# Case Study

FIBERLINE INTERVENTION

## FLI DELIVERS HIGH-QUALITY VERTICAL SEISMIC WELL PROFILES 90% FASTER THAN CONVENTIONAL METHODS

**APPLICATION:** Multiple fixed offset VSPs in an uncompleted unconventional onshore well

**LOCATION:** Mid-continent USA

## THE CHALLENGE

A major US operator was looking to gather VSP data to calibrate regional 3D surface seismic data. The method chosen was a conventional geophone VSP logging system deployed on wireline, along with a seismic vibrator energy source. Seeking a more cost-effective, efficient method for obtaining the data, and looking for a direct comparison, the customer also commissioned Well-SENSE to deploy its FiberLine Intervention solution in the same well.

The >9,000 ft drilled but uncompleted (DUC), horizontal well was located in mid-continent USA. The vertical section and portions of the deviated section in the well, containing a liner hanger restriction, were to be logged.

### ABOUT VSP

**A Vertical Seismic Profile (VSP) is a method used to obtain a high resolution and depth-calibrated image of a subsurface profile in the vicinity of a wellbore.**

A Zero Offset VSP in a vertical well, where the energy source is positioned close to the wellhead, will produce a normal incident seismic reflectivity image, often referred to as a 'corridor stack'. The corridor stack is a seismic trace wherein seismic reflections and events are tied directly to known well depths. The trace can be spliced directly into a surface seismic profile to help calibrate the 2D or 3D seismic data.

An Offset VSP is obtained by locating the energy source at a significant distance from the wellhead. Lateral, high resolution images are produced using the source and receiver geometry to identify subsurface formations and features away from the well and to calibrate surface seismic data and improve data processing.

VSPs are typically acquired using conventional, wireline deployed borehole seismic logging tools containing multi-component geophones. In recent years, fibre-optic Distributed Acoustic Sensing (DAS) has been utilised in wells to more efficiently capture comparable and useful seismic images along the length of the fibre. The fibre is typically deployed in a purpose built cable on tubing or casing or by customised intervention methods such as wireline, slickline or coiled tubing, where one or more fibres are contained and protected within these assemblies.

However, both conventional geophone and these types of DAS surveys are still costly, risky, time consuming and require significant equipment and personnel to obtain the VSP data. For this reason, VSP surveys relying on these methods are performed only occasionally.

## METHOD AND RESULTS

**A Well-SENSE engineer travelled to the wellsite with all necessary equipment in a pickup truck and quickly connected FLI's Plug and Play launch capsule to the wellhead. Well-SENSE employed a 2.75 in. outer diameter FLI tool with sufficient length of single-mode fibre, which was prepared and tested offline in advance.**

The FLI probe was launched hydraulically into the well and fibre was installed to over 9,000 ft in 30 minutes. During free fall descent, the probe successfully penetrated a 4-1/2" liner hanger, inside 7" casing, at the base of the vertical section of the well before landing in the inclined section of the heel of the well. During descent DAS monitoring provided acoustic vs. depth data.

The Zero Offset VSP data, covering the entire accessible wellbore, was output in less than forty-five minutes after launching the probe into the well. Over the next two hours, five additional VSPs, including Offset VSPs, were acquired, utilising various energy source locations near the wellhead and at several distant locations. Useful seismic images containing both compressional and shear direct and reflected waves were obtained and subsequently processed.

Following the last data record, the fibre was cut at the wellhead, the degradable probe and fibre were left in the well and the FLI launcher and wellhead equipment were removed within thirty minutes. The entire operation, from rig up to rig down with six VSPs, was completed in four hours.

The probe was disposed of during subsequent well completion operations proving that it can be pumped down the well without affecting operations such as injectivity testing, plugging and perforating or fracking.

The results of the Zero Offset VSP FLI data were comparable to the conventional geophone data. However, the FLI data was acquired in approximately 1/10th of the time, or 90% faster than the conventional geophone survey. Due to the significant time savings to acquire the initial VSP data, there was time remaining to record five additional VSPs in the same well. Where overall data acquisition operations for the conventional geophone VSP spanned a two day period, the FLI Zero Offset VSP was completed within two hours.

In this project subsequent well operations, including fall-off testing, plug & perforating and fracing the well, were conducted within a few months of data collection.

## CONCLUSIONS

**The operation showed that FLI can be used to rapidly obtain low cost and low risk DAS VSP data. The efficiency and small footprint of the solution enables a wide range of borehole seismic applications, from check shot surveys to 3D VSPs, to be executed in an extremely cost-effective manner in almost any wellbore, onshore or offshore.**

FLI projects such as this have often been completed within six weeks of the initial enquiry. They deliver reduced HSE and operational risk due to the dramatic reduction and simplicity in measurement equipment. In addition, the probe and fibre can be left in the well as they degrade over time, eliminating the risk of a fishing or lost in hole operation.

The FLI solution reduces project costs compared to conventional methods for in-well sensing by over 50% and overall project cost savings, including energy source and data recording, is estimated to be in the order of 33%.