Application of Ambient Noise Autocorrelation Imaging to Dense Seismic Arrays at Local and Regional Scale

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Autocorrelations of ambient seismic noise records can be a useful tool for estimating the reflectivity of the subsurface from basement to Moho. To overcome the noise contamination that results from the dominance of surface waves in ambient seismic noise, cross-correlation of noise time series recorded by closely spaced station pairs in a dense seismic array can be used to generate gathers equivalent to zero offset reflection sections.

We demonstrate applications of the technique to dense seismic arrays at various scales, including an exploration-scale array (an array with aperture between 300 m to 1.5 km), arrays with apertures between 6-10 km, and a regional-scale array with 60-80 km aperture. Initial data processing for these applications includes experimentation with a range of values for parameters such as frequency range, time/frequency normalization, cross-correlation and step length, and maximum time lag, to find optimum parameter values and obtain virtual source gathers. Near-offset traces from these virtual source gathers were then used to form a gather equivalent to a zero-offset reflection section. Various sizes of the stacking bins were tested to determine trade-offs between lateral resolution of the image and contamination from random noise. A P-wave reflectivity image was then obtained by subtracting a linear average of all the traces in the gather to minimize the masking effect of the effective source time function.

Some of these arrays included sources, including an airgun array, Vibroseis, and a propelled weight drop (PEG) source, and were recorded for different lengths of time. We apply the method to the datasets with and without the presence of these sources. A comparison between primary results obtained for the data subsets with and without these sources indicates that comparable images of the subsurface can be obtained without the use of sources.
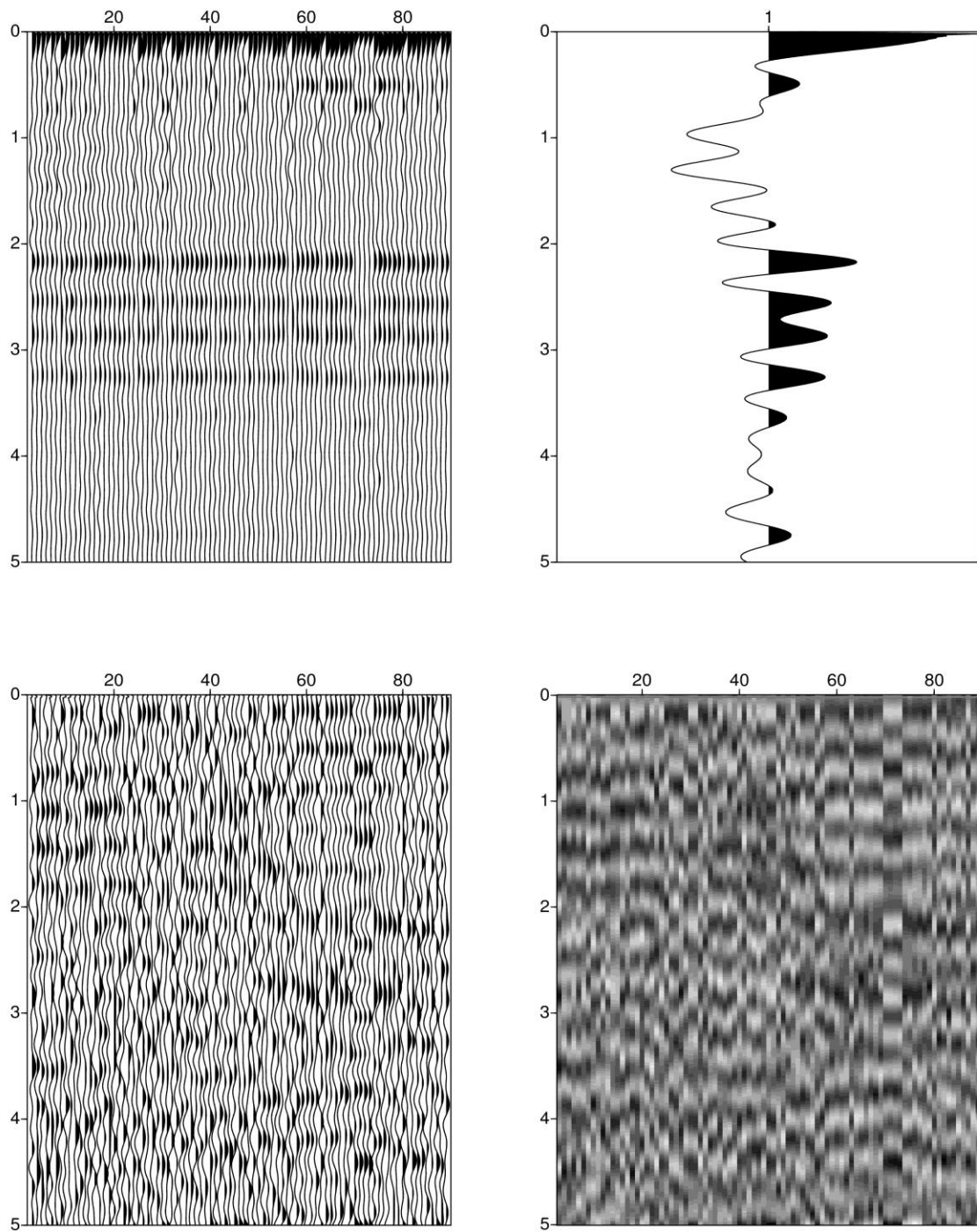
Figure 1: (a) zero offset reflection section equivalent gather produced from virtual source gathers (b) linear average of all the traces in the gather (c)&(d) images of the subsurface obtained by subtracting the linear average from the gather