

Uncorrelated data driven vibroseis deconvolution

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The theory of exploiting a linear frequency modulated signal corrupted by Gaussian noise for pulse compression can be traced back to several independent radar patents in the 1940s and 1950s. This early work on matched filter theory is now routinely used in the field when the recorded vibroseis signal is cross-correlated with the desired input source signature (pilot sweep). Unfortunately, the actual ground-force signal includes additional higher and lower-order harmonics introduced by the non-linear effects of a spatially varying vibroseis-earth system. As a result, the conventional pilot sweep will only compress the fundamental sweep and uncompressed harmonics will give rise to high-amplitude apparent dispersive near-surface waves. To remove these effects, an accurate estimate of the ground-force is needed.

The high fidelity vibroseis system is one such method which estimates the ground force signal from the reaction mass and baseplate accelerometers. But these measurements are sensitive to local non-linear distortions of the vibrator system. We propose a new method based on our observation that the harmonics are preserved in the near-surface wave propagation modes. Using the uncorrelated air-coupled rayleigh wave we can model the near-field ground force signal. This spatially varying ground-force estimate now includes useable harmonic distortion frequencies up to 150Hz (Figure 1). Using this signal to design an optimum inverse filter yields higher-resolution results when compared to conventional correlation (Figure 2).

This new ground force estimation method offers a new approach to improving the seismic resolution by removing the uncompressed harmonic arrivals and improved signal compression.

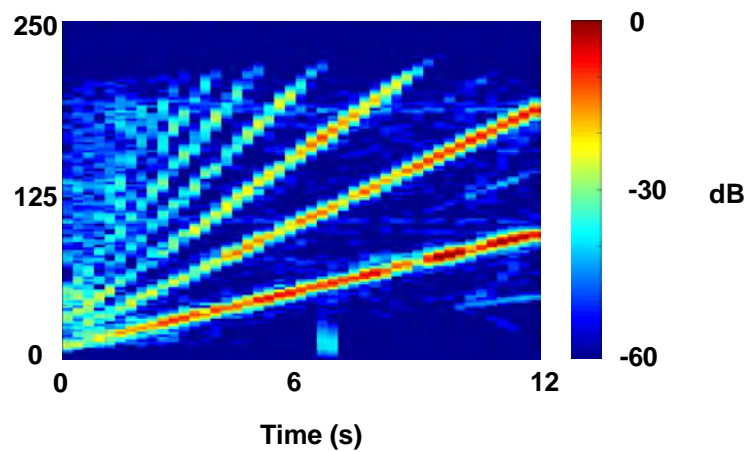


Figure 1. Frequency – time display of the data driven near-field ground-force estimate.

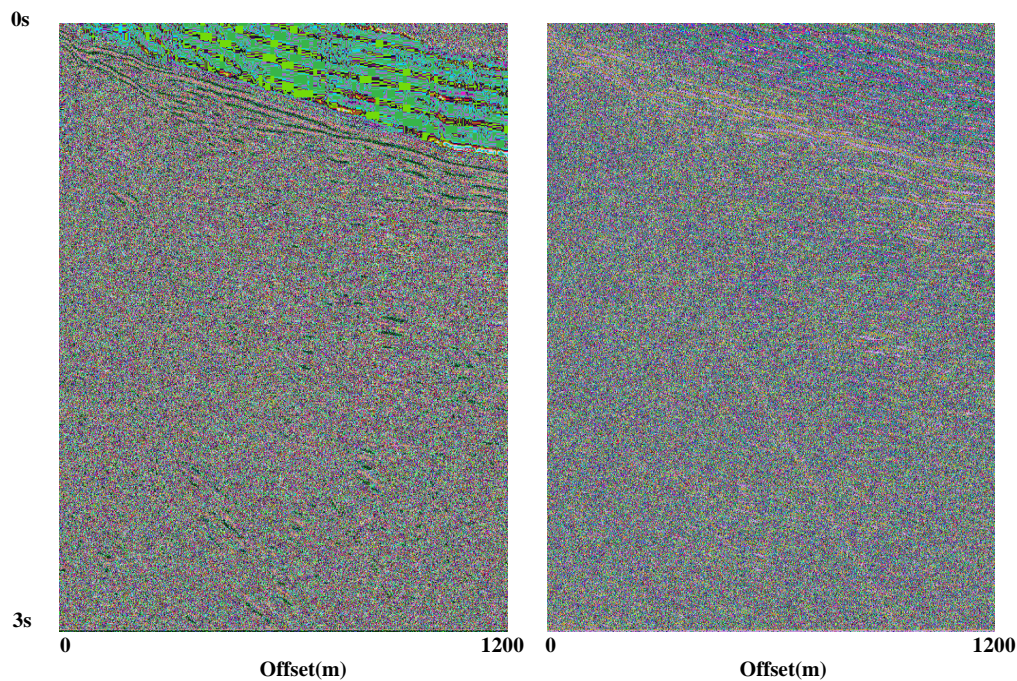


Figure 2. Common source record comparison of conventional correlation (left) versus data driven deconvolution (right).