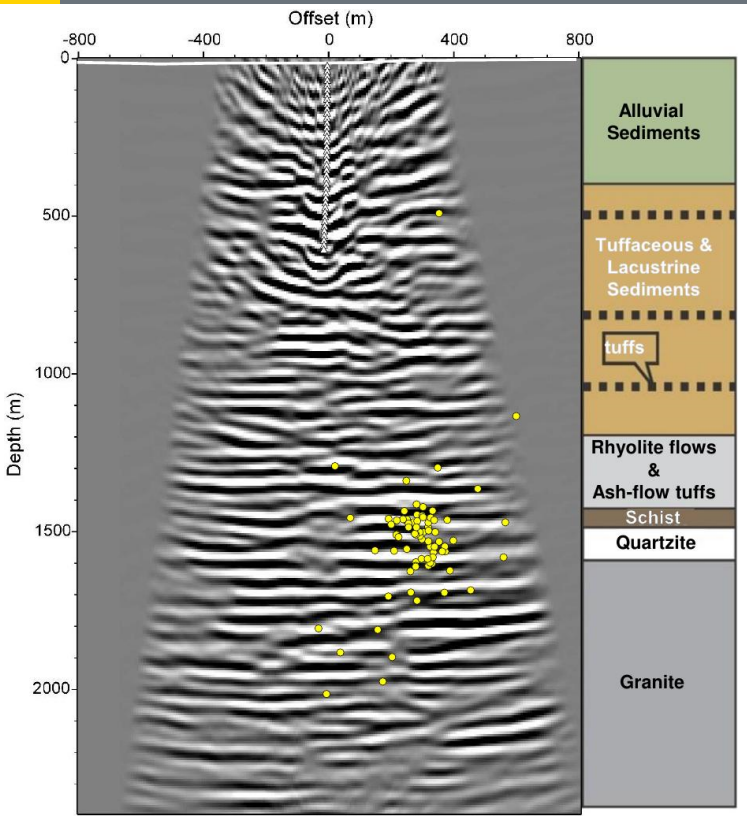

Full-waveform inversion of 2010 walkaway VSP Data from Raft River geothermal site

Project Officer: William Vandermeer, Lauren Boyd

Total Project Funding: $250K

November 13, 2017

Mandatory slide

Principal Investigator

Lianjie Huang

Los Alamos National Lab

Track 3: EGS General R&D

Relevance to Industry Needs and GTO Objectives

- Challenge:
  - Build accurate velocity model using vertical seismic profiling data for high-resolution migration imaging
- Innovative aspects:
  - Employ full-waveform inversion to achieve high-resolution velocity model building.
- Impact on the following GTO's goals:
  - "Improving processes of identifying, accessing, and developing geothermal resources" and
  - "Overcoming technical obstacles and mitigating risk"
  - Accelerating a commercial pathway to and securing the future of Enhanced Geothermal Systems (EGS)

Methods/Approach

- Process raw vertical seismic profiling (VSP) data acquired at the Raft River EGS site in 2010
- Obtain up-going and down-going waves of the VSP data
- Apply newly developed least-squares reverse-time migration-guided full-waveform inversion algorithm to processed data to produce a high-resolution velocity model for migration imaging
- Perform reverse-time migration using the velocity model and up-going waves of the VSP data to obtain high-resolution subsurface images

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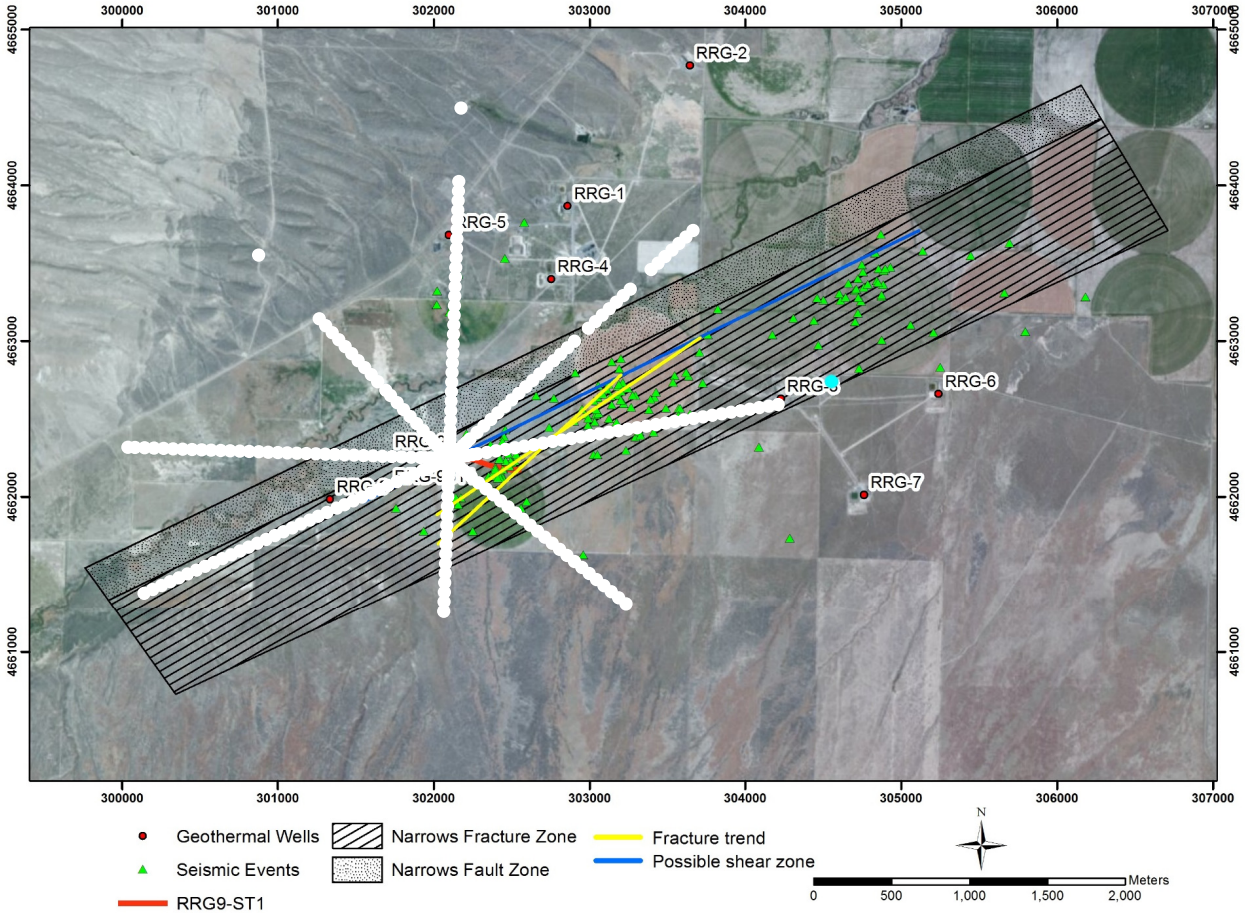
Technical Accomplishments and Progress

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Original Planned Milestone/ Technical Accomplishment	Actual Milestone/Technical Accomplishment	Date Completed
Build a velocity model	Used full-waveform inversion to build a velocity model	June, 2017
Conduct migration imaging	Applied reverse-time migration to the 2010 VSP data from Raft River EGS site	June, 2017

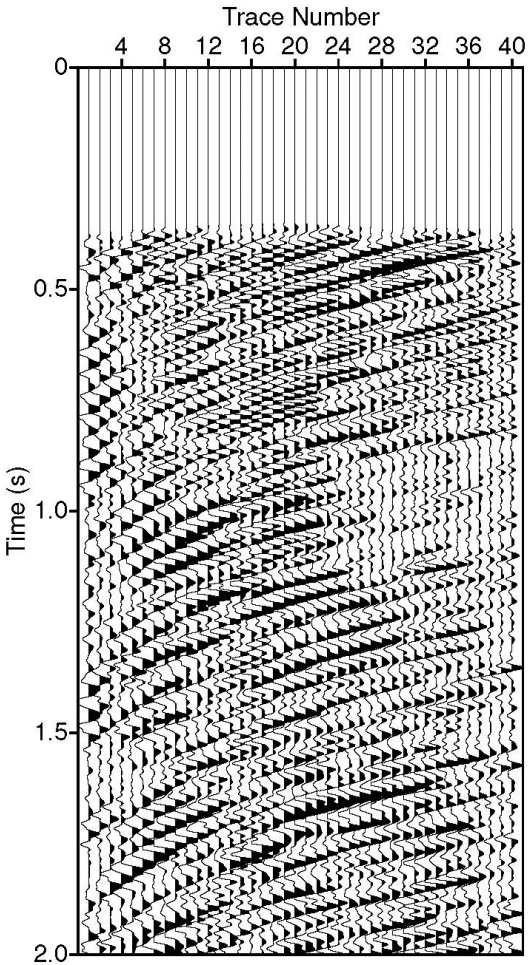
Mandatory- may utilize multiple slides

Raft River Geothermal Field



Walkaway VSP data were acquired at Raft River EGS site using 40 geophones

PP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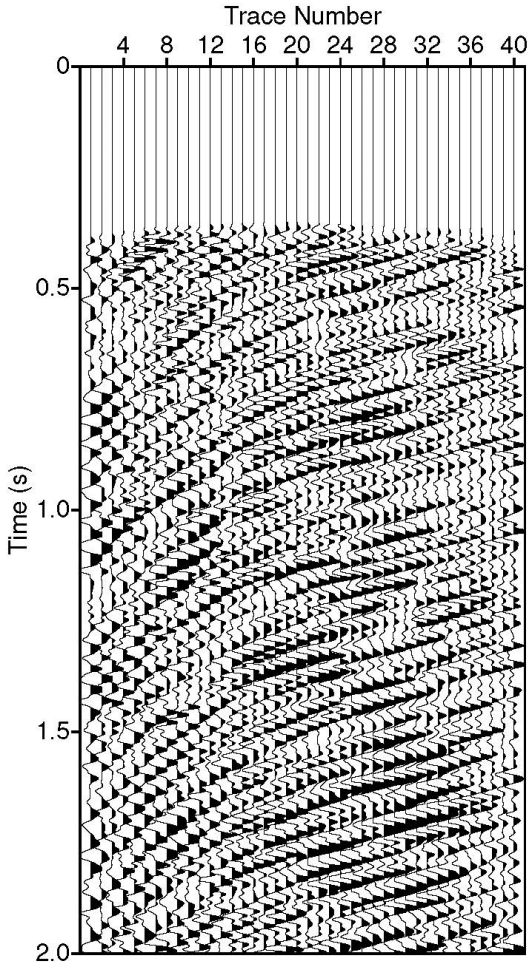
0.5
1.0
1.5
2.0
Time (s)

PS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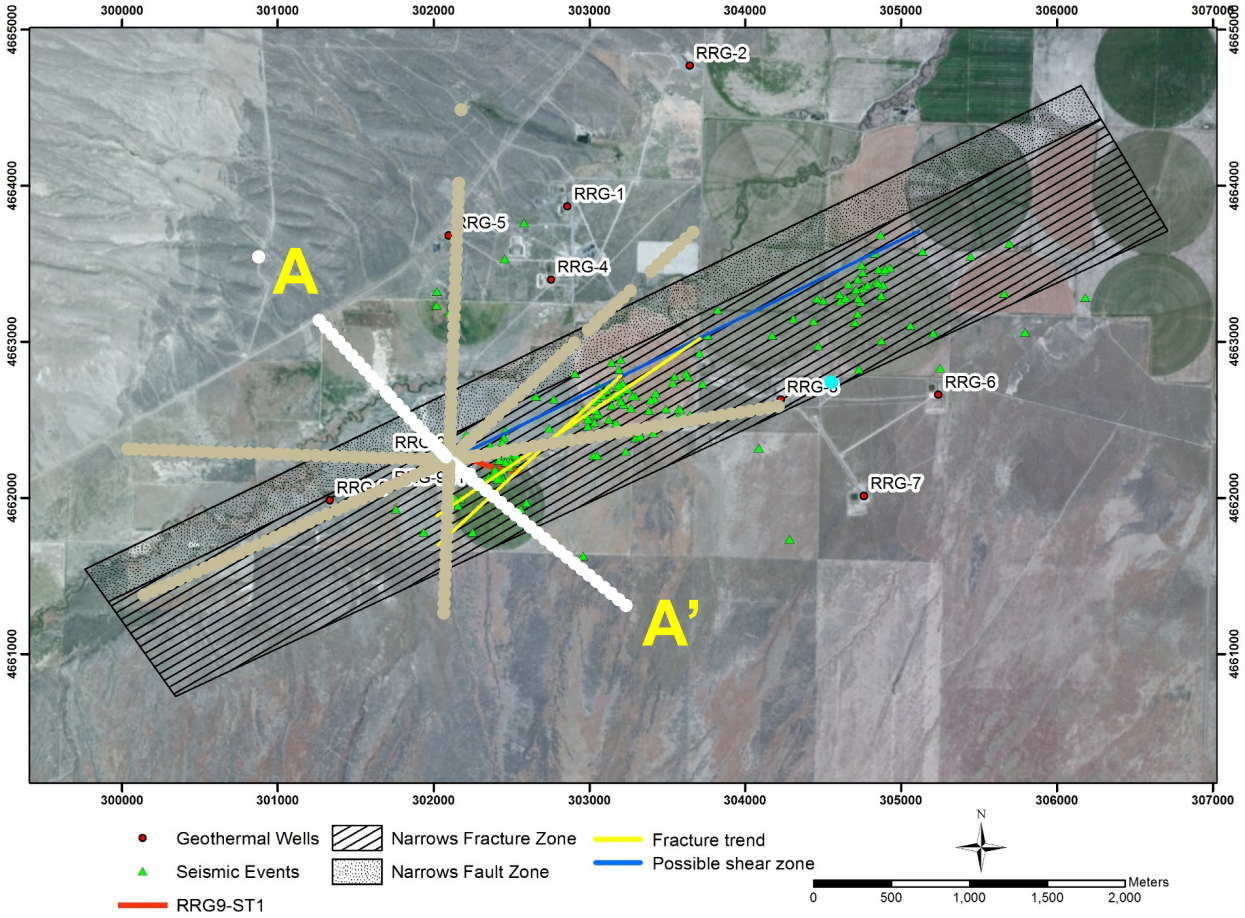
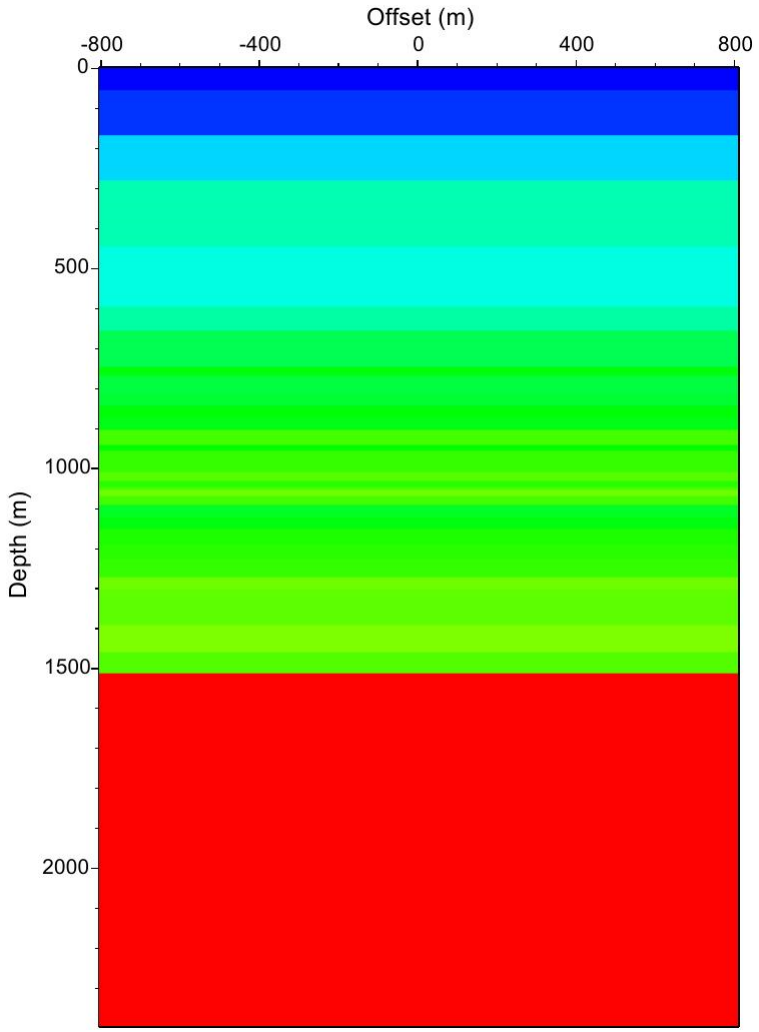
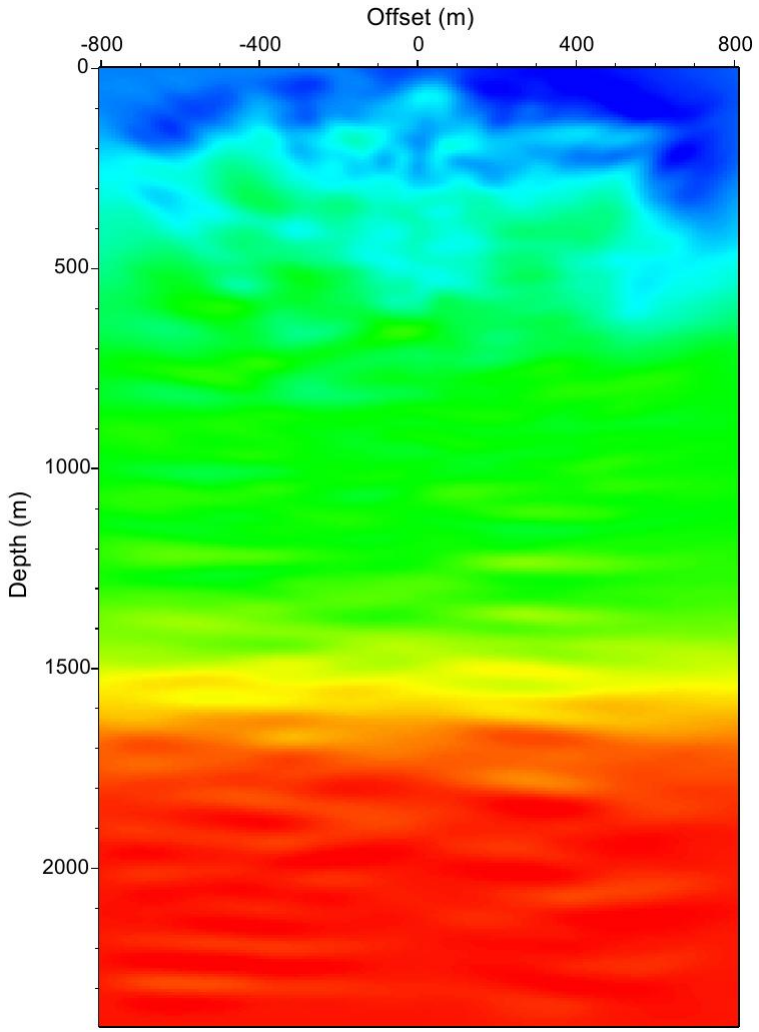
Technical Accomplishments and Progress



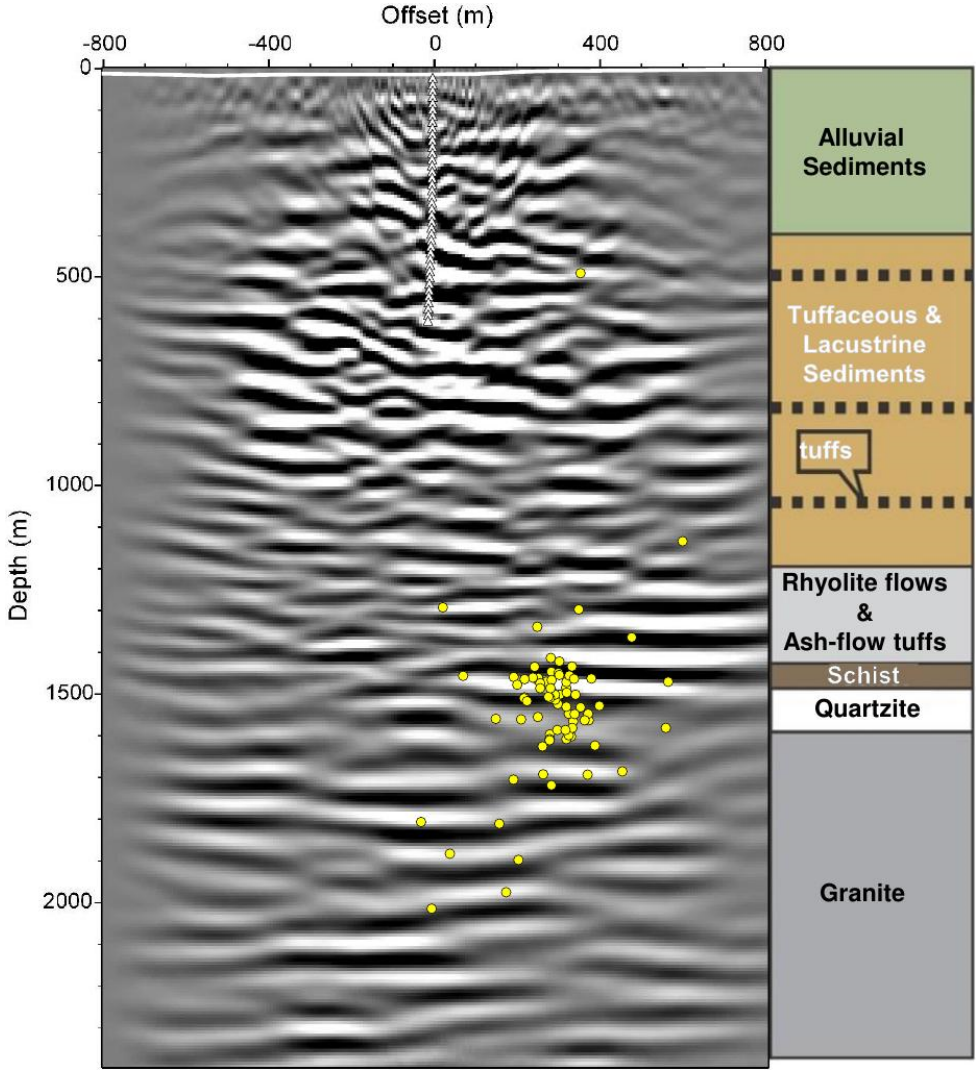
Initial Velocity Model



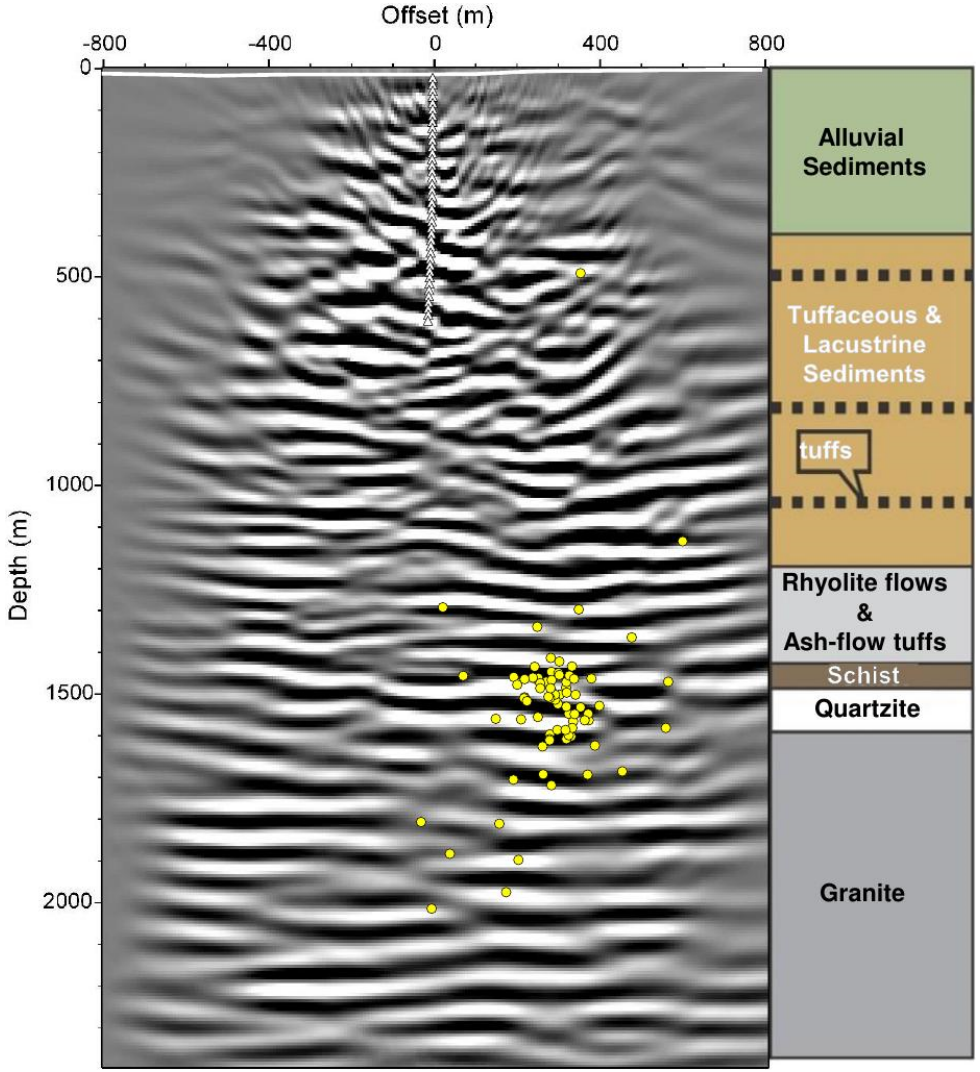
FWI Velocity Model



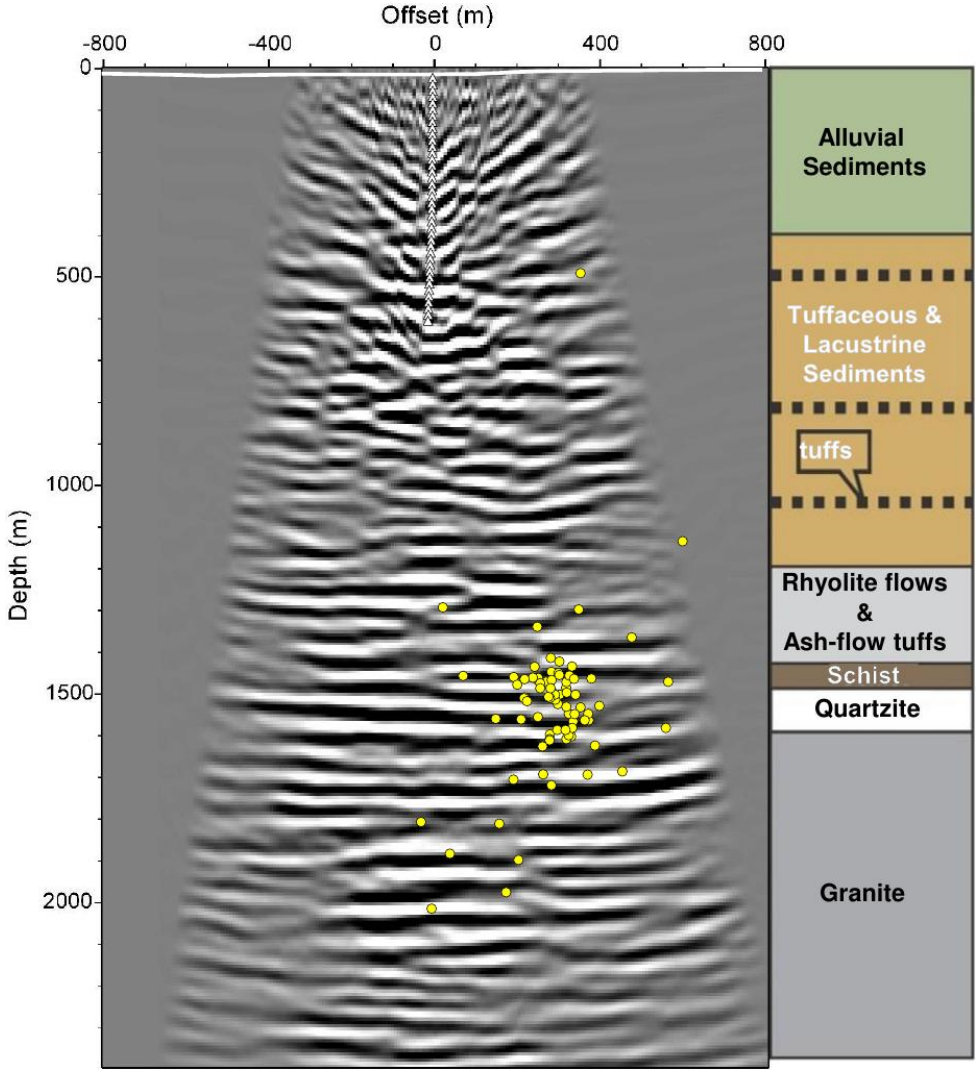
PP Migration Image with 1D Velocity Model



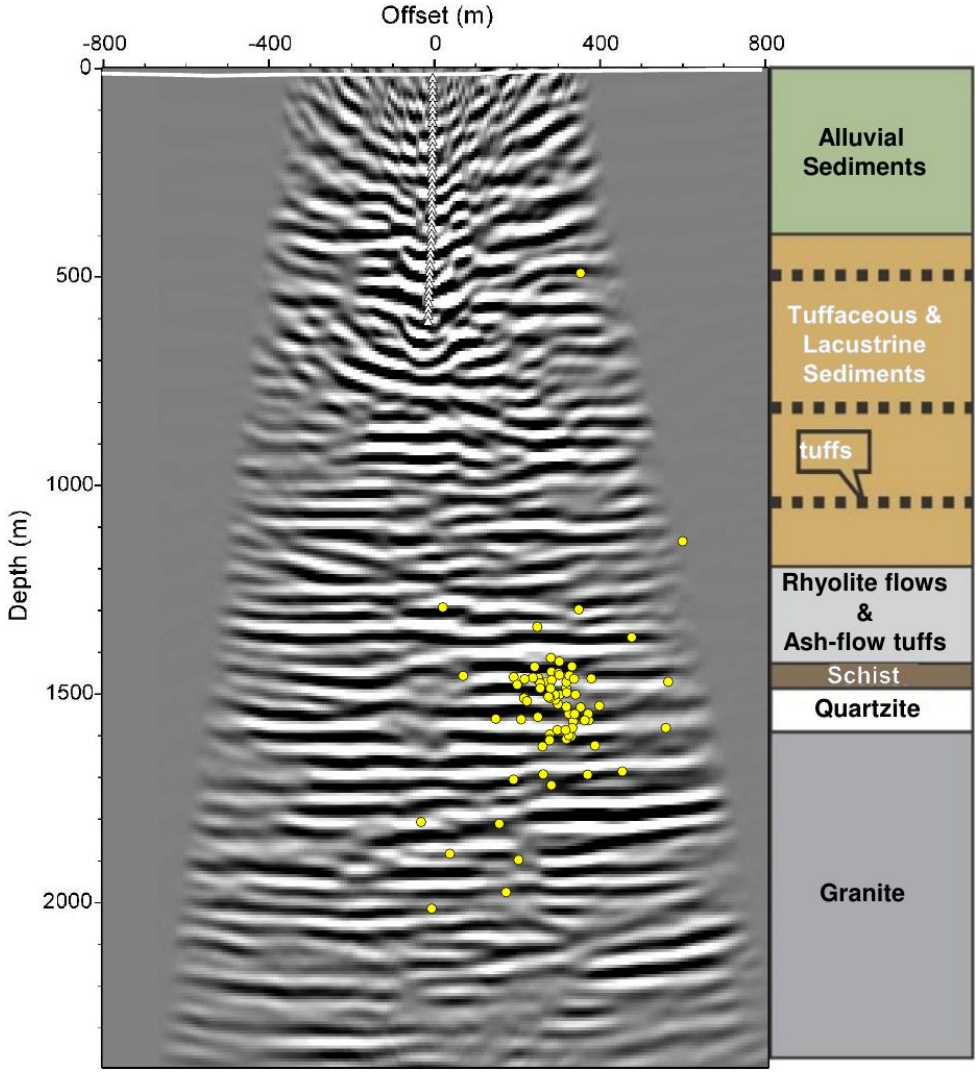
PP Migration Image with FWI Velocity Model



PS Migration Image with 1D Velocity Model



PS Migration Image with FWI Velocity Model



Research Collaboration and Technology Transfer

- U.S. Geothermal Inc. provided the VSP data acquired at the Raft River EGS site.
- LBNL provided MEQ locations.
- The University of Utah helped with geologic interpretation.

Mandatory- may utilize multiple slides

Future Directions

- Project ended.
- Future applications of full-waveform inversion to other VSP data to build high-resolution velocity models for subsurface characterization and migration imaging.

Mandatory-may utilize multiple slides

Mandatory Summary Slide

- Full-waveform inversion is capable to build a high-resolution velocity model using VSP data.
- Migration imaging with FWI velocity models improves image resolution.
- The spatial resolution of the converted PS image is higher than that of the compressional PP image.
- Reflectors in migration images are consistent with geologic layers.
- Migration imaging reveals additional geologic layers.
- MEQ occurred around discontinuities of reflectors.

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