

# FiberVSP™ Service

## DISTRIBUTED ACOUSTIC SENSING (DAS) FOR VSP

Halliburton Borehole Seismic Services (BHS) provides customized, reliable high-resolution solutions that bridge the gap between surface seismic and the wellbore to improve reservoir analysis.

The Halliburton FiberVSP™ service is one of the latest technologies in our family of fiber-optic services. Our FiberVSP service is a distributed acoustic sensing (DAS) technology for Vertical Seismic Profile (VSP) data acquisition. It provides a cost-effective complement to conventional VSP acquisition, and is ideally positioned for time-lapse VSP studies.

The ability to access and interrogate the fiber-optic cable without requiring well intervention allows for the possibility of acquiring VSP data using DAS for a single survey through time-lapse 3D VSP studies, quickly and economically. It is an efficient and risk-averse method for acquiring VSP data on fiber-optic cable at a high-spatial resolution.

Using industry-leading borehole seismic energy sources and downhole technologies combined with dedicated experts, BHS offers improved data quality while minimizing rig time. Advanced source-receiver and fiber technology is crucial toward obtaining a more accurate and comprehensive geological picture of the well, field or reservoir. Coupled with advanced VSP processing from presurvey plan design and data acquisition through to complex data processing and interpretation, our total approach delivers results.

### BENEFITS

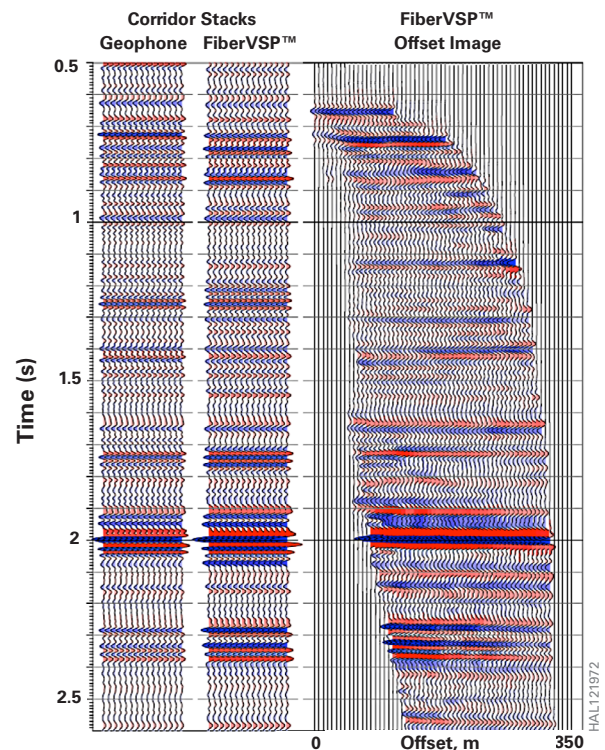
- » Reduces uncertainties – with high-resolution depth-spacing sampling
- » Minimizes risks – no well intervention
- » Maximizes recovery – time-lapse surveys
- » Increases reserves – map fluid movement
- » Multipurpose fiber – VSP, pressure, flow, noise, temperature

### APPLICATIONS

- » Calibrate surface seismic (average/interval/RMS velocities, acoustic log calibration, synthetic seismograms)
- » Validate surface-seismic attributes (true wavelet tie using phase, frequency, time/depth; multiple identification, prediction beneath bit, Q estimation)
- » Complex high-resolution 2D and 3D P- and S-wave imaging of reservoir boundaries, fault identification, time-lapse 4D studies, fluid movement mapping



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Combined use of P and S DAS VSP data, SEG Workshop Fiber-Optic Sensing for Exploration and Monitoring: Developments, Applications, and Challenges, Dallas. (Wu et al., 2016).

## BOREHOLE SEISMIC SERVICES EQUIPMENT

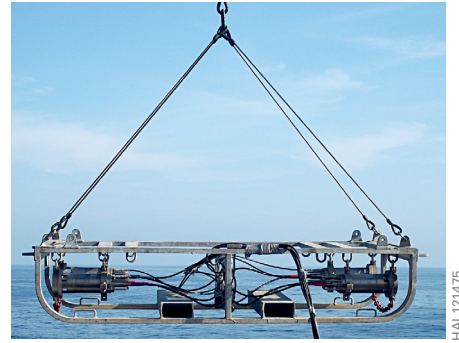
### Recording Systems

The Halliburton proprietary FiberVSP™ acquisition system employs a systematic procedure to calibrate and set up the fiber-optics interrogator unit customized for each well. This procedure sets the appropriate gauge length, pulse width and optical power, among other parameters, allowing for the best signal quality, which minimizes optical fading, maximizes signal to noise and provides the highest spatial resolution. A particular feature of our FiberVSP technology is the capability to record all seismic auxiliary signals, such as time-zero pulse and reference sweep signal, directly onto the optical data stream. This allows for precise detection of each seismic record's start time.

In-field data preprocessing and quality control are performed by our FiberBHS software. This software gives real-time VSP field processing, which provides visual inspection of the denoised seismic data and a field processing report that documents the data acquisition, including data images, first-break picks and interval velocity plots for static-source offsets.

### Energy Sources

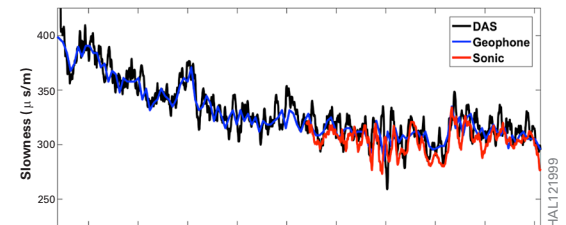
Halliburton BHS provides the full range of auxiliary equipment, including compressors, airgun array source controllers with constant real-time tuning, near- and far-field signatures, gun pressure and depth. In addition, we offer a range of tuned gun arrays designed to optimize peak/peak-to-peak barm output and peak-to-bubble ratio with broad, flat frequency spectrum and source directionality. Our land vibroseis units use advanced vibrator electronics to deliver repeatable and reliable broadband results to match surface-seismic acquisition parameters.



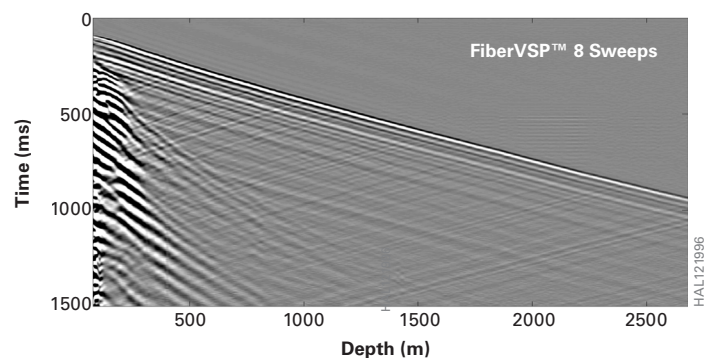
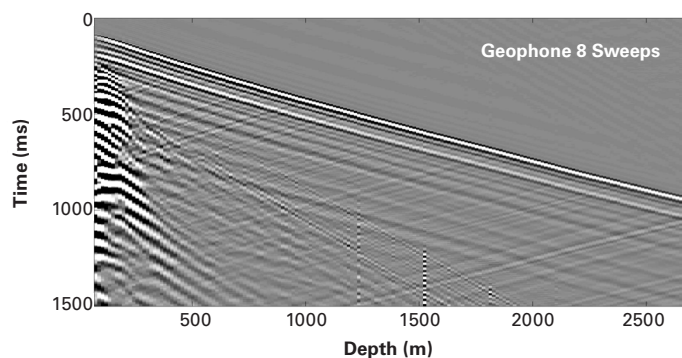
BHS DC 1000 Tuned Airgun Array



BHS Truck- and Buggy-Mounted Vibrator Units



Comparison of slowness logs derived from FiberVSP™ software (black), geophone (blue) and sonic (red) data (Willis et al., 2016).



Comparing DAS and Geophone Zero-Offset VSP Data Sets Side-By-Side; Focus Article - CSEG Recorder 2016 (Willis et al., 2016).

For more information, contact your local Halliburton representative or visit us on the web at [www.halliburton.com/FiberVSP](http://www.halliburton.com/FiberVSP)

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