Extracting Seismic Profiles from Background Seismic Signals

Michael FEHLER
Geophysics Group; Los Alamos National Laboratory; Los Alamos, NM USA
Email: fehler@lanl.gov

K. Sabra, P. Gerstoft, P. Roux, W. Kuperman
Marine Physical Laboratory, Scripps Institution of Oceanography, La Jolla, CA, USA

The idea of obtaining the seismic trace representing the impulse response at one receiver due to a source at another receiver has discussed by many authors. Jon Claerbout (see e.g. Rickett and Claerbout, 1996; Claerbout, web) introduced the concept to seismology. It has been investigated in the laboratory by Lobkis and Weaver (2001), observed in seismic data by Campillio and Paul (2003), and in the ocean by Roux and Kuperman (2004). Quoting from Rickett and Claerbour (1996) "*By cross correlating noise traces recorded at two locations on the surface, we can construct the wavefield that would be recorded at one of the locations if there was a source at the other.*" Rickett and Claerbout (1996) called the approach *Daylight Acoustic Imaging.* Norton and Won (2000) call the approach *Time exposure acoustics.* The method has been applied to studying solar structure (Duvall et al., 1993).

We investigate the capability to use background seismic signals to develop seismic record sections. Our first test involves using numerical data representing a suite of simple earthquakes to generate a 2D record section. Figure 1 shows the geometry of source and receivers. We generated a record section for a band-limited source located at the position of the star on the surface and receivers located at the triangles in Figure 1. Figure 2 shows the resulting trace data. We also numerically calculated traces resulting from cross correlation of traces at the surface source location and the surface receiver locations resulting from sources buried within the Earth that are considered to be distributed earthquakes. The traces we obtain by cross correlation show clearly the waves reflected from the subsurface layer boundary that are seen in the traces obtained for the surface source.

We also compute cross-correlations from ambient noise recorded over 150 broadband seismic stations located in California. Startion locations are shown in Figure 3. A simple and straightforward processing yielded hundreds of cross-correlation pairs, for receiver separations of up to 250 km, that clearly exhibit coherent broadband dispersive wavetrains (Figure 4). A record section of the waveforms as a function of increasing receiver separation shows clearly that the recovered signals are propagating wavetrains.

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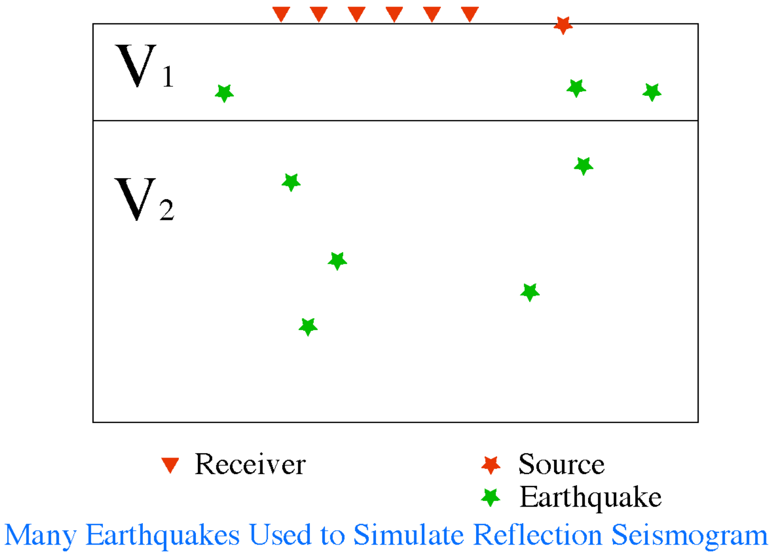

Figure 1. Geometry used for numerical simulation. The 2D medium consists of a layer over a half space. A source is located at the position of the star at the surface and receivers are located at the locations of the triangles. Locations of simulated earthquake sources are shown using stars within the medium.

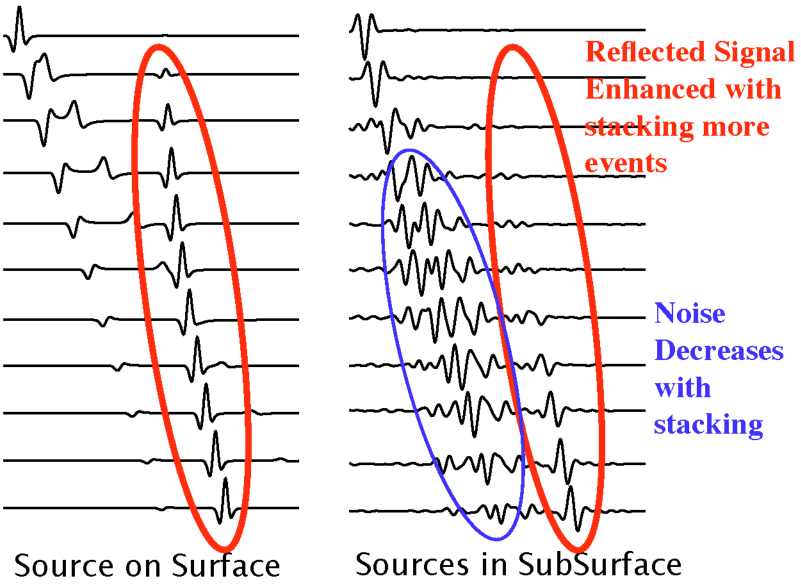

Figure 2. Results of numerical simulation. Traces on left show a shot gather for the source at the surface in Figure 1. Traces on right are obtained by stacking the cross--

correlated traces at surface source location with those at the receiver locations resulting from sources at the earthquake locations in Figure 1.

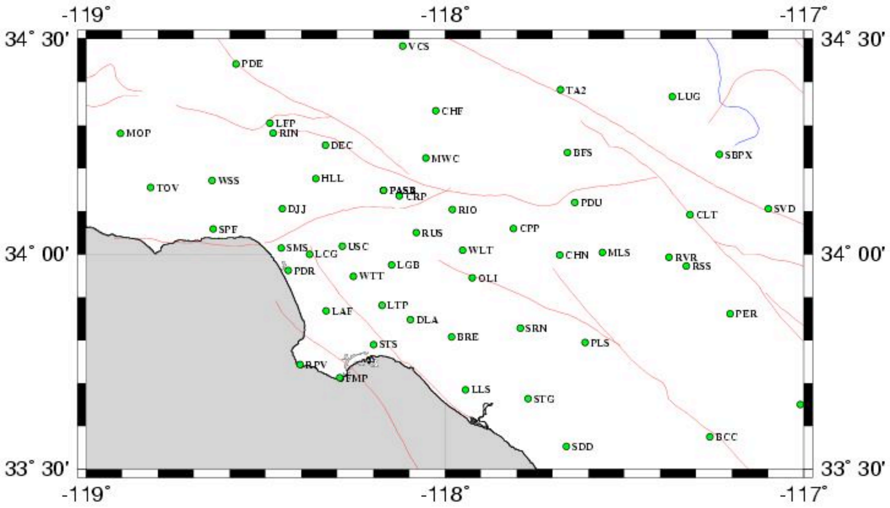

Figure 3. Locations of broadband stations in Southern California used for analysis.

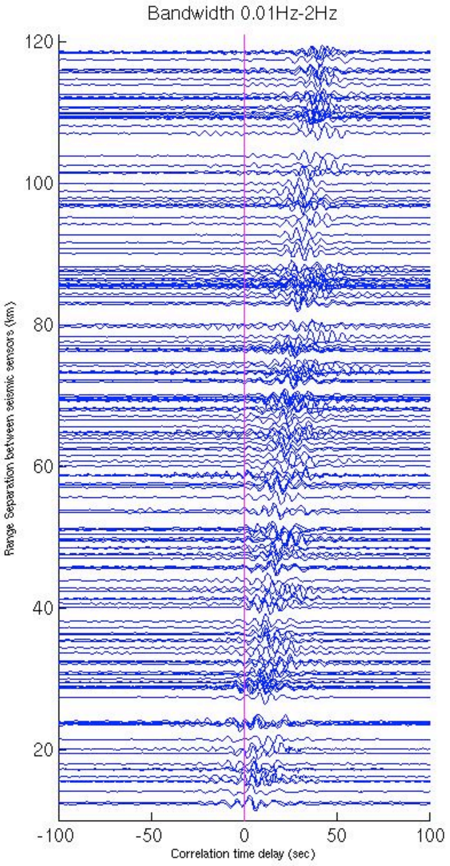

Figure 4. Record section obtained by cross-correlating noise between stations in the Southern California seismic network.