Processing and Imaging of Seismic Data Acquired with Buried Vertical DAS Arrays

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ABSTRACT

A smart distributed acoustic sensing (DAS) uphole system was recently deployed in Saudi Arabia to acquire seismic data for near-surface characterization and targeted deep imaging. This system utilizes a cost-effective, permanently installed optical fiber as a seismic sensor. Dense grids of on-demand smart DAS upholes provide accurate characterization of long-wavelength statics and greatly reduce structural uncertainty, especially for low-relief structures. Connecting multiple upholes with a single fiber enables seismic surveys to be efficiently acquired with buried vertical arrays that can provide robust subsurface images superior to conventional surface seismic. This is attributed to a significant reduction in direct and scattered ground-roll and ambient noise, and the ability to more accurately build a near-surface velocity model. We have completed a field test where multiple upholes were connected with a single fiber and acquired in combination with a 2D reflection survey using a vibroseis source. We present processing and imaging results of the buried vertical DAS arrays. Vertical travel-times along the wells are used to estimate near-surface velocities and static corrections near the boreholes. They are interpolated between adjacent holes and produce a near-surface depth velocity model and a long-wavelength static model for the whole survey area. Seismic data recorded in all boreholes is processed using specific processing flow to obtain final subsurface images in depth and time domains. Preliminary steps in the time processing flow, comprise linear noise removal in the common-receiver domain. Topographic static corrections are applied using uphole data. Stack sections corresponding to each depth level are obtained and merged together to provide a single stack from surface. The estimated long-wavelength static corrections are used to adjust the stack to the regional reference datum. In the depth processing flow, the velocity model is a combination of the near-surface model obtained from upholes and a deeper depth velocity model obtained with conventional model building techniques such as tomography or other methods. In this way, the smart DAS uphole system provides a complete dataset for near-surface characterization as well as calibrated depth imaging of deep target structures. Such an integrated system can be useful for more accurately imaging low-relief structures or any other targets obscured by a challenging near surface.