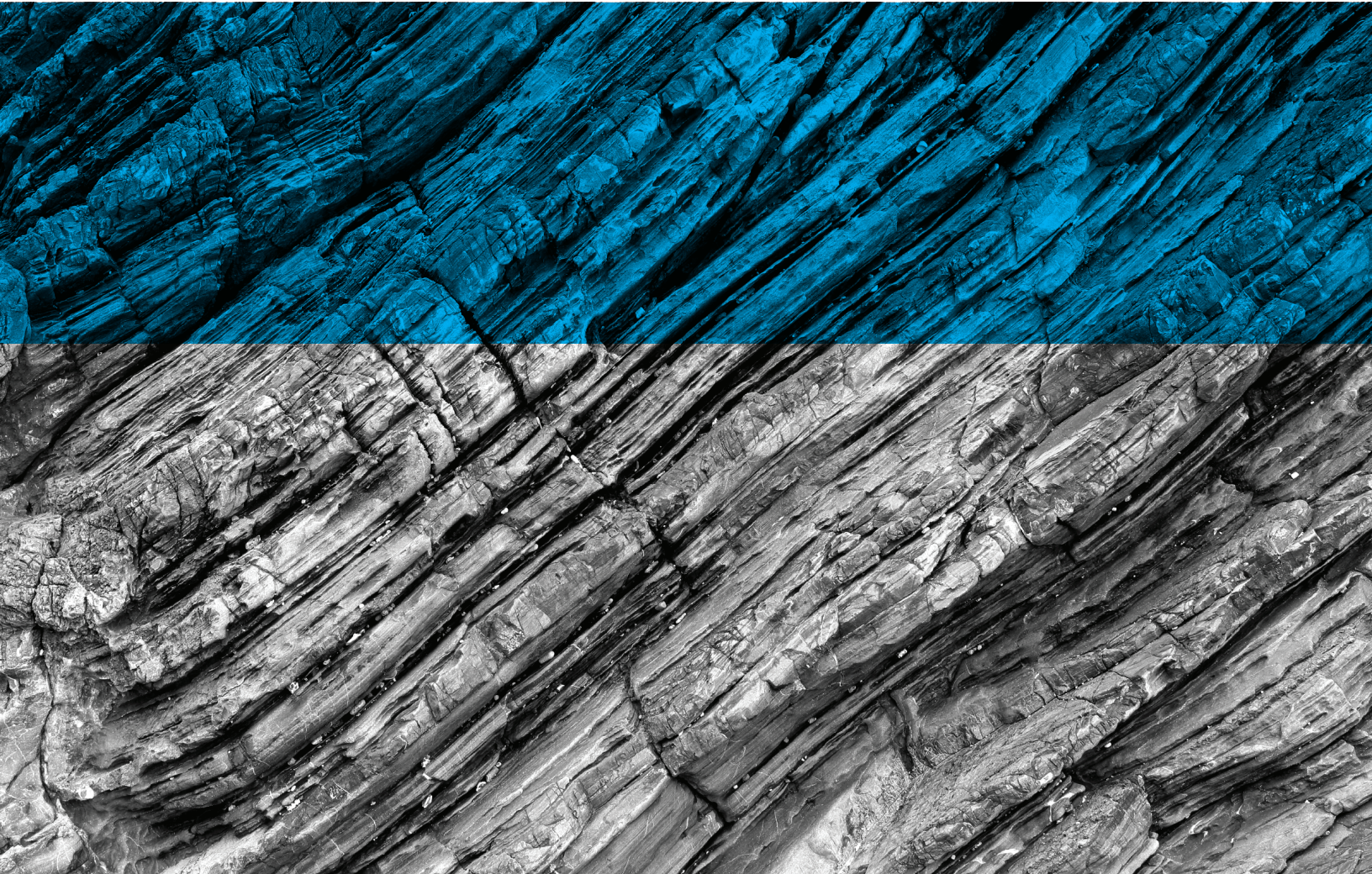




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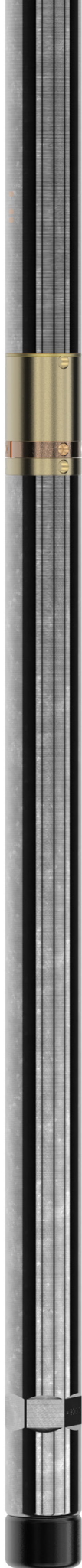
Casedhole Formation Evaluation Solutions

A Complete Approach to Advanced Reservoir Monitoring

To deliver top-tier reservoir performance, you have to understand reservoir fluids, the performance of the completion, and confirm the hydraulic integrity of the wellbore.

Getting that data isn't easy...

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Casedhole Formation Evaluation

Getting the data you need

The casedhole formation evaluation (FE) solutions suite is a group of cutting-edge casedhole logging tools that provide comprehensive data to drive reservoir performance. The suite is extremely versatile, and includes the Reservoir Analysis Sonde (RAS™), a pulsed-neutron tool that can be combined with production logging and well integrity tools to deliver just the right data for your objectives. The tools in the suite operate in either memory or surface-readout mode and can be conveyed using wireline, slickline, or tubing.

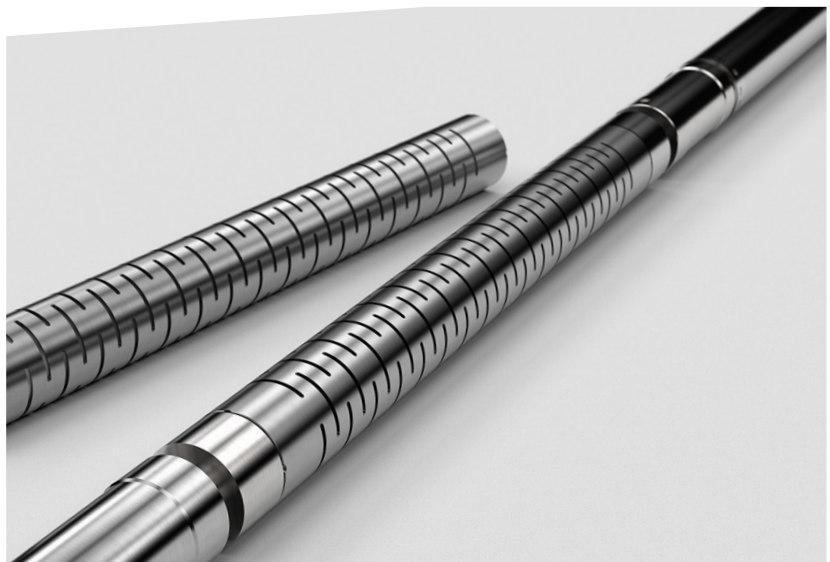
The casedhole formation evaluation solutions suite includes:

- Pulsed-neutron tool, which measures:
 - Oil, gas, and water content and flow
 - Rock porosity
 - Rock lithology using silica activation and spectroscopy
- Spectral gamma ray tool, which measures:
 - Potassium, uranium, and thorium in the rock
- Standard and array production logging tools:
 - Measure wellbore performance

Other combinable tools include:

- Well integrity suite, including the RADii® segmented bond log, MAC™, and iQ™ electro-magnetic thickness tools:
 - Enables better reservoir understanding

RADII®



RAS Applications:

- Reservoir monitoring challenges such as monitoring hydrocarbon levels, diagnosing high water production, and monitoring in waterfloods or carbon dioxide floods
- Harmonization of reservoir data in wellbores
- Production/injection profiling and performance analysis
- Completion effectiveness and wellbore integrity tests

The Pulsed-Neutron Tool

A Closer Look at the RAS

The backbone of the casedhole formation evaluation suite is the RAS, a proprietary 3-detector pulsed-neutron tool which uses sigma and carbon-oxygen (C/O) techniques to measure reservoir saturation.

The tool features an array of three gamma detectors. For sigma and C/O, the near and far detectors use a breakthrough material called lanthanum chloride (LaCl₃).

The gamma ray signals are then sorted by time and energy using high-speed digital spectrometers; in each pulsing mode, three 256-channel spectra are acquired.

The pulsed-neutron generator is extremely durable, and typically provides 1,000 hours of continuous run-time. It features a long-life neutron tube, stable electronics and output, precise pulse shape control, and a non-volatile recorder and hour meter.

In addition to the full-capability casedhole formation evaluation RAS, a RAS-S sigma-only tool is also available upon request.

RAS Specifications

Temperature rating	320°F (160°C)
Pressure rating	15,000 psi (103.4 MPa)
Diameter	(43mm)
Length	141-in. (3573mm)
Weight	44lb (20kg)
Measure point - Near	84-in. (2134mm)
Measure point - Far	91-in. (2311mm)
Measure point - Long	101-in.(2565mm)
Materials	Corrosion-resistant

Logging Specifications

Vertical Resolution	24-in. (610mm)
Max Logging Speed (sigma)	20-ft (6 m) /min
Max Logging Speed (C/O)	5-ft (1.5 m) /min
Depth of Investigation (sigma)*	9 to 12-in. (229 to 305 mm)
Depth of Investigation (C/O)*	5 to 6-in (127 to 152 mm)
Precision Sigma	<0.5 c.u.
Precision C/O Ratio**	5% of full scale

*depends on wellbore and porosity

**result with 5.5-in casing, 22 p.u. sandstone

Measurement Hardware Specifications

Source Type	14-MeV neutron generator
Near Detector	LaCl ₃ gamma ray
Far Detector	LaCl ₃ gamma ray
Long Detector	Nal gamma ray
Firing Rate (C/O mode)	30us pulse at 6.25 KHz
Firing Rate (sigma mode)	Typical: 200us pulse at 500 Hz

Advantages of LaCl₃ Material

- Similar density and C/O performance to sodium iodide, but with much faster emission and much better peak resolution
- Provides high-throughput and peak resolution regardless of temperature variations in the wellbore



SGRCL01™ ▲ SPECTRAL GAMMA RAY & CCL

Measurement Modes

- Sigma: water saturation detected via thermal neutron decay (optional gas detection from detector array)
- C/O: oil saturation detected with gamma spectroscopy
- Water flow: water velocity from oxygen activation
- GasPhi: measures gas saturation from the detector array

RAS Features

- 3-detector array that includes time and energy spectra
- High-resolution LaCl₃ detectors
- Advanced calibration mechanisms to ensure accuracy
- Fully combinable with other Probe Formation Evaluation, Well Integrity, and Production Logging solutions tools.



Reservoir insight drives asset performance.

And with our rigorous product testing, unbeatable customer service, and world-class geoscience support, you can provide both.



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INTEGRITY



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PRODUCTION
LOGGING



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INTERVENTION



SURFACE
SYSTEMS



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