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Please fill in your manuscript title.	The Application of Refraction Migration to a Distributed Acoustic Sensing Dataset for Near-Surface Characterisation

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Abstract

Objectives/Scope: Obtaining an accurate near-surface velocity model is an ongoing challenge in seismic exploration. Conventionally, a near-surface velocity model can be obtained by inverting the traveltime first-break picks of the direct and refracted events in the seismic records. However, tomographic inversion of first-break traveltimes often yields long-wavelength (i.e. smooth) background velocity models. Our objective is to provide a higher resolution image of the near-surface structures by migrating the refracted events in the seismic records. This imaging procedure is applied to a recently acquired dataset using a buried distributed acoustic sensing (DAS) fiber optics cable in Saudi Arabia.

Methods, Procedures, Process: The refraction imaging methodology is composed of two main steps. Initially, traveltime tomographic inversion is applied to first-break picks in order to obtain a smooth migration velocity model, which can describe the kinematic behavior of refracted events. The refraction events are then separated from the data and migrated using the background velocity model to obtain a short-wavelength subsurface reflectivity distribution of the near surface. The refraction imaging condition is similar to that of reflections, in which the refraction event is smeared over the path along the subsurface refractor.

Results, Observations, Conclusions: We apply the proposed refraction migration methodology to both a synthetic dataset and a field DAS dataset. These datasets have a similar acquisition geometry, which consists of 560 equally-spaced shots along the earth surface. The profile extends for about 5.6 km, and the shot spacing is about 10 m. The DAS cable was buried around 1 meter below the surface and extended for about 3 km centered below the 5.6 km profile. There are 752 receiver stations spaced at around 4 meters. The frequency range of both the simulated and field data is limited to 100 Hz with a dominant frequency of about 12 Hz. The first-break traveltimes were picked on all 421,120 raw traces. Finally, the refracted P-wave energy was windowed using a mute function as a pre-processing step to migration. Initial velocity models for both the synthetic and field data are obtained using slope-intercept analysis to determine the velocities and depth of the flat refractors. Tomographic traveltime inversion

was applied to the time picks in both cases, and smooth background velocity models were obtained after 10 steepest descent iterations. Subsequently, the refracted events were imaged with the inverted velocity model using Kirchhoff migration. The migration yields a high-wavenumber subsurface reflectivity distribution representing the near-surface structure.

Novel/Additive Information: We conclude that applying the proposed refraction migration of the DAS data can be quite useful in providing the true subsurface detailed structures, which compliments the classical long-wavelength smooth background velocities obtained using traveltime tomography.