HALLIBURTON

FORMATION EVALUATION | ACOUSTIC

LOGIQ® WaveSonic® service

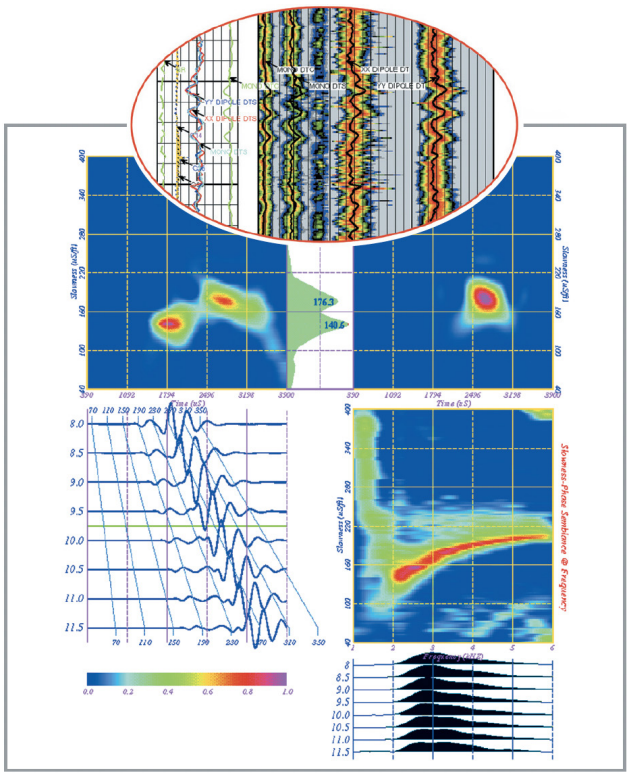
Halliburton's third-generation, ultra-reliable, crossed-dipole sonic tool

BENEFITS

- Low-frequency monopole and dipole sources for deeper investigations of sonic slowness measurements beyond any near-wellbore alteration effects
- Broadband 8-level, quad-receiver array for high-quality waveform data; all 96 waveforms for each set of transmitter firings are recorded at the surface for advanced waveform processing techniques
- Can be combined with all LOGIQ openhole tools
- On-depth, low-frequency bender-bar source provides a clean source signal:
  - No need for dispersion corrections for slowness determination
  - No depth shifting of waveform data for anisotropy analysis
- Drillpipe-conveyed operations are possible due to the strength of the isolator design

Halliburton's LOGIQ® WaveSonic® crossed-dipole sonic tool makes it easy to determine fast and slow shear-wave travel times and their orientation in the formation. With the WaveSonic service, you can even calculate minimum and maximum principal stresses and stress field orientation by combining oriented slowness data with overburden and pore-pressure data. This information is vital for geomechanical analysis, wellbore stability, and production enhancement-treatment design.

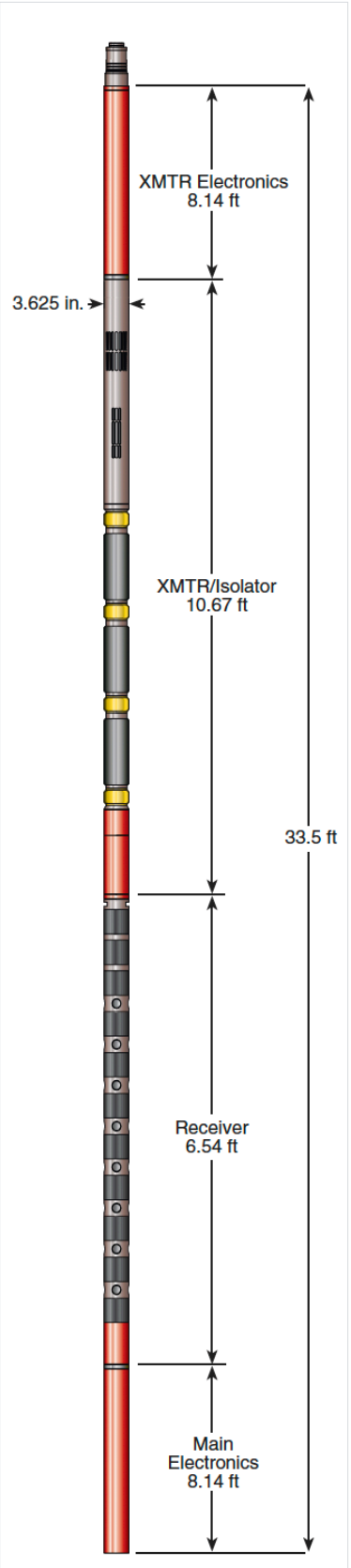
Sonic anisotropy and the orientation of the anisotropy can be used to determine the orientation of natural fractures. Sonic attributes such as P-wave slowness, fast and slow shear-wave travel time, identification of compressive fluids in the pore space, and anisotropy orientation allow for better 3D seismic analysis.



This is an example of a semblance diagnostic plot of the waveform data from the eight waveforms. In the circle is a section of a log showing monopole P-wave slowness and semblance quality, monopole refracted shear-wave slowness and semblance quality, X-X dipole slowness and semblance quality, and Y-Y dipole slowness and semblance quality.

The product of superior technology

Halliburton's LOGIQ WaveSonic service provides simultaneous monopole and crossed-dipole sonic information. P-wave and S-wave slowness can be obtained in formation conditions ranging from poorly consolidated high-porosity gas-saturated sandstones to low-porosity carbonates. The flexural wave energy is propagated from a low-frequency, on-depth, crossed-dipole bender-bar source. The low-frequency flexural wave travels at the true shear slowness of the formation. A low-frequency monopole source is utilized, so the P-wave and flexural-wave data have similar depths of investigations well beyond any near wellbore alteration.



WaveSonic service specifications

DIMENSIONS AND RATINGS	
Maximum Temperature	350°F (177°C)
Maximum OD	3.625 in. (92.1 mm)
Maximum Pressure	20,000 psi (138 MPa)
Minimum Hole	4.5 in. (114.3 mm)
Maximum Hole	16.0 in. (406.4 mm)*
Make Up Length	34 ft (7.3 m)
Weight	520 lb (236 kg)
BOREHOLE CONDITIONS	
Borehole Fluids	Saltwater, Freshwater, Oil
Recommended Maximum Logging Speed	30 ft/min (9.1 m/min) simultaneous monopole and crossed dipole 2 samples per foot
Maximum Hole	Centralized
HARDWARE CHARACTERISTICS	
Source Type	Piezoelectric Monopole On-Depth Bender-Bar X-X and Y-Y Dipole
Sensor Spacings	0.5 ft (15 cm) between receivers Dipole 9.2 ft (2.8 m) to 1st receiver Monopole 10.2 ft (3.1 m) to 1st receiver
Firing Rate	Variable (Software Controlled)
Digitizing Interval	Programmable
Samples per Sensor	Programmable
Source Characteristic	Dipole 500 Hz to 3 kHz-programmable Monopole center frequency 5 to 6 kHz, 1 kHz to 12 kHz bandwidth
Measurement Bandwidth	500 Hz to 20 kHz
Combinability	All LOGIQ® tools
Build Rate/Dog-Leg-Severity	20° per 100 ft (20° per 30 m) without flex joints

MEASUREMENT	
Principle	Time-slowness Δt_c, Δt_{sxx}, and Δt_{syy}
Range	Dynamic
Vertical Resolution	6 in. (15 cm)
Depth of Investigation	3 ft to 20 ft (0.9 m to 6.1 m)
Resolution	0.2 µs
Primary Curves	Δt_c, Δt_{syy}, and Δ_{sxx}
Secondary Curves	VPVS, θ_c, ITTp, ITTs semblance quality, slowness anisotropy, Poisson's ratio, Stoneley slowness

CALIBRATION	
Primary	Internal check
Secondary	Sonde simulator
Wellsite Verifier	Casing for 57µs/ft Δt_c check

PHYSICAL STRENGTHS**			
Hardware	Tension	Compression	Torque
Tool Joints	100,000 lb (444 kN.m)	100,000 lb (444 kN.m)	N/A
Isolator	100,000 lb (444 kN.m)	100,000 lb (444 kN.m)	N/A

* 20 in. (500 mm) for monopole data with eccentered tool
** Strengths apply to new tools at 70°F (21°C) and 0 psi (0 MPa)

For more information, contact your local Halliburton representative or visit us on the web at www.halliburton.com