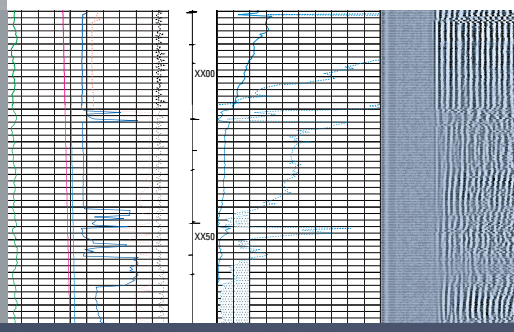
Schlumberger

Memory Slim Cement Bond Logging Tool



Through-tubing cement bond logging

Applications

- Evaluation of circumferential cement bond between casing and formation
- Free-pipe and free-casing indication without need for surface torque application
- Estimation of cement compressive strength

Benefits

- Efficiency of cementing operation confirmed through tubing
- No need to pull tubing
- Tool conveyance flexibility
- Surface-readout systems not required
- Fast, easy, economical operation

Features

- Compact 1 11/16-in. logging platform with simultaneous recording of gamma ray, casing collar location, pressure, temperature, and waveforms
- Can be run in 2 7/8- to 7 5/8-in. casing
- Full waveform digitization downhole
- Cement bond log values corrected for pipe size and weight, temperature, and fluid properties
- Conformance to rigorous Schlumberger logging-while-drilling-tool shock specifications
- Resistance to corrosion
- Processing identical to electric-line-conveyed surface-readout service
- Multiple data output and interpretation formats
- Integrated collapsible tool centralization
- Over 40 hr of combined tool running time possible
- Over 16 hr of continual waveform recording time available
- Suitable for logistically challenging operations

Through-tubing cement evaluation

The memory slim cement bond logging tool provides 3-ft cement bond log (CBL) and 5-ft Variable Density* log measurements. Because of its slim size (1 11/16 in.), the tool can be run into the zone of interest without removing the tubing from the well. All measurements are recorded from a single pass. The memory slim CBL tool can be run with other memory PS Platform* production logging tools for complete well and reservoir evaluation in one descent.

The principal application of the tool is to provide an evaluation of cement quality and integrity around the casing. This information can be used to ascertain cement quality and devise solutions, such as cement-squeeze programs, when necessary.

Fast, highly efficient operation

This memory tool service delivers cement bond and Variable Density logs of the same accuracy and quality as those from surface-readout logging configurations when logistical, operational, or downhole constraints prevent use of the surface-readout system.

The compact size and portability of the memory slim CBL package facilitate rapid deployment. One Schlumberger engineer can quickly set up all equipment required for the job. All tools are certified as transportable by passenger aircraft.

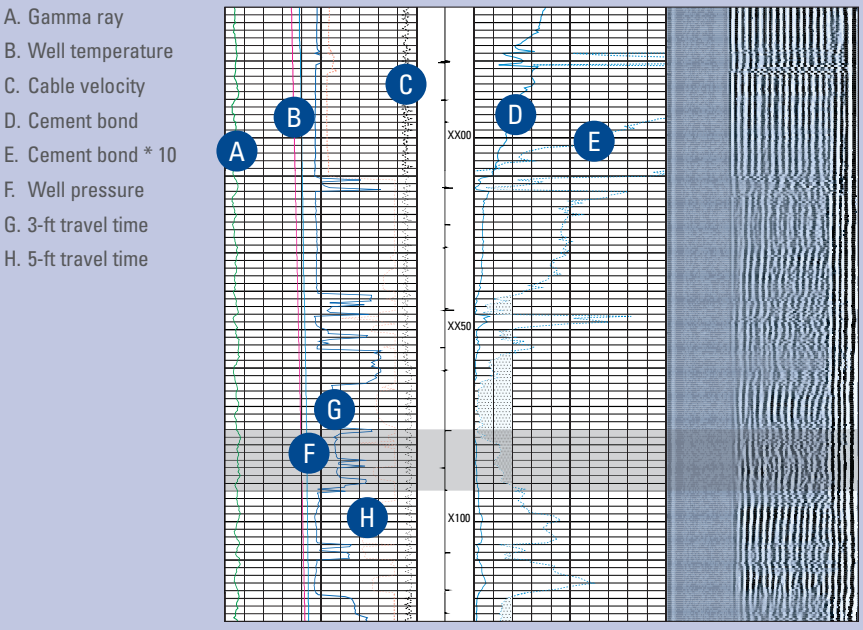
Tools and sensors can be conveyed in the borehole by drillpipe, coiled tubing, slickline, or unintelligent tractor. A standard 15/16-in. sucker-rod connection provides a crossover between the tools and conveyance system.

Flexibility and reliability

The portable surface system is designed for maximum flexibility. Using a surface-system computer and software, the Schlumberger wellsite engineer programs the tool to acquire the required data series. Waveforms are fully digitized downhole; PS Platform software performs onsite data processing—or postprocessing when necessary—and prepares the log presentation.

Depth-recording systems are available for both hazardous and nonhazardous environments. Optional external sensors enable recording of cable and line tension or surface pressure. The

The standard presentation shows correlation curves and travel times in Track 1, 3-ft CBL curves in Track 2, and a 5-ft Variable Density log display in Track 3. Good bonding is represented by the shaded area (XX76 ft to XX92 ft).



combination of leading-edge technology in the surface system and the advanced downhole instruments provides memory production logging data that are indistinguishable from data acquired in surface-readout operations.

Cement bond logging technology

Acoustic waves emitted by the tool transmitter travel different paths to the receivers. The waveform obtained at the receiver is a conglomerate of the arrivals from each path. Sound travels fastest through solid materials, so the first arrival is usually the sonic wave traveling outward from the transmitter, through the borehole fluid, up the casing, into the borehole, and to the receiver.

The CBL measurement is the amplitude of the casing first arrival (E1) at the 3-ft receiver. E1 is a function of the attenuation caused by the shear coupling of the cement sheath to the casing. The attenuation rate depends on the cement compressive strength, cement thickness, casing diameter, pipe thickness, and percentage of bonded circumference.

The longer 5-ft spacing is used to record the Variable Density waveform for better discrimination between casing and formation arrivals. The Variable Density log is generally used to qualitatively assess the cement-to-formation bond, and it helps detect gas.

In fast formations, sound travels faster through the formation than it does through the casing. The amplitude of a first arrival will reflect losses incurred while traveling through the casing and borehole fluid.

The next arrivals will usually be sound waves traveling through the formation rock to the receiver. The amount of fluid or gas behind the pipe affects whether formation arrivals will be seen at all in the waveform.

The importance of cement evaluation

It is imperative that every well with hydrocarbon production potential be properly cemented to hydraulically isolate the zone of interest. In the ideal case, good cement-to-casing and cement-to-formation bonds will exist throughout the perforated zones so that there is no hydraulic communication between the zone of interest and other zones.

Broadly speaking, there are two primary causes for poor cement jobs.

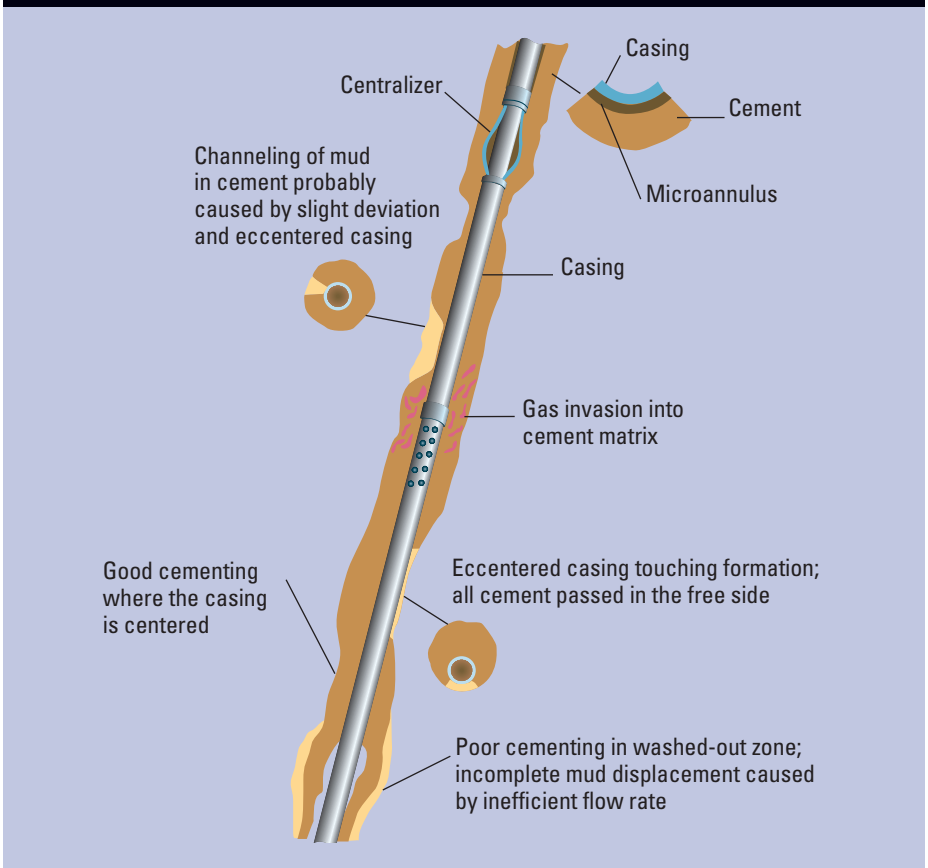
- Flow problems of mechanical origin, such as poorly centralized pipes in deviated wells, washed-out boreholes, inefficient preflushing, and incorrect flow regimes, lead to incomplete mud removal in the cement annulus.
- Degradation of the cement slurry during the curing stage is caused by a difference between the cement pore pressure and the formation pressure. When a standard cement dehydrates and starts shrinking and the pore pressure becomes less than the formation pressure, the cement quality can be degraded by formation fluids or, even worse, by inflow of gas.

Laboratory measurements have shown that a typical well-cured cement has a permeability of approximately 0.001 mD, with a pore size less than 2μ and porosity around 35%. However, when gas migrates within the slurry before it is completely cured, the pore structure is partially destroyed, and the gas can generate a network of tubular pores that reach 0.1 mm in diameter and lead to permeabilities as high as 1 to 5 mD. This compromised cement can support the casing, but it is unable to prevent migration of gas from the formation. Additives are available to prevent this migration and ensure zonal isolation of gas-bearing intervals.

A comprehensive cement evaluation program can determine the quality of the cementing operation or the need for repair, as well as the cause of failures, so that the cementing program can be improved for future wells.

CBLs—especially those able to identify cement channels—can distinguish zones that are properly isolated.

Cement slurry displacement problems.



One-trip cement evaluation and production logging in a deviated well

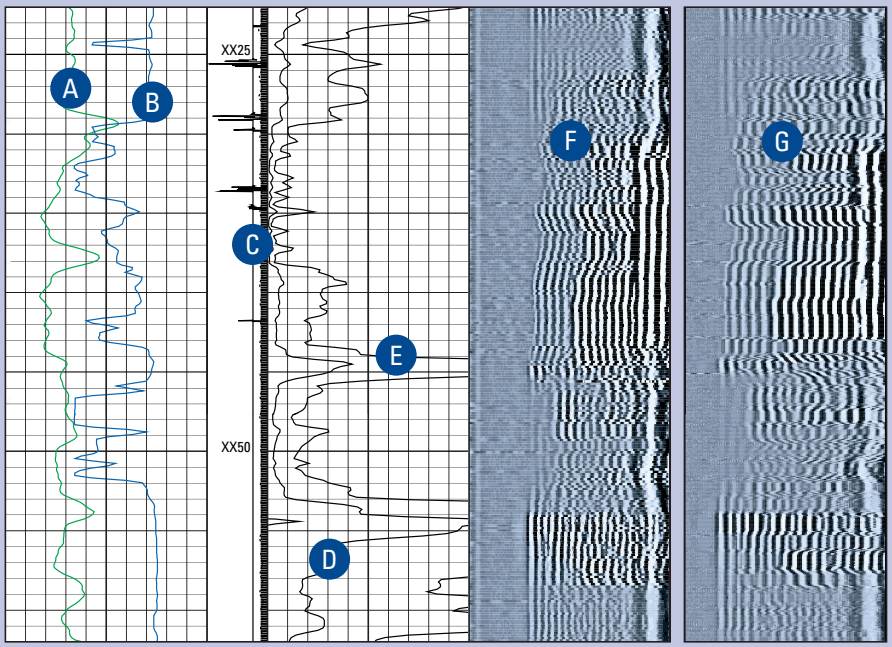
Running a PS Platform service in the string below the memory slim CBL tool in West Africa saved significant time and expense, while providing high-quality data.

Memory slim CBL tool.

Water production from a well had increased to 97%, and cement evaluation was specified to determine whether the upper two producing zones were effectively isolated from a wet interval in a lower formation. The temperature readings and CBL confirmed that most of the water being produced was flowing behind the casing from a lower zone to the upper zones.

The lower zone was perforated using the eFire-Slickline* electronic firing head system and was sealed with a cement squeeze. Water cut measured at the surface was reduced from 97% to 15%.

The Variable Density log service deployment on coiled tubing (A-F) delivered time and cost savings along with surface-readout-quality data (G). Both logs identify poor cement quality at XX54–XX57.



A. Gamma ray
B. Travel time
C. Casing collar locator
D. 3-ft CBL
E. 3-ft CBL * 5
F. Initial memory Variable Density log
G. Subsequent surface-readout Variable Density log

Memory Slim Cement Bond Logging Tool Specifications

Max. operating temperature	300°F [150°C]
Max. pressure	15,000 psi [103.4 MPa]
Length	23.4375 ft [7.15 m]
Weight	100.2 lbm [45.45 kg]
Casing sizes	2⅞–7⅝ in.
Tool OD	1.6875 in. [43 mm]

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