Schlumberger

OBMI

Borehole imaging in oil-base mud

Applications

- Structural analysis
  - Structural dip determination
  - Fracture and fault detection
- Stratigraphic analysis
  - Characterization of sedimentary deposits
  - Stratigraphic dip determination
  - Thin-bed detection
- Core analysis
  - Depth matching
  - Orientation
  - Missed interval coverage
- Compartmentalization and permeability analyses
- High-resolution net pay count
- Sample and formation test positioning
- Detection of drilling-induced features

Benefits

- Detection and measurement of features too small for conventional logs
- Detection of anisotropic features
- Differentiation of structural and stratigraphic features
- Flexibility retained in choosing mud systems

Features

- Operates in any oil-, diesel- or synthetic-base mud
- High-resolution, oriented formation image
- 0.4-in. button size, 1.2-in. resolution
- Five measurements per pad
- Quantitative R_{xo} measurement
- Compact, integrated design
- Combinable top and bottom
- 3600 ft/hr maximum logging speed
- Two-axis caliper

A tradition of electrical coring

Before it was called logging, the downhole measurement of formation properties was called "electrical coring." Inspired by this ideal, Schlumberger developed formation imaging to advance log structural and stratigraphic analysis to new levels of insight. The OBMI* Oil-Base MicroImager tool is the latest Schlumberger imaging solution and another industry first, extending microresistivity imaging into the environment of nonconductive invert-emulsion mud systems.

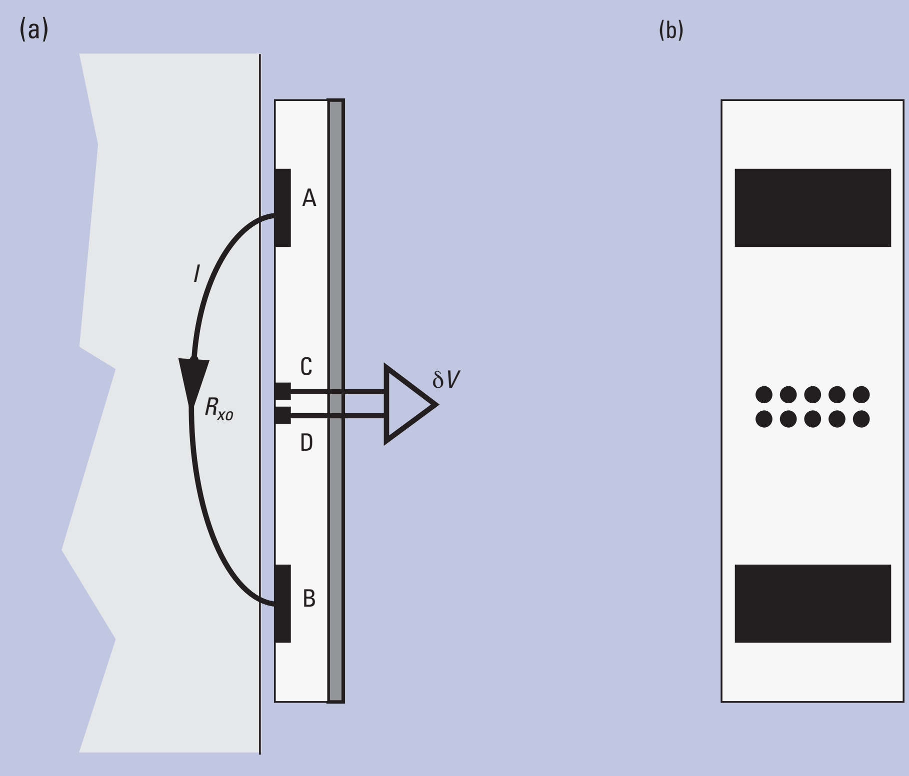
The measurement challenge

The increasing use of oil- and synthetic-base mud systems to limit drilling risks and improve efficiency poses many challenges for formation imaging. Even a thin film of nonconductive mud is essentially an opaque curtain, preventing conventional microresistivity imagers from measuring the formation. The presence of nonconductive mudcake or mud filtrate further complicates the situation. Oil-base mud can be displaced with water-base mud at considerable expense, but there is no guarantee that measurement will be possible. Addressing the need for images in this difficult environment clearly demanded a novel approach.

Uniquely engineered for oil-base mud

The solution for imaging in nonconductive muds pairs cutting-edge technology with a simple, time-honored principle of resistivity logging. While logging, the pads of the OBMI tool are applied against the borehole wall, where a thin layer of nonconductive mud is between the pad face and the formation. In accordance with the four-terminal or short-normal method of measuring resistivity, an alternating current is injected into the formation between the two electrodes at opposite ends of each pad. The unique electronics inside the OBMI pad and cartridge measure the potential difference between paired button electrodes at the center of the pad. From this value, the resistivity of the invaded zone R_{xo} in the small interval of the formation opposite the sensors is accurately and quantitatively calculated using Ohm's law.

Innovative OBMI technology extends microresistivity image logging to the nonconductive mud environment. (a) Profile of an OBMI pad applied to the borehole wall, with current I passing between the current electrodes A and B and measurement of the potential difference between the voltage electrodes C and D. (b) Five pairs of voltage electrodes on the OBMI pad face.



Each of the four pads acquires five measurements, and the data are displayed as a color image, oriented with respect to the geometry of the tool and borehole. Structural and stratigraphic features as small as 0.4 in. [1 cm] can be seen, yielding a wealth of high-resolution, azimuthal information unobtainable through conventional logging techniques. The resemblance of the OBMI image to whole-round core enables virtual visualization of the reservoir—a first for the nonconductive mud environment.

The OBMI tool has been validated in the field with more than 20 brands of diesel-, oil- and synthetic-base muds.

Engineered for efficiency

Making breakthrough measurements is but one benefit of the OBMI tool. The compact, integrated design and maximum logging speed of 3600 ft/hr ensure efficient wellsite rig-up and operation. The through-wired sonde enables running other services such as the UBI* Ultrasonic Borehole Imager below the OBMI tool on the same descent. To ensure high reliability, the OBMI tool is built to the same mechanical shock standards as the proven Platform Express* tools.

Clear dip and structure resolution

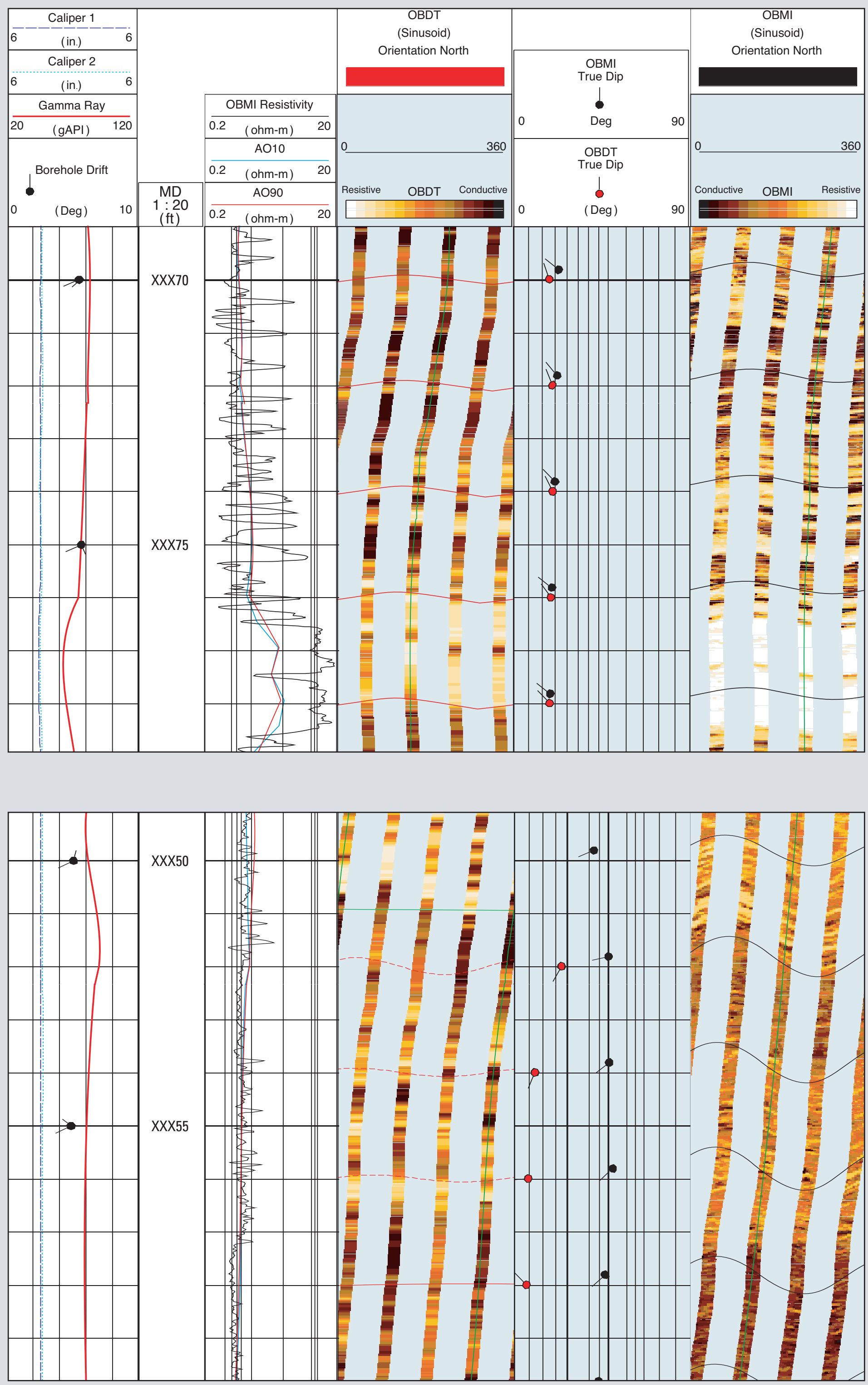
Comparison of OBMI images with an OBDT* Oil-Base Dipmeter Tool log acquired in the same well demonstrates the quantum leap in information for formation evaluation. In the example to the right, the value of the high-resolution OBMI image is readily apparent in resolving otherwise ambiguous dip and structural features.

In an interbedded, contrasting sequence of sand and shale, an automatic algorithm can accurately identify and compute the formation dip from both data sets. However, the OBDT tool measures one curve per pad at a resolution of about 2 in. The array of high-resolution sensors on each OBMI pad provides an image, and bedding and structure that are unresolved by the OBDT data are clearly visible.

In a shale formation that has little resistivity contrast, automatically computed dips are often in error, and it is necessary to resort to manual methods. Using dipmeter data, it is a challenge to determine the dip in this manner.

The sensitive response of the OBMI measurement and the image it provides enable manually picking dips with confidence. The OBMI data yield accurate dip in this formation even when processed by the automatic algorithm.

The OBMI image (far right track) is developed from five resistivity measurements per pad. OBDT data (center track) are displayed as a pseudoimage consisting of one data point per pad. OBDT-computed dips are plotted in red and OBMI dips in black for a sand/shale sequence (top) and low-contrast shale sequence (bottom).

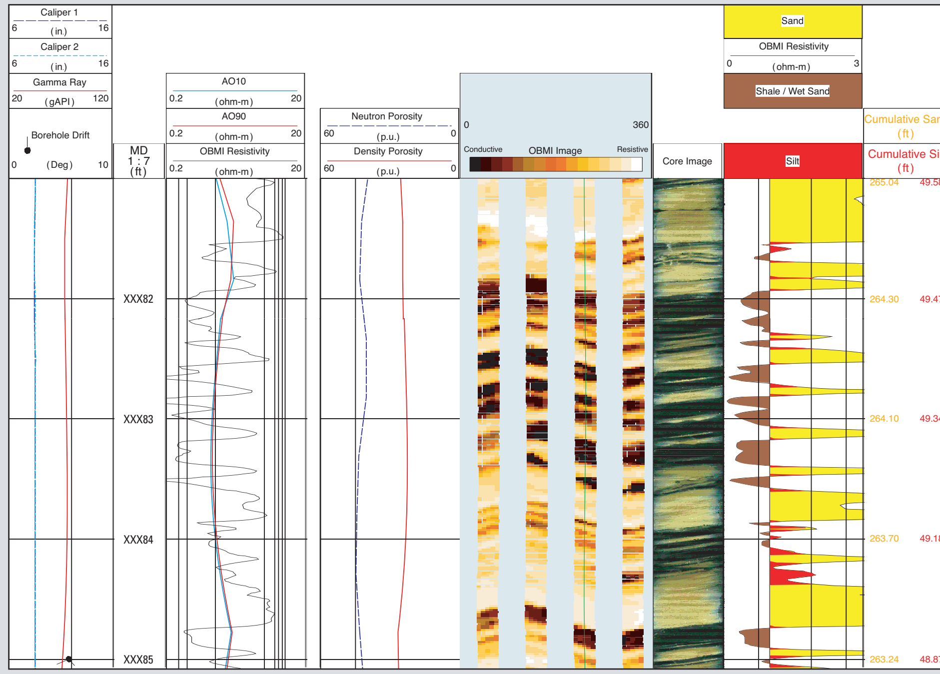


Deepwater answers in focus

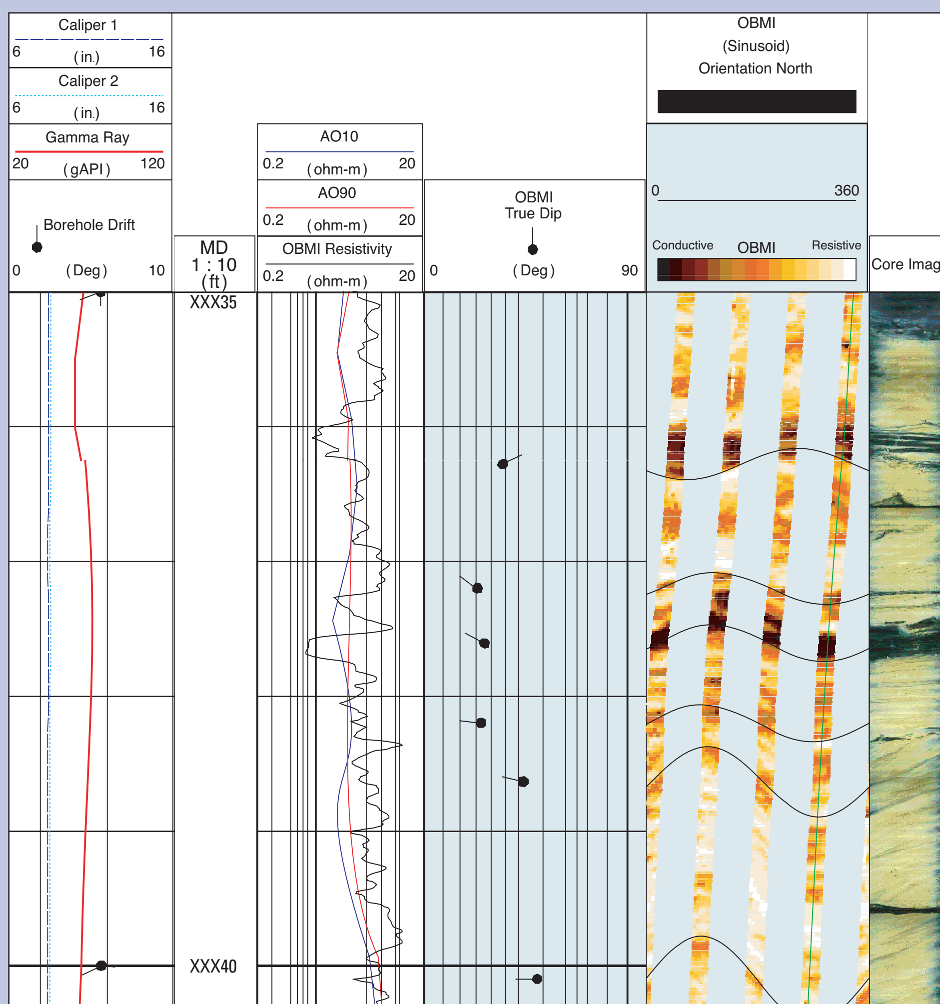
A Gulf of Mexico deepwater operator ran the OBMI tool in a partially cored appraisal well to more fully characterize the thinly bedded reservoir sediments and refine the net pay count. The OBMI image accurately reproduced the cored interval. An abrupt change in the core dip, previously thought to be coring induced, was demonstrated to be natural in origin by the image.

Stratigraphic analysis was successfully extended beyond the cored interval using the OBMI image. The OBMI R_{xo} data correlated well with grain-size information from sidewall cores. The resulting net pay count was increased by more than 50 ft from that determined by conventional log analysis.

OBMI images and quantitative R_{xo} measurement from a deepwater well in the Gulf of Mexico show an excellent match to the ultraviolet-light core photograph and conventional logs. Thresholds are applied to the OBMI R_{xo} data to calculate the net pay thickness in the far-right track.



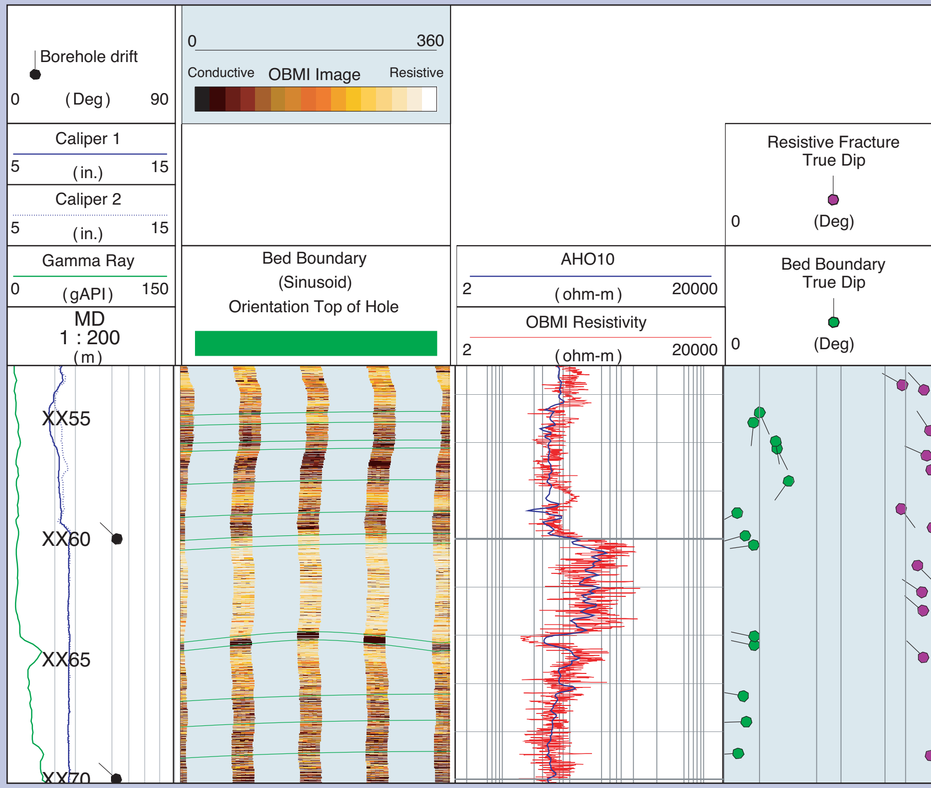
The OBMI image proved that the reversal in dip direction at XXX36.5 ft is a natural feature, not induced by twisting during the coring process.



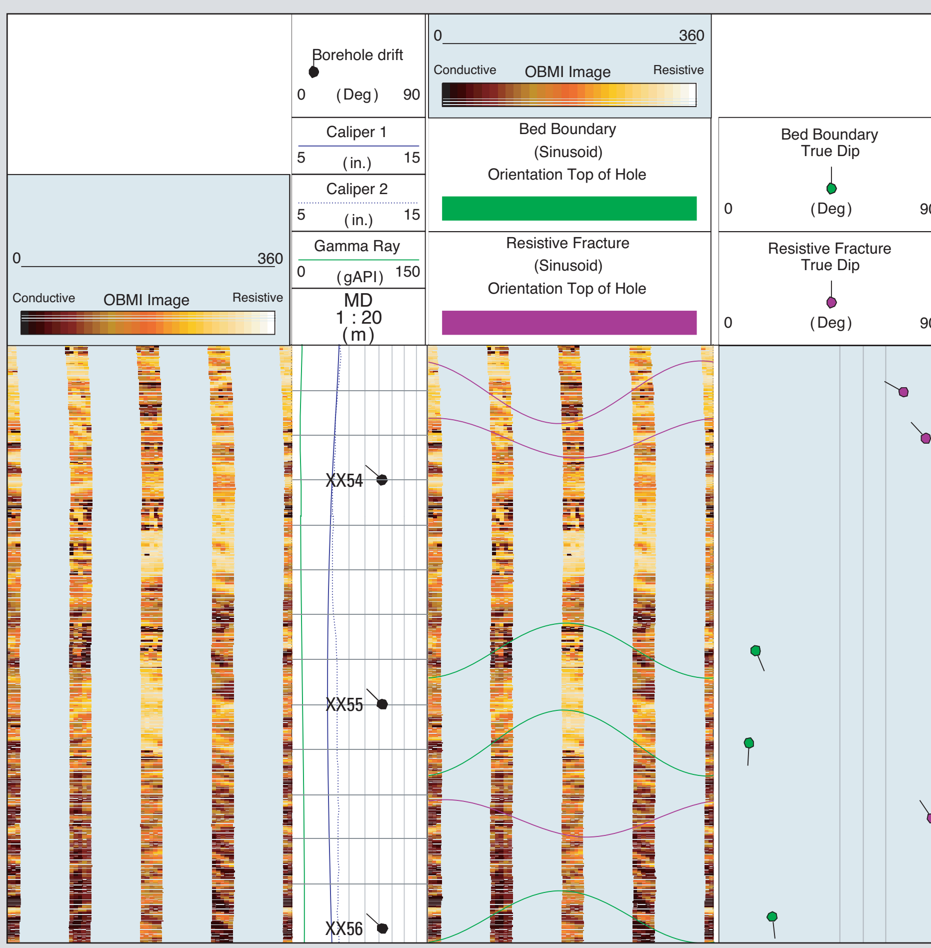
Insight to structurally complex settings

An operator in the Alberta Foothills, Canada, drilled a pilot hole for a horizontal well in a poorly bedded reef buildup. The lateral borehole was planned to follow the long axis of the reservoir to maximize the productive interval. The structural dip—too subtle for a dipmeter to determine—was clearly revealed in the OBMI image, confirming that the reservoir had been penetrated in the planned location. The image also confirmed the existence of fractures perpendicular to the planned lateral, a critical factor for maximizing productivity.

The OBMI image provides a structural overview of the bottom of a pilot hole for a horizontal well in the Alberta Foothills, confirming the target between XX52 and XX60 m. The accuracy of the OBMI R_{xo} measurement is verified by excellent correlation with the shallow AIT Array Induction Imager Tool log.*



Determining structural dip is challenging in reservoirs such as this massive reef because of the lack of clear bedding. The OBMI image enables handpicking the dip. A set of fractures (purple) could also be identified.



Customized image visualization

OMBI image logs are not static paper prints but an interactive, versatile data set for analysis with OBMI-Viewer software. The OBMI images are placed on a PC-compatible CD-ROM with the OBMI-Viewer set of stand-alone tools for image display and interpretation. The application is intuitively easy to use, with a Web-browser-styled interface and on-line help system. Changing the depth or color scale, manually picking dip and compiling a sand count are just some of the analyses quickly executed with a few clicks of the mouse. The interpreted images can also be printed.

You choose the mud—Schlumberger delivers the images

Whatever your choice of mud system, Schlumberger has a formation-imaging solution for your well.

In challenging environments, drill with the oil- or synthetic-base mud that provides the best drilling performance. Logging with the OBMI tool in nonconductive mud systems provides you with the insight that only a microresistivity imaging tool can deliver. High-resolution OBMI images help you limit risks without limiting your operational flexibility or the information needed for optimized decision making.

Tool Specifications

Length	17 ft
Weight	310 lbm
Max OD	5.75 in.
Max caliper	17.5 in.
Recommended hole size	7–16 in.
Max temperature	320°F [160°C]
Max pressure	20,000 psi
Conveyance	Wireline or TLC* Tough Logging Conditions system
Effective button size	0.4 in.
Effective resolution	1.2 in.
Depth of investigation	3.5 in.
Coverage in 8-in. hole	32%
Max logging speed	3600 ft/hr
Combinability	Top and bottom

OBMI Oil-Base MicroImager tool

www.slb.com/oilfield

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