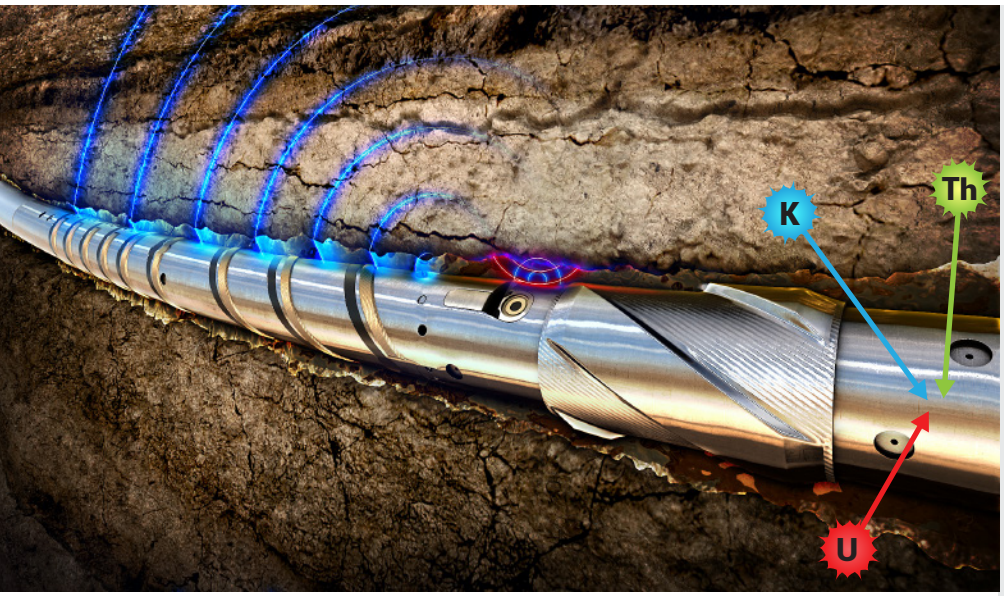
# ULT UNCONVENTIONAL LOGGING TOOL

TECHNICAL DATA SHEET




**Scientific Drilling's Unconventional Logging Tool (ULT) is a compact, integrated LWD system designed for geosteering, evaluation, and optimized completion of unconventional reservoirs.**

The ULT tool includes the following measurements, integrated into a 6 ¾" sensor collar:

### Azimuthal Spectral Gamma Ray

**MEASUREMENTS:**

+ High-precision total gamma ray
+ Potassium, Uranium, and Thorium (K,U,Th) concentrations
+ 32-bin azimuthal gamma ray borehole image

### Ultrasonic Borehole Imager

**MEASUREMENTS:**

+ 128-bin high-resolution ultrasonic amplitude and travel time images
+ Independent mud slowness measurement
+ 128-bin standoff/caliper from travel time and mud slowness measurements

### Azimuthal Sonic

**MEASUREMENTS:**

+ Azimuthally focused unipole transmitter with full-waveform receiver array
+ Conventional compressional and shear slowness (DTC, DTS)
+ 16-bin azimuthal DTC and DTS measurements

## APPLICATIONS

+ Geosteering
+ Unconventional reservoir completion
+ TOC evaluation
+ Clay content determination
+ Fracture detection
+ Formation dip interpretation
+ Formation mechanical properties
+ Porosity measurement

## BENEFITS

+ Reduces geosteering uncertainty
+ Builds accurate geologic models
+ Improves petrophysical interpretations
+ Characterizes the reservoir fracture network
+ Develop Engineered completions strategy
+ Eliminates time-consuming wireline runs

## FEATURES

+ Includes an inclination sensor and tri-axial accelerometers to measure RMS vibration, shock count, peak shock, and triggered fast-sampling (1 kHz) vibration data
+ Compatible with Scientific Drilling's mud pulse or EM MWD systems
+ Can be run in stand-alone memory mode with any mud motor, RSS, or MWD system

| GENERAL SPECIFICATIONS | |
|---|---|
| TOOL SIZE | 6.75 in (nominal), 7.5 in max @ wear bands |
| STABILIZER SIZE | 8.25 in or 8.5 in |
| HOLE SIZE RANGE | 8.375 in to 8.75 in<br>(up to 9.875 in for spectral GR and sonic) |
| TOOL LENGTH | 14.5 ft sensor collar, 32 ft w/ battery collar & saver subs |
| MAX DOG LEG | Rotating 10°/100 ft (single stabilizer configuration)<br>Sliding 15°/100 ft |
| MAX OPERATING TEMPERATURE | 338°F (170°C) |
| MAX FLOW RATE | 750 gpm |
| MAX PRESSURE | 20,000 psi |
| MAX RPM | 300 rpm |
| MAXIMUM WOB | 60,000 lb |
| MAX TORQUE | 25,000 ft-lb |

## MEASUREMENT SPECIFICATIONS

### AZIMUTHAL SPECTRAL GAMMA RAY

| | RANGE | REPEATABILITY@100 API and 60 ft/hr |
|---|---|---|
| TOTAL GAMMA RAY | 0 to 1,200 API | ± 0.87 API |
| POTASSIUM | 0 to 20% | ± 1.2% of reading |
| URANIUM | 0 to 500 ppm | ± 2.9% of reading |
| THORIUM | 0 to 500 ppm | ± 5.7% of reading |
| AZIMUTHAL SECTORS | 32 recorded, 4 real-time | |

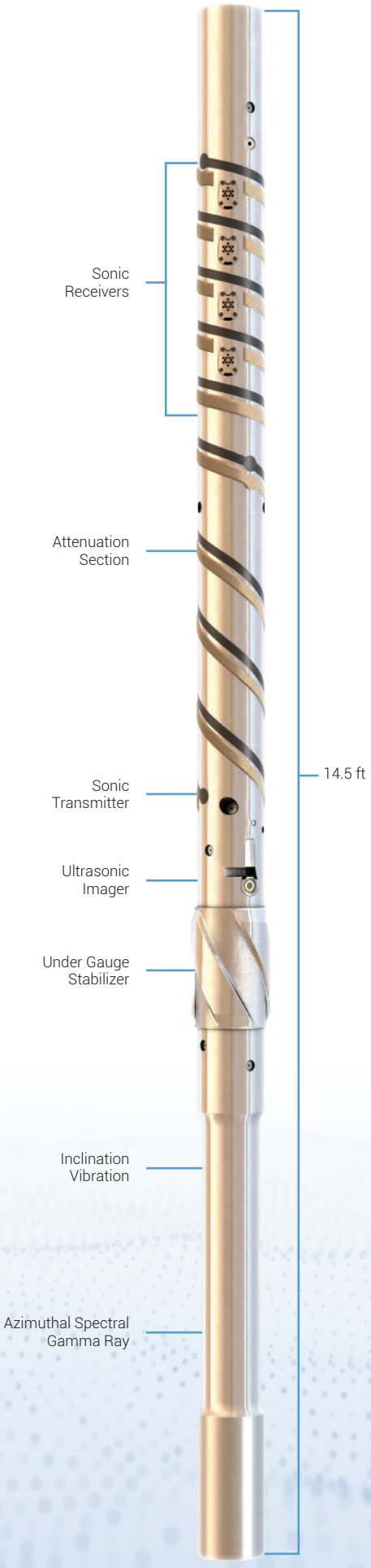
### AZIMUTHAL SONIC

| | RANGE | ACCURACY |
|---|---|---|
| DELTA-T COMPRESSIONAL | 30-270 µs/ft | ± 1.25 µs/ft |
| DELTA-T SHEAR | 70-270** µs/ft | ± 1.25 µs/ft |
| MEASUREMENT TYPE | Azimuthally focused unipole | |
| TRANSMITTER FREQUENCY | 12.5 kHz | |
| T-R SPACINGS | 48, 54, 60, 66 in | |
| AZIMUTHAL SECTORS | 16 sectors recorded;<br>Up/Down DTC, Vert./Horiz. DTS real-time | |

### ULTRASONIC IMAGER

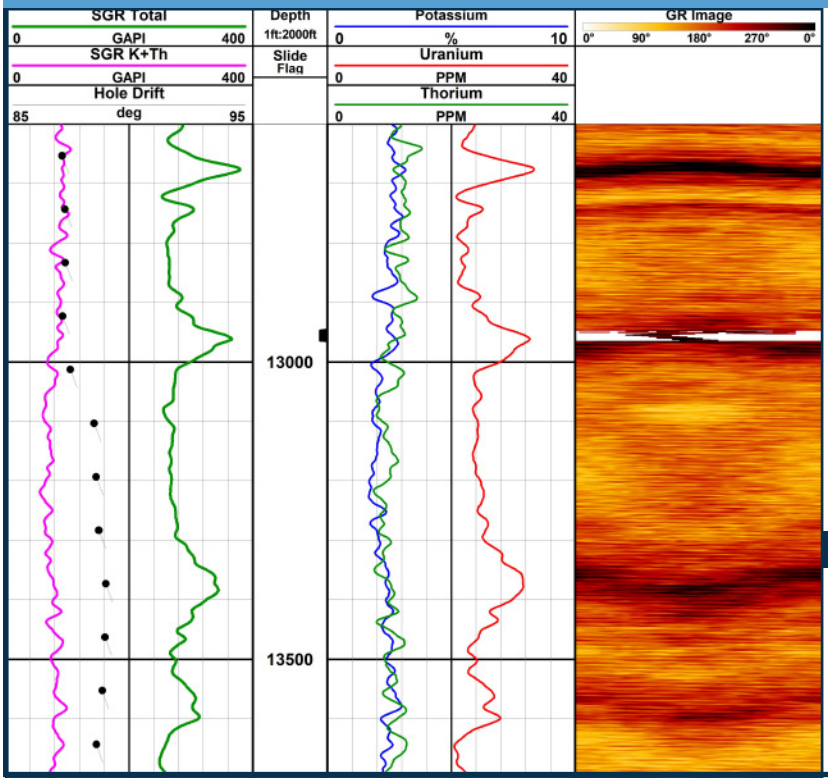
| | |
|---|---|
| MEASUREMENTS | 128 sector amplitude image, 128 sector travel time & standoff, Mud slowness |
| STANDOFF RANGE | 0 to 3 in from transducer face |
| STANDOFF ACCURACY | ± 0.05 in |

*Specifications are subject to change without notice
**Limited by mud slowness
Refer to MWD system technical data sheet for vibrational limits




For more information on improving your drilling efficiency [while staying on target] contact your Scientific Drilling sales representative or visit:
**http://scientificdrilling.com/LWD**

## AZIMUTHAL SPECTRAL GAMMA RAY




ULT azimuthal spectral gamma ray data from the Marcellus Shale.

Large variations in the total gamma ray are driven by variations in kerogen-associated uranium.

The relatively constant potassium, thorium, and uranium-stripped API gamma ray curve (SGR K+Th) suggest that the formation clay content is relatively constant, despite the large variations in total gamma ray.

The azimuthal gamma ray image shows a transition from drilling down-structure to drilling up-structure, associated with a change in wellbore inclination after the sliding interval.

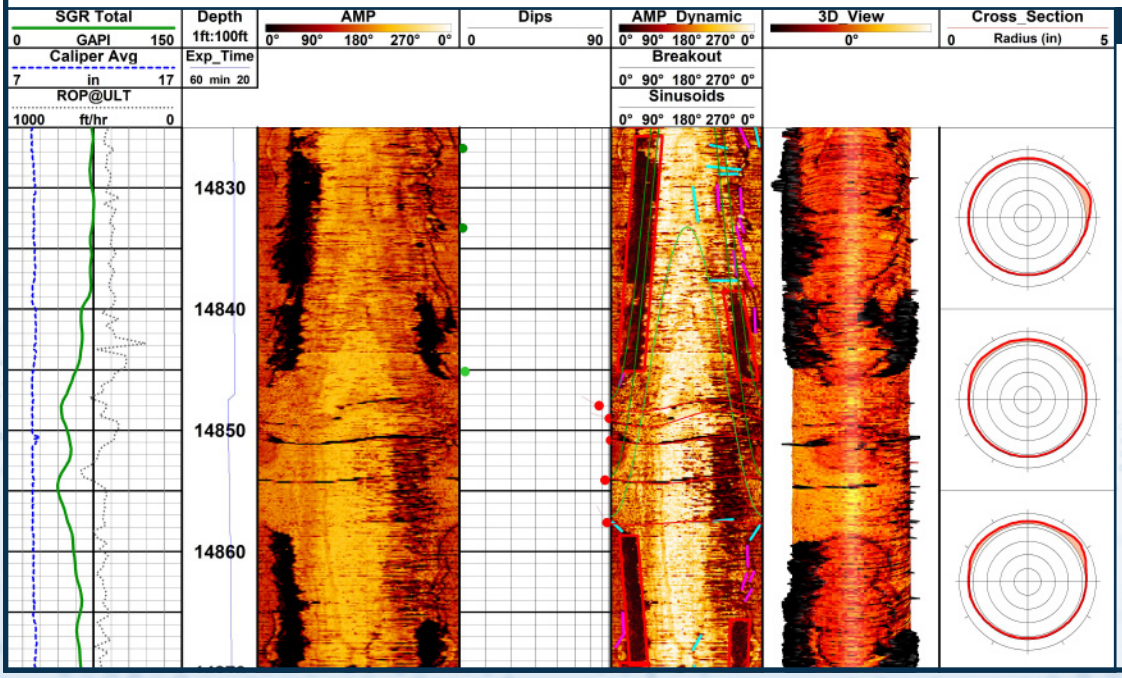
### MEASUREMENT APPLICATIONS

- Geosteering with real-time high-precision total GR, azimuthal GR image, and KUTh.
- TOC evaluation from uranium-TOC correlations.
- Clay content determination in uranium-bearing shales and carbonates

## ULTRASONIC BOREHOLE IMAGER

ULT high-resolution ultrasonic image data recorded in horizontal Permian Basin well while drilling at 400 to 500 ft/hr.

Stress-induced compressional fractures and borehole breakout are evident on the left and right sides of the hole. A group of open natural fractures can be seen between 14,846 and 14,857 ft.



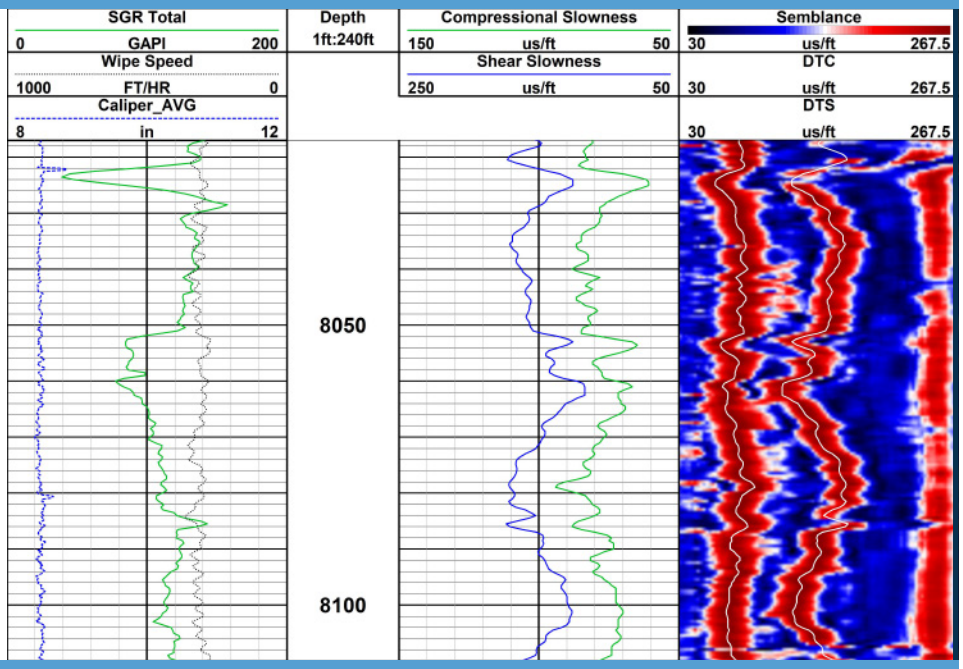

### MEASUREMENT APPLICATIONS

- Detection of natural, drilling-induced, and hydraulic open fractures
- Min/max stress directions from fracture orientation
- Accurate formation dip interpretation
- 360-degree borehole caliper

## AZIMUTHAL SONIC

ULT sonic compressional and shear slowness logs and semblance projection.

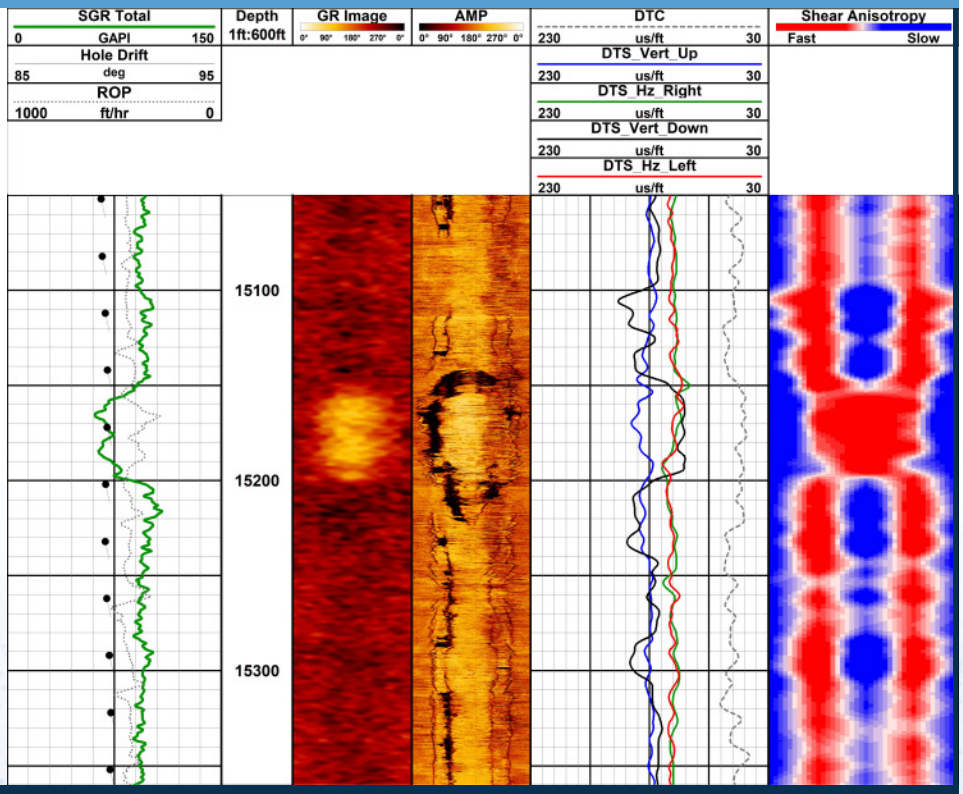
This log was recorded on a wiper run, two days after drilling, in a vertical well in the Anadarko Basin of Oklahoma.




## AZIMUTHAL SONIC

ULT sonic azimuthal shear slowness curves and shear anisotropy image, along with ULT azimuthal gamma ray and ultrasonic borehole images from a horizontal well in West Texas.

VTI anisotropy is evident from the separation between the faster left and right (red and green) horizontal shear slowness curves, and the slower up and down (blue and black) vertical shear slowness curves. Also note the bed boundary response of the "down" shear curve as the wellbore encounters a cleaner, faster, formation on the low side of the hole around 15,150 to 15,200 ft.




### MEASUREMENT APPLICATIONS

- Formation mechanical properties (Poisson's ratio, anisotropy ratio, UCS, etc.)
- Resolve intrinsic VTI shear anisotropy from horizontal wells in shale reservoirs.
- Sonic porosity from DTC, along with gas detection and lithology determination from Vp/Vs ratio.
- Sourceless, porosity-based, geosteering from real-time up/down DTC measurements.