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Case study: **Fiber-Optic Borehole Seismic Acquisition**

Location: Deepwater West Africa

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

Dense Zero-Offset and Walkaway VSP Data Acquired in Minutes in Vertical Deepwater Well

Fiber optics acquire high-quality borehole seismic images, proven as a standalone solution

Carbon Emissions:
Reduced ~83.43 metric tons of CO_2e

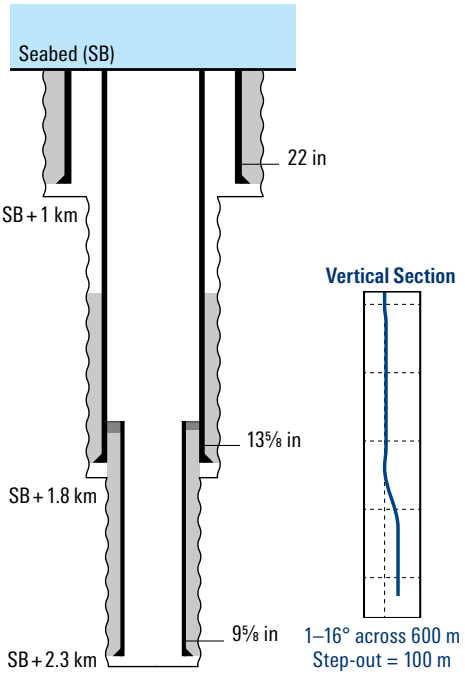
An operator obtained high-quality vertical seismic profile (VSP) data in a single run and in a fraction of the time of conventional tools by using the Optiq Seismic* fiber-optic borehole seismic solution that leverages distributed acoustic sensing (DAS) technology and high-strength Optiq TuffLINE* torque-balanced fiber-optic wireline conveyance. During initial field testing, the VSI* versatile seismic imager was run simultaneously to confirm the dense data acquired by the Optiq Seismic solution. The acquisition results proved Optiq Seismic solution's high-quality results.

Acquire high-quality zero-offset and walkaway VSP data

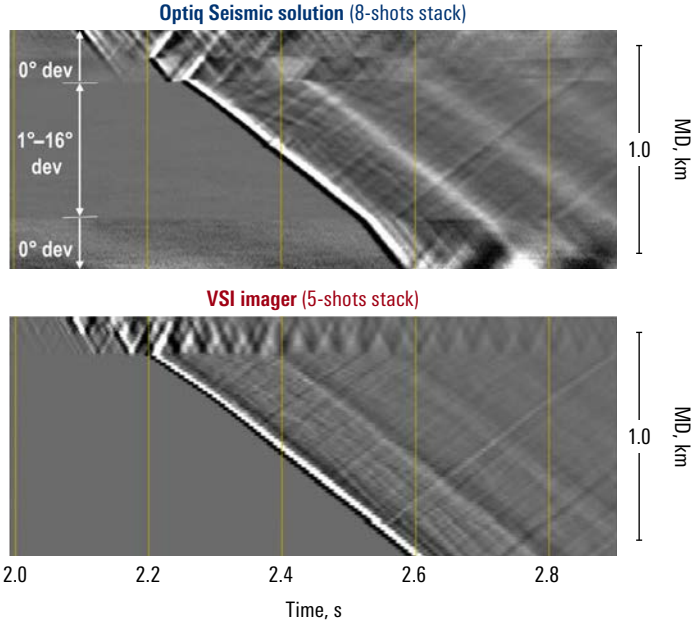
The operator of a field in deepwater West Africa wanted to obtain high-quality zero-offset and walkaway VSP data in the cased hole section of a nearly vertical appraisal well in a short time frame. The high-quality VSP data was needed to measure the anisotropy response of rocks drilled from shale above the reservoir to as shallow as possible.

Obtain borehole seismic data in a fraction of the time

The Optiq Seismic solution was deployed to optimize data density and acquisition efficiency, and as part of initial field testing, the VSI imager was used to confirm the results. Triaxial geophones enable an accurate local estimation of Thomsen parameters across the receiver array, and data from the Optiq Seismic solution enabled global traveltime tomography to constrain anisotropy parameters. The Optiq Seismic solution leverages DAS technology, unique Optiq TuffLINE conveyance, and a state-of-the-art optical interrogator to acquire high-quality data. The solution's optical interrogator unit at surface was connected to Optiq TuffLINE conveyance to deploy the VSI versatile seismic imager toolstring—comprising 16 imager tools at 15-m spacing and a GR tool. VSI imager's triaxial geophone accelerometers significantly reduce acoustic noise for superior clarity and interpretation. And for each source shot, the Optiq Seismic solution recorded a full well profile along the length of the cable, reducing acquisition time from the hours required for conventional VSP acquisitions to just minutes. Based on the significant time saved and average emissions from a deepwater rig, it is estimated that this solution reduces energy consumption by 99% and carbon emissions by 83.43 metric tons of CO_2e.



Optiq Seismic solution and VSI imager recorded high-quality waveforms in the 600-m cased hole section.



The top image shows zero-offset VSP data recorded using the Optiq Seismic solution, and the bottom image shows data acquired using the VSI imager anchored geophones. The Optiq Seismic solution acquisition had a 4-KHz pulse frequency rate. Excellent data quality was recorded over the 600-m interval where the well deviation was greater than 1°.

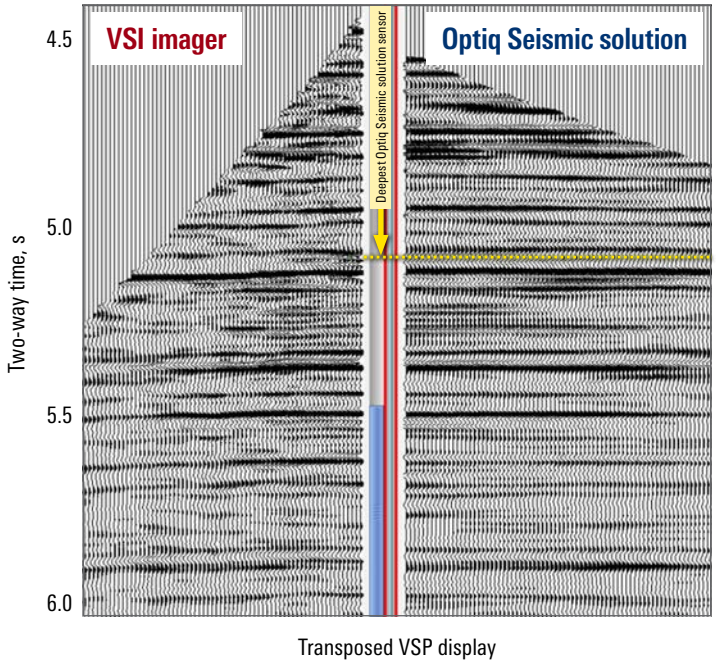
Case study: Dense zero-offset and walkaway VSP data acquired in minutes, deepwater West Africa

Relieving the Optiq TuffLINE conveyance tension by 1.5 m enabled good coupling with the formation across the 600-m deviated section of 1–16°. During the zero-offset VSP, eight shots were stacked using the Optiq Seismic solution, and five shots were stacked using the VSI imager. During the walkaway survey, the Optiq Seismic solution recorded only one shot per position, with the boat sailing at 4.63 km/h. Dual six-gun arrays were operated at 7-m depth off the aft of the supply boat, and the six airguns were autotuned with in-sea TRISOR* acoustic source control system to ensure all shots were synchronized within 0.5 ms. The airgun source parameters were also optimized to improve the signal-to-noise ratio across the seismic bandwidth.

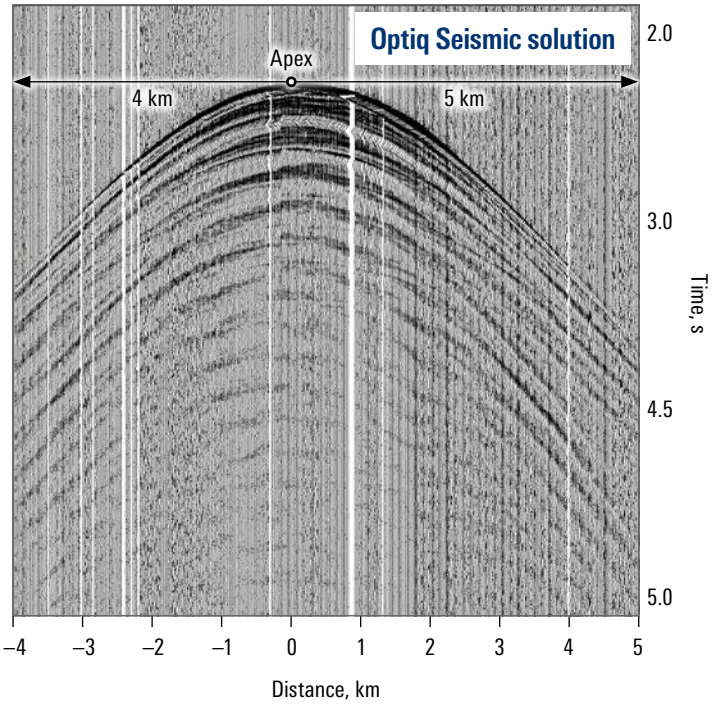
Record high-quality waveforms over 600-m borehole section

The operation enabled recording wideband 4–80 Hz of Optiq Seismic solution data at the reservoir level and quality look-ahead VSP of more than 1 km below the deepest measurement point, as confirmed by comparison with VSI imager data. Good signal-to-noise ratio was also achieved for both the zero-offset VSP and the 9-km walkaway surveys.

This result confirmed Optiq Seismic solution as a new, proven method to acquire borehole seismic data in a fraction of the time compared with conventional tools while significantly reducing carbon emissions and impact to marine mammals that is often associated with seismic operations.



The transposed zero-offset VSP data from the VSI imager and Optiq Seismic solution shows upgoing waves deconvolved to zero-phase over 4–80 Hz. In this type of display, the most accurate data is in the center, where it is easier to correlate different upgoing datasets.



The Optiq Seismic solution walkaway survey receiver gather of field raw shots shows good signal-to-noise ratio. The image shows an asymmetric line with 4-km offset to the left of the apex and 5 km to the right, with 360 shots at 25 m with gaps. The signature changes are due to pressure drop.

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