

# Offset, Walkway and 3D Vertical Seismic Profiles

## HIGH-RESOLUTION IMAGES FOR ENHANCED RESERVOIR CHARACTERIZATION

Halliburton Borehole Seismic Services (BHS) can help enhance reservoir characterization with customized, reliable, high-resolution images provided by Far-Offset, Walkaway and 3D 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.

### OFFSET IMAGING

Offset, Walkaway and 3D VSPs image formations in one or more directions laterally away and beneath the wellbore. The results are high-resolution 2D and 3D P and S images that yield important structural and stratigraphic information. These assist in reservoir delineation, including identification of faults and salt flanks, as well as enhancing amplitude-versus-offset (AVO) calibration and anisotropy detection.

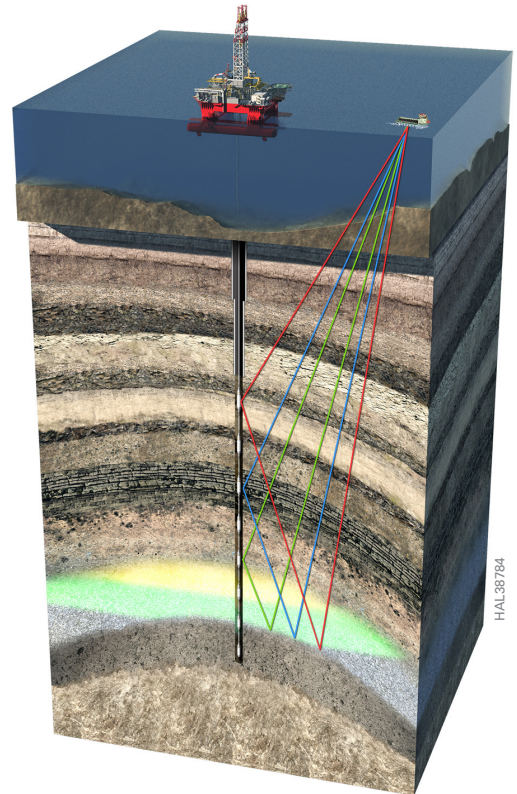
Integrated with surface-seismic and well-logging data, Offset VSP data can be used to define and describe formation rock properties/pore-pressure indicators, and identify other reservoir attributes with high resolution. The results give operators a clearer understanding of the best ways to exploit the reservoir, enabling more accurate drilling decisions.

Various acquisition modes are possible. In the static offset-source mode, the offset source is positioned in one or more directions from the wellbore. All wave modes are captured by 3-component geophones, spaced at ~50 ft or 15 m apart, to produce high-resolution 2D images. Static offsets minimize near-surface velocity or topography issues.

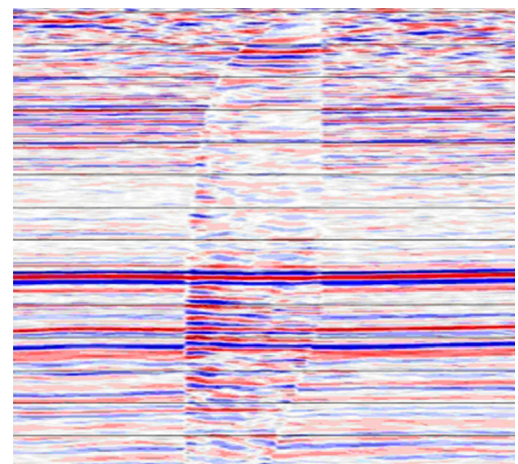
For Walkaway surveys, the source moves progressively away from the wellbore. For 3D VSPs, the source is configured in a spiral or grid pattern. These VSPs are useful for imaging, AVO and anisotropic studies.

### APPLICATIONS

- » Stratigraphic and structural reservoir delineation
- » AVO calibration and anisotropy detection
- » 3D and time-lapse 4D offset imaging
- » P-wave and shear-wave imaging
- » Complex reservoir analysis
- » Fracture detection and fluid-movement mapping
- » Multiple-azimuth walkaway survey



Offset VSP



Offset VSP Imaging

(Courtesy of Anadarko)

**BENEFITS**

- » Stratigraphic and structural reservoir delineation
- » Provides greater vertical and lateral spatial resolution
- » Improves velocity analysis for surface-seismic processing with an accurate velocity model
- » Captures all wave modes using 3-component geophones, providing shear and compressional images
- » Provides rock properties/pore-pressure indicators
- » Enhances surface-seismic resolution using AVO calibration and anisotropy analysis
- » Provides high-resolution images and attributes beneath and away from the well for interwell reservoir imaging
- » High-resolution imaging for reservoir boundaries (salt flank imaging and fault identification in complex areas) to correlate with surface seismic

**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 source and downhole array technologies with experienced, dedicated experts worldwide to provide operators with improved data quality while reducing rig time.

**SEISMIC RECORDING SYSTEMS**

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, first-arrival picks and critical velocity data.

**ENERGY SOURCES FOR MARINE AND LAND APPLICATIONS**

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, 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.

**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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