Time-Lapse Crosswell Seismic Survey: Detecting Various Geobodies

Conrad Kolb, Joel Le Calvez
Schlumberger

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Abstract

Crosswell seismic surveying is an underused technique that measures a seismic signal transmitted from a vibroseis source located in one well to a receiver array located in a nearby well. Recorded data may be processed to create a reflection image or to map the acoustic velocity or other properties of the cross-section area between those two wells. Placement of the source and receiver array in nearby wells, near the zone of interest, enables the cross section between the wells to be surveyed with extremely high resolution. It also bypasses the issues associated with seismic signal propagating through attenuative, near-surface formations, as is the case in surface seismic and borehole seismic surveys. The crosswell seismic technique is therefore used for high-resolution reservoir characterization when surface seismic or vertical seismic profile data lack resolution or for time-lapse monitoring of fluid movements in the reservoir. Following a series of profiles acquired and processed in various geological settings around the world, we document on two synthetic datasets (the first one with a cavity and the second one with a fault) that, in some cases, a full-waveform inversion algorithm is able to identify time-lapse changes using a sonic log, propagated into a 3D model, as the baseline and updating the velocity model with the acquired data. This is very promising for two reasons. First, we are able to identify large-scale changes with the current full-waveform inversion code, which we can expand beyond CO2 injections to steam injections. Additionally, any update to the frequency limitation in the full-waveform inversion code would bring further benefits. Second, we are able to see the differences without a baseline, which previously, hindered many jobs due to the mobilization cost to acquire two profiles (before and after). This could open up new opportunities that were

previously too costly in terms of acquisition time and financial considerations to deploy.