New Pre-correlation Filters to Remove Vibroseis Direct Wave

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Vibroseis data recorded at short source-receiver offsets can be swamped by direct waves from the source. As the energy of the direct waves is larger than that of the reflections from the subsurface, the sidelobe problem of correlation can lead to low seismic resolution on correlated vibroseis data. Two pre-correlation filtering approaches are proposed to suppress correlation noise. The first uses a long optimum Wiener filter (LOWF) to remove the direct wave, on the assumption that the onset time of the direct wave is known precisely. The second is a combination of a 'squeeze & unsqueeze' transformation, together with the application of either an optimum least-squares filter or a linear recursive notch filter. A correlation recognition operator searches for the first arrival. We demonstrate that both filtering procedures can provide excellent direct wave interference cancellation on synthetic data. But when the correlation recognition for searching for the first arrival fails, a heavy harmonic distortion will be caused with the LOWF filter. If the tapers of the source sweeps are badly distorted, another kind of harmonic will be introduced in the filtered version for the 'squeeze-filter-unsqueeze' (SFU) process.

The LOWF filter appears to be more suitable for low-noise vibroseis data, and the SFU filter is more effective when we know exactly the sweep tapers.

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