Smart DAS Upholes for Near Surface Model Building and Deep Imaging

Pavel Golikov[1], Robert Smith[1], Andrey Bakulin[1], and Mustafa Al-Ali[1]

[1]Saudi Aramco, Dhahran, Saudi Arabia.

ABSTRACT

Complex near-surface geology is the biggest challenge for land seismic imaging. In arid environments typical of the Arabian Peninsula, the near surface can be hundreds of meters thick and possesses huge vertical and lateral velocity variations. Static corrections derived based on adequately spaced upholes are effective in resolving long and short-wavelength anomalies. However, uphole data is costly especially with growing utilization of 3D seismic and increasing survey sizes. Refraction tomography gradually replaced uphole-based methods for static corrections. However, refraction tomography has many limitations and is not always able to provide the desired accuracy. This is especially apparent when exploring for low-relief structures where the size and amplitude of the structure is often comparable to near-surface anomalies. In this case, nothing can replace a direct velocity measurement through the near-surface at the point of interest. Therefore, reverting to uphole surveys while improving their quality and acquisition efficiency is a plausible option. In this paper, we demonstrate a novel approach for near-surface characterization using smart upholes that utilize Distributed Acoustic Sensing (DAS) as the seismic sensor. Unlike traditional upholes, these smart DAS upholes can be performed on demand. First, all holes are pre-drilled at desired locations, equipped with low-cost DAS fiber cable, and finally backfilled. Subsequently, uphole surveys can be efficiently acquired using single source at each hole. Weight drop source provides adequate first break picks required for near-surface model building. A 3D grid of sufficiently dense upholes can produce excellent model of long-wavelength statics with accuracy required to reveal low-relief structures. We show results from a field test in Saudi Arabia validating the concept of smart DAS upholes. We further demonstrate that multiple upholes can be connected by a single fiber that enables acquisition of seismic surveys with vertical DAS arrays to image the deeper part, which produces images superior to those obtained from conventional surface seismic.