GeoTracker™

At-bit Azimuthal Propagation Resistivity Tools

Well Resolutions Technology

Features

- Propagation resistivity measurements a few inches behind the drill bit
- All the measurements are temperature compensated for maximum thermal stability
- Continuous inclination and RPM
- 3-axes shock and vibration monitoring
- 150°C and 175°C rated

Benefits

- Larger depth of investigation up to 30 in. (0.76 m) means earlier payzone exit warning
- Work with all types of mud including OBM
- Modular design improves tool serviceability by the customer
- Interface with legacy Tensor MWD systems

Applications

- Geosteering
- Geostopping
- Shale-gas drilling
- Tight-sands drilling
- Coal-beds drilling

Options

- Azimuthal gamma at bit
- Annular pressure at bit

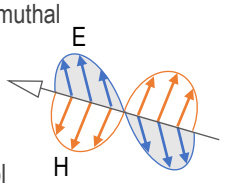
The industry's first at-bit resistivity tools that work in any type of drilling fluids including oil-base muds.

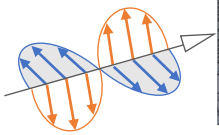
OVERVIEW

The GeoTracker™ at-bit resistivity tool performs propagation resistivity measurement at similar frequencies as used by the conventional LWD propagation resistivity tools. Average and sixteen sectors of attenuation and phase-difference resistivity data are acquired in the tool memory. Four quadrants of resistivity data are available for real-time transmission. The larger depths of investigation offered by the resistivity measurements help reduce unplanned exits from payzones.

PRINCIPLE OF MEASUREMENT

The GeoTracker™ tool employs a modular, side-mounted EM wave propagation resistivity sensor to perform resistivity measurement with a 16-sector azimuthal resolution capability. All the data are temperature compensated to provide stable measurements over a wide range of borehole temperatures. By design, the tool operates in all types of mud, including OBM.





MWD INTEGRATION

The GeoTracker™ tool interfaces with many 3rd party MWD systems including the legacy Tensor MWD systems. A standard software module is available for displaying the at-bit resistivity and the other data transmitted in real time.

OPERATIONAL ADVANTAGES

The modular design of the GeoTracker™ tool offers great field serviceability by the customer, including replacement of the resistivity sensor in shop or even at a rig site.

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GeoTracker provides near-bit azimuthal resistivity measurements for earlier warning of approaching bed or fluid boundaries.

GeoTracker provides bulk resistivity measurements near the bit which may give early indication of an overpressured zone.

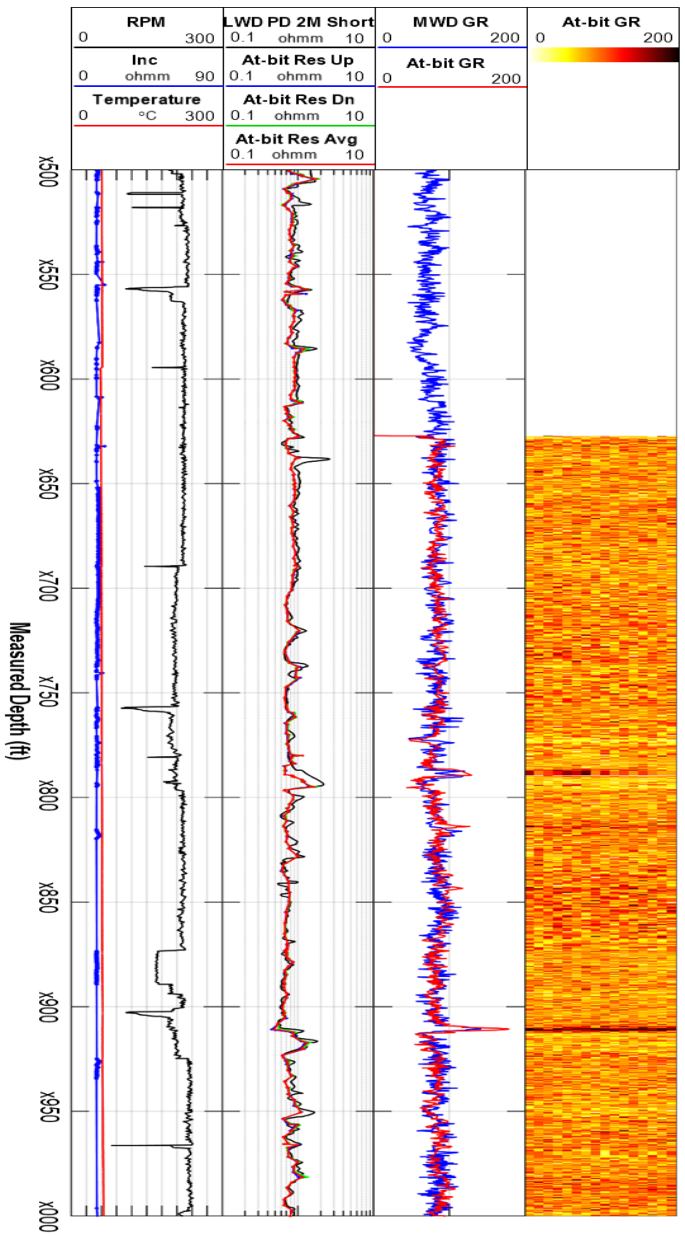
GeoTracker, when run below a mud motor, transmits data across the motor, via a field-proven EM short-hop communication system, to the MWD system above the motor for further transmission to the surface in real time.

GeoTracker performs in any type of drilling fluids including water-base mud, oil-base mud, foams, or other types of drilling fluids.

TOOL FEATURE HIGHLIGHTS

- Compatible with any type of muds, which makes the tool a suitable choice to run in complex hole conditions
- Short length (2.92 ft or 0.89 m) enables close sensor-to-bit distance
- High-capacity tool memory to record days of measurement data
- Drop-in EM short-hop receiver module retains MWD tool string retrievability
- Available in 4-3/4 in., 6-3/4 in., and 8 in. collar sizes

Comparison with LWD Propagation Resistivity



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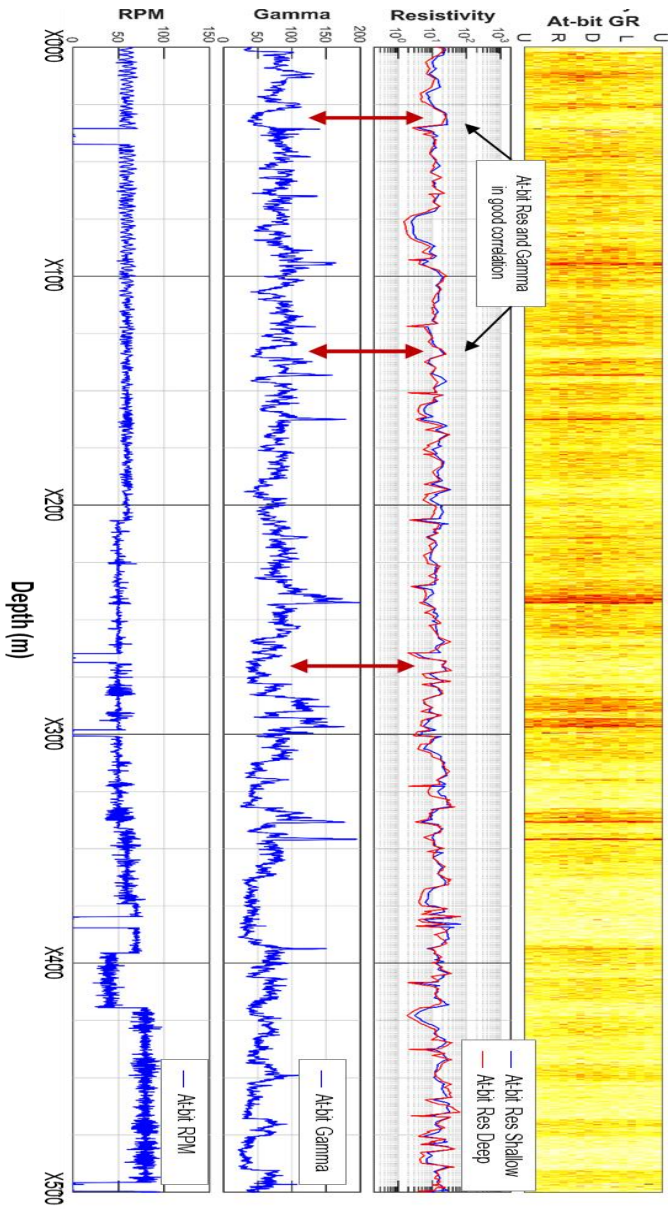
Field Example – Low-angle Well, Oil Base Mud

Date	—	09/2020
Location	—	Canada
Mud type	—	OBM

- ✓ At-bit resistivity and At-bit gamma data acquired from the same 6.75" sub
- ✓ At-bit deep and shallow resistivities trend each other well, indicating measurement consistency
- ✓ At-bit resistivity in good correlation with gamma, showing good confidence in the measurements



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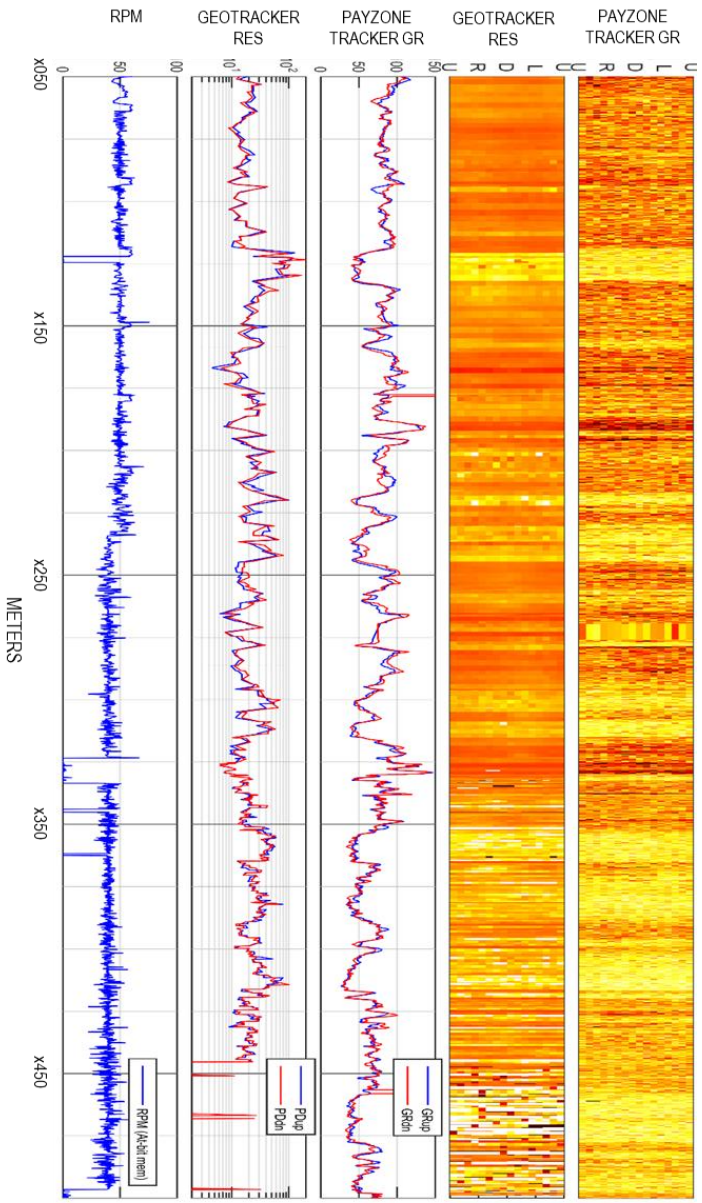

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Tool Size	4.75 in*	6.75 in	8 in
Length	35 in	35 in	35 in
Nominal OD	5.0 in	6.75 in	8 in
Max OD	5.25 in	7.0 in	8.25 in
Max ID	1.313 in	2 in	3.25 in
Connection PIN Up	3-1/2 REG (IF option)	4-1/2 REG (IF option)	6-5/8 REG
Connection BOX Down	3-1/2 REG	4-1/2 REG	6-5/8 REG
Yield Strength	15,140 lbf-ft	29,900 lbf-ft	50,000 lbf-ft
Make-up Torque	12,000 lbf-ft	24,000 lbf-ft	46,000 lbf-ft
Max DLS Rotating	15°/100ft	8°/100ft	6°/100ft
Max DLS Sliding	30°/100ft	16°/100ft	12°/100ft
Max Downhole Drilling Torque	12,000 lbf-ft	24,000 lbf-ft	46,000 lbf-ft
Max RPM (Downhole)	200 RPM	200 RPM	200 RPM
Max Flow Rate	340 gpm	750 gpm	1000 gpm
Max Operating Pressure	20,000 psi	20,000 psi	20,000 psi
Max Operating Temperature	150°C / 175°C	150°C / 175°C	150°C / 175°C
Max Operating WOB	25,000 lbs	50,000 lbs	75,000 lbs
Max Sand Content	<1%	<1%	<1%
Max Number of Recuts	4	4	4
Receiver Gap Collar			
Drop-in Length	35 in	35 in	35 in
Max OD	4.75 in	6.75 in	8.25 in
Connection	3-1/2 IF	4-1/2 IF	5-1/2 IF
Yield Strength	18,000 lbf-ft	34,000 lbf-ft	75,000 lbf-ft
Make Up Torque	12,000 lbf-ft	24,000 lbf-ft	58,000 lbf-ft
Receiver Assembly			
Drop-in Length (with one metal centralizer)	64.5 in		
OD	1.875 in		
Measurement			
Inclination @ Bit			
Range	0 - 180 degrees		
Repeatability	±0.2 degrees (sliding)		
Measure Point to Bit	12 in		
Azimuthal Resistivity @ Bit (Available in GeoTracker or GeoTracker DUO)			
Range	0.1 – 200 ohmm		
Accuracy	10% (< 10 ohmm) or 10 mmhos (> 10 ohmm)		
Depth of Investigation	Up to 30 in. (0.76 m)		
Vertical Resolution	6 in. (0.15 m)		
Number of Sectors	16		
Measure Point to Bit	16 in. (0.41 m)		
Azimuthal Gamma @ Bit (Available in PayzoneTracker or GeoTracker DUO)			
Range	0 - 1000 AAPI		
Accuracy	±5API @ 250API		
Number of Sectors	16		
Measure Point to Bit	16 in (0.41 m)		
Battery Life (With Both Resistivity and Gamma)			
CC-cells Tools	Up to 130 hrs		
DD-cells Tools	Up to 200 hrs		
Recommended Operating Parameters			
RPM	Up to 200 for minimum fatigue		
Formation Resistivity	2 -200 ohmm for optimal short-hopping		
Mud Resistivity	2 -200 ohmm for optimal short-hopping		
Vibration	Max 20 Grms, 50-1000Hz		
Shock	Max 500 G, 0.5ms (z-axis), 1000 G, 0.5ms (x- or y-axis)		
Running Below a Mud Motor**			
Max Bend Setting	1.50°	1.50°	1.50°
Max DLS Rotating	15°/100ft	8°/100ft	6°/100ft
Max Surface RPM	60	60	60
Max Mud Motor RPM	180	180	180

*Single sensor only (resistivity or gamma). **Do not run any stabilizer. Most mud motors have higher WOB capacity than GeoTracker.

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