Treasure Valley Seismic Reflection Project - April, 2000 Union Pacific Noise Tests

Report Prepared for the Idaho Department of Water Resources

Lee M. Liberty and Spencer H. Wood
Center for Geophysical Investigation of the Shallow Subsurface (CGISS) and
Department of Geosciences
Boise State University
Boise, Idaho 83725

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Boise State University

1.0 Summary

We have acquired and processed two seismic reflection noise tests using two different seismic sources along the Union Pacific railroad in southwest Boise as the feasibility portion of a seismic reflection program with the Idaho Department of Water Resources. Results suggest that production seismic reflection work along the railroad line from Eagle Road in Meridian to Orchard Road in Boise should continue this summer using a trailer-mounted weight drop seismic source. Results from the seismic reflection noise tests show that many reflections in the upper 2000 ft. are present in the subsurface. These reflections will better define hydrostratigraphic boundaries that can characterize the hydrogeologic aquifer in a region where few well logs and high uncertainties in correlating lithologic units appear.

2.0 Setting

The region between Meridian and southwest Boise (Figure 1) contains few deep water wells and the stratigraphy is too complex to tie major hydrostratigraphic boundaries between wells. We plan to use seismic reflection methods to connect regional water well information and to better understand the subsurface geology in the upper 1500-2000 feet below land surface. Prior to seismic reflection work, initial site selection and seismic noise tests are necessary to best design and acquire a production seismic reflection survey. This report summarizes the Phase I portion of the seismic program.

2.1 Site Selection

Seismic reflection work in an urban setting can be challenging due to cultural noise and permitting issues. Continuous access along private properties is difficult to permit with many land owners. Access along city streets is both dangerous and leads to poor data quality due to traffic and other cultural noises. Railroad lines can be ideal with regard to access, due to their straight and continuous nature, and access is from only one agency. But, railroads are often built upon fill material that can degrade seismic signals. In addition, power lines often follow the railroad and urban cultural noise is still present. We selected the Union Pacific railroad line between Boise and Nampa to acquire seismic reflection noise test data to determine if these concerns regarding access and noise will adversely affect seismic signals. A continuous profile along this line will aid in interpreting the structural and stratigraphic style for the region and can be tied to the deep water wells in the region. We collected the initial seismic data along this profile to obtain parameters necessary to optimally acquire a production seismic reflection profile.

3.0 Seismic Acquisition

We acquired seismic noise tests at two locations along the railroad (Figure 1). The first

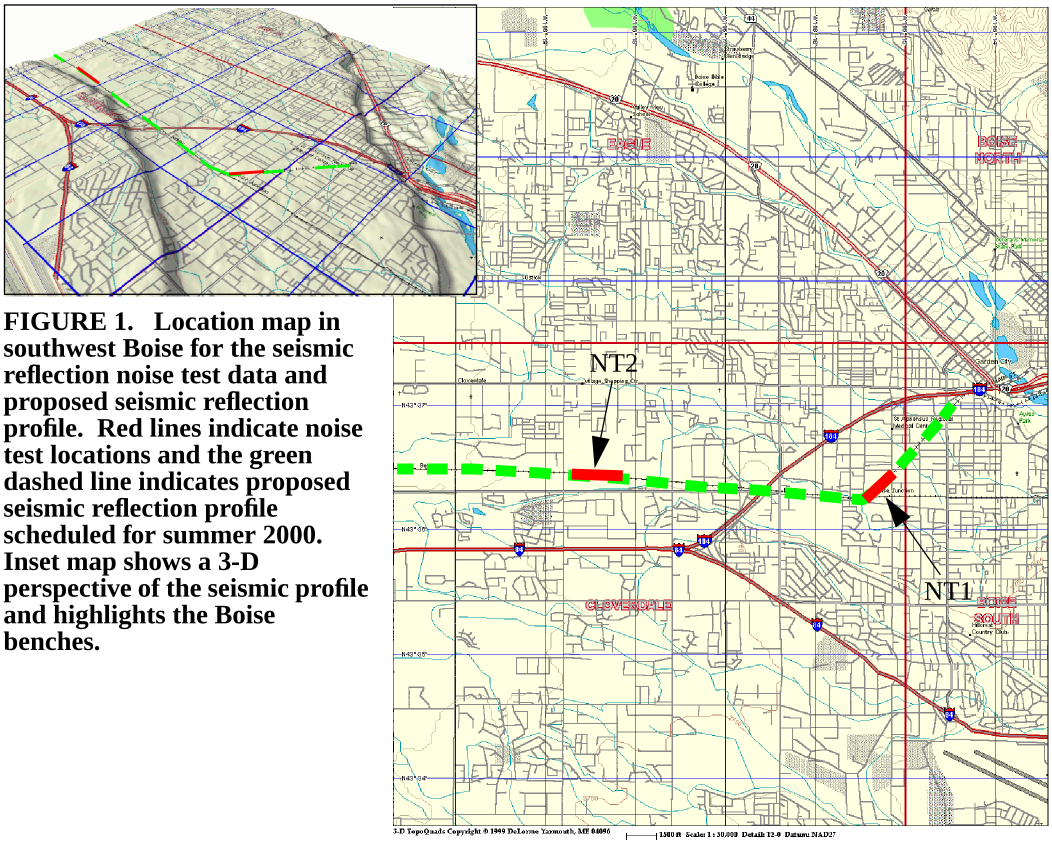

FIGURE 1. Location map in southwest Boise for the seismic reflection noise test data and proposed seismic reflection profile. Red lines indicate noise test locations and the green dashed line indicates proposed seismic reflection profile scheduled for summer 2000. Inset map shows a 3-D perspective of the seismic profile and highlights the Boise benches.

noise test, NT1 is located north of Franklin road and west of Orchard Road. This segment of the railroad line is oriented northeast-southwest and a profile along this segment is in-line with the dip of the basin. Some railroad fill material may be present below the land surface at this location. The second noise test, NT2, is located along the Union Pacific railroad east of Five Mile road and north of Franklin Road. This site contains major power lines overhead, industry noise from a nearby bread plant, and air and street traffic. With both experiments, we acquired data with a 60-channel seismograph and a 1 m geophone spacing. We walked away at 60 m interval to simulate a densely spaced shot gather that defines the reflection character and the noise components that we will encounter with a production seismic reflection profile. We used 10-Hz geophones, recorded with a 0.5 ms sample rate, and used both a hitch-mounted and trailer-mounted seismic source (Figure 2).


FIGURE 2. Images of the seismic recording truck and Union Pacific right-of-way from NT2 (top) and trailer-mounted seismic source (right) that we plan to use during the production phase of the seismic reflection project.

4.0 Seismic Processing

We processed the noise tests with Landmark’s ProMAX seismic processing software. This software is an oil-industry standard for seismic reflection processing. We initially added a source and receiver geometry to the seismic data for spatial positioning. After we applied the geometry, we combined the raw seismic records to simulate a densely-spaced seismic reflection shot gather to identify continuous reflections. We applied an f-k filter to attenuate surface waves and a spectral whitening filter to enhance the reflection signals while attenuating other sources of noise. Also, we muted the air wave signal to produce a section that contains mostly reflection energy.

5.0 Discussion

Figure 3 shows the processed NT1 gather and a depth corrected section that simulates a portion of a stacked seismic reflection profile. These figures are not adequate to interpret structural geology, but provide insight into the seismic stratigraphy that we should anticipate during the Phase II portion of the project. The returned signal from near-offsets traditionally does not show high quality reflections due, in-part, to the presence of dispersive surface wave energy, hence the necessity to acquire an array of offsets to optimally image all target depths.

NT1 Seismic Gather

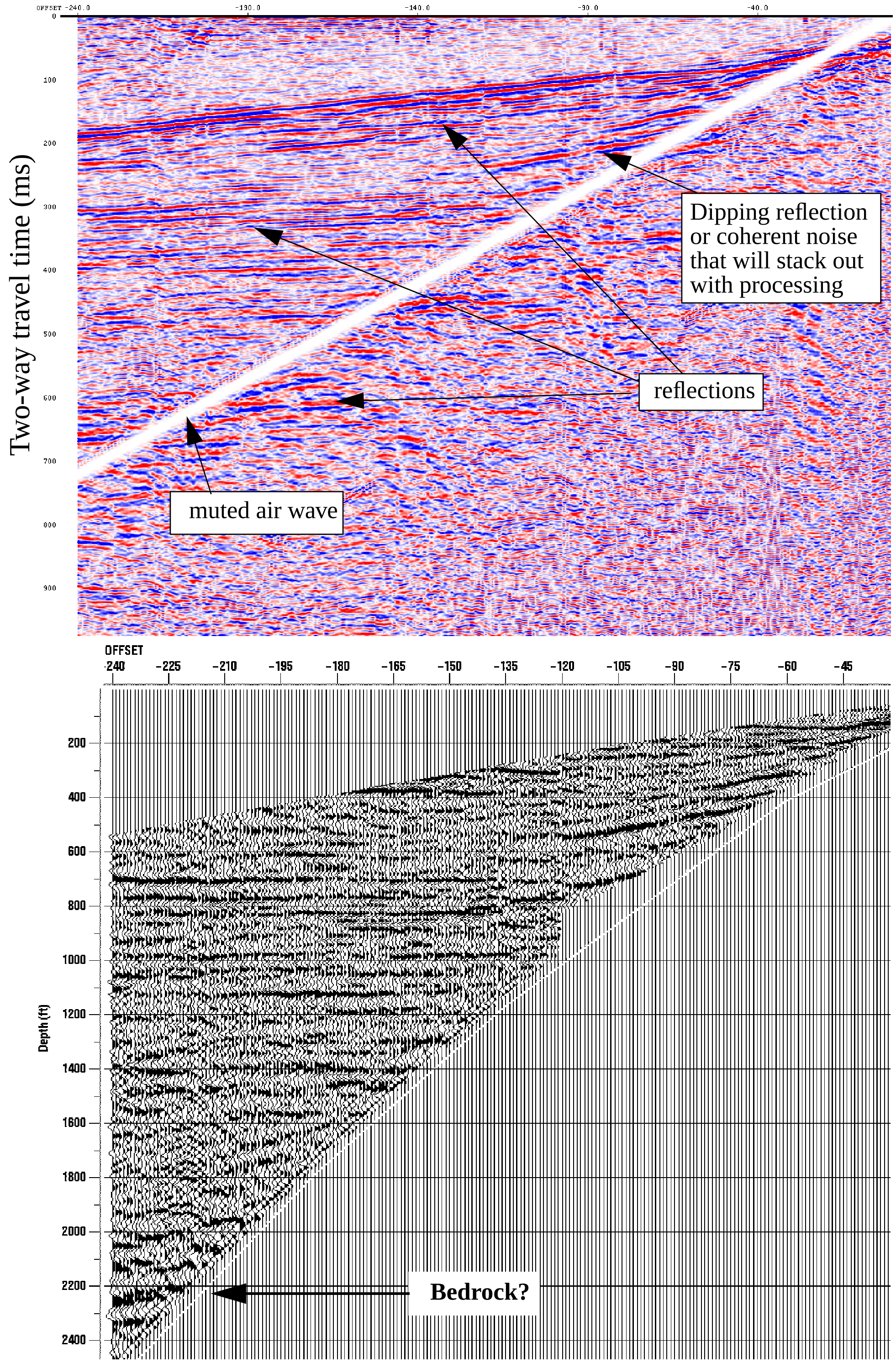

FIGURE 3. (A) Processed gather from site NT1 along the downtown railroad spur near Orchard Road. Processing includes f-k and 40-150 Hz spectral whitening filters and air wave mute. (B) Depth converted section representing a corridor stack. Note reflections to greater than 2000 feet with the CGISS trailer mounted weight drop device. The low frequency reflections at the base of the section may represent reflections from bedrock.

Note the presence of many reflections throughout the NT1 section to approximately 1 second two-way travel time or greater than 2000 feet depth (Figure 3b). A strong reflection package appears between 700-1400 ft. depth, then a strong, low frequency reflection package that may represent bedrock appears at approximately 2200 ft. depth. The NT1 site is typical of the conditions that we will encounter along the northeast spur of the railroad and should represent the quality of reflection data along this profile. Note that we will acquire redundant data (up to 60-fold) during production seismic reflection work and that the data quality for the seismic along this profile should be excellent.

Figure 4 shows the results from NT2. NT2 is located east of Fivemile Road and represents

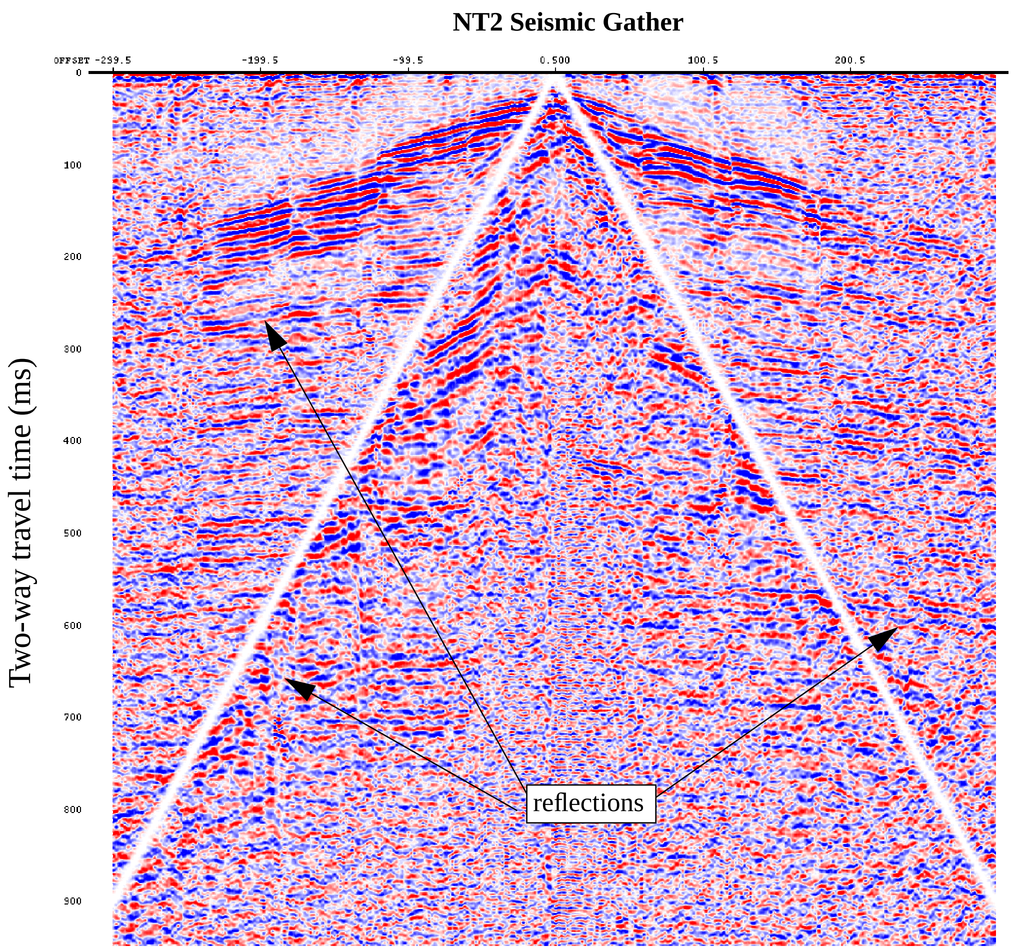

FIGURE 4. Processed gather from site NT2 along east of Five Mile Road and north of Franklin Road. Processing includes f-k and 40-150 Hz spectral whitening filters and air wave mute. Similar reflections compared to NT1 appear on this section, though slightly degraded due to cultural noise.

an area of industrial and electrical noise. At this site, we acquired seismic data with two different weight drop sources. The data from the smaller weight drop source (hitch-mounted) was not adequate to image deep in the section, and we will only show results from the trailer-mounted weight-drop system.

Although the results from NT2 data appear more noisy than the NT1 data, reflections still appear to similar depths, and with proper seismic reflection acquisition and processing parameters, we should be able to acquire a high-quality seismic reflection profile along the main Union Pacific railroad.

6.0 Conclusions

The seismic noise tests show that a high quality seismic reflection program should prevail this summer. Noise tests from two locations show seismic reflections down to a depth of 1500-2000 ft., even where cultural noise, including power lines, industrial noise, and traffic appear. We recommend that we proceed with Phase II of the Treasure Valley seismic program with the trailer-mounted weight-drop source.

7.0 Acknowledgments

We would like to thank Bob Adams and Gary Bonner from Union Pacific for permission to access Union Pacific property for these tests and for the upcoming production seismic reflection work. R.D. Bolger and Sara Smith provided valuable field assistance. CGISS contribution number 00-04.