Oil giant overcame salt structure and saved $10 million with look-ahead borehole seismic

Halliburton provided the information this Latin American oil company needed to continue drilling a well it was ready to abandon.

**OVERVIEW**

On a new well, in the last section before the reservoir, this operator hit an unexpected salt layer it couldn’t see with conventional surface seismic. After drilling through 30 meters of salt, with no end in sight, the company considered abandoning the well, but wanted a technique to image below total depth before doing so.

Halliburton urged the operator to consider an innovative look-ahead VSP technique – a first for this area. Look-ahead VSP would allow the operator to image the base of salt to determine its depth. Halliburton processed the data overnight and determined that the company was only 150 meters away from exiting the salt and hitting the reservoir. With that information and renewed confidence, the operator decided to continue drilling – and found the base of salt just one meter away from Halliburton’s prediction.

The operator also used Halliburton’s borehole seismic data to plan the next well locations. The success of the project led the company to award Halliburton five additional wells.

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<th>CHALLENGE</th>
<th>SOLUTION</th>
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<td><strong>Exhausted drilling budget</strong></td>
<td><strong>Usable data overnight</strong></td>
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<td>The company had exhausted its allotted budget for this well and saw no end in sight to the salt they were drilling through. They had to decide whether to continue drilling through the salt with no clear goal or walk away from the well.</td>
<td>Halliburton performed the VSP survey in 18 hours and worked overnight to process it. Based on the resulting information, the company saved the well and avoided spending millions of dollars on a new well.</td>
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<td><strong>Data accuracy</strong></td>
<td><strong>Advanced imaging</strong></td>
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<td>Poor reflectivity between the carbonate host rock and the base of salt made interpreting the seismic very difficult. The operator could not determine the salt’s thickness and needed a better image of the base of salt.</td>
<td>Halliburton incorporated advanced processing techniques to provide high-resolution images. This enabled Halliburton to identify the base of salt reflector and the top of the reservoir. The operator reached the bottom of the salt in 149 meters – just one meter short of the 150-meter prediction.</td>
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<td><strong>Drilling through salt</strong></td>
<td><strong>Optimized drilling performance</strong></td>
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<td>Drilling salt structures presents many technical challenges. Salt can make pore pressure and fracture gradient below it unpredictable. It also has a tendency to shift during drilling. This required the operator to modify well designs and drilling processes.</td>
<td>Halliburton reduced the risk of drilling through salt by identifying and predicting the base of salt, as well as providing indicators of pore pressure ahead of the bit. This data helped the operator apply safe mud weights and exit the salt structure with minimal risk.</td>
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A CASE STUDY: Look-ahead vertical seismic profile (VSP) saved $10 million well

5,573m TD

Halliburton acquired the borehole seismic data in just 18 hours and processed it overnight to provide an accurate base of salt prediction.

185-meter salt structure

Operators successfully saved the well by continuing to drill through the salt structure based on Halliburton’s salt-exit prediction and tapped into the reservoir.

$10,000 VSP investment

The VSP cost approximately $100,000, but saved the company $10 million.

$10 million well

Halliburton’s borehole seismic accurately predicted the base of the salt layer within one meter.

Solving challenges™
Halliburton provided the information this Latin American oil company needed to continue drilling a well it was ready to abandon

**Unforeseen salt structure threatened well**
The operator had drilled a well more than 5,500 meters in a carbonate section, when they struck unexpected salt. Due to poor resolution and lack of reflectivity between carbonates and salt – which obscured the salt’s boundaries – they couldn’t determine the base of salt from the original surface seismic survey.

Drilling through salt is expensive and risky so the company had to decide whether to continue drilling or abandon the well.

**Innovative look-ahead-of-the-bit technology**
Before abandoning the well, Halliburton recommended an innovative zero-offset VSP survey to estimate depth-to-drill ahead of the bit, which was a first for the area. The look-ahead VSP survey provides accurate time/depth information and a true seismic image at the wellbore. This technique enabled the operator to “look” hundreds of meters ahead of the bit and discover the depth of the salt structure and top of the reservoir. With this knowledge, they could make an informed decision.

**Integrated Halliburton teams delivered data overnight**
Because of the stand-by rates for an expensive rig, Halliburton had to provide its depth prediction as soon as possible.

Halliburton mobilized the necessary equipment to the rigsite and acquired the borehole seismic data in just 18 hours. Then, Halliburton delivered the data to the nearest processing center more than 40 kilometers away. There, analysts worked overnight to process the data and provide a recommendation to the operator in the morning.

**High-resolution images showed critical formation information**
The high-resolution VSP images clearly illuminated the details of the base of salt as well as the target reservoir. Halliburton identified both the base of salt and the top of reservoir reflectors and estimated that the base of the salt was 150 meters below the bit. The company decided to continue drilling the well.
Halliburton provided the information this Latin American oil company needed to continue drilling a well it was ready to abandon

The operator modified well design and drilling parameters
Salt tends to move during drilling and pore pressures directly beneath salt can be unpredictable, creating a risky environment. The data acquired from the look-ahead VSP survey helped the operator minimize these risks while drilling through the salt.

Halliburton also used information obtained from the VSP to help estimate the subsalt pore pressure. The company updated the well plan, drilling parameters and drilling fluids accordingly.

$100,000 VSP saved $10 million investment
The operator safely exited the salt formation and tapped into the reservoir in 149 meters – just one meter away from Halliburton’s prediction. The accurate interpretation helped the operator save the well. The company saved its investment of close to $10 million in well costs by spending $100,000 on a last-minute VSP.

Company awarded Halliburton five additional wells
Due to the success of the project, the company awarded Halliburton with five more wells in the region.

Now Halliburton is applying the same technique to help operators in Brazil overcome similar salt challenges.