HOLE ENLARGEMENT TOOL APPLIED IN SOUTHERN ARGENTINA SAVES MORE THAN 10 HOURS IN COMPLETION OF CONVENTIONAL WELL FOR MATURE FIELDS

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Abstract

Drilling on mature fields presents technical challenges that requires innovate approach to maximize efficiency. At Southern Argentina, one of these challenges, normally associated with near depleted fields are circulation losses, that along with presence of reactive clays; produce hole swelling, leading to additional set-up operations for hole conditioning that increases completion's time, thus having a negative impact on costs and production rate; in addition of poor data acquisition from logging.

The project stated in this document shares how hole enlargement tools are applied in these wells to be able to drill at a larger outer diameter, offering an increased annular clearance window. This application reduces the need of additional wiper trips and set-up trips, hence offering the opportunity of optimizing completion times and improves the quality of data acquisition from wireline tools, without changing the current well casing architecture for both surface and production sections.

After conducting an analysis that evaluates the lithological and drilling environment; an integral hole enlargement polycrystalline diamond cutter (PDC) drill bit, which is a single body that contains a 6.75 inches drill bit pilot, with eccentric blades that enlarges up to 9.5 inches hole diameter, was designed aimed to drill both Comodoro Rivadavia Top and Mina El Carme Top formations, in a single run, at a competitive rate of penetration (ROP). Then a study on the motorized bottom hole assembly allowed to determine further details regarding geometric interference, hydraulic efficiency and operational parameters to ensure effective hole enlargement.

This novel approach at Southern Argentina, provided an average hole size of 9.4 inches for the production section, with a drilling time very close to a traditional technique, and allowed to save ten hours in the first experience and near 12 hours in the second experience, by eliminating the conditioning trips while providing the conditions for improved quality of data acquisition.

This project expands the horizon of alternatives to maintain cost efficiency and production rate for conventional drilling at Chubut and Santa Cruz province in Southern Argentina.

Introduction

The global energy sector continues to face the dual challenge of increasing energy demand while minimizing the costs associated with hydrocarbon extraction. In mature fields like the Golfo San Jorge Basin in Southern Argentina, where most fields are near depleted state, and formations like Comodoro Rivadavia which contain reactive clays, further complicate drilling operations.

Drilling in such environments not only represents technical constraints but also economic pressures that demand innovative and cost-effective approaches to maintain production levels for operators and ensure project viability in the near future.

Furthermore, the region's conventional reservoirs have entered late stages of development, with reduced formation pressures. These conditions contribute to problems such as circulation losses and borehole instability, on top of the notably swelling due to hydration of such reactive clays. Figure 1 shows example of hydratated clays balling up a tool.


Figure 1. balled up tool due to clays.

Such swelling can obstruct the WOB (weight on bit) transfer, reducing drilling efficiency and also can significantly delay operations by necessitating additional wiper and conditioning trips. These extra operations extend completion times, increase non-productive time (NPT), and hinder the passage of wireline tools, ultimately degrading the quality of petrophysical data acquisition. Poor data quality compromises reservoir evaluation and management, directly impacting production rates and project economics.
This document´s goal is to present an alternative cost-effective solution to addresses these challenges through a case study that involves the use of an eccentric hole enlargement bit. By enlarging the wellbore in the production section without altering the existing casing program and existing mud program, it offers a novel approach to mitigate the negative effects of drilling and completion from borehole instability, enhance logging efficiency, and reduce time-consuming tasks — thereby the solution will drive down costs and improve productivity.

Development

Background information

In the subject wells located in Southern Argentina, at the Golfo San Jorge Basing, that covers the south of Chubut province and north of Santa Cruz province; the drilling architecture is typically divided into two main sections. The surface section is initiated with either a 12.25-inch or 13.5-inch drill bit, subsequently cased using a 9-5/8-inch casing of 36 pounds per feet that has an inside diameter of 8.921 inches and drift diameter of 8.765 inches. It sets the stage for the critical production section, which is traditionally drilled with an 8.75-inch drill bit to remain within the constraints of the casing and anticipated logging and completion tool sizes.
The production section is drilled thru two main Formations. The first one is Comodoro Rivadavia Fm, the second one is Mina El Carmen Fm. Comodoro Rivadavia (Stinco, 2002) has traces of clays that are affected by the drilling fluid. The drilling fluid, also known as “mud”, is a water-based fluid, where the water component hydrates the clays, reacting in a way that creates formation swelling. Drilling with an 8.75-inch drill bit leaves limited annular clearance between the BHA (bottom hole assembly) and borehole wall when drilling, producing constraints to the energy transfer from surface to bottom, negatively affecting the drilling performance. To overcome this energy transfer deficiency, operators recur to additional reaming or conditioning trips, which although necessary, extend rig times and increases operational costs.
Another aspect for this case, is how it impacts the logging operations after the drill is complete. Wireline logging is critical for evaluation of subsurface formation, that involves lowering a string of tools on a cable to measure various rock properties. Under normal wellbore condition, the hole is smooth, near gauge, and free of obstructions for the tool string to move freely, with measurements taken either in a stationary position or while moving the tool thru the wellbore. Figure 2.

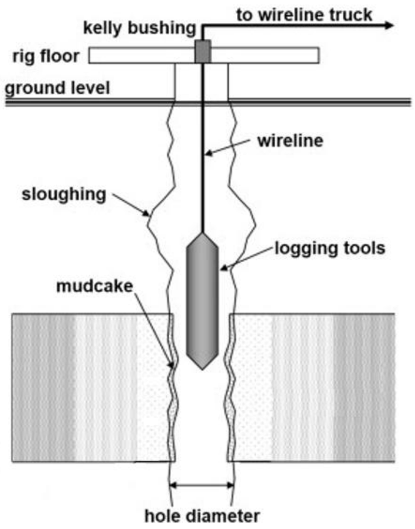

Figure 2. Basic schematic of wireline tool operation

Centralization, and tool conveyance (free movement) is critical to avoid data gaps and poor quality. Excessive washouts or tight spots alters the tool geometry, degrade pad contact and generate unpredictable tool standoff. In essence, having well swelling and/or washouts, affects the clearance, altering the described performance of the wireline tool.

In addition, the smaller clearance between the borehole wall and the casing during the completion operations, added to the altered collapse pressure, causes borehole closure and further contact with the casing string, which leads to several optimization constraints, like slow down the casing speed rate and increased risks of casing failure due to high friction.

To address these challenges, an eccentric polycrystalline diamond compact (PDC) was evaluated and implemented. This integral tool combines a pilot bit and eccentric reaming blades within a single body. During drilling, the pilot bit initiates the borehole, while the eccentric blades follow to enlarge the hole to a larger diameter. The tool is designed with two distinct centers of rotation: one for the pilot bit and another for the eccentric blades. As the bit rotates off-bottom, it maintains a pass-through diameter suitable for casing or restrictions. Once the pilot bit contacts the formation, the eccentric blades engage and begin cutting a larger diameter, effectively reaming the hole while drilling progresses. This mechanism enables simultaneous drilling and hole enlargement, reducing the need for separate reaming runs, improving annular clearance, and enhancing operational efficiency. Figure 3

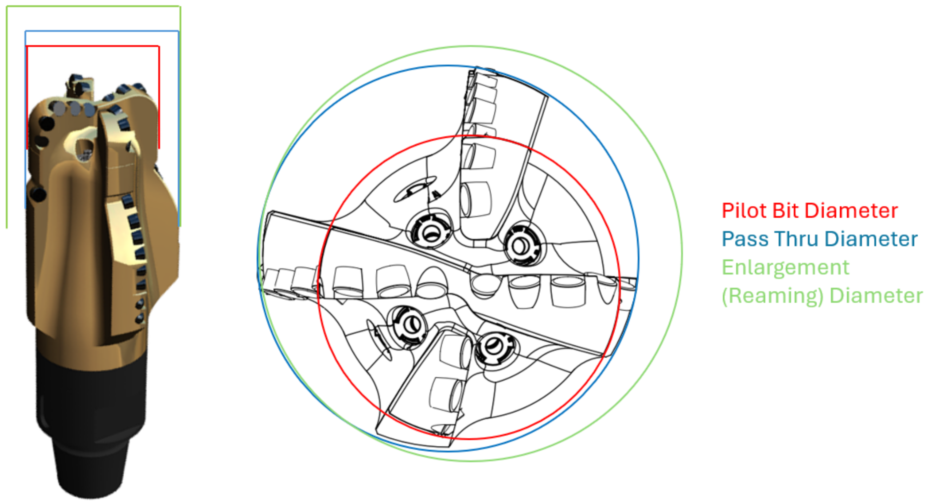

Figure 3. three dimensional render image of hole enlargement tool and top view drawing with eccentric diameters.

The rationale behind this approach is to utilize a tool that can pass through the previous casing string while still drilling a larger borehole (Figure 4). In the event of borehole wall closure, the additional annular clearance mitigates the risk of restricted weight transfer and excessive friction, ensuring smoother drilling dynamics and reducing the likelihood of casing installation issues. Furthermore, the enlarged hole diameter and the reaming action help condition the wellbore, minimizing the need for additional wiper trips and creating optimal conditions for wireline logging. This contributes to improved data acquisition quality and reduces non-productive time (NPT), ultimately supporting more efficient and reliable well completions.

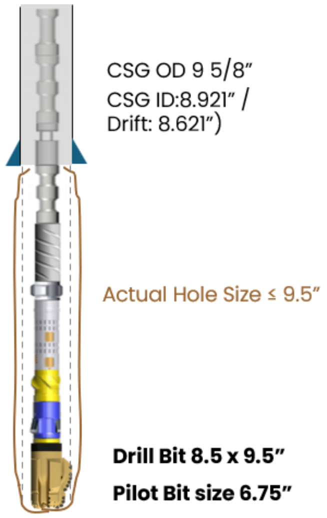

Figure 4. Illustration of hole enlargement operation for case study.

Design and Operational Considerations

For the Southern Argentina application, the tool of choice was an integral hole enlargement polycrystalline diamond cutter (PDC) bit, featuring a 6.75-inch pilot section and eccentric blades capable of enlarging the borehole up to 9.5 inches. The pass-through diameter remained at 8.5 inches, enabling compatibility with the existing well architecture and BHA.
Given the geological characteristics of the two key formations—Comodoro Rivadavia and Mina El Carmen—which are known for their interbedded claystones and sandstones and exhibit reactive behavior when exposed to water-based fluids, the performance objectives for the drilling assembly were defined as follows:

- Durability of the pilot PDC cutting structure: The bit must withstand the abrasive and reactive lithology to complete the section in a single run without compromising performance or integrity.
- Efficiency of the reamer blade configuration: The eccentric blades must reliably enlarge the borehole to the target diameter within a reasonable timeframe, maintaining a competitive rate of penetration (ROP).
- Hydraulic optimization: The tool must ensure effective cuttings evacuation and cooling, minimizing bit balling and maintaining borehole cleanliness throughout the run.

Based on previous formation evaluation for Golfo San Jorge (Droeven, 2009), and gathering drilling experience from recent offset data, a PDC drill bit design with 5 or 6 blades and 16mm cutter size provides the current benchmark in performance for an 8.75in size.

Following the process described by Vempati et. aL 2004, the behaviors in the current 8.75-inches PDC drill bit designs can be extrapolated to a different size or configuration, so despite having differences in design, it can quickly cover the basic needs of the application.
Figure 5 shows the input parameters from the application, the feature list of the PDC drill bit.

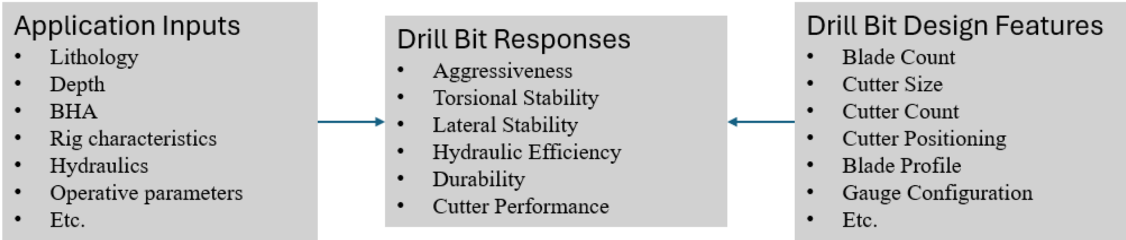

Figure 5. Relationship between application inputs and drill bit features defines drill bit response

What this means is that the current 8.75in drill bit design has score in each of the responses. A reference example table of scores are in figure 6.

Application Query	Application Choice	Aggressiveness	Cleaning Efficiency	Torsional Stability
		Score	Score	Score
UCS, psi	*Very Low(<5000)*	5	5	5
	Low(5, 000 - 10,000)	4	4	4
	Medium (10,000 - 15,000)	3	3	3
	High (15,000 - 20,000)	2	2	2
	Very High (>20,000)	1	1	1
Rattiness (interbedded)	*Low*	5	0	1
	Medium	3	0	3
	High	1	0	5
Balling Potential	*No balling potential*	-	0	-
	Lowballing potential	-	3	-
	High balling potential	-	5	-

Figure 6. Example of score table for PDC drill bit response

The goal of the selection process is to select design features in the new hole enlargement PDC drill bit that can match the current score, so the responses are within expected for the current application. Illustration on what affects design response score is in figure 7.

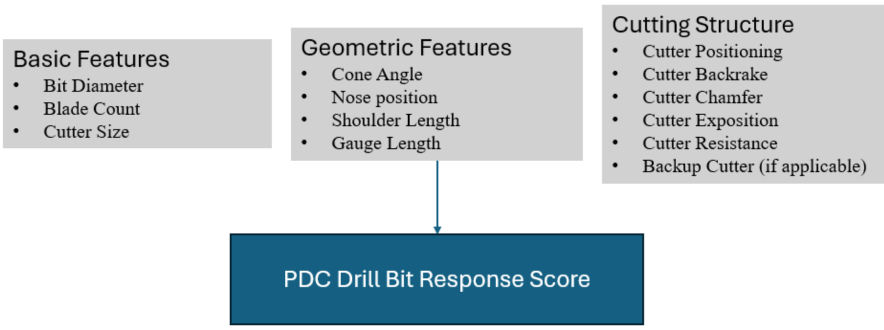

Figure 7. Design features affects response score.

To match the application response score, a PDC drill bit pilot design of 4 blades and 19mm cutter size is selected. The body has 3 reamer blades, also designed with 19mm cutters. The gauge length of the pilot bit is 3.5 inches in length and total length is 23.9 inches. A three-dimensional render model can be seen in figure 8.

Figure 8. Three Dimensional Render of the selected hole enlargement PDC drill bit.

Using an advanced simulation software (Hernandez, 2023), that can recreate the drilling environment, modifications in the design can be executed to adapt the response of the hole enlargement PDC drill bit to the requirements of the application in terms of durability and performance.

The first step in this process involves identifying the lithologies to be drilled. This includes evaluating rock strength and determining the depth at which the formation transitions from the Comodoro Rivadavia Formation to the Mina El Carmen Formation. Understanding these geological boundaries is essential for anticipating drilling challenges and optimizing bit design. A representative formation log illustrating this transition is shown in Figure 9.

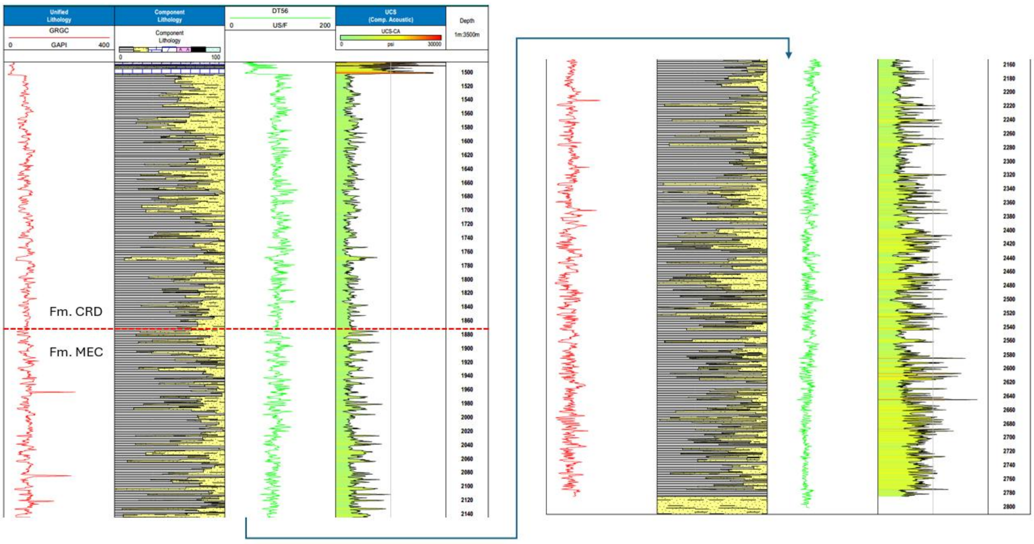

Figure 9. Rock strenght, gamma ray readings, acoustic readings and transition layer plot.

Once the hole enlargement drill bit design and drilling conditions has been set, a drilling simulation is executed to analyze the response in such conditions and go thru the iterative optimization cycle, until a suitable response is obtained.

The next step involves evaluating the Bottom Hole Assembly (BHA). In this case study, a motorized BHA was selected to compensate for the limited power output of the existing rig. This configuration ensures sufficient energy delivery to the assembly and, ultimately, to the drill bit, enabling effective hole enlargement.

When deploying an eccentric reaming tool below a bent motor, it is critical to assess the geometric constraints at the pass-through diameter. These calculations are essential to prevent excessive side loads on both the bit and BHA components, particularly during the drill-out of cement and the shoe track from the previous casing section. Improper alignment or loading can lead to tool failure or inefficient drilling performance.

Figure 10 presents the geometric analysis and clearance calculations used to validate the BHA configuration implemented in this application.

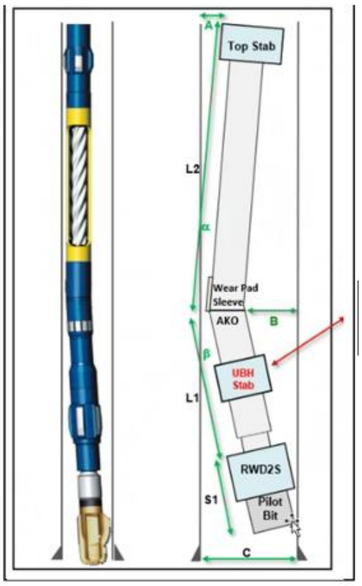

Figure 10. geometric interference calculation for a motorized BHA and Hole Enlargement PDC drill bit.

The results of the geometric analysis confirm that the BHA configuration provides sufficient clearance to pass through the internal diameter of the previous casing string without interference. This ensures that the eccentric PDC bit and motor assembly can be safely deployed without inducing excessive side loads or mechanical stress on the components. Adequate clearance is particularly critical during the drill-out of cement and the shoe track.

A third aspect to consider is the hydraulic response. A critical step in optimizing the available hydraulic energy to both obtain a suitable performance and to mitigate risks of balling or erosion, as well as determine the correct ratio between pressure drops in the pilot bit and the reamer blades. For this matter, computational fluid analysis is used to analyze flow path and flow velocities. figure 11.

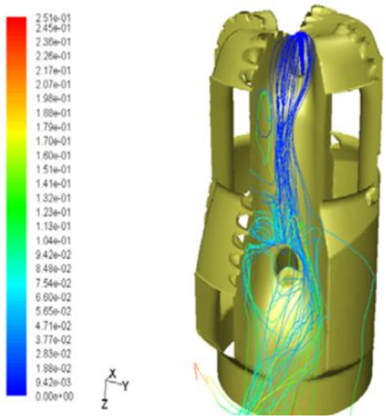

Figure 11. computational fluid analysis with flow path. Color scale shows fluid velocity

The results of the hydraulic performance analysis are presented in Figures 12 and 13. Hydraulic parameters were carefully optimized to ensure high flow velocities and efficient cuttings transport, both of which are critical for maintaining borehole stability—especially in the enlarged hole section. Effective hydraulics not only support bit cleaning and cooling but also help prevent cuttings accumulation, which can lead to pack-off or reduced rate of penetration (ROP). The configuration demonstrated a balanced performance between mechanical efficiency and hydraulic effectiveness, contributing to the overall success of the hole enlargement operation.

Figure 12. Hydraulic performance at the hole enlargment PDC drill bit.

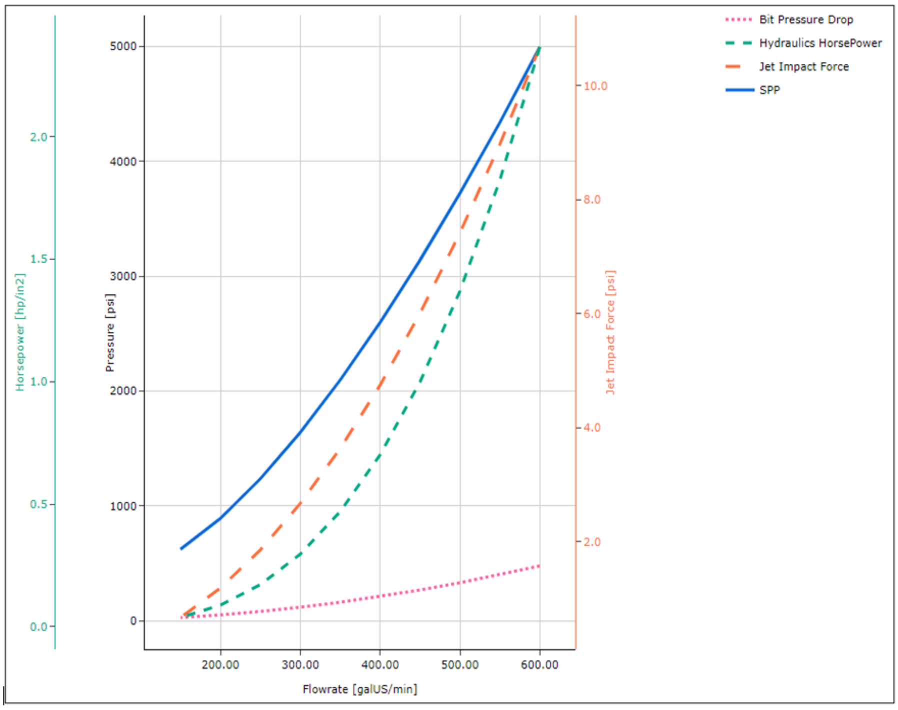

Figure 13. Hydraulic performance at the system.

Execution and Results

The selected one-piece hole enlargement PDC drill bit successfully drilled the entire production interval at target well in a single run. The average on bottom rate of penetration for the enlargement operation was within average of field. Figure 14 shows a direct benchmark comparison between the target well and the two previous offset well in the area.

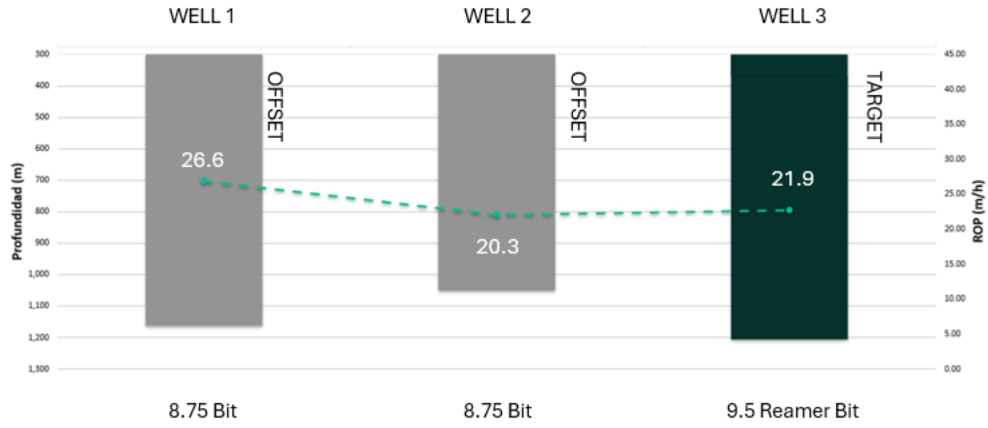

Figure 14. Performance comparisson

Figure 15 shows an extract of the recorded continuous drilling parameters, especially in the transition between the two formation tops, demonstrating the low variance of surface torque and motor differential pressure, symptoms of accepted stability during the hole enlargement. ROP is also consistent within expectations.

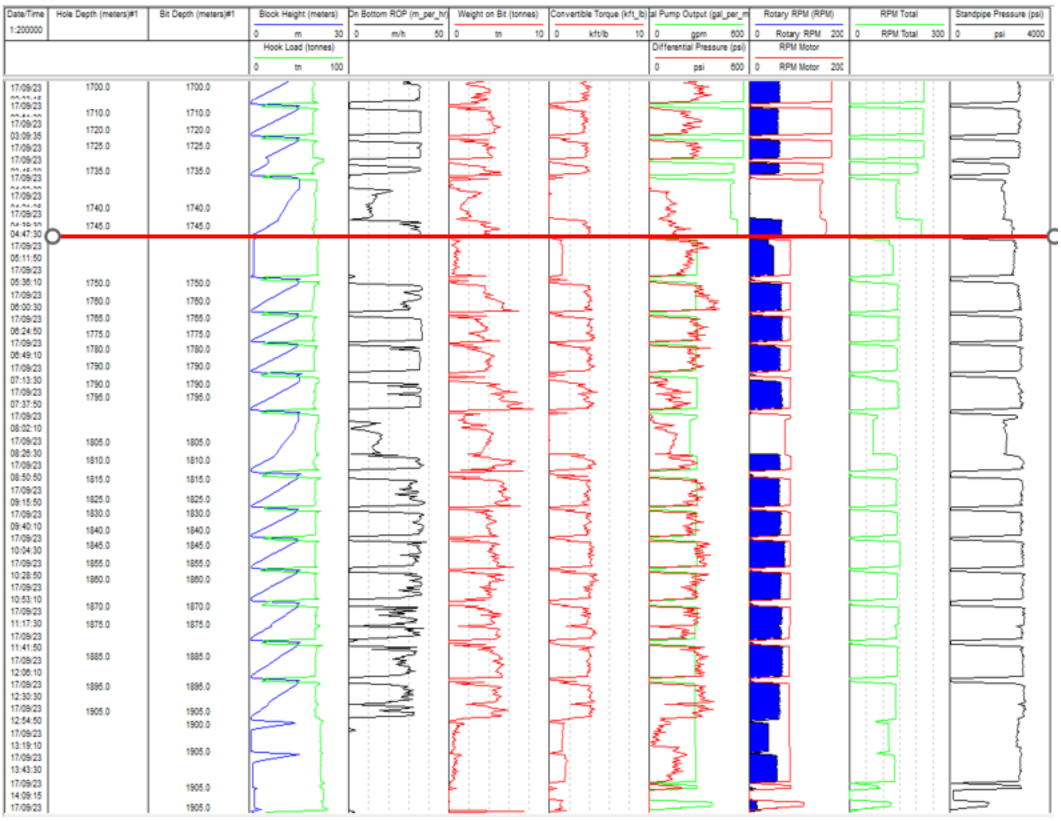

Figure 15. Recorded continuos drilling parameters for target well.

During the drilling, no significant symptoms of wellbore instability were detected, hence the operator decided to continue with no wiper trips. And after completion of the section, in the subsequent logging operations, caliper tracks (Figure 16), indicated an average borehole diameter of 9.37 inches, demonstrating effective and consistent enlargement throughout the interval.

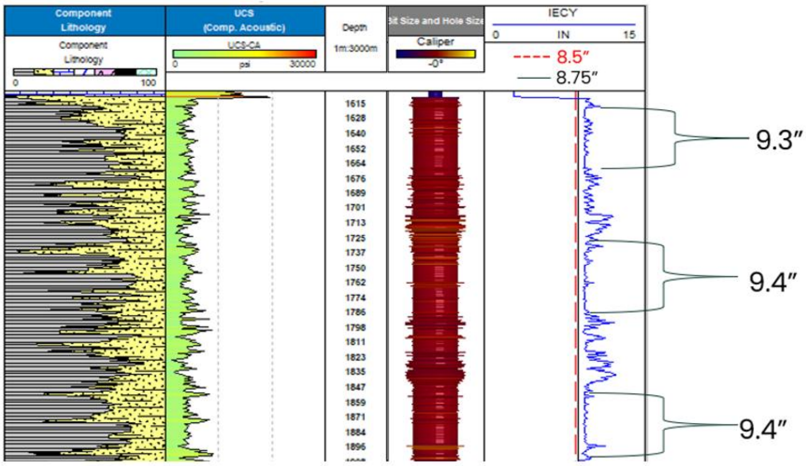

Figure 16. Caliper log demostrate effective hole enlargement

The implementation of the enlarged hole strategy delivered several key operational benefits:

- **Elimination of Wiper Trips**: The increased annular clearance effectively mitigated the risk of tight spots caused by formation swelling, thereby removing the need for additional conditioning runs.
- **Enhanced Logging Efficiency**: Logging tools were successfully deployed without obstruction, resulting in high-resolution data acquisition with minimal signal degradation—crucial for accurate petrophysical evaluation.
- **Reduced Operational Time and Cost**: As illustrated in **Figure 17**, the first field implementation achieved a time savings of approximately **10 to 12 hours**. Comparative analysis with offset wells suggests a potential reduction of up to **24 hours** in total drilling and completion time, translating into significant cost savings and improved rig efficiency.

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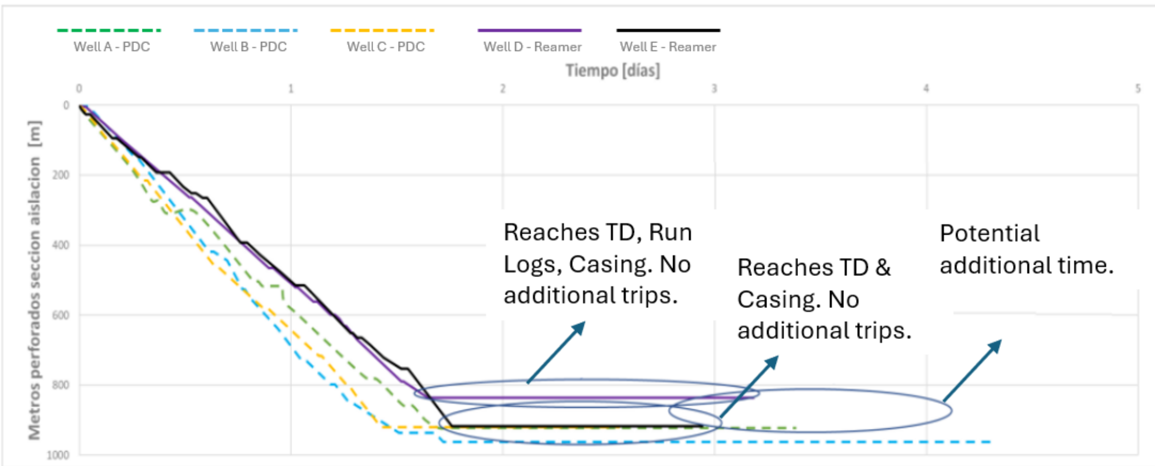

Figure 17. Time-Depth analysis comparing results from offset and target wells in the case study.

Conclusion

In conclusion, the innovative drilling approach presented in this case study demonstrates a significant advancement for revitalizing oil and gas operations in southern Argentina. By engineering a solution that strategically increases the annular space, the method effectively eliminates the need for wiper trips—one of the most time-consuming and cost-intensive aspects of wellbore conditioning in the region.
The success in preventing tight spots and borehole instability without altering the current casing program not only reinforces operational reliability but also offers an adaptable framework for similar geological settings without a traumatically shift on current inventory assets and drilling scenario.
Furthermore, the deployment of logging tools without obstruction and the acquisition of high-resolution data emphasizes the method's capacity to enhance subsurface evaluation while reducing non-productive time. The documented savings in operational time across multiple implementations highlight the tangible economic benefits, especially when scaled across multiple wells in a campaign across Golfo San Jorge.
Most notably, the approach delivers these gains without compromising drilling performance, as evidenced by the rate of penetration remaining comparable to traditional methods. This balance between innovation, efficiency, and risk mitigation positions this methodology as a forward-thinking model for sustainable development in mature or technically challenging basins. As the industry seeks smarter, leaner strategies to adapt to evolving energy demands, this case sets a precedent for how targeted engineering solutions can unlock new value in legacy regions like southern Argentina.

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