**Case study**: Asia

# INTeX cement service ensured casing cut depth in P&A operation

One common challenge in plug and abandonment operations is accurately assessing the condition of the cement sheath behind casing and determining the cement top as well as the solids' top depth, which can be different from the cement top.

Successful determination of solids' condition behind casing is critical to determine the depth above which to cut the casing. Often when the casing cut is made just above the top of the cement (TOC), the casing cannot be pulled out because of barite sag creating suction on the casing, holding it back in the opposing direction. Barite and other solids sag forms as the common drilling mud additive settles above the TOC over many years of the well's life.

Using traditional cement evaluation technology, detecting solids above the original TOC can make it difficult to accurately determine the casing cut depth.

A major operator in Asia wanted to perform a cut and pull operation on 7-in. casing and was concerned about the risks associated with barite/solids sag above the original TOC.

The operator's objectives were to:

- Confirm the TOC inferred from a 1979 cement bond log (CBL)
- Verify the quality of cement behind the 7-in. casing
- Establish a cement/solids free point for cutting and pulling the 7-in. casing

The candidate well was completed in the early 1960's as an oil producer and was eventually shut in in the mid 2000's due to high water cut. The wellbore is vertical with a maximum deviation estimated at 1.5°. A Portland-based class G cement with a density of 15.3 ppg (1830 kg/m$^3$) was used to cement the 7-in. OD, 26 lbs/ft weight casing. A 1979 CBL showed the TOC behind the 7-in. casing to be at the depth of X450 ft (X37 m). (Fig.1).

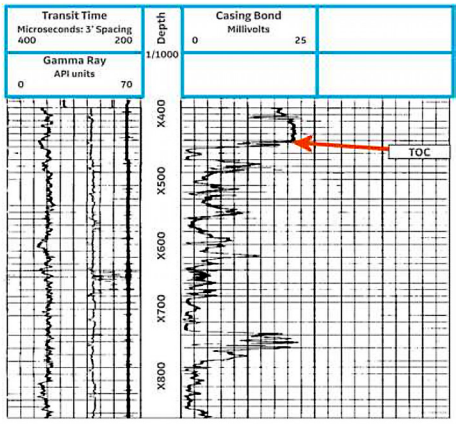


**Fig. 1:** Original 1979 CBL log shows TOC detected around X450 ft

A Wireline team from Baker Hughes recommended a solution centered around the innovative **Integrity™ eXplorer (INTeX) cement service**, which identifies solids bonded to casing through the attenuation of shear acoustic waves that can travel only through a solid medium. To address these objectives beyond any uncertainty, Baker Hughes recommended a logging suite comprising the INTeX service,

## Challenges

- Casing cut depth
- Detection of solids behind casing (bonded and microannulus)

## Results

- Accurately determined casing cut depth
- Confirmed original TOC
- Detected solids/barite particles settled above original TOC
- Successfully evaluated cement quality across depleted reservoirs
- Saved approximately two days in rig time and other associated costs

segmented bond tool (SBT), variable density log (VDL), gamma ray (GR), and casing collar locator (CCL).

The results of the analysis are shown in Fig. 2 and Fig. 3 across the upper and lower sections of the well, respectively. These results are purposely simplified and presented as a gas-liquid-solidsmicroannulus (GLSM) map to help interpret and remove all ambiguities. From the results of the analysis presented in Fig. 2 across the upper section of the well, there is a distinctive change of cement/solids condition at X440 ft (X34 m), which confirms the original TOC from the 1979 CBL log.

Consistent with the operator's prediction, there is clear evidence of solids particles (bonded and microannulus) deposited above the original TOC. During the 38 years of existence, solids from the mud left above the TOC had settled above the cement.

Even though the original TOC was confirmed around the depth of X440 ft the solid top extends to the depth of X340 ft (X04 m). Cutting the casing immediately above TOC can therefore be risky since the settled solids can prevent the casing to be pulled, especially in barite mud.

The results of the analysis presented in Fig. 3 across the lower section of the well shows good cement coverage over many intervals. Some microannulus and fluid filled channels were detected, but overall the lower section of the well showed good circumferential cement coverage reported by the INTeX service. This was confirmed by two independent measurements, the CBL (low amplitude) and VDL (no casing arrivals and strong formation arrivals).

Baker Hughes recommended cutting the casing  at a depth not to exceed X340 ft. The operator successfully pulled and retrieved the casing on the first attempt, avoiding downtime and additional costs associated with repeated cut and pulls. Estimated savings in rig time and other associated costs was two days.

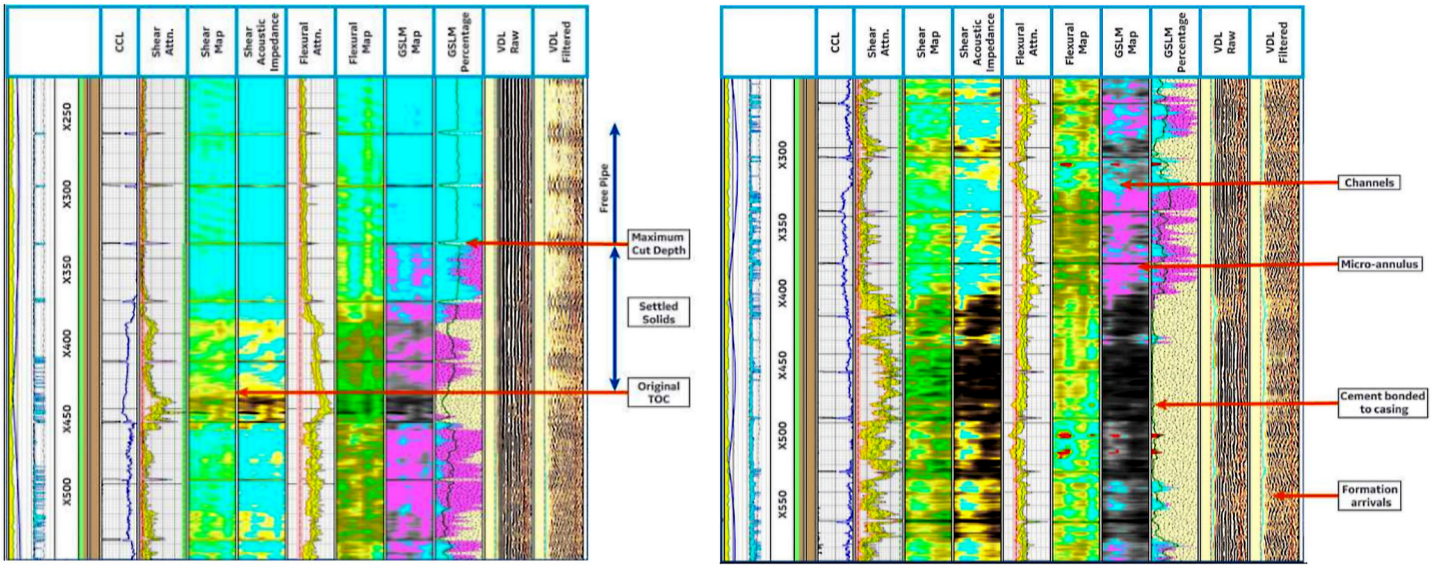


**Fig. 2** (left) Shear and flexural cement analysis results across the upper section. Original TOC from the 1979 CBL is clearly visible around the depth of X440 ft. Over the 38 years of existence, some solids have settled above the original TOC. The top of settled solids is determined to be at X340 ft and this is also the maximum recommended casing cutting depth. **Fig. 3** (right) Shear and flexural cement analysis results across the lower section shows some microannulus (solids/cement) and random channeling, however overall good circumferential cement coverage around the 7-in. casing. This result was confirmed by two other independent measurements—VDL and CBL (green curve in the GSLM percentage track).

Baker Hughes