

Repeated Mine Blasts Recorded on a Dense Broadband



S23A-2530

Array, Ruby Mountains, Nevada



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Motivation

- Active seismic surveys across large areas are cost-prohibitive. If mine blasts can successfully be used for source energy, passive seismic studies in areas with regular active seismic sources can be complemented by interpretation of the energy recorded from these sources.
- The Ruby Mountains Core Complex (RMCC), located in the Basin and Range region in northeastern Nevada, is surrounded by three mining operations roughly in line with the Ruby Mountain Seismic Experiment recorders.
- We hope to create a first order velocity model from the stacked mine data, and compare it to results from more conventional methods.

Ruby Mountains Seismic Experiment

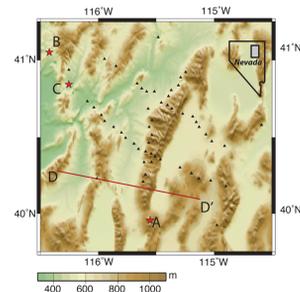


Figure 1: Triangles represent RMSE stations, stars the mines, and D-D' the cross-section from [3]

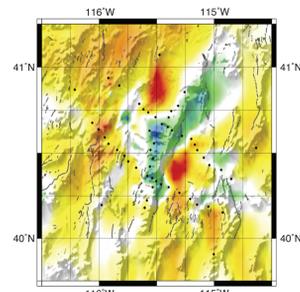


Figure 2: RMSE ambient noise tomography ~15 km below surface.

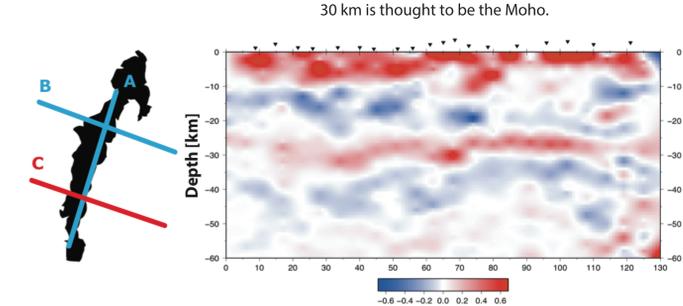


Figure 3: Receiver function across the C-line show variations in the crustal depth. The reflector at about 30 km is thought to be the Moho.

A 50-station broadband passive seismic array with dense station spacing of 5-10 km arranged in three crossing lines over the RMCC (Figure 1).

The array was deployed from June 2010 through June 2012.

RMSE ambient noise tomography indicates faster seismic velocities through the mountains and slower velocities in the adjacent basins (Figure 2).

Receiver function analysis also identified a clear Moho (Figure 3) using teleseismic events.

Results from our active mine blast survey will complement these techniques when we produce a full velocity model.

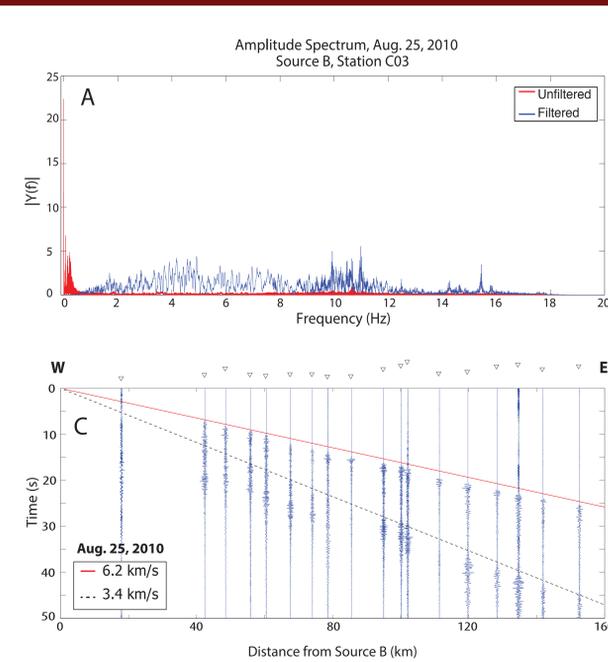
Preliminary Results

Data Preparation

We first selected arrivals at the two closest stations and categorized origin locations by the delta time and GPS coordinates provided by the mines.

The lengthy signal requires a filter to help deconvolve the data. We applied a high pass Butterworth filter to the data, with a 1Hz cutoff. Data is sampled at 40 Hz.

Below we display the "best" single shot from Mine B, examining the signal shape prior to stacking. We are interested to see if signal-to-noise improves with stacking. Prior to stacking mean signal-to-noise is 22.5.



A-B. Station C03 was chosen as a representative station to show the spectral analysis before filtering, after filtering, and after stacking.

C-D. The "best" individual trace from analyzed data compared to data after stacking. Stacked traces are multiplied by a factor of 10, the individual by 1.

E. Location variations of August 2010 blasts from Mine B. Blue blasts are an order of magnitude greater than the turquoise. The green point is the centroid location of the stacks.

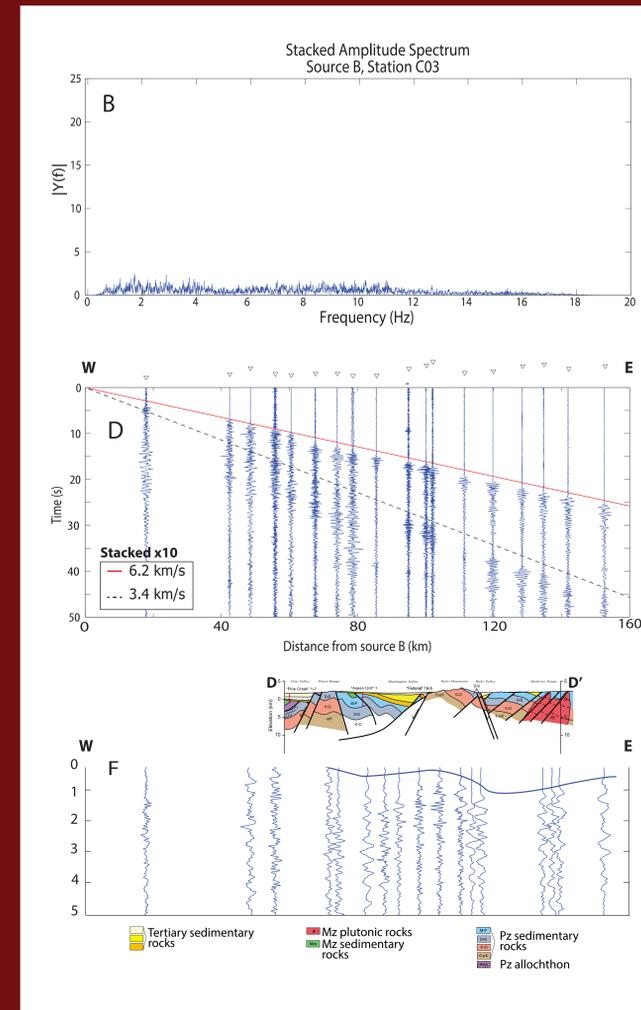
F. Ruby Line C roughly projected onto cross section from [3] shows basin delays. Traces are reduced to eliminate travel delay.

Stacked Traces

Mine blasts are "ripple-fired": a single blast fires many tens of shot-holes with planned delays over hundreds of milliseconds and does not produce a compact seismic source.

To mitigate the lengthy signal we stack multiple blasts from similar locations (successive blasts on subsequent days are fired close by, but not at identical locations) that occurred on different days, with the hope that the onset of the blast will stack constructively between blasts, but that the later part of the source signatures will interfere destructively.

Below are the data from Mine B after stacking.



Discussion

- The shape of the arrivals, even when corrected for elevation, corresponds with that of the regional topography. Velocities decrease in topographic lows and increase in topographic highs, fitting the expectation of slower sediments in basins and faster crystalline rocks in the mountains.
- So far, stacking has not improved the shape of the data over the best individual trace. Stacked signal-to-noise is 11.5, compared to 22.5 prior to stacking.
- We find the best-fit P-wave velocity across the C-line to be 6.2 km/s, regardless of whether data is stacked or not. This velocity is consistent with other studies which found velocities of 6.1-6.2 km/s across the southern Rubies [2,4].
- Our best-fit S-wave velocity is 3.4 km/s, slightly slower than previous studies found [2]. We do not gain resolution on the S-wave arrival until after 100 km, where stations are primarily in basins.

Future Work

- Incorporate more data into the stacks in order to successfully increase P- and S-wave amplitudes.
- Increase resolution via stacking such that we can successfully identify the Moho reflection and other reflections.
- Create crustal velocity model utilizing P- and S-wave velocities determined from the stacks.

Acknowledgements

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References

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