High Resolution Waveform Tomography at a Groundwater Contamination Site: Surface Reflection and VSP Datasets

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Abstract

We have applied a form of waveform tomography (Pratt et al., 1998) to datasets from a vertical seismic profile (VSP), coincident 2D reflection, and a 3D surface dataset from Hill Air Force Base (HAFB), Utah. The transmitted waves recorded at depths in the VSP data constrain deep structures better than the surface data. However, surface data with large offsets that are not contaminated by ground roll provide good depth-constraint on seismic phases such as the refraction and reflection wavefields. We have applied the waveform tomography to 45 36.0-meter-long 2D surface profiles that were extracted from the 3D dataset. The profiles are almost perpendicular to the surface spread of the VSP experiment. Travel time tomography applied to the profiles using first arrival picks provides initial velocity models for the waveform tomography. Source signatures for individual shots are inverted at each iteration of the waveform tomography. Seismic velocity increases from ~300.0m/s at the surface to ~1600.0m/s at 16.0m depth. The 11 profiles which intersect the VSP profile correlate reasonably well with the VSP velocity model. The cross-sectional geometry of a paleo-channel, the structural trap containing most of the DNAPLs, can be identified in each of the final velocity models. The combination of the cross-sectional images of the paleo-channel from waveform tomography provides a 3D perspective on velocity structure and the channel with relatively high vertical and lateral resolution (~1.5m).