

Multi-well 3D DAS-VSP Survey offshore Abu Dhabi: a New Way to Acquire Surface Seismic?

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Abstract

While shooting a dense ocean-bottom nodes (OBN) survey offshore Abu Dhabi, ADNOC decided to simultaneously record 3D vertical seismic profiles (VSP) using the distributed acoustic sensing (DAS) technology on the optical fibers already present in the wells. The objective was not only to provide the benefits generally afforded by 3D VSPs, but to use the surface-related multiples and obtain a 3D image of the subsurface comparable to (if not better than) the OBN survey.

The OBN survey involves 4C nodes on a 25x150m grid and shot points on a 25x25m grid. It is shot over a producing field with four artificial islands used as drilling pads. All the wells drilled on these islands are highly deviated before turning horizontal in the reservoirs. They are completed with optical fibers behind casing that run from the surface to reservoir level. We decided to use DAS interrogators to “eavesdrop” on the OBN seismic sources while they shoot in the vicinity of the islands. The added cost is minimal, especially since we do not have to halt production, and the benefits are many.

VSPs provide local measures of attenuation, velocity, anisotropy, and multiple content that can aid surface seismic processing. Furthermore, a 3D VSP can provide an image of the subsurface that has higher resolution than surface seismic, but which does extend too far from the well. A recent imaging technology for 3D VSP uses seismic multiples to reconstruct the subsurface as if it were acquired by surface seismic. The extent of the final image is controlled by the source patch and not the well trajectory. This imaging technology is very promising but suffers from weak signal-to-noise ratio. To mitigate this issue, we used six wells per island to reconstruct the subsurface in a 150km² area around the island. The wells were chosen for the length of their usable fiber and their diverse trajectories.

At time of writing one island has been acquired: six wells each recorded around 3,000m of fiber (1ms sample rate and 1m receiver interval) for 25 days from about 407,000 shots (each source location was shot twice for the surface seismic survey). Data quality is good despite production noise, which is quite significant for injectors and gas-lifted producers. The second island will be acquired in September. Should the imaging with multiples technology meet our expectations, we could acquire “surface seismic” from 3D VSPs for a fraction of the cost because we only need the sources and not the dense ocean-bottom nodes. Also, it would make 4D seismic monitoring more accurate since the fibers are permanently installed in the wells.