Baker Hughes

SoundTrak

Acoustic logging while drilling

Accurate formation compressional and shear slowness

Baker Hughes' SoundTrak service provides the industry's most accurate and flexible acoustic measurements while-drilling. This service provides compressional and shear wave travel-time in "fast" and "slow" formations. This allows real-time access to critical formation information that maximizes drilling efficiency and wellbore placement.

The system combines advanced array technology with a rugged tool. This ensures accurate and reliable logging performance in some of the industry's most challenging drilling environments.

The **SoundTrak™ service** employs proprietary acoustic technology to directly measure valid formation slowness. Multi-frequency excitation ensures high data quality in both fast and slow formations, as well as in a wide range of hole sizes. These measurements can be used for a variety of real-time and post-well applications. These include:

- Seismic time-depth tie for quick, precise determination of formation depth and thickness
- Formation strength calculation to identify sanding potential and borehole stability issues at an early stage

Superior acoustic logging in slow formations

The SoundTrak service offers a unique Quadrupole excitation that provides direct shear slowness measurements in extremely soft (slow) formations, eliminating the need for large dispersion corrections typical for LWD dipole acoustic tools.

Quadrupole excitation obtains accurate formation shear slowness directly using industry standard Slowness-Time-Coherency (STC) method.

Quadrupole signal to noise ratio is enhanced by:

- Azimuthal receiver array configuration
- Azimuthal receiver stacking
- Mechanical acoustic isolator

SoundTrak acoustic services agree with those from advanced wireline measurements.

Reduced uncertainty while drilling

As a direct input into pore pressure prediction, the SoundTrak LWD service can help operators mitigate potential drilling hazards in real-time. As a result, drilling efficiency is optimized and the potential for stuck pipe incidents is significantly reduced. The SoundTrak service's ability to acquire accurate compressional slowness using multi-frequencies in ultra-slow formations improves the drillers ability to assess shallow drilling hazards typically encountered in slow formations and large boreholes.

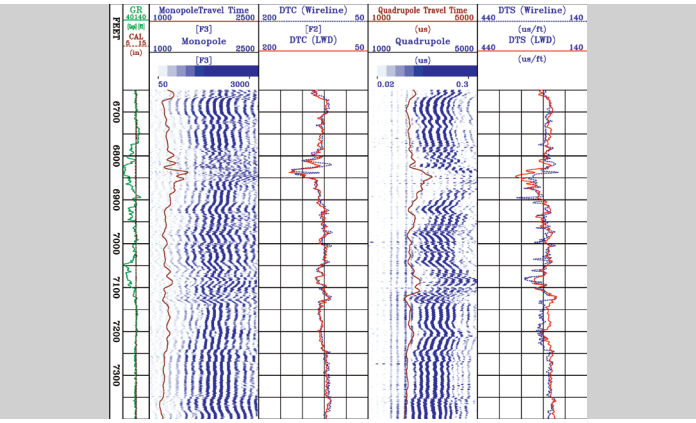
Real-time updating of pre-drill models is possible when suitable data for pore pressure prediction are available. Borehole acoustic velocities provide an accurate method for pore pressure prediction and are not sensitive to the formation water's salinity and temperature variations. Unlike traditional quantitative resistivity method, real-time compressional slowness in conjunction with resistivity can further reduce uncertainty in updating pore pressure models while drilling.

Wellbore positioning through seismic tie-back

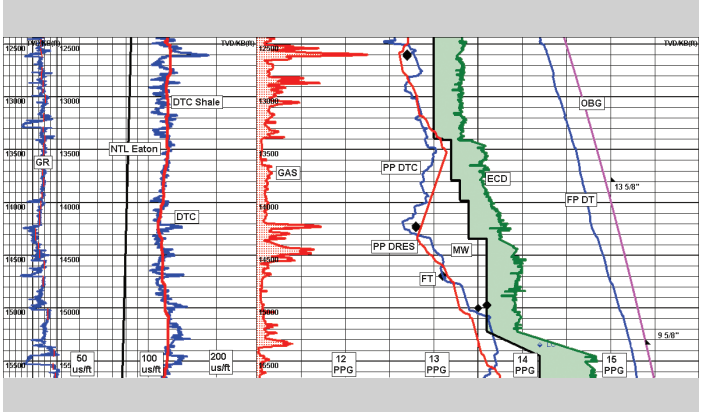
Accurate seismic time-depth tie can significantly enhance the operator's ability to land the well and optimally position it within the reservoir. The SoundTrak service's real-time compressional slowness measurements provide a reliable method for correlating and updating pre-well seismic models – facilitating precise wellbore placement and increased hydrocarbon recovery.

With the seismic section being time-based (two-way travel time), it is crucial that the driller identify the bit location relative to the seismic section. Baker Hughes' SoundTrak service provides real-time compressional slowness for this correlation through a two-step procedure.

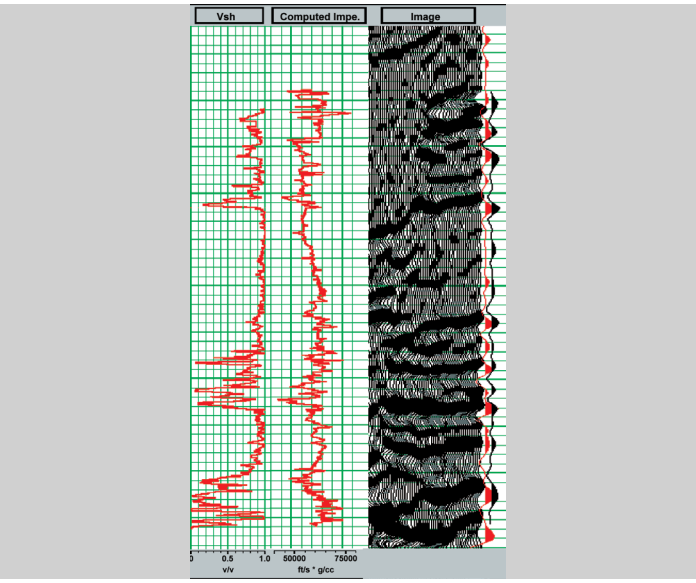
- A depth-based and up-scaled (real-time) impedance log is calculated using formation compressional slowness and formation density (**LithoTrak™ service**)
- Impedence log convolved with seismic wavelets are input to calculate a synthetic seismogram that is correlated directly to nearby common depth point (CDP) traces yielding the desired time-depth conversion



Excellent agreement between LWD and wireline derived compressional and shear slowness.



Pore pressure prediction chart showing real-time pore pressures derived from compressional slowness and resistivity. The predicted pore pressures were calibrated using pressure data from offset wells.



Comparison between synthetic seismograms derived from seismic (red) and LWD (blue). The LWD derived synthetic seismogram is superimposed on the CDP gather at the well location.

Superior measurement

- Accurate slowness in “fast” and “slow” formations in a variety of hole sizes
  - Multi-frequency
  - Multi-pole acquisition schemes
- Azimuthal receiver array configuration suppresses tool eccentricity effect
- The industries widest acoustic LWD measurement range
  -Compressional up to 190 us/ft
  - Shear up to 520 us/ft
- True formation shear slowness “directly” using quadrupole excitation to minimize dispersion correction

Critical, real-time answers

- Real-time pore pressure prediction
- Real-time seismic time-depth tie
- Increased drilling safety and efficiency
- Borehole stability issues addressed by combined use of compressional and shear slowness measurements

Application summary

- Real-time pore pressure prediction
  - ECD management
  - Wellbore stability
- Real-time seismic time-depth tie
  - Casing point selection
  - Wellbore placement
- Rock mechanical properties analysis
  - Bulk modulus
  - Shear modulus
  - Poissons’s ratio
- Acoustic light hydrocarbon indicator
  - Gas zone identification
  - Vp/Vs ratio
- Amplitude vs offset analysis
  - Fluid typing
  - Lithology typing
  - Abnormal pressure indication
- Acoustic porosity evaluation
  - Petrophysical analysis
  - Secondary porosity identification