Enhancing reflection SNRs on Vibroseis common-source gathers acquired with m-sequence pilots

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INTRODUCTION

Vibroseis raw field data acquired with four simultaneous vibrators controlled by m-sequence pilots are deblended by crosscorrelation. The deblended common-source gathers (CSGs) have reflections that are somewhat degraded by (1) direct-arrival-related artifacts and (2) crosstalk between vibrators. Crosstalk due to surface waves and direct arrivals from nearby vibrators are especially strong. (1) A three-trace averaging and subtraction procedure reduces interference by artifacts. (2) Keeping the separation between adjacent vibrators to 100m or less decreases crosstalk interference. (3) Local slant stacking further increases reflection signal-to-noise ratios (SNRs). Figures 1 to 3 show how each step increases the clarity of the reflections. Figure 4 and 5 show deblended CSGs from four vibrators running simultaneously, before and after SNR enhancement, for two vibrator separations.

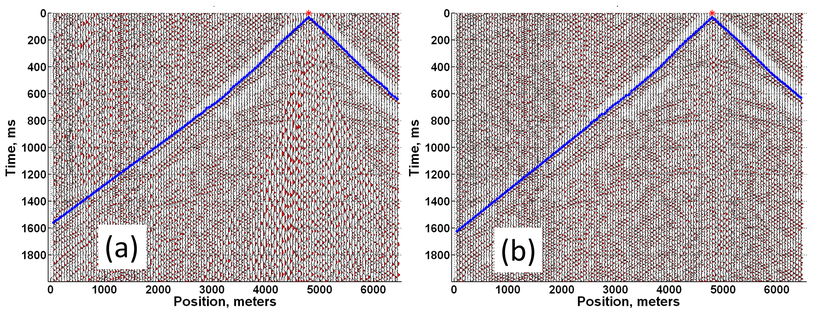


Figure 1: AGC plots of a) unfiltered deblended common source gather; (b) after application of [10-30-100-150] Hz bandpass filter. Blue line shows time picks for first arrivals.

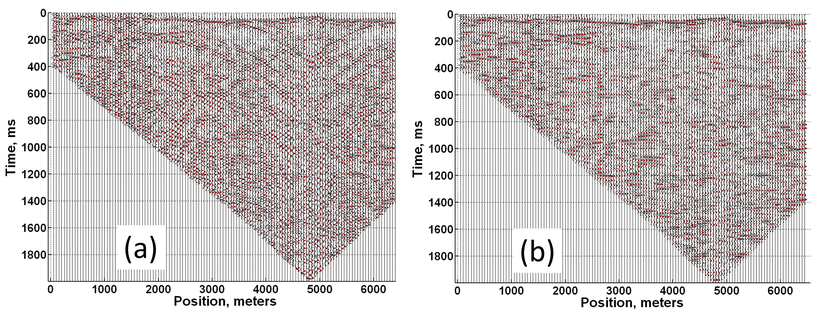


Figure 2: (a) All traces aligned to first-arrival times; (b) first-arrival-related artifacts, estimated by three-trace averaging of aligned traces.

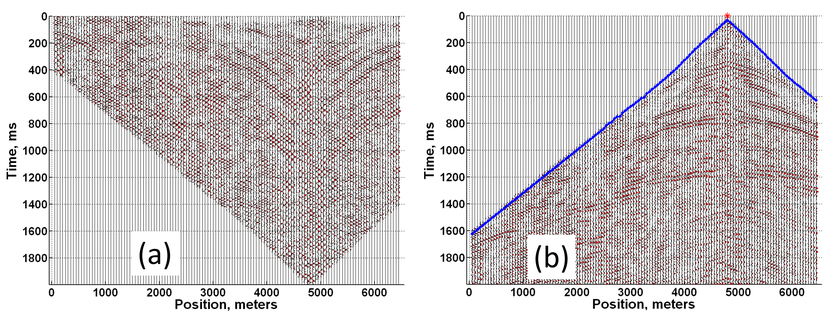
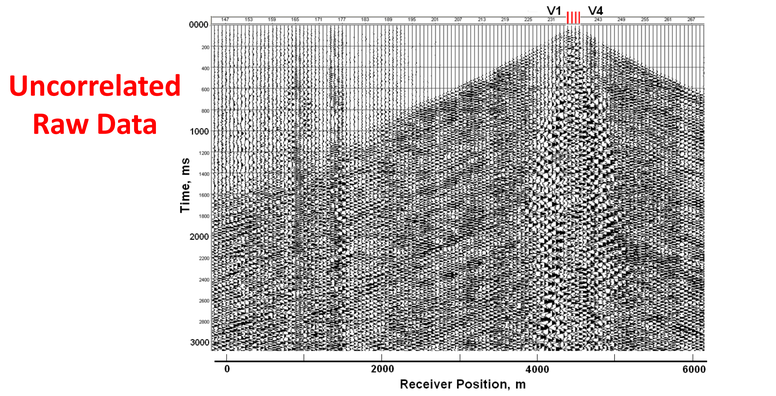


Figure 3: (a) Figure 2(a) minus Figure 2(b); (b) the difference after reversing the alignment. Note the improvement in the appearances of the reflections compared to Figure 1(b).

VIBRATOR SPACING = 50M

Uncorrelated Raw Data



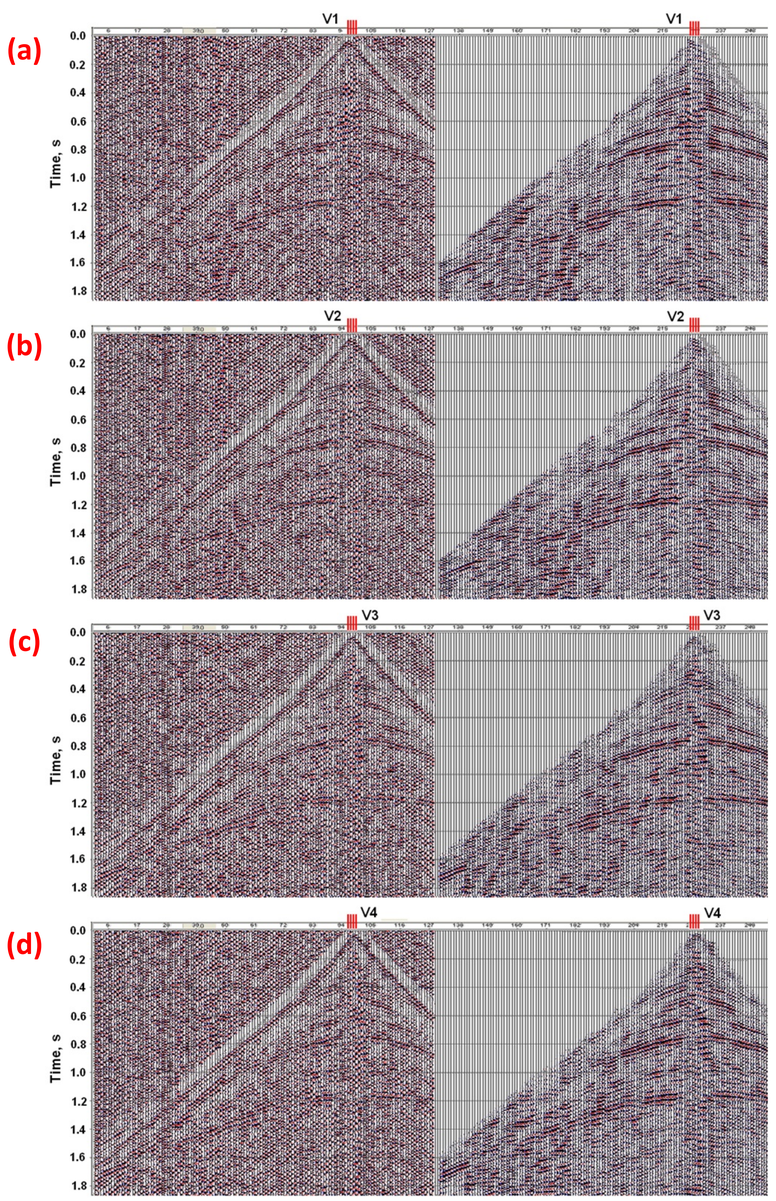
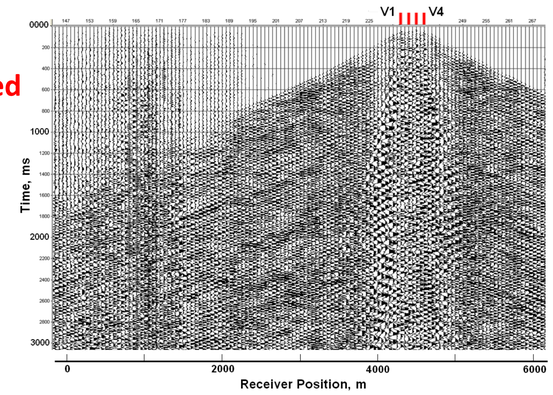


Figure 5: Top: unfiltered raw data from four simultaneous vibrators. (a) to (d): Deblended CSGs for vibrators V1 to V4. Left side CSGs are filtered and unenhanced. Right side: CSGs after artifact reduction and local slant stacking to attenuate crosstalk and random noise.

VIBRATOR SPACING = 100M

Uncorrelated Raw Data



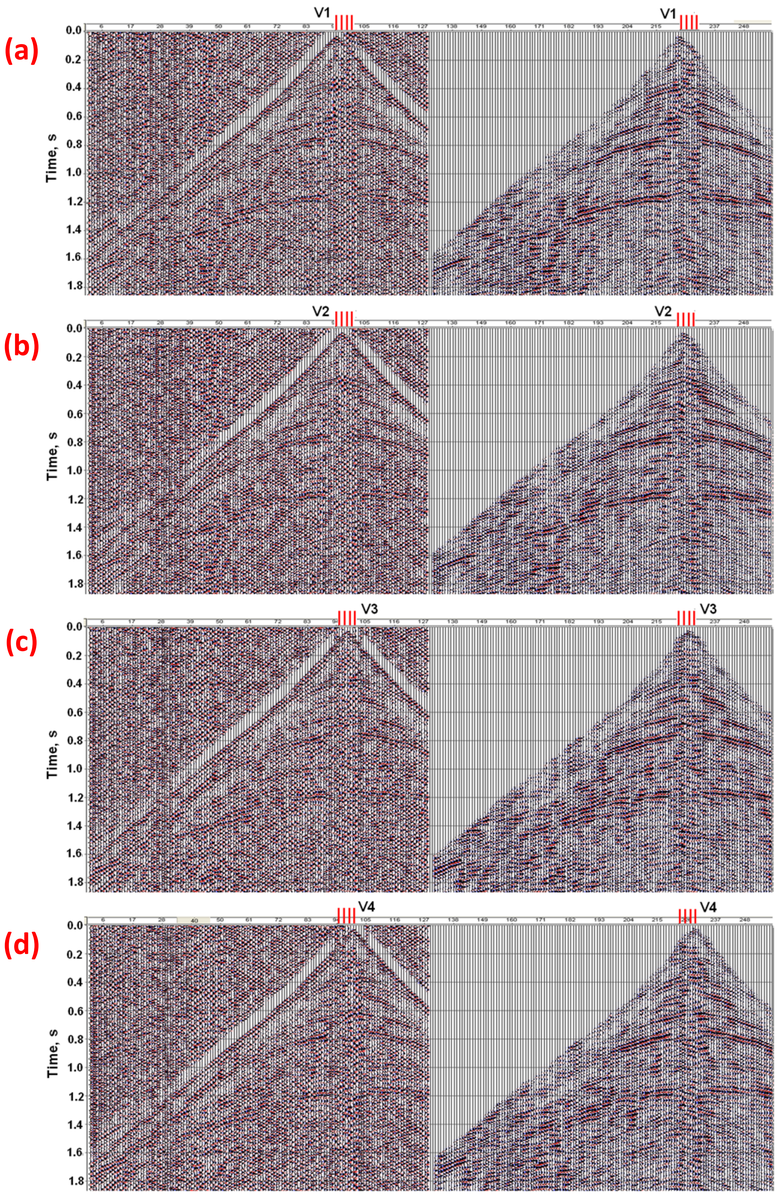


Figure 6: Top: unfiltered raw data from four simultaneous vibrators. (a) to (d): Deblended CSGs for vibrators V1 to V4. Left side CSGs are filtered and unenhanced. Right side: CSGs after artifact reduction and local slant stacking to attenuate crosstalk and random noise.