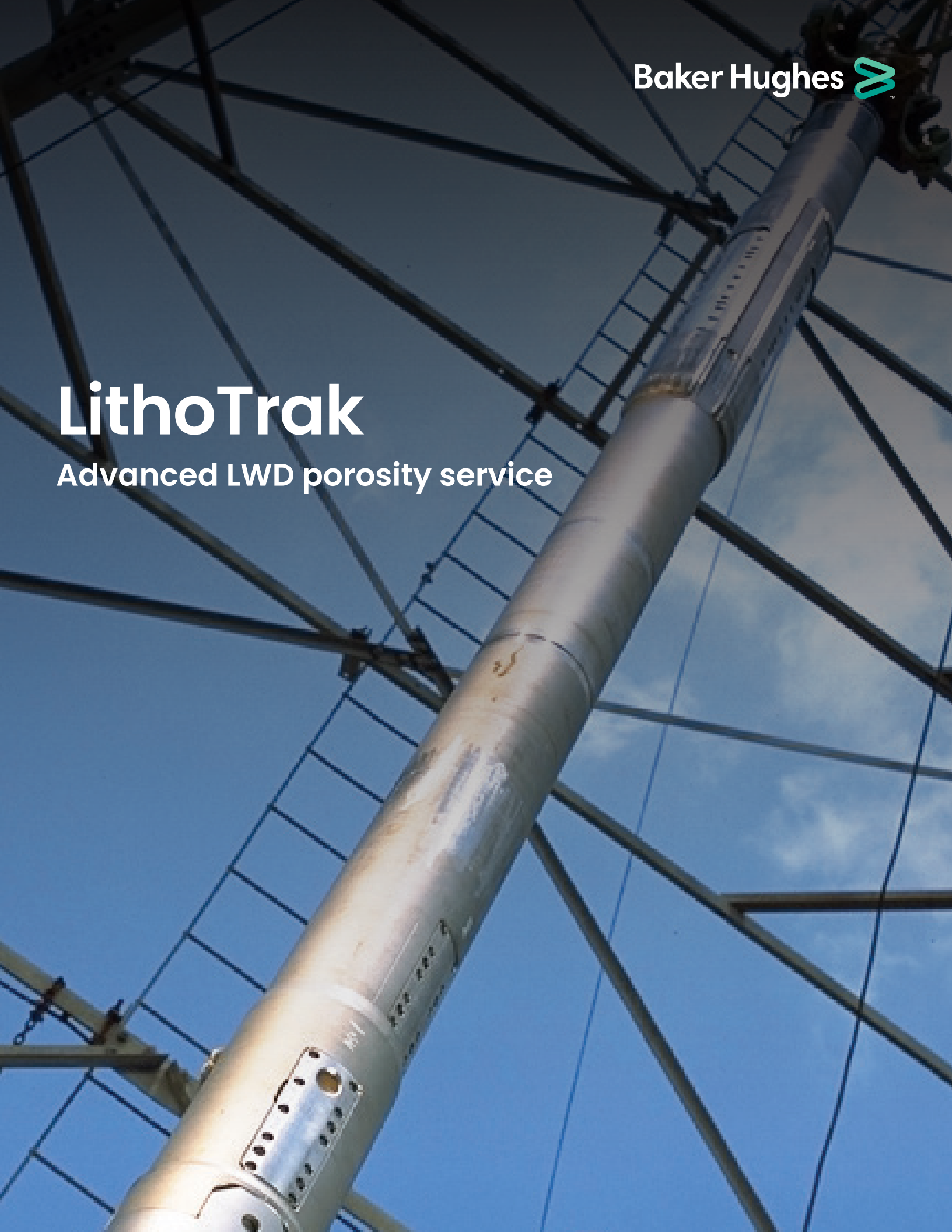


LithoTrak

Advanced LWD porosity service



LithoTrak advanced LWD porosity service

Formation density—porosity accuracy

Baker Hughes **LithoTrak™ advanced LWD porosity service** provides accurate, reliable and versatile nuclear porosity and formation density logs using an innovative downhole acquisition process. The service also provides azimuthally sectored density and photoelectric (Pe) images along with caliper measurements while drilling.

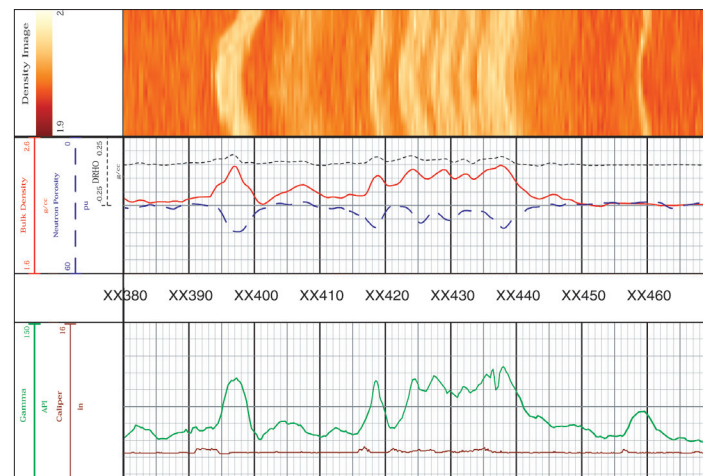
Versatility is engineered into the hardware with enhanced features to provide the industry's most flexible acquisition schemes. Each data point is tied to a corresponding caliper measurement, to ensure accurate density evaluation with minimal standoff effect. Caliper measurements are also used for neutron porosity compensation and accurate borehole profile for completion operations.

Azimuthal services available with the LithoTrak service include:

- Azimuthal imaging data for wellbore placement and positioning
- Azimuthal Pe available for open fracture identification
- Azimuthal caliper measurements for wellbore stability analysis

Superior LWD reliability and repeatability

The LithoTrak service's density measurement reliability separate it from other LWD porosity offerings. Tool design ensures more precise nuclear measurements, lowering the potential for standoff errors, such as those encountered by other logging techniques.

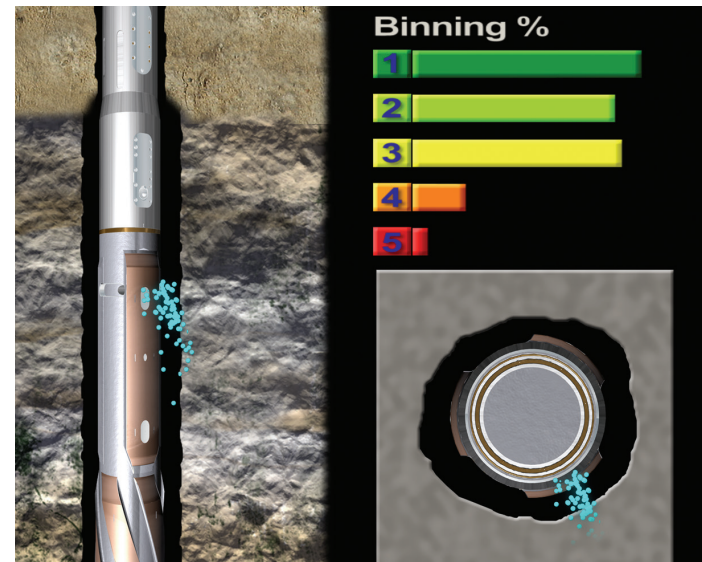


Imaging capabilities from the density measurements reduce the uncertainty in Reservoir Navigation modeling by tying discrete bed surfaces to geological models.

Enhanced reservoir navigation using precise, real-time porosity

The real-time value of formation evaluation is often proportional to the well profile's complexity. With today's

drilling programs frequently featuring multiple target zones (with each one adding to the well's potential uncertainty), the need for precise, real-time reservoir navigation data has never been more critical. When combined with potential fluid content and lithology identification, the LithoTrak service's accurate formation porosity permits operators to update their drilling plans in real-time. With the LithoTrak service, acquisition methods and data density can be optimized as needed to successfully complete various well sections with minimal uncertainty.



Proprietary standoff binning software integrates a direct measurement of standoff with each density sample to ensure measurements with minimal standoff are given preference ensuring more accurate and precise formation density measurement.

The value of LithoTrak data can be further enhanced through the integration of additional Baker Hughes LWD services. The combination of LithoTrak density and porosity data with Baker Hughes' superior **OnTrak™ integrated measurement while drilling (MWD) and logging while drilling (LWD) service** permits the calculation of high-accuracy saturation estimates while-drilling.

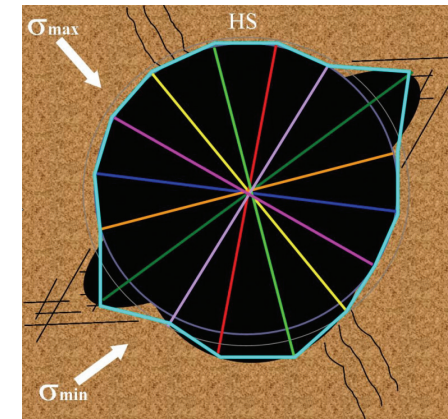
High resolution reservoir images

Because the BHA is rotating during acquisition, data are azimuthally referenced to provide a density image of the borehole. The LithoTrak service's 16-sector borehole image provides detailed information about the structural nature of the bed boundaries crossed. Real-time image data can be used to confirm or adjust wellpath trajectory in geosteering applications.

Enhanced wellbore stability

Reducing the assumptions present in the drilling process permit enhanced drilling hazard avoidance, improving safety and reducing wellsite non-productive time (NPT).

- The LithoTrak azimuthal caliper and imaging measurements provide enhanced representations of borehole shape that can be used to actively manage wellbore stability



In-situ stresses create breakout identifiable through azimuthal caliper and imaging.

- Time-lapse acquisition can help identify the location of increased cuttings, helping active equivalent circulating density (ECD) management in deep wells with dynamic pore pressure concerns

Accurate reservoir characterization

LithoTrak services improve reservoir characterization with:

- Accurate density measurements and Pe (Photoelectric) data to identify lithology
- Caliper measurements are used to identify breakout directions and to quantify proper environmental corrections
- Mechanical properties evaluation when integrated with **SoundTrak™ acoustic logging while drilling service**

LithoTrak service features can be employed in refining reservoir models with:



LithoTrak density images enhance reservoir navigation via the identification of dipping beds traversed while drilling—permitting refined well positioning for maximum productivity.

- High-resolution images for structural analysis
- Identification of thin sands and high-angle features
- Fracture detection through Pe images in weighted muds

Enhanced reservoir navigation

The LithoTrak service's azimuthal density data allows operators to update their reservoir models while drilling to refine wellbore positioning for maximum productivity.

LithoTrak service's real-time borehole images provide:

- Detailed geomechanical and structural information
- Early identification of the direction and the amount of bed dipping
- Enhanced reservoir navigation

Application summary

- Accurate, real-time quantification of porosity and gas identification for saturation calculations
- Reservoir Navigation using high-resolution imaging and gas—oil/water identification in real-time
- Wellbore stability analysis using azimuthal caliper and density imaging in real-time
- Structural formation dip analysis and updating reservoir models from density imaging
- Update seismic models with synthetic seismogram derived from density data and acoustic compressional data

Superior accuracy

- Flexible acquisition schemes to meet multiple needs and ensure superior data accuracy:
 - Standoff binning
 - Azimuthal sectoring
 - Density imaging
- Fast sampling rates:
 - Rapid data acquisition for high ROP applications
- Reliable acquisition:
 - All hole angle deviations
 - Managed standoff for long ERD intervals
 - Superior stabilizer protection
 - Protected detector section
 - Wear indicators
- High-quality data acquisition in various drilling situations:
 - Straight hole rotary
 - Steerable motors
 - Rotary steerable systems
- Reduced borehole corrections:
 - Optimized neutron design for accurate formation response

Real-time advantages

- Increased recovery from enhanced reservoir navigation
 - Azimuthal density data
 - High-resolution density and Pe images for structural confirmation
- Accurate, real-time density and neutron measurements:
 - Correlation to field marker zones
 - Early quantification of pay zones
- Superior safety in tight ECD environments
 - Reliable fluid content identification in high-permeability reservoirs
- Reduced risk with improved wellbore integrity evaluation
 - Azimuthal caliper data
 - High-resolution density
- Enhanced wellbore stability

