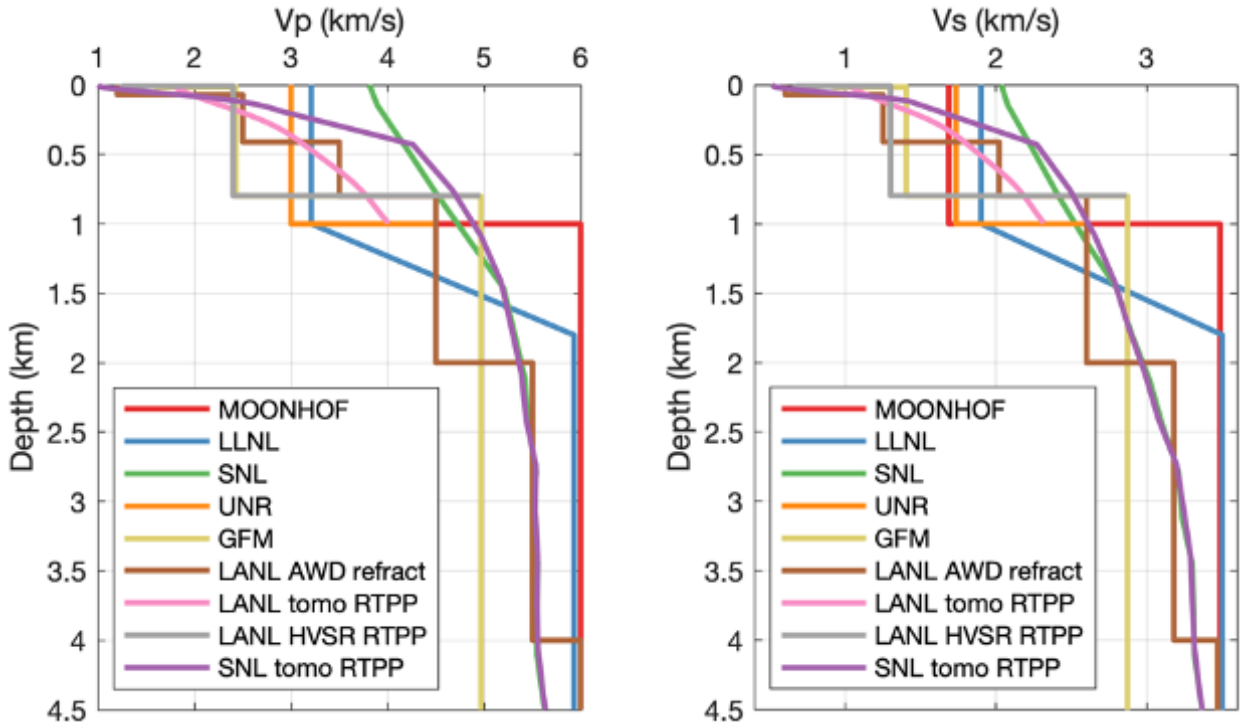


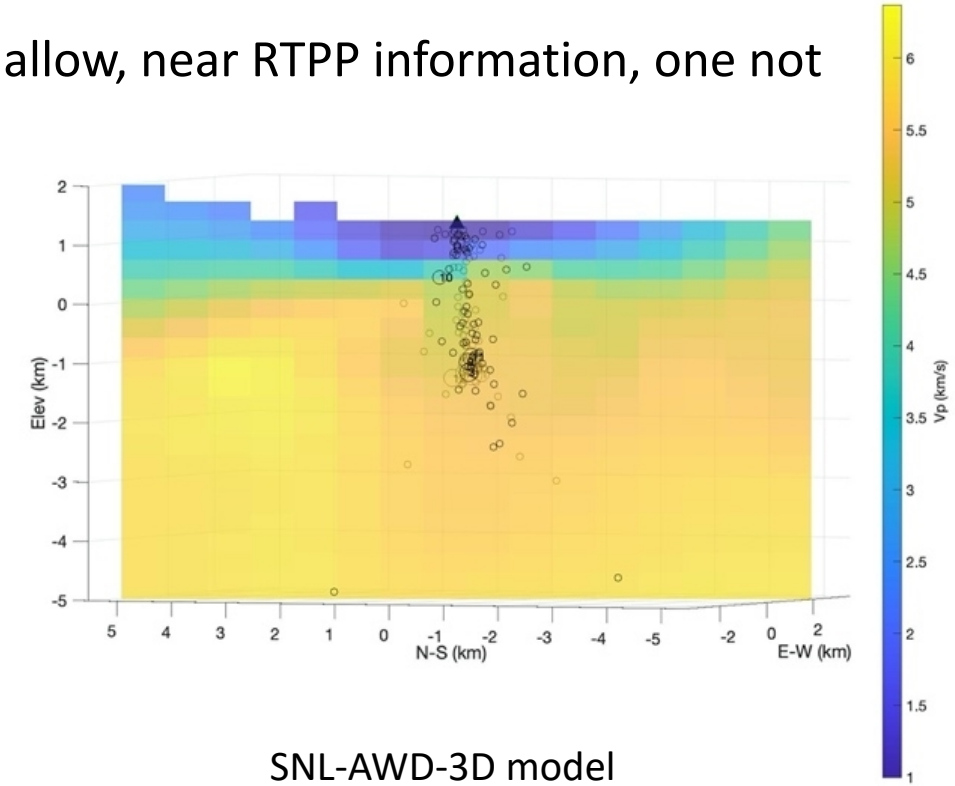


We considered 8 different sets of existing phase arrivals for these events, ultimately using manual correlation and agreement by a team of analysts to select our final set of arrivals

Velocity Models

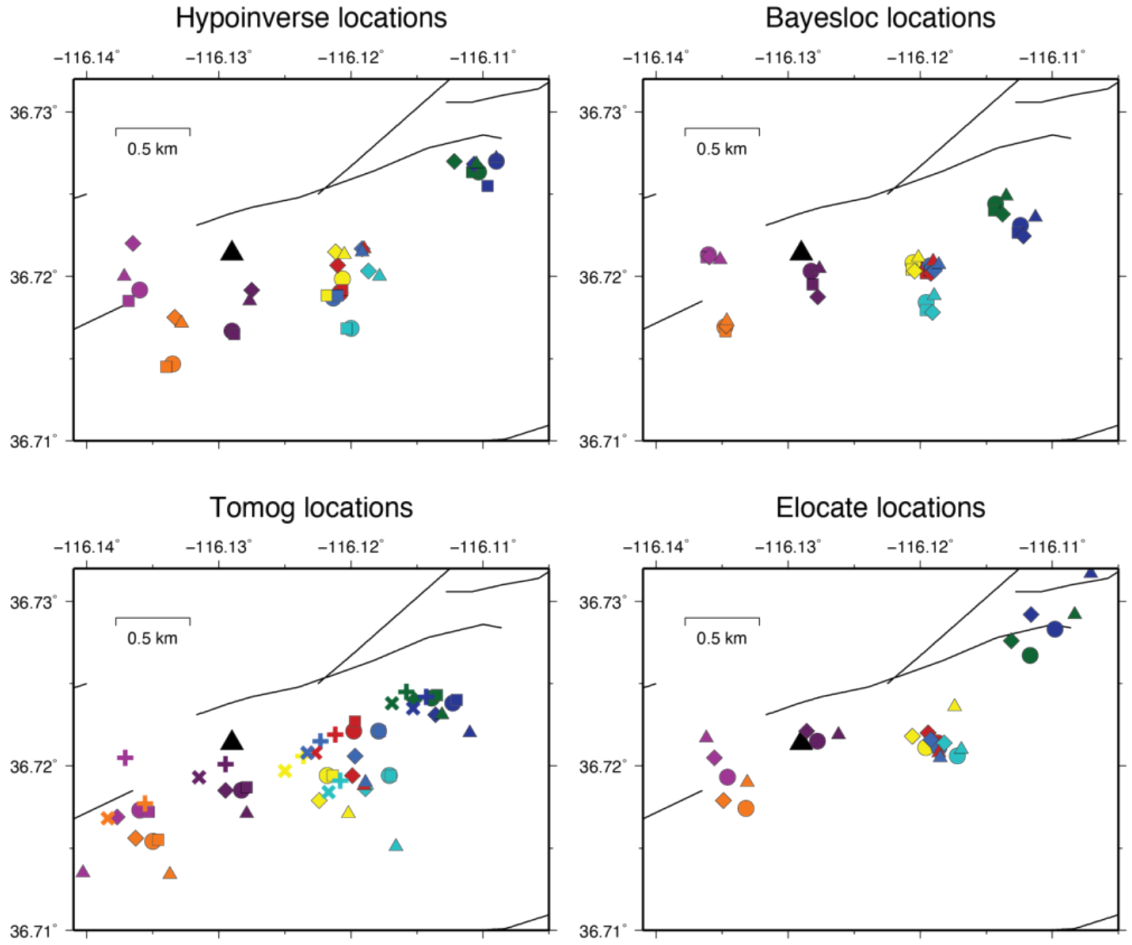
- Four pre-existing regional velocity models and incorporated new and preliminary results for five new velocity models that provide information on the very shallow (< 2km) structure near station RTPP
- Two variations of a 3D velocity model; one incorporating very shallow, near RTPP information, one not

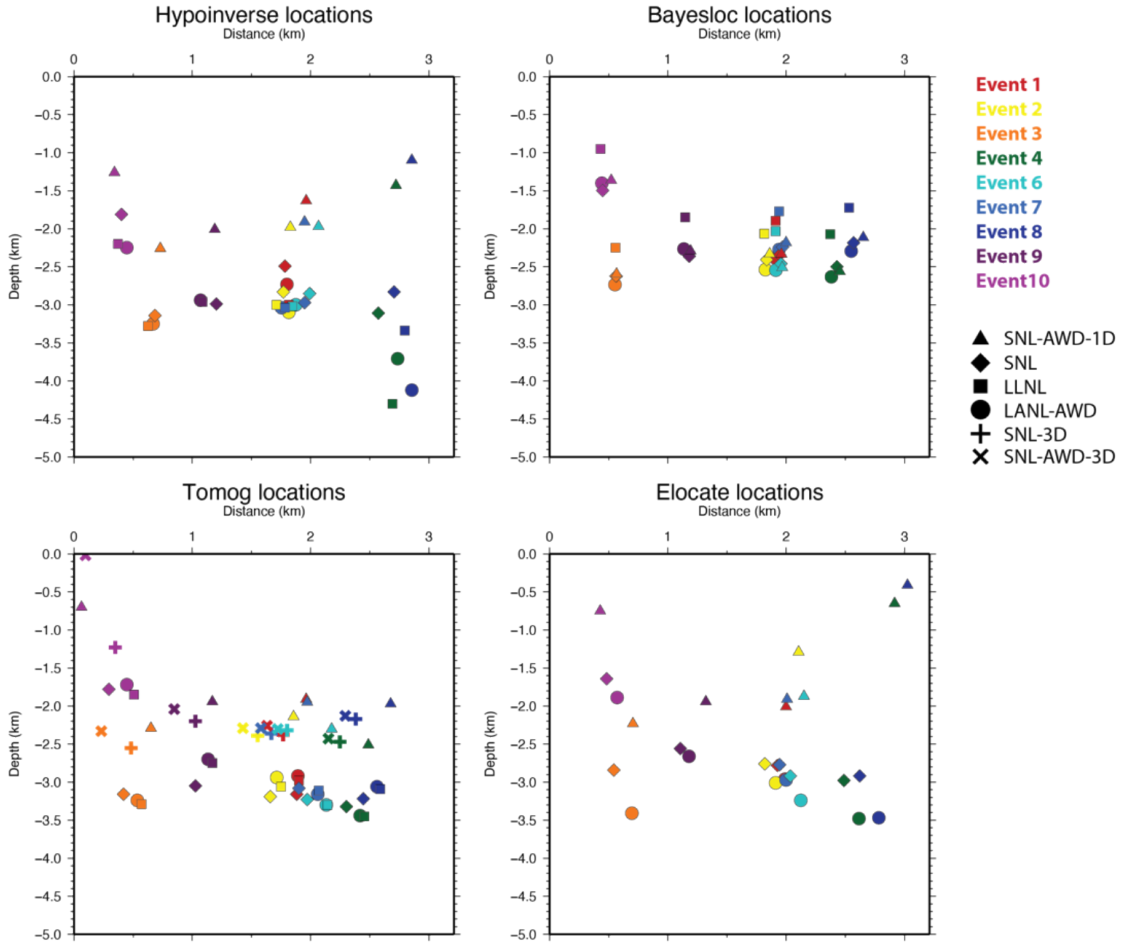




SNL-AWD-3D model

Methods include Hypoinverse, Bayesloc, Elocate, and Tomog

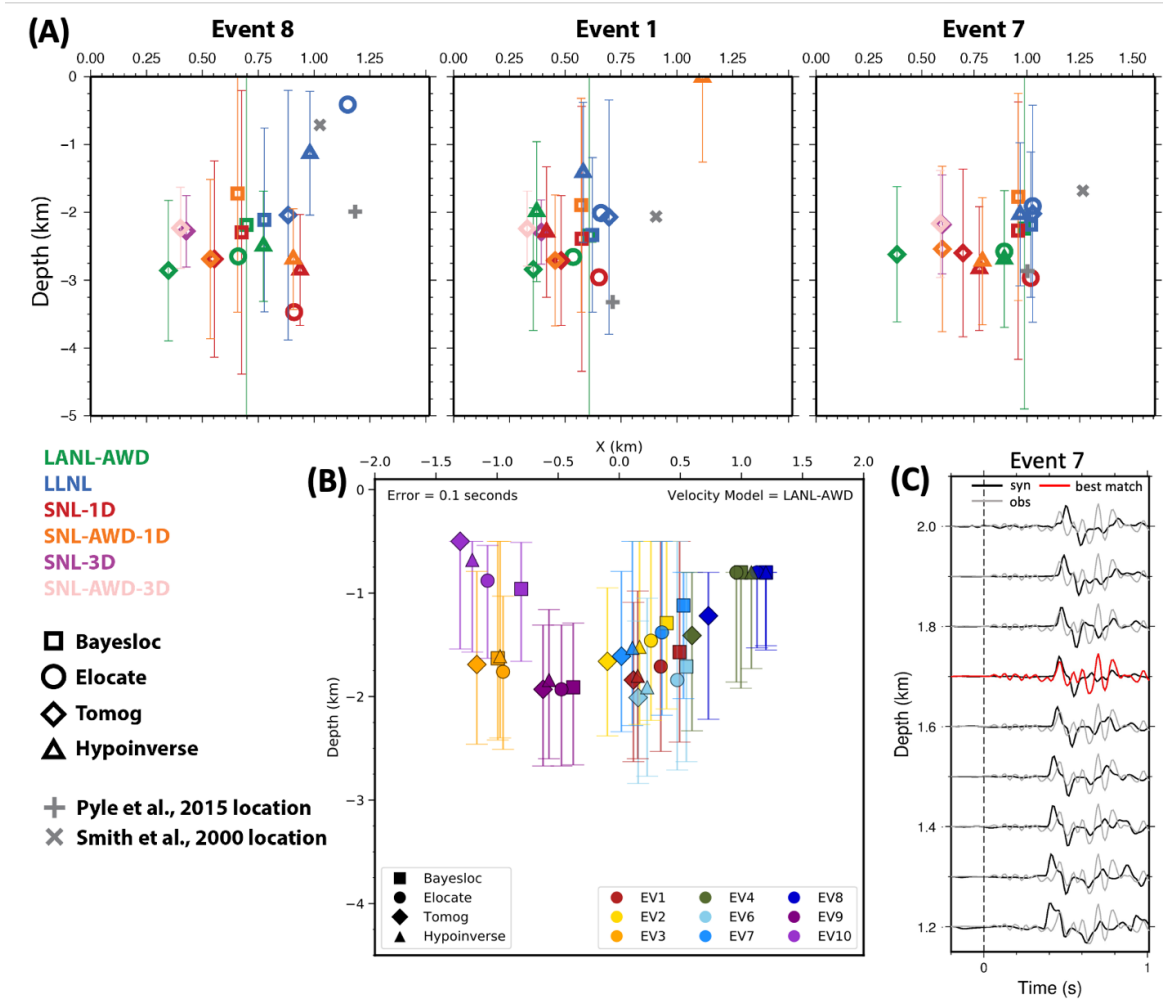




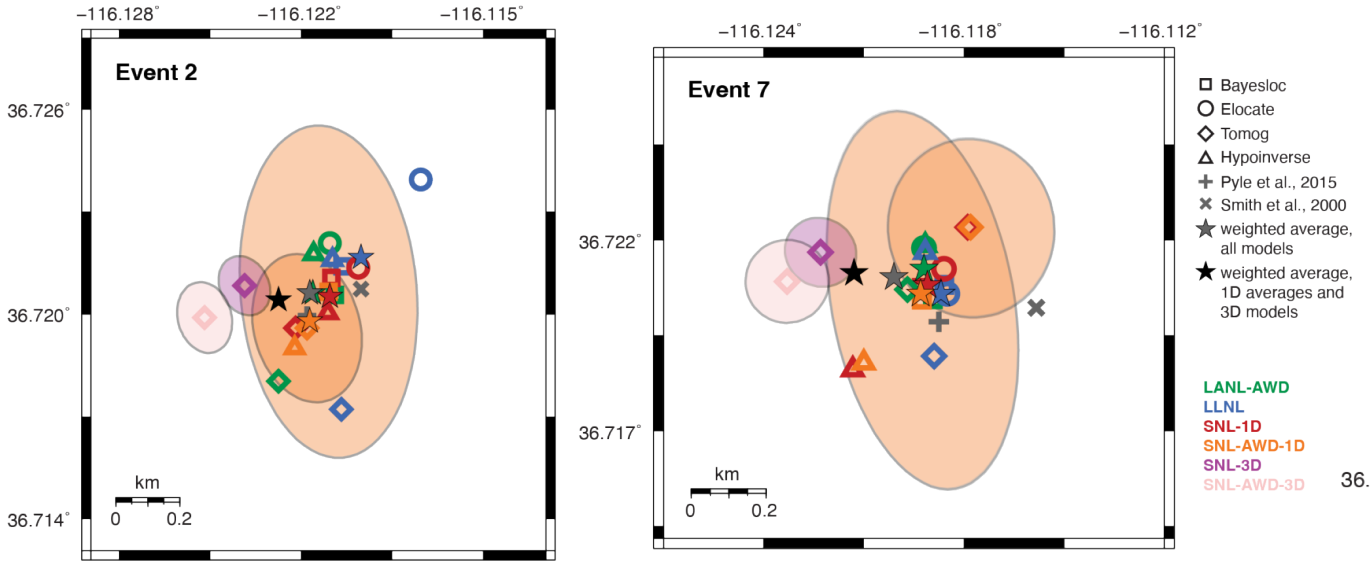
Event Depths are particularly important for RV/DC

Depth determination utilized multiple methods

- Relocation algorithms
- S-P times at RTPP using TauP
- Reflectivity waveform modeling

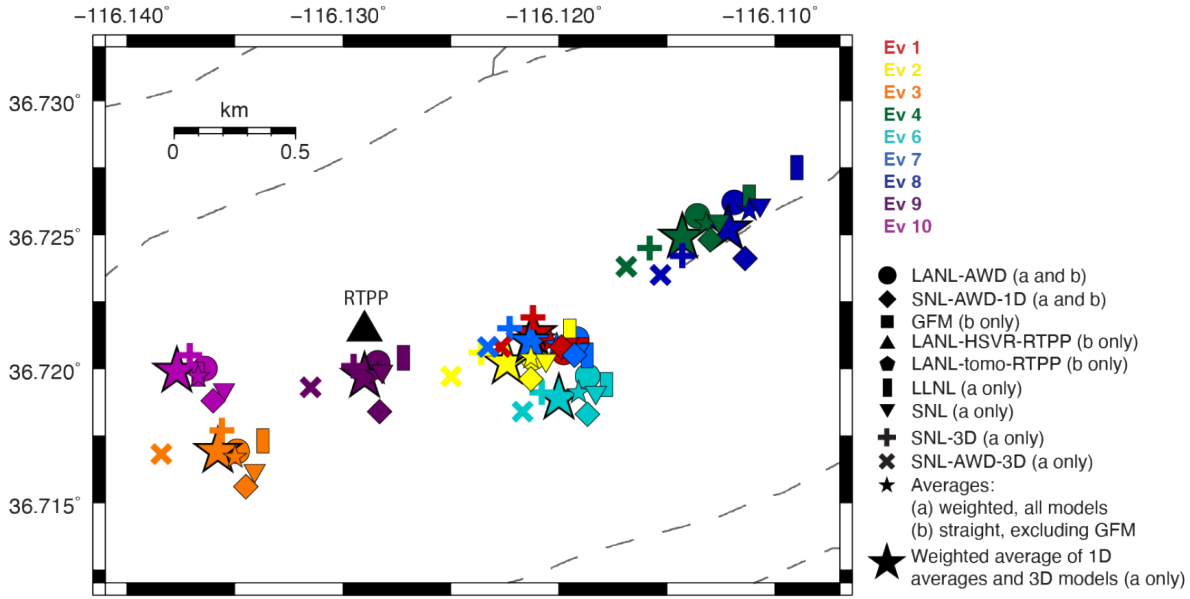


Epicentral Locations



“Best” epicentral locations for each event along with averages across algorithms for each velocity model

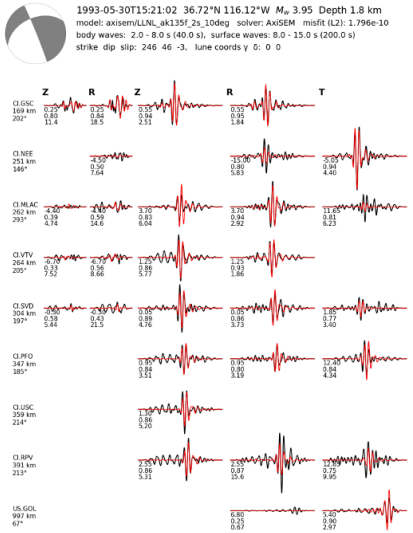
For events 2 and 7, views of all locations from the different algorithms and velocity models



Conclusions

- We relocated 9 events from the 1993 Rock Valley earthquake sequence
- Explored many of the causes of uncertainty in event location including
  - Differing sets of phase arrivals
  - Different velocity models
  - Different relocation algorithms
- For this well-recorded sequence, locations for any particular event for the various combinations of velocity model and algorithm are within approximately 600 m of each other
- Depths have greater uncertainty – depths from relocation algorithms are deeper than those obtained from other methods
- Best epicenters are selected as averages between the 1D model relocations and the 3D model relocations
- Best depths are selected from the TauP modeling

Depth Locations from Moment Tensor Analysis



Moment tensor modeling from Jonas Kintner and Ryan Modrak (left) and Andrea Chiang (right) give similar depth estimates to those established earlier