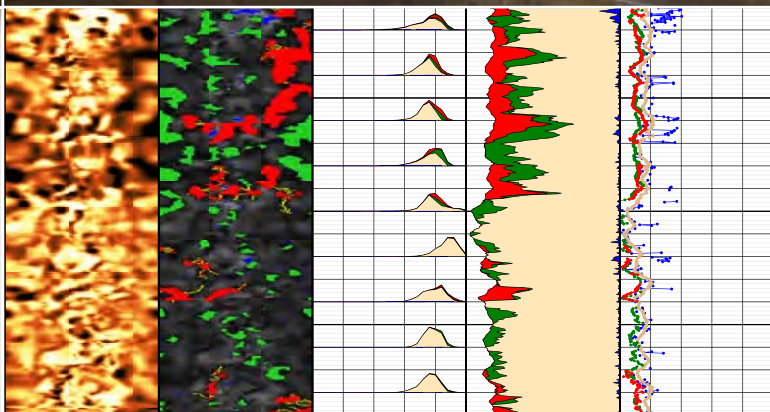


# Schlumberger

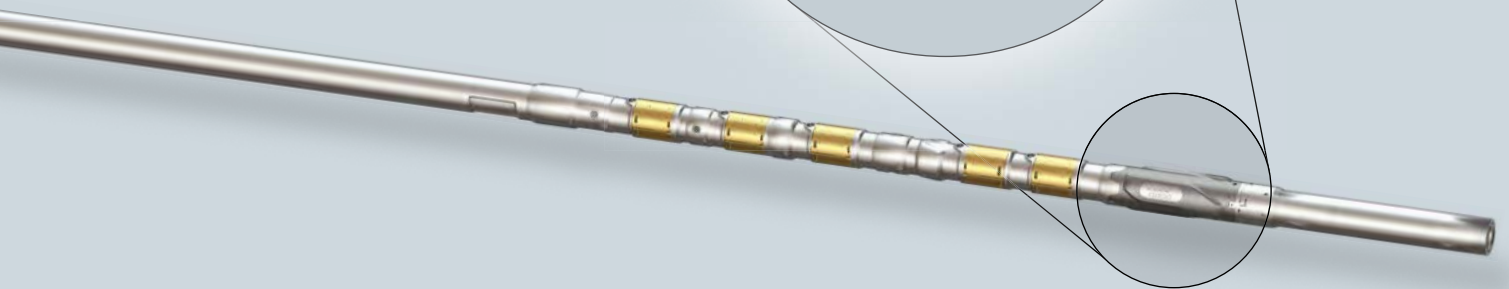


## MicroScope HD

Resistivity and high-definition imaging-while-drilling service

# MicroScope HD

*The sleeve of the MicroScope HD service features eight high-resolution button electrodes that enable dip, fracture, and texture answer products.*



The MicroScope HD\* resistivity and high-definition imaging-while-drilling service provides unmatched logging-while-drilling (LWD) imaging for reservoir description, from structural modeling to sedimentology analysis. This service enables detailed fracture characterization and completion optimization in conductive drilling fluids.

## Applications

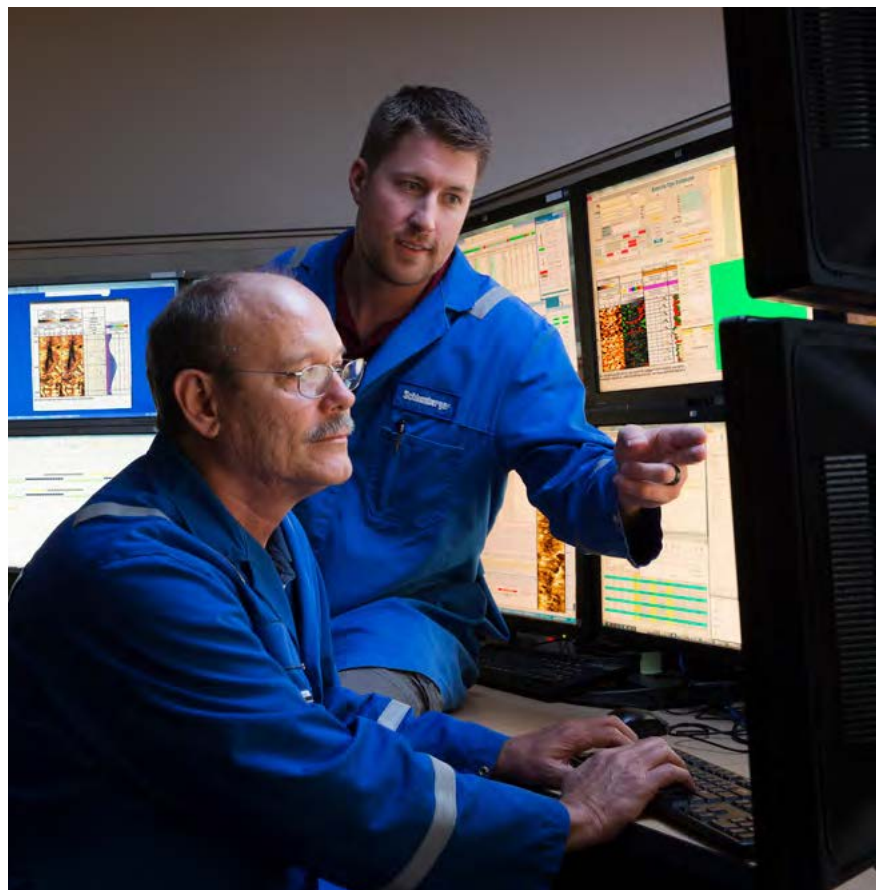
- Structural analysis: high-definition formation bedding and fault dip picking and analysis
- Sedimentology: textural analysis for porosity evaluation and thin-bed quantification
- Fracture characterization: geological modeling of fracture properties, dimension, and intensity

## Benefits

- Optimization of completion design and stimulation planning
- Identification of thinly laminated or bypassed pay zones
- Enhancement of well trajectory positioning within complex fracture networks
- Drilling risk prevention through fracture characterization

## Features

- High-resolution, real-time borehole imaging
- Enhanced image resolution of 0.4 in
- Innovative, noise-reduction signal processing
- Integration with MicroScope\* resistivity- and imaging-while-drilling service
- Advanced answer products using Techlog\* wellbore software platform and Petrel\* E&P software platform



### High-definition LWD imaging for detailed structural analysis

The resolution of the MicroScope HD service is based on the button size of 0.4 in. Aligned with sampling theory, images produced by MicroScope HD service are sampled at one-half the resolution, or 0.2-in pixels, vertically and horizontally so as not to compromise the theoretical resolution. This method means that the dimensions of any feature that is 0.4 in or larger can be estimated from the image, and the size of features smaller than 0.2 in can be estimated by quantifying the current flow to the electrode. Fine-scale details such as fractures filled with conductive fluids also appear on the images; their true size can be inferred using the fracture aperture answer product.

### Refined resistivity imaging for geological reservoir description

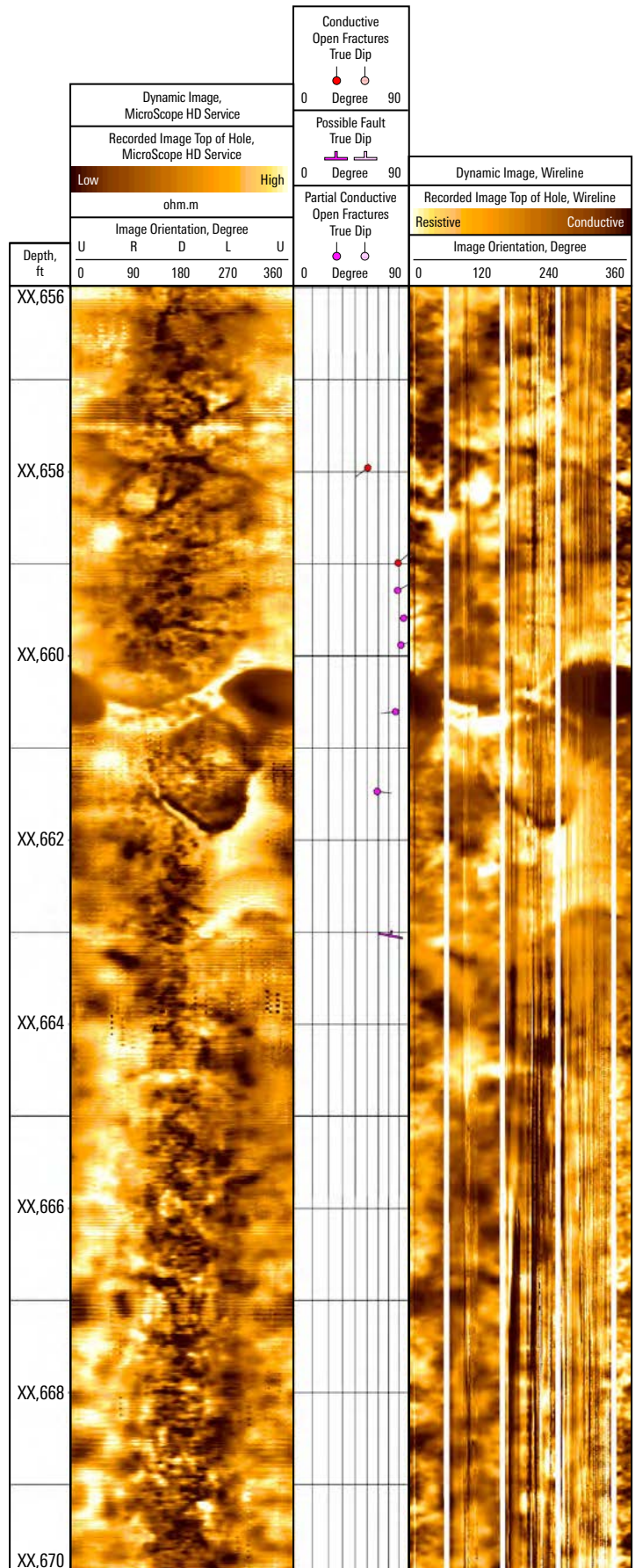
This fine resolution enables operators using MicroScope HD service to quantify fine features of the downhole environment for geological interpretation of siliciclastics, carbonates, and unconventional shale oil and gas reservoirs. The high-definition resistivity imaging supports fracture and dip analysis for structural evaluation of reservoir sections and sedimentology evaluation, including image-based porosity determination and thin-bed analysis.

### Fracture characterization for production optimization

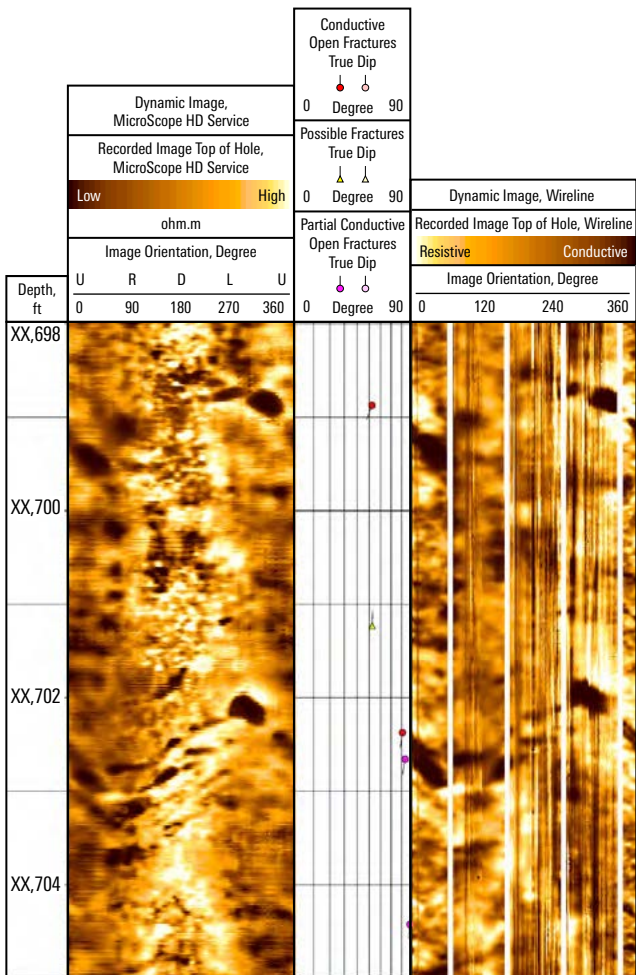
High-definition images from the MicroScope HD service can be used to identify whether fractures are conductive or resistive and determine the continuous or discontinuous morphology and geometry of each fracture. It also characterizes the fracture density and distribution along the logged interval.

These images successfully identify fractured zones contributing to drilling mud losses. Subsequently, completion design is developed to isolate those fractured zones as well as to select proper perforation zones away from the fractures.

This service's resistivity range is pushing the industry's current boundaries, working in formations with resistivity up to 10,000 ohm.m.



High-resolution images from MicroScope HD service (left) and wireline image data (right).



High-definition images acquired by MicroScope HD service show fractures as compared with wireline images.

### Structural modeling to evaluate formation structure bedding orientation

Structural interpretation of reservoir sections is vastly improved by the use of high-quality bedding dips. High-definition images aid accurate determination of structural dips as well as detection and determination of faults, folds, and unconformities in almost all formation types. MicroScope HD service provides critical information for well-to-well correlation in highly deviated and horizontal wells, enhancing structural cross sections and models with data such as accurate computations of true stratigraphic thickness.

### Sedimentology analysis for porosity evaluation and thin-bed analysis

#### Porosity evaluation in fractured and vug-rich reservoirs

MicroScope HD service enables quantification and classification of matrix and vuggy porosity with its high-definition images. This evaluation of porosity facilitates partitioning of isolated, connected, and fracture-connected vuggy porosity.

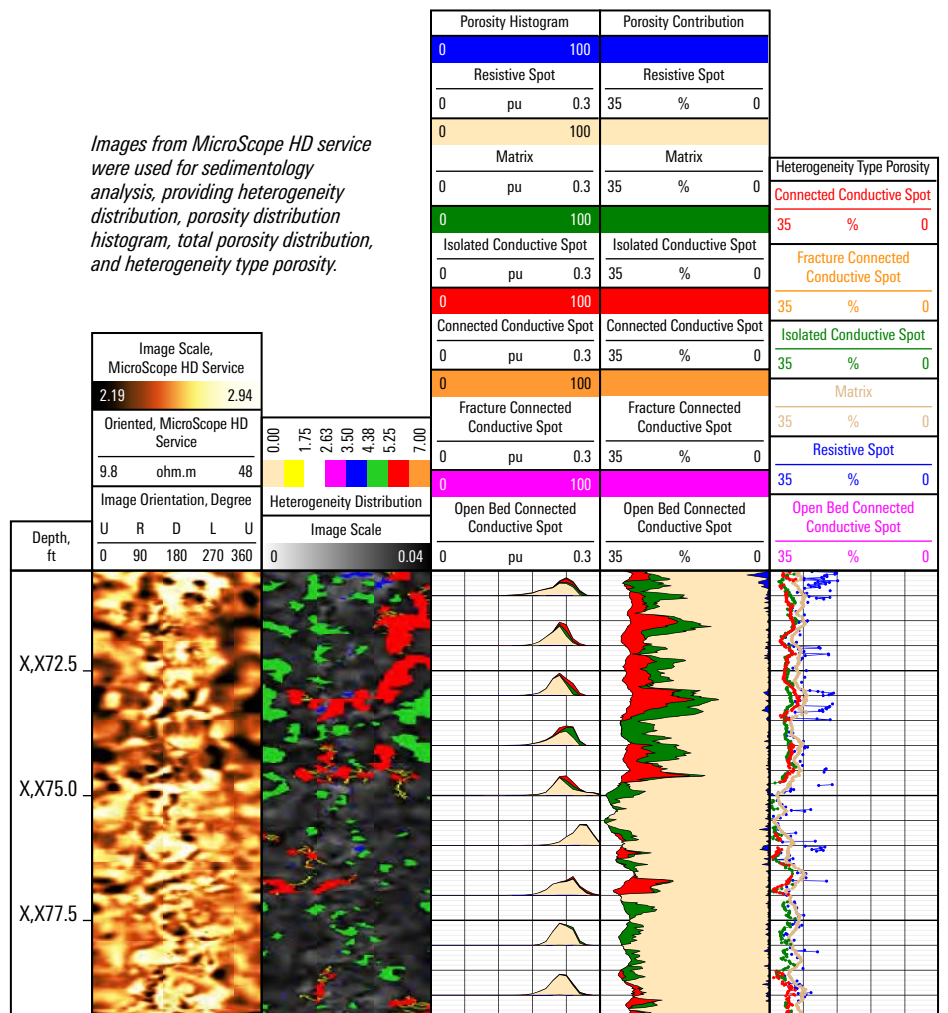
#### Thin-bed detection and evaluation to identify pay zones

Laterolog images from the MicroScope HD service can be used for determining net pay in thin and laminated sediments. This service can be used to resolve laminations as thin as 0.4 in, which are often present in fluvial and turbidite depositional environments.

#### Sedimentology evaluation for petrophysical reservoir understanding

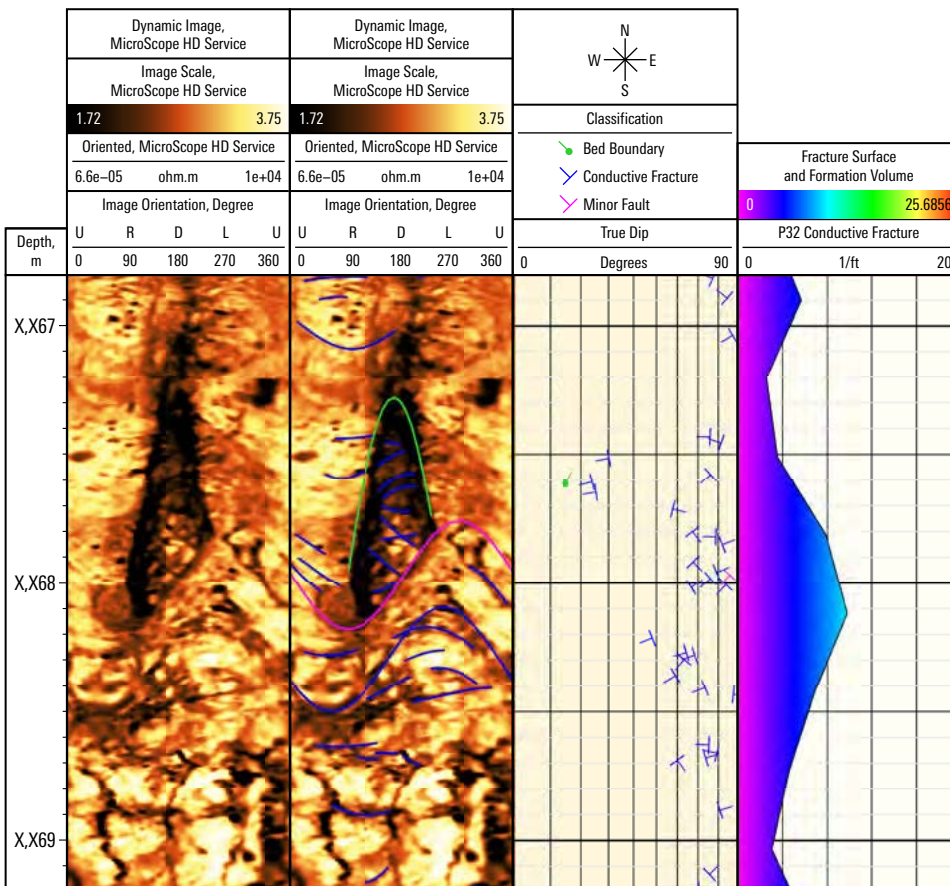
High-definition images from the MicroScope HD service enable recognition of sedimentological features that guide the interpretation of dip data and identification of paleoenvironments. Examples include scour surfaces, cross-bedding loading and injectite, and dewatering features. Such results lead to better reservoir geometries and petrophysical parameters definition.

Images from MicroScope HD service were used for sedimentology analysis, providing heterogeneity distribution, porosity distribution histogram, total porosity distribution, and heterogeneity type porosity.



## Characterization of naturally fractured reservoirs for production optimization

Complete characterization of fractures is now possible with LWD, using high-definition images from the MicroScope HD service. This service quantifies fracture aperture, fracture orientation, and density in complex reservoirs. The resulting information enables proactive decisions for optimization of zones for multistage completions.



Images from the MicroScope HD service show fractures, fracture surface, and fracture volume.

## The MicroScope HD service provides answers, not just datasets

Answer products provided using the Techlog and Petrel platforms include

- automatic dip picking
- dip analysis
- structural reconstruction
- fracture segment extraction
- fracture aperture analysis
- fracture statistics
- textural analysis
- porosity mapping
- sand count.



General Specifications	MicroScope HD 475 Service	MicroScope HD 675 Service
Hole size, <sup>†</sup> in [mm]	5 $\frac{7}{8}$ –6 $\frac{1}{2}$ [148 to 165]	8 $\frac{1}{2}$ –9 $\frac{7}{8}$ [216 to 250]
Tool length, ft [m]	18 [5.5]	15.6 [4.75]
Tool weight, lbm [kg]	1,000 [453]	1,750 [800]
Collar dimensions		
Nominal diameter, API, in [mm]	4 $\frac{3}{4}$ [120.65]	6 $\frac{3}{4}$ [175.26]
Maximum diameter, in [mm]	5 $\frac{9}{16}$ [134.62]	6 $\frac{9}{16}$ [175.90]
Top thread connection	NC 38 box	5 $\frac{1}{2}$ FH box
Bottom thread connection	NC 35 box	5 $\frac{1}{2}$ FH box
Maximum operating temperature, degF [degC]	302 [150]	302 [150]
Power supply	MWD turbine power	MWD turbine power
Downhole memory		
Capacity, GB	1.5	1.5
Recording time, standard definition, h	700	700
Recording time, high definition (100 rpm), h	300	300
Combinability	Fully combinable with all Schlumberger tools	Fully combinable with all Schlumberger tools
<b>Mechanical Specifications</b>		
Dogleg severity		
Rotary mode, °/100 ft [°/30 m]	15 [15]	8 [8]
Sliding mode, °/100 ft [°/30 m]	30 [30]	16 [16]
Hydraulics		
Maximum operating pressure, psi [kPa]	20,000 [137,895]	20,000 [137,895]/25,000 [172,369] optional
Flow range, galUS/min [m <sup>3</sup> /min]	0–400 [0–1.5]	0–800 [0–3.03]
Pressure drop constant ( <i>C</i> ) <sup>‡</sup>	8,500	55,000
Maximum sand content	3% by volume	3% by volume
Lost circulation material tolerance	Medium nut plug, 50 ppg [23 kg/0.004 m <sup>3</sup> ]	Medium nut plug, 50 lbm/galUS [23 kg/0.004 m <sup>3</sup> ]
Maximum system shock level	30 min at Shock Level 3 (50 g <sub>n</sub> ) or cumulative 200,000 shocks above 50 g <sub>n</sub>	30 min at Shock Level 3 (50 g <sub>n</sub> ) or cumulative 200,000 shocks above 50 g <sub>n</sub>
Tension, lbf	250,000	330,000
Compression, lbf	50,000	80,000
Torque, ft.lbf	8,000	16,000
<b>Measurement Specifications</b>		
High-definition imaging		
Button size, in [mm]	$\frac{3}{8}$ [10.16]	$\frac{3}{8}$ [10.16]
Pixel size, in [mm]	$\frac{1}{8}$ × $\frac{1}{8}$ [5.08 × 3.18]	$\frac{1}{8}$ × $\frac{1}{8}$ [5.08 × 3.18]
Vertical resolution, in [mm]	$\frac{3}{8}$ [10.16]	$\frac{3}{8}$ [10.16]
Azimuthal bin count	160	208
Coverage	Full borehole coverage at 300 ft/h and 60 rpm	Full borehole coverage at 300 ft/h and 60 rpm
Depth correction	Available up to 300 ft/h and 120 rpm	Available up to 300 ft/h and 120 rpm
Maximum instantaneous rpm for high-definition imaging	375	290
<b>Resistivity</b>		
Range, ohm.m	0.2–20,000 ohm.m	0.2–20,000 ohm.m
Button resistivity accuracy <sup>§</sup>		
0.2–250 ohm.m	±5%	±5%
250–500 ohm.m	±10%	±10%
500–1,000 ohm.m	±20%	±20%
Toroid resistivity accuracy		
0.2–2,000 ohm.m	±5%	±5%
2,000–5,000 ohm.m	±11%	±11%
5,000–10,000 ohm.m	±22%	±22%
Mud resistivity		
Range, ohm.m	0.01–20	0.01–20
Accuracy		
0.01–0.03 ohm.m	±12%	±12%
0.03–3 ohm.m	±8%	±8%
>3 ohm.m	±5%	±5%
Azimuthal GR		
Range	0–1,000 gAPI	0–1,000 gAPI
Accuracy	±5%	±5%
Statistical resolution	±5% gAPI at 100 gAPI and 200 ft/h [61 m/h]	±5% gAPI at 100 gAPI and 200 ft/h [61 m/h]
Axial resolution	10 in	10 in

<sup>†</sup> MicroScope HD 675 service imaging sleeve only for 8 $\frac{1}{2}$ -in hole size.

<sup>‡</sup> Pressure drop, psi = [(mud weight, lbm/galUS) × (flow rate, galUS/min)<sup>2</sup>] / *C*.

<sup>§</sup> For  $R_{mud} > 0.04$  ohm.m.

A special collar design makes this service less susceptible to data error related to stick/slip while drilling — with noise reduction and better signal processing for consistent and thorough data.

Resistivity Environments	MicroScope HD 475 Service	MicroScope HD 675 Service
Water-based mud		
Mud resistivity 0.01–5 ohm.m	Quantitative resistivity and imaging	Quantitative resistivity and imaging
Mud resistivity 5–20 ohm.m	Qualitative imaging and dip interpretation	Qualitative imaging and dip interpretation
Oil-based mud	Correlation with bit resistivity only	Correlation with bit resistivity only

Button Resistivity	MicroScope HD 475 Service				MicroScope HD 675 Service			
	Extra Deep	Deep	Medium	Shallow	Extra Deep	Deep	Medium	Shallow
Depth of investigation, in	6	5	3	1.5	7	5	3	1.5
Axial resolution, in <sup>†</sup>	0.4	0.4	0.4	0.4	0.6	0.6	0.6	0.6
Bit and Toroid Resistivity	Bit <sup>‡</sup>	Extradeep Toroid	Deep Toroid		Bit	Extradeep Toroid	Deep Toroid	
Depth of investigation, in	30	6	5		30	6	5	
Axial resolution, in	48	15	15		48 <sup>§</sup>	15	15	
Image Resolution	Extra Deep	Deep	Medium	Shallow	Extra Deep	Deep	Medium	Shallow
Axial resolution, in <sup>††</sup>	1	1	1	1	1.5	1.5	1.5	1.5

<sup>†</sup> Thickness of a 1-ohm.m feature in a 10-ohm.m background for which 90% of the formation resistivity value at the center of the bed is measured.  
Axial resolution, or along-tool-axis resolution, was previously referred to as vertical resolution for logging measurements acquired in vertical wells.

<sup>‡</sup> Specification applies when bit is closely below tool.

<sup>§</sup> For bit electrode length of no more than 30 ft.

<sup>††</sup> Thickness of a 1-ohm.m feature in a 10-ohm.m background for which 10% of the resistivity contrast is measured.



Find out more about MicroScope HD service  
at [slb.com/microscopehd](http://slb.com/microscopehd)

#### Case Studies

- Acquiring high-resolution LWD resistivity images at 0.4-in vertical resolution, the MicroScope HD service helped an operator optimize the perforation design of a naturally fractured reservoir offshore Libya.
- LWD-acquired imaging identified the cause of severe drilling mud losses in a heavily fractured reservoir of Oman, helping develop a proactive completion design for well production.
- Real-time, high-definition LWD images guided the placement of a 4,196-ft [1,279-m] drain hole in a complex sand reservoir for the operator.

#### MicroScope

High-resolution resistivity measurements and borehole imaging.  
[slb.com/microscope](http://slb.com/microscope)

#### Techlog

Integration of all wellbore-centric data types into multidiscipline workflows.  
[slb.com/techlog](http://slb.com/techlog)

#### Petrel E&P

Collaboration of discipline experts for best possible decision making—from exploration to production.  
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