

# Walkaway and Walkaround Vertical Seismic Profile

## HIGH-RESOLUTION IMAGES, AVO CALIBRATION, ANISOTROPY ESTIMATION AND FRACTURE DETECTION

Halliburton Borehole Seismic Services (BHS) helps enhance unconventional reservoir characterization with customized high-resolution data for AVO calibration, anisotropy estimations and fracture detection from Walkaway and Walkaround Vertical Seismic Profiles (VSP).

### THE COMPLETE PACKAGE

Halliburton uses the latest technology in data acquisition coupled with advanced VSP software to provide quality images of the borehole and its vicinity. From presurvey plan design to data acquisition, processing and interpretation, our fully trained professionals work with you from start to finish to optimize the value on every project.

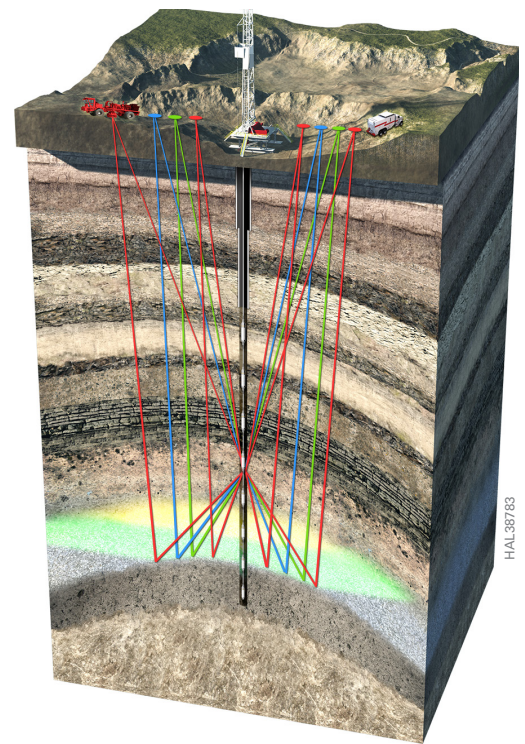
### WALKAWAY AND WALKAROUND VSPs

Walkaway VSP surveys, in addition to providing high-resolution P and S images, can also provide VTI measurements and AVO calibrations. From multiple shot points walking away from the wellbore, we gather a complete set of arrival angles through the overburden. Velocity measurements and arrival angles are analyzed to measure VTI and AVO.

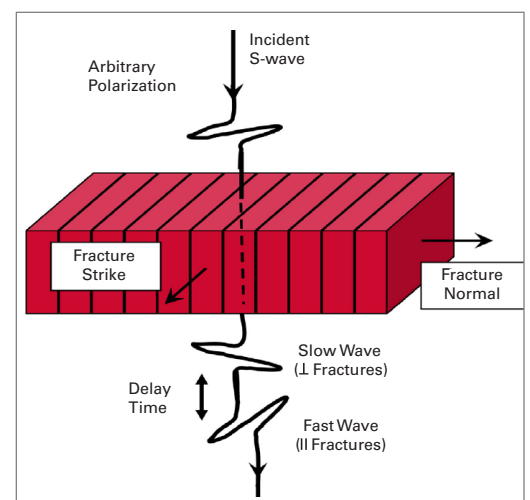
Walkaround VSP surveys are similar to Walkaway VSP surveys except they are acquired in many azimuths around the wellbore. The idea is to acquire enough azimuthal data to measure the fast (S1) and slow (S2) shear-wave splitting. The results from measuring the traveltime arrivals from azimuthal offsets will provide the stress-field information for fracture detection. Anisotropy parameters of delta and epsilon estimations are provided as post-processing deliverables.

### APPLICATIONS

- » HTI anisotropy measurements
- » VTI anisotropy measurements
- » Fracture detection
- » P and shear-wave imaging
- » Complex reservoir analysis
- » 3D and time-lapse 4D offset imaging
- » AVO calibration



Walkaway VSP



Shear-Wave Splitting

## BENEFITS

- » Three-component geophones capture all wave modes, providing shear and compressional images
- » Q estimation, AVO and anisotropy parameters are used to enhance surface-seismic resolution
- » Fracture orientation – fast shear-wave azimuth; and fracture intensity – azimuthal velocity anisotropy
- » HTI and VTI measurements
- » Fast and slow shear-wave measurements
- » Improved velocity analysis for surface-seismic processing with an accurate velocity model
- » High-resolution images and attributes beneath and away from the well for interwell reservoir imaging

## DATA PROCESSING SOFTWARE

Halliburton iBHS™ next-generation data processing software incorporates advanced proprietary processing techniques to address the basic to the most complex reservoir imaging challenges.

## PRESURVEY MODELING

As a key to a successful survey, Halliburton BHS provides accurate 2D and 3D presurvey modeling to optimize parameters for data acquisition.

## DATA ACQUISITION

To obtain an accurate and comprehensive geological picture of the well, field or reservoir, Halliburton BHS combines industry-leading borehole seismic energy sources and downhole array technologies with experienced, dedicated experts worldwide to provide operators with improved data quality while reducing rig time.

## SEISMIC RECORDING SYSTEM

Avalon and Sercel PC-based systems provide digital and analog recording with full QC capabilities and interface with vibrator electronics and digital airgun source controllers. This technology helps ensure optimization of sources and frequency bandwidth, and enables users to monitor S/N ratio and first-arrival picks with critical velocity data.

## ENERGY SOURCES FOR MARINE AND LAND APPLICATIONS

Halliburton BHS provides a 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, peak-to-bubble ratio, with broad, flat frequency spectrum and source directionality.

Our land vibroseis units use advanced vibrator electronics to deliver repeatable, reliable broadband results to match surface-seismic acquisition parameters.

## DOWNHOLE TOOLS

Halliburton BHS downhole tools are designed for use in open and cased holes using 7-conductor wireline. All tools are 3-component with various options of gimbal, and fixed packages in single-, dual- and quad-receiver package configurations with a high locking-force-to-weight ratio. BHS tools can be deployed via wireline, pumpdown, tool-pusher logging (TPL) and tractors.

## Tool Specifications

Tool Array	Maximum Number of Sondes	Length in. (mm)	Diameter in. (mm)	Maximum Pressure psi (MPa)	Maximum Temperature °F (°C)	Weight lb (kg)
ASR-HP	2	35 (889)	3 (76)	25,000 (172)	400 (204)	38 (17.2)
Geochain™ 60	60	35 (889)	3 (76)	25,000 (172)	356 (180)	38 (17.2)
GeochainX™ 60	60	35 (889)	3 (76)	25,000 (172)	385 (195)	38 (17.2)
ASR-EHT	2	35 (889)	3 (76)	25,000 (172)	435 (224)	38 (17.2)
GeochainSlim™ 100	100	45 (1,143)	1 <sup>11</sup> / <sub>16</sub> (43)	20,000 (138)	356 (180)	10 (4.5)
ASR-EHP	2	35 (889)	3 <sup>1</sup> / <sub>4</sub> (83)	30,000 (297)	400 (204)	51 (23.1)
Geochain™ EHP 60	60	35 (889)	3 <sup>1</sup> / <sub>4</sub> (83)	30,000 (297)	356 (180)	51 (23.1)
GeochainX™ EHP 60	60	35 (889)	3 <sup>1</sup> / <sub>4</sub> (83)	30,000 (297)	385 (195)	51 (23.1)
ASR-EHT-EHP	2	35 (889)	3 <sup>1</sup> / <sub>4</sub> (83)	30,000 (297)	435 (224)	51 (23.1)
MaxiWave®	100	17 (432)	3 <sup>1</sup> / <sub>2</sub> (89)	17,400 (120)	275 (135)	17.6 (8.0)

Geochain™, GeochainSlim™ and GeochainX™ are trademarks of Avalon Sciences Ltd. MaxiWave® is a registered trademark of Sercel.

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

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