MULTICHANNEL SEISMIC EXPERIMENT WITH A DRILL-BIT SOURCE

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ABSTRACT

The challenge in experiments using the drill bit as a seismic source is to separate the weak drill-bit signal from noise generated by industrial activity near the well. In a new seismic experiment, the ambient elastic field is recorded during the drilling of a well with a multichannel array laid on the Earth's surface. The novel concept is the dense sampling of the acoustic wavefield in *space*, such that multichannel filtering could subsequently focus and amplify the weak signal while suppressing noise. Focusing of the drill-bit signal is possible because the drill-bit source acts as a vertical point force, and therefore the spatial coherency (moveout) of the drill-bit signal is predictable when the depth of the well and RMS seismic velocities are known.

Observations of field data recorded with a conventional 1-D seismic line during drilling show that the strongest-amplitude events in the data are noise. I apply median smoothing and iterative velocity filtering to attenuate noise whose moveout differs significantly from the moveout expected from the drill-bit signal. After velocity filtering, the drill-bit signal remains still weaker than events in the data with similar moveout across the 1-D seismic line — background noise, which has a uniform velocity spectrum, or strong noise from a source located at the surface. However, temporal cross-correlation of the velocity-filtered data with a reference signal from a geophone located in a shallow borehole, separates the signal and noise waveforms in *time*. Then, stacking velocity analysis of the cross-correlated data reveals a coherent event whose traveltime delays are consistent with those expected from the drill-bit signal.

From the analysis of these data, I obtained average traveltime delays through the subsurface, as well as models for the ambient noise. Such traveltime delays, if determined over a range of depths, could be used for time-to-depth conversion of surface seismic data

or for tomographic reconstruction of velocities near the borehole. The strong sources of noise observed in this first experiment suggest a 2-D acquisition geometry for future experiments, so that more ambitious goals, such as imaging of reflectors, could be pursued.

I expect that the processing sequence developed for the analysis of these data will be of interest also in other seismic experiments that deal with similar signal processing issues: detection of weak sources in strong noise, estimation of traveltime delays for non-impulsive signals, and accurate and efficient velocity filtering by linear transform methods.

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