

PeriScope

Real-time bed boundary mapping for steering wells to the best place and evaluating formations in less time.

UNMATCHED RESERVOIR NAVIGATION CAPABILITY

The PeriScope* bed boundary mapper provides unmatched reservoir navigation capability, using unique symmetrized directional measurements with maximum sensitivity to formation or fluid boundaries. These measurements make it possible to map boundaries in real time, even when anisotropy and structural dip variation are present—the only way inversion can be performed without a predefined geological model. By guiding decision-making for real-time placement of a horizontal well in the best place in the reservoir, the PeriScope mapper enables the drilling team to maximize well production and minimize well costs.

DIRECTIONAL, DEEP MEASUREMENTS

The unique PeriScope mapper makes 360° deep, directional measurements that show the orientation of boundaries as far as 21 ft from the borehole, using a combination of state-of-the-art tilted coil technology and multiple frequencies and spacings—2MHz, 400 kHz, and 100 kHz at 96 in, 84 in, 74 in, 44 in, 40 in, 34 in, 28 in, 22 in, and 16 in. In addition, the mapper provides high-quality, multifrequency—2 MHz, 400 kHz, and 100 kHz—resistivity measurements, azimuthal gamma ray measurements, and annulus pressure measurements.

PROACTIVE WELL PLACEMENT

High-speed mud-pulse telemetry transmits the PeriScope measurements to the surface in real time. This allows proactive well placement to increase recovery and access reserves previously considered economically marginal.

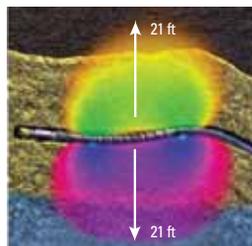
- Proactive well placement based on PeriScope mapping tripled production from a heavy-oil reservoir in the US.
- In the Middle East, real-time navigation using PeriScope mapping placed more than 3,000 ft of wellbore within a reservoir that was only 4 ft thick.

PeriScope Specifications

Mechanical Specifications	PeriScope 475	PeriScope 675
General		
Drill collar nominal OD	4.75 in API	6.75 in API
Max. diameter (on wear bands)	5.28 in [134.11 mm]	7.5 in [190.5 mm]
Makeup length (without lower crossover)	23.5 ft [7.2 m]	18.3 ft [5.6 m]
Total tool weight	1,200 lbm [544 kg]	1,800 lbm [816 kg]
Top thread connection	NC 38 box	5 1/2 FH box
Bottom thread connection	NC 35 box	NC 50 box
Max. operating temperature	300 degF [150 degC]	300 degF [150 degC]
Hole size range	5 3/4 to 6 3/4 in	8 1/4 to 9 7/8 in
Rotation speed range	10 to 300 rpm	10 to 300 rpm
Bending		
Max. tool curvature	Rotating Sliding 15°/100 ft [15°/30 m] 30°/100 ft [30°/30 m]	8°/100 ft [8°/30 m] 16°/100 ft [16°/30 m]
Max. downhole shocks	30 min continuous at 50 g _n or 200,000 shocks at 50 g _n	30 min continuous at 50 g _n or 200,000 shocks at 50 g _n
Axial		
Max. jarring load	200,000 lbf [889,644 N]	330,000 lbf [1,467,913 N]
Max. weight on bit	F = 16,000,000/L ^{2†}	F = 74,000,000/L ^{2†}
Hydraulics		
Max. operating pressure	25,000 psi [172 MPa]	25,000 psi [172 MPa]
Pressure drop constant (C) [‡]	8,000	121,000
Max. flow rate	400 galUS/min [1,514 L/min]	800 galUS/min [3,028 L/min]
Max. sand content	3% by volume	3% by volume
Lost circulation material tolerance	Medium nut plug, 50 lbm/galUS	Medium nut plug, 50 lbm/galUS
Max. dissolved oxide content	1 × 10 ⁻⁶	1 × 10 ⁻⁶
Min. drilling fluid pH	9	9
Torque		
Max. operating rotary torque	8,000 ft.lbf [10,847 N.m]	12,000 ft.lbf [16,270 N.m]
Connection makeup torque	9,000 ft.lbf [12,202 N.m]	24,000 ft.lbf [32,540 N.m]

†L = Distance between stabilizers

‡Pressure drop (psi) = Mud weight (lbm/galUS) × Flow rate² (galUS/min)²/C



The PeriScope mapper enables precise well placement through exact knowledge of fluid and bed boundary contact points.

APPLICATIONS

- Maximize production
- Place wells precisely in thin and complex reservoir targets
- Detect water
- Avoid sidetracking
- Refine reservoir models

BENEFITS

- Increase production rates and recovery
- Reduce or delay water production
- Access reserves previously considered economically marginal
- Cut drilling cost by avoiding drilling hazards and eliminating need for pilot hole
- Estimate reserves more accurately
- Shorten BHA by integrating resistivity and azimuthal deep measurements in one tool

FEATURES

- Formation and fluid boundary mapping while drilling
- High-resolution azimuthal sensitivity for accurate boundary orientation while drilling
- Unique symmetrization that provides accurate boundary mapping independent of anisotropy and dip
- Fully compensated multidepth resistivity measurements while drilling

Measurement Specifications											
Resistivity measurement		Accuracy [§]					Range (ohm.m) ^{††}				
Phase shift resistivity	2 MHz	± 2%					0.2 to 60				
	400 kHz	± 0.3 mS/m					60 to 3,000				
		± 2%					0.1 to 10				
Attenuation resistivity	100 kHz	± 2 mS/m					10 to 100				
	2 MHz	± 2%					0.05 to 2				
		± 10 mS/m					2 to 20				
Attenuation resistivity	400 kHz	± 3%					0.2 to 25				
	2 MHz	± 1.5 mS/m					25 to 50				
		± 3%					0.1 to 3				
Attenuation resistivity	100 kHz	± 10 mS/m					3 to 10				
	2 MHz	± 3%					0.01 to 1				
		± 30 mS/m					1 to 3				
Vertical resolution (ft) ^{‡‡}		Phase shift transmitter-receiver spacing (in)					Attenuation transmitter-receiver spacing (in)				
		16	22	28	34	40	16	22	28	34	40
R = 0.1 ohm.m	100 kHz	0.6	0.6	0.6	0.6	0.6	1.4	1.6	1.7	1.8	1.8
R = 1 ohm.m	2 MHz	0.7	0.7	0.7	0.7	0.7	1.8	1.8	1.8	1.8	1.8
	400 kHz	1	1	1	1	1	3	3.5	4	4	4
R = 10 ohm.m	100 kHz	1.2	1.4	1.5	1.6	1.7	2.5	2.9	3.2	3.3	3.6
	2 MHz	1	1	1	1	1	4	5	6	6	6
Radius of investigation (in) ^{§§}		Phase shift transmitter-receiver spacing (in)					Attenuation transmitter-receiver spacing (in)				
		16	22	28	34	40	16	22	28	34	40
Frequency	2 MHz	18.5	22	25	27.5	30	35.5	41	44	48	52.5
	400 kHz	23	28.5	33	37	41	51	57	60	65	67.5
	100 kHz	24.5	31	36	41	44	52	60	63	67	69
Directional measurement											
Operating frequency		100 kHz, 400 kHz, 2 MHz									
Spacing		22 in, 34 in, 44 in, 74 in, 84 in, 96 in									
Azimuthal coverage		360°									
Azimuthal resolution		2°									
Equivalent azimuthal sectors		180									
Detection range		21 ft at 50/1 ohm.m and 0.03 dB threshold or only limited by conductivity difference									
Gamma ray											
Range		0 to 250 gAPI									
Vertical resolution		10 in [254 mm]									
Statistical repeatability		± 2 gAPI at 100 gAPI, 100 ft/h, and 3-point average									
Azimuthal sensitivity ratio, front:back		3.3:1 (PeriScope 475), 11:1 (PeriScope 675)									
Accuracy		± 3%									
Image		Real-time and memory									
Azimuthal sectors		4									
APWD* Annular Pressure While Drilling											
Range		25,000 psi [172 MPa]									
Accuracy		± 25 psi [0.172 MPa]									
Resolution		± 1 psi [0.007 MPa]									
General											
Power		MWD turbine									
Memory		104 MB									
Drilling mud type		No limit									

[§]Above the specified resistivity value, the accuracy is expressed in terms of constant conductivity (mmho/m)

^{††}Resistivities above 200 ohm.m require dielectric processing

^{‡‡}Width at half maximum of the response functions along the tool axis

^{§§}Values for which the integrated radial geometric factor reaches 0.5 in a 10 ohm.m formation