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Please fill in your manuscript title.	2D Near-Surface Velocity Profile Estimation Using Multi-Offset Data from Smart DAS Uphole Acquisition System

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Abstract

Objectives/Scope:
An accurate near-surface velocity model is essential for constructing an enhanced image of a reservoir. The velocity model can be estimated from a smart DAS uphole seismic profiling first breaks. The objective is to develop a robust nonlinear trave-ltime inversion framework for constructing an accurate near-surface velocity model to be used for characterizing the subsurface in the vicinity of the DAS uphole.

Methods, Procedures, Process:
First, a three-dimensional gridded velocity model is adopted in which traveltimes are accurately computed using an algorithm based on the eikonal equation. The algorithm requires a large number of forward modeling computations when the discretized 3D medium has a large number of nodes. The cost and accuracy of the forward modeling algorithm are directly proportional to the medium sampling. Therefore, one can improve the constructed velocity model by reducing the mesh size, thereby increasing the number of grid points. Second, the ray-path connecting each source-receiver pair is calculated using an algorithm based on Fermat's principle. The ray-paths for all receivers are, later, used for constructing an L2 objective function together with its gradient. Third, an iterative quasi-Newton method employing the BFGS (Broyden-Fletcher-Goldfarb-Shanno) updating formula is deployed to build an updated velocity model. The objective function may have multiple minima because the ray-path depends on the velocity field; therefore, one may need to pay special attention to the starting velocity model.

Results, Observations, Conclusions:
To build the velocity model accurately, there have to be many dedicated sensing stations well positioned within the uphole. The coordinates of such stations need be determined with high accuracy to reduce the errors in the reconstructed velocity model. The same applies for the sources when the situation allows, as is the case when one is probing the subsurface with surface vibroseis. Equally important are the picked first arrival times. The observed data accuracy, including the measuring precision and the errors estimation, is essential for reconstructing accurate velocity model using a gradient-based method. Test on synthetic data demonstrated the robustness of the proposed framework with encouraging results. The algorithm will be applied to a DAS uphole dataset acquired over an area, which requires a detailed near-surface velocity model to be used for imaging the subsurface.

Novel/Additive Information:
The proposed framework splits the problem into two phases in an iterative manner. The first phase involves forward modeling to build the objective function and its gradient using the current velocity model. The second phase comprises optimization using a quasi-Newton algorithm to minimize the objective function with relatively few iterations. Halting the algorithm prior to convergence allows to partially update the velocity model while safeguarding against falling into a local minimum. The algorithm then re-evaluates the objective function and gradient as in phase one.