

Refraction Microtremor and Optimization Methods for Site Strength and Earthquake Hazard Assessments



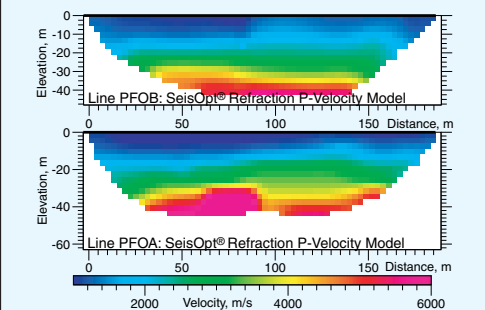
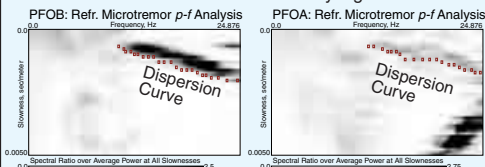
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Refraction: Microtremor and Optimization

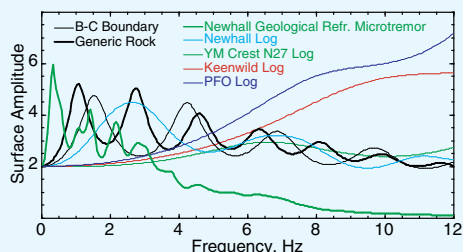
Methods

- Refraction Microtremor** (Louie, BSSA, 2001): Noise on refraction array transformed to p - f space (below, gray), picked for dispersion, modeled for Vs with depth.
- P-wave refraction SeisOpt[®]** (optimsoftware.com): Refraction arrivals optimized for 2-d velocity (below, color); horiz. averaged and converted to Vs using the Poisson-solid assumption.
- Velocity Logs:** Downhole shear-wave profiles by Redpath or USGS (courtesy F. Vernon, UCSD); one hole with Rosrine OYO shear-velocity log.



Non-Generic Rock

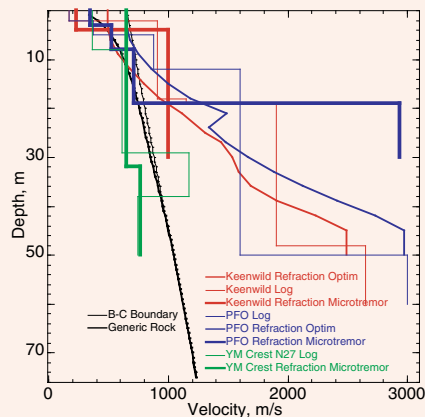
- "Generic Rock" of Steidl *et al.* is average of logs
- Keenwild and PFO logs are very different – Hard Rock
- "Generic Rock" implies deep soil as with Newhall log to 107 m



Borehole and Refraction Results

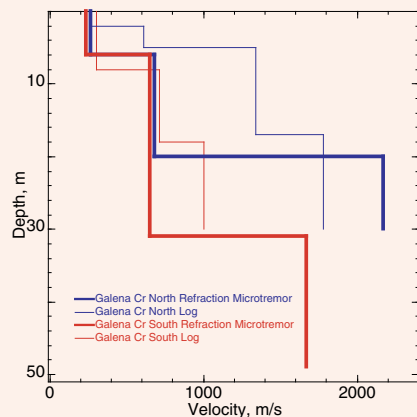
Velocity Data

- 3 sites with downhole Vs and refraction microtremor
- 2 sites with P-wave refraction SeisOpt[®]
- "Generic Rock" summary from Steidl *et al.*, 1996
- B-C Boundary from Frankel *et al.*, 1996



Reno I-580 Extension

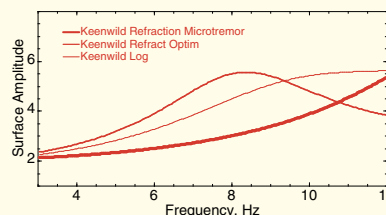
- Interstate extension requires concrete-arch bridge with 300-m span
- Redpath-logged holes at abutment sites
- Average Vs is a foundation design parameter



Model Spectra

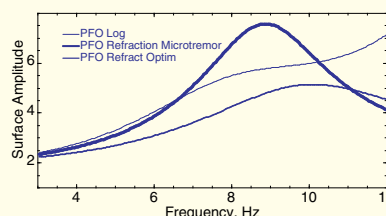
Keenwild – Hard Rock Site in the San Jacinto Mts.

- Little data constraining response below 5 Hz
- Small details from borehole add confusion above 10 Hz
- Velocity gradient in refraction SeisOpt[®] gives 8 Hz peak



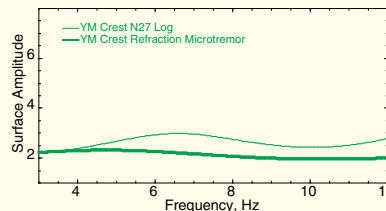
PFO – Hard Rock Site in the San Jacinto Mts.

- Little data constraining response below 5 Hz
- Small details from borehole add confusion above 10 Hz
- Both refraction microtremor and SeisOpt[®] give 9-10 Hz peak



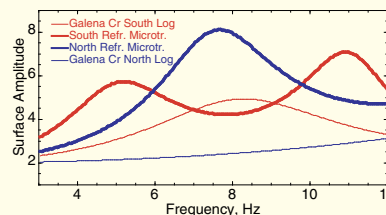
YM Crest – Yucca Mountain, southern Nevada

- Almost no velocity gradient near surface
- No significant amplification in 3-12 Hz band
- Refraction microtremor data suggest but don't constrain velocity inversion



Reno I-580 Extension – Refraction Microtremor vs. Log Spectra

- Refraction microtremor averages over 200-m-long section
- Logged boreholes are at ends of refraction lines
- 30-meter depth-averaged velocities match well, spectra do not

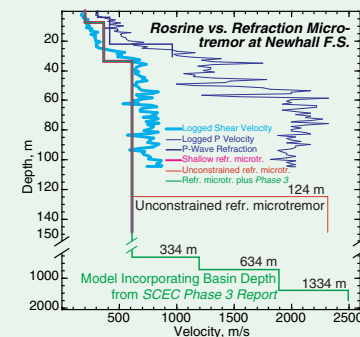


Results

- Velocity models estimated with refraction methods produce similar average velocities and spectra, versus models from borehole logging.
- The models must be estimated over the same depth intervals as the logs to produce similar spectra.
- Adding geological information to models suggests velocities from only the upper 100 meters are not adequate for estimating spectra.

Newhall – Rosrine OYO Log at Fire Station

- Refraction microtremor matches log to 107-m logged depth
- Refraction microtremor suggested 124-m basin depth
- "Shallow refraction microtremor" avoids poorly constrained depth
- 1350-m basin depth from SCEC Phase 3 Report suggests a geologically realistic model



Newhall – Rosrine OYO Log at Fire Station, 107 m deep

- Refr. microtremor could not constrain velocities below log depth
- To 100-m depth, log and refr. microtremor give same spectra
- Including basin depth from Phase 3 Report yields entirely different response

