

Case study: Fiber-Optic Borehole Seismic Acquisition

Location: Offshore Norway

Aligned with United Nations Sustainable Development Goals: 12—Responsible consumption and production, 13—Climate action, 14—Life below water.



# Fiber-Optic Borehole Seismic Solution Records VSP in Less Than 30 min During Formation Testing

Optiq Seismic solution acquires time-depth and waveform data while running formation testing tool, offshore Norway

**Carbon Emissions:**  
Reduced ~28.16 metric tons of CO<sub>2</sub>e

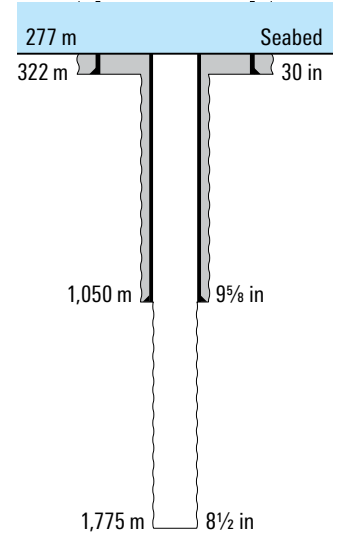
An operator obtained high-quality vertical seismic profile (VSP) data, including look-ahead data, in near-real time while running the MDT\* modular formation dynamics tester. The Optiq Seismic\* fiber-optic borehole seismic solution—leveraging distributed acoustic sensing (DAS) technology and high-strength Optiq TuffLINE\* torque-balanced fiber-optic wireline conveyance—enabled the VSP survey to be recorded in minutes, minimizing the environmental impact compared with conventional borehole seismic solutions.

### Acquire VSP data with optimized density and efficiency

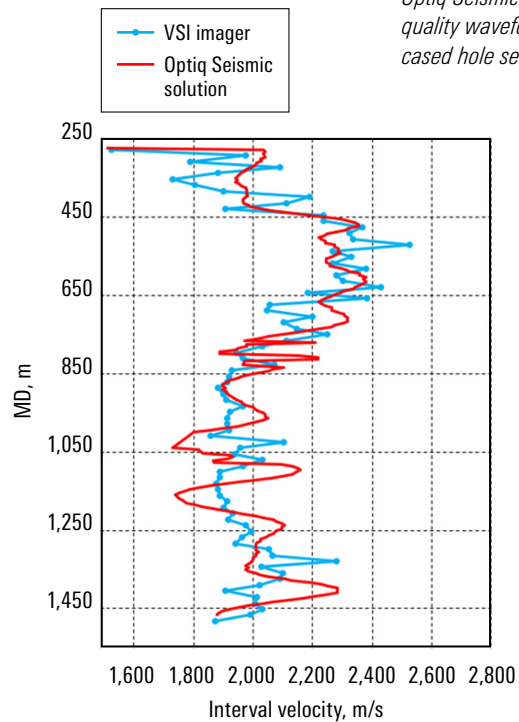
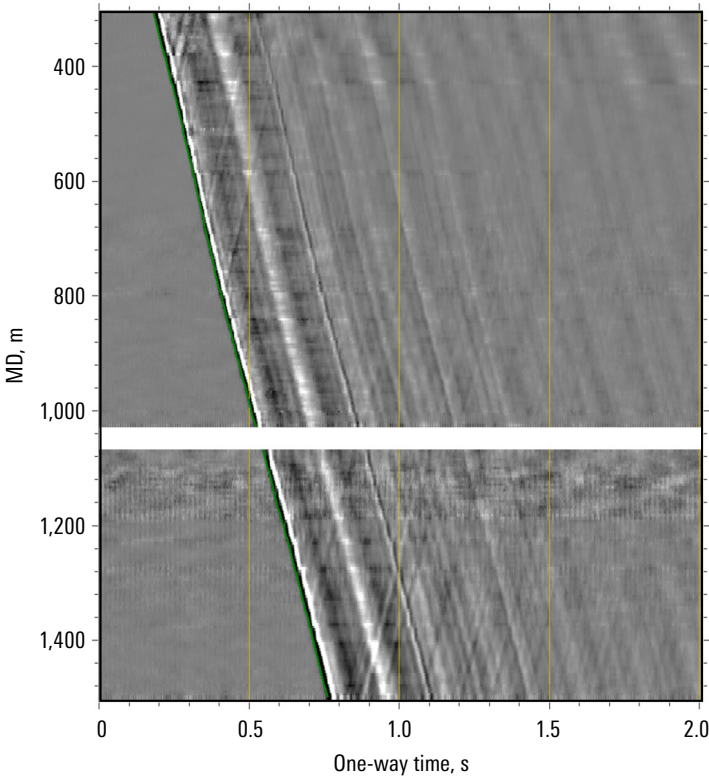
An operator wanted to obtain high-quality VSP data on wireline in both the open- and cased hole sections of a vertical well drilled offshore Norway—and in as minimal rig time as possible—to accurately measure the reflectivity response (corridor stack).

### Reduce acquisition time from hours to minutes

To optimize VSP density and efficiency, Schlumberger used the Optiq Seismic solution—enabled by high-strength Optiq TuffLINE fiber-optic wireline conveyance and a state-of-the-art optical interrogator—simultaneously with the MDT modular formation dynamics tester. The Optiq Seismic solution significantly



Optiq Seismic solution recorded high-quality waveforms in both open- and cased hole sections up to seabed.



Optiq Seismic solution data stacks recorded in open- and cased hole exhibit clear first arrivals and coherent reflectors. The data gap corresponds to noisy traces removed around the casing shoe. The bandwidth is 4–80 Hz at target. A good match with the VSI\* versatile seismic imager interval velocities was obtained during preliminary Optiq Seismic solution processing.

## Case study: Fiber-optic VSP recorded in <30 min during formation testing, offshore Norway

improves operations at lower cost because a full well profile is recorded along the cable for each shot in only minutes rather than hours using a conventional surveying tool.

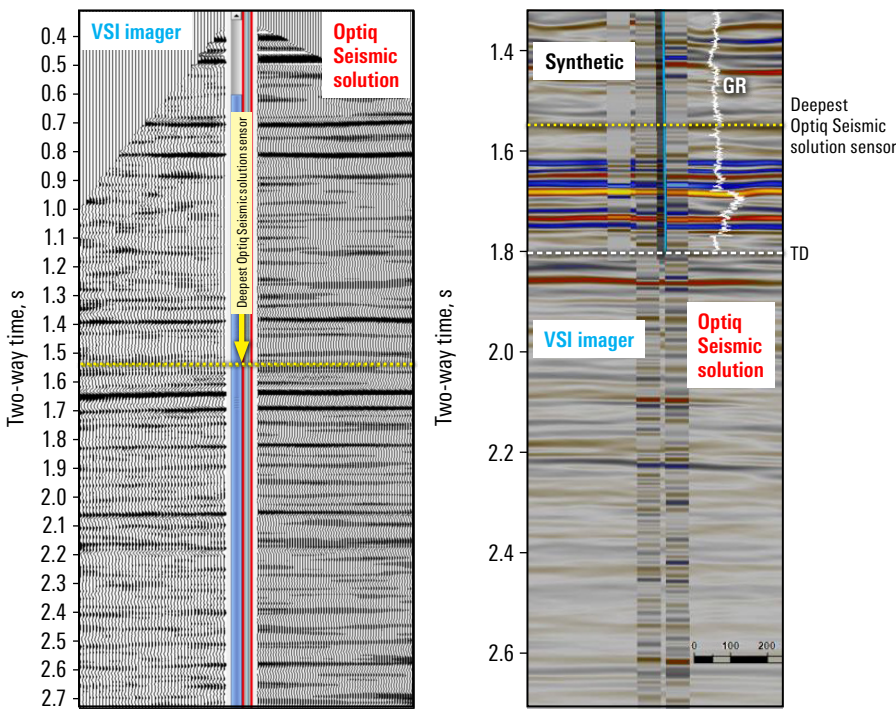
After deploying the toolstring to 1,519 m, cable tension was relieved to optimize coupling while maintaining a tension above the cable weight in mud, and 45 shots were stacked. While pulling out of hole, the MDT tester probe was set at the casing shoe, cable tension was relieved, and 21 shots were stacked. The data was analyzed in near-real time to show that all survey objectives were met. The VSI imager was later run, enabling a full comparison with Optiq Seismic solution data.

A triple G-gun source was deployed at 7-m depth from the rig crane and autotuned with in-sea TRISOR\* acoustic source control system to ensure perfect synchronization within 0.5 ms of all VSP shots. The source parameters were optimized to improve the signal-to-noise ratio across seismic bandwidth.

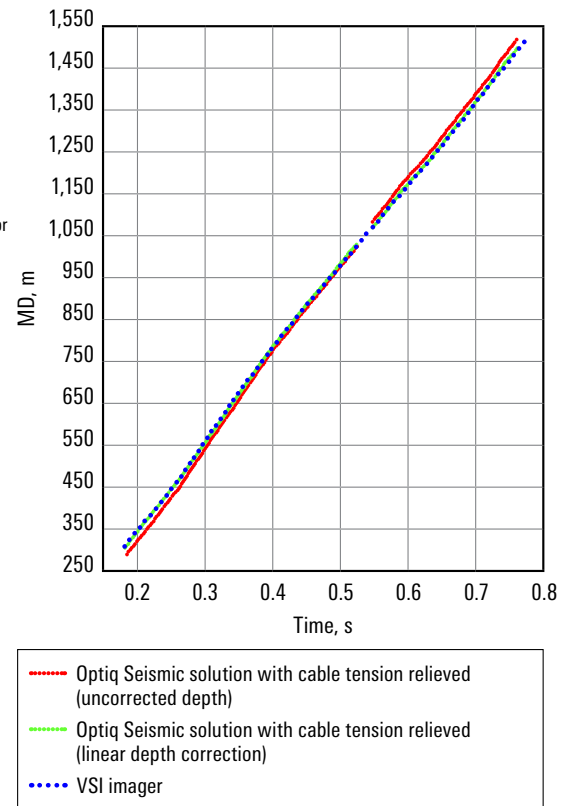
### Obtain high-quality VSP data while reducing environmental impact

The unique Optiq TuffLINE fiber-optic wireline conveyance enabled recording 4–80 Hz of stacked time-depth and waveform data at the reservoir level and with high-quality look-ahead data of more than 1 km below the deepest sensor while also running the MDT tester toolstring. The acquired data was confirmed with VSI imager data.

The novel Optiq Seismic solution, leveraging high-strength Optiq TuffLINE conveyance, acquired borehole seismic data without a dedicated run and with a reduced number of shots. In this job, operational time was reduced by 95%, reducing energy consumption and carbon emissions by an estimated 28.16 metric tons of CO<sub>2</sub>e based on average deepwater rig emissions. The Optiq Seismic solution also helped minimize impact to marine mammals, which is often associated with seismic operations. The operation demonstrates the Optiq Seismic solution's capability to not only capture accurate reflectivity responses in near-real time but also to minimize the environmental impact.



The VSI imager and Optiq Seismic solution upgoing waves were deconvolved as zero phase over 4–60 Hz and displayed as transposed VSPs (left panel). The seismic match is very good with the synthetic image and both the Optiq Seismic solution and VSI imager corridor stacks (right panel).



The open- and cased hole Optiq Seismic solution stacks were corrected assuming a linear distribution of relieved cable tension. The results matched well with the VSI imager time-depth data. Finite element modeling of cable behavior can further improve results.

[slb.com/OptiqSeismic](http://slb.com/OptiqSeismic)

**Schlumberger**

\*Mark of Schlumberger.  
Transition Technologies is a mark of Schlumberger.  
Other company, product, and service names are the properties of their respective owners.  
Copyright © 2021 Schlumberger. All rights reserved. 21-RPEV-8415666