

Case study: Casanare, Colombia

NANOSHIELD sealing nanotechnology enhanced CARBO-DRILL system, provided wellbore stability for drilling complex well

The foothills of Colombia’s Llanos basin, which lie next to the eastern range of the Andes Mountains in Casanare Department, is a well-known, highly complex area in terms of geology. It is characterized by a high-tectonic environment of interbedded coal, shale, and sandstone structurally repeated (sometimes even inverted) and formations with high dips geomechanically unfavorable by the attack angle. Drilling projects present significant operational challenges in this particular area of the world. Formation instability has proven to be one of the biggest challenges when drilling the overburden sections, with

tight-hole and pack-off events being common problems.

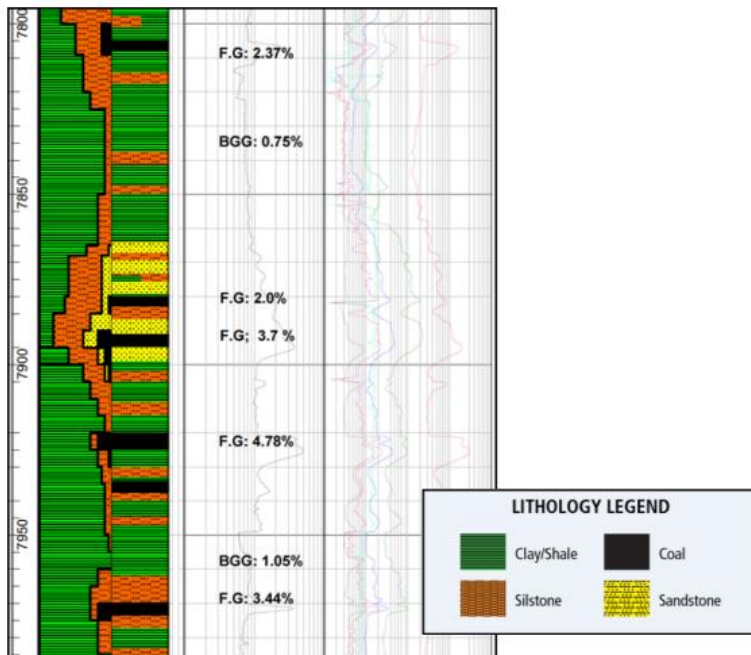
Recently, a major operator using a bundled service contract provided by a competitor experienced severe issues with the competitor’s fluids system. Several coal and shale instability issues had led to two directional tools being left in hole, three failed sidetrack attempts, a significant amount of nonproductive time, and several overcosts to the point of jeopardizing completion of the well. In total, the operator had spent approximately USD 17 million on the exploratory well, USD 1 million in fluids alone.

Challenges

- Highly complex geological area
- Interbedded coal, shale, and sandstone in the same section
- Operation problems due to hole instability
- NPT and high operational costs

Results

- Improved wellbore stability, enabling successful drilling, tripping, and casing the 14 3/4-in. section to 10,350 ft (3,155 m) planned depth on first attempt
- Displaced incumbent drilling fluids provider



Lithologic sequence of the well showing clay/shale, sandstone, coal, and silstone intercalations

As a part of the operator's "last chance plan" to successfully drill and case the overburden section, Baker Hughes worked with the operator on a solution to overcome the problems related to hole stability in a high-tectonism environment with coal, shale, and sandstone intercalations.

Based on laboratory tests supervised by operator representatives, Baker Hughes designed a **CARBO-DRILL™ invert emulsion system** enhanced with advanced nanotechnology. The **NANOSHIELD™ wellbore sealing polymer** improves wellbore stability and hole quality, while maintaining more stable fluid properties. Baker Hughes also committed to providing superior technical support during operations.

Baker Hughes has been applying nanotechnology in the challenging Colombian foothills dating back to

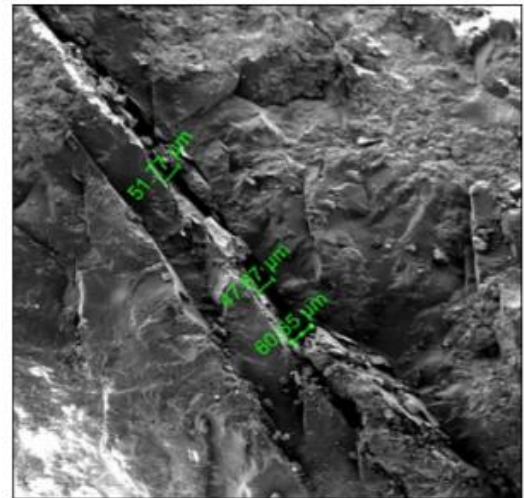
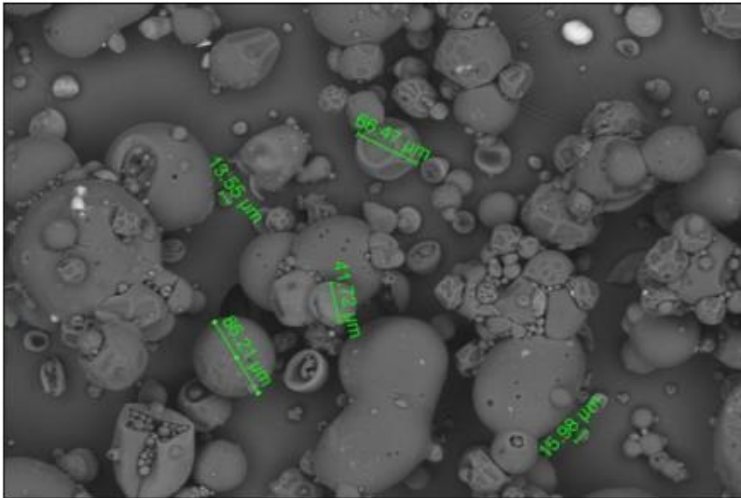
2013 in wells up to 20,000 ft (6,096 m) deep. The NANOSHIELD sealant for extreme wellbore stability has been the major differentiator, providing borehole stability by its nature to deform and seal microfractures found in coal and shale interlayers.

The Baker Hughes solution also included feeding data analysis from offset wells into its **BRIDGEWISE™ engineering software** to formulate the best product combination to develop an effective strategy to seal coal bed microfractures and improve wellbore strengthening. The sealing strategy also included **LC LUBE™ sized, synthetic graphite; CARBO-TROL™ filtration control additive** to help seal pores, bedding planes, and microfractures in the formation and filter cake; **ECCO-BLOK™ water-dispersible natural resinous material** for shale stabilization; and calcium carbonate in different sizes.

Once the competitor's drilling fluid was displaced and the drilling practices used in the previous attempts were evaluated, Baker Hughes intervened as the fluids solutions provider. The operator saw outstanding results, including drilling to deeper depths (section TD of 10,350 ft [3,155 m] compared with the original well of 7,180 ft [2,188 m]), successful trips in and out of the well, and satisfactory running casing to the planned depth.

The CARBO-DRILL system enhanced with NANOSHIELD sealant provided the expected coal and shale stability in this challenging well.

Following the success of this intelligent fluids solution, the operator assigned Baker Hughes as the fluids provider for the remaining well sections and has recently confirmed Baker Hughes for an upcoming drilling fluids project (originally assigned to the competitor).



Photos taken with Baker Hughes Bogota scanning electron microscope show NANOSHIELD sealing polymer (left), and fracture width measurements of coal samples from the well.