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Repsol Minimizes Drilling-Related Problems and Improves Efficiency by Applying Automated MPD

@balance services eliminate NPT related to wellbore instability, hole cleaning, differential sticking, and severe mud losses in remote jungle well, Peru

CHALLENGE
Overcome challenges associated with drilling a long, deviated reservoir section in a highly mechanically unstable interbedded formation with high probability of differential sticking, mud losses, and intersecting natural fractures.

SOLUTION
- Use managed pressure and underbalanced drilling services.
- Engage @balance Control* managed pressure drilling (MPD) system to minimize pressure variations in the open hole and maintain an equivalent circulating density (ECD) high enough to keep the wellbore stable yet low enough to prevent differential sticking and mud losses.

RESULTS
- Showed no signs of wellbore instability or differential sticking.
- Rigged up MPD system in remote jungle location in less than 15 hours.
- Achieved excellent wellbore condition for effective running of 7-in liner.

Drill through a narrow 0.5-lbm/galUS window limited by wellbore instability and the risk of differential sticking
Repsol experienced a number of challenges while drilling the production section of its highly deviated Sagari wells in Peru. The succession of high-permeability, low-pressure sand reservoirs presented a high risk for losses and differential sticking. The operation also required drilling through the highly mechanically unstable interbedded Shinai Formation. In addition, naturally fractured dolomite leads to low ROP and risk of severe losses. In one well, with a narrow 0.5-lbm/galUS operating window, Repsol sought an automated MPD solution that would enable nearly constant bottomhole pressure, mitigating the risk of wellbore instability and high ECDs that can induce losses and differential sticking.

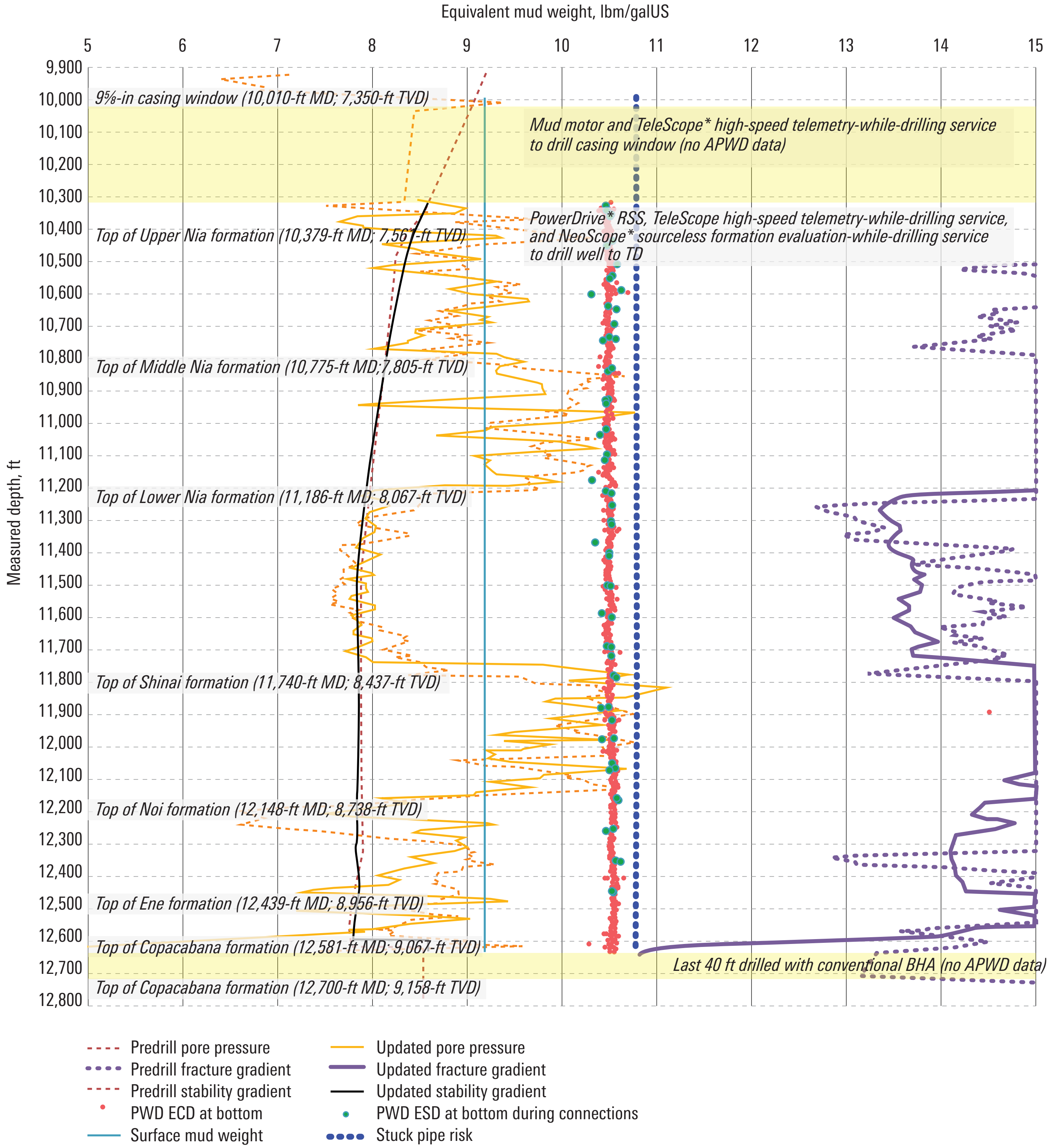
Minimize pressure variations and sustain ECD
M-I SWACO recommended a mud weight of 9.2 lbm/galUS along with the @balance Control MPD system. The system's small footprint enabled streamlined transportation via helicopter to the remote jungle rig site and rigged up in less than 15 hours. The package included a HOLD* remotely operated annular control device with a dual-sealing element assembly, $4\frac{1}{16}$-in automated choke manifold with two VERSA-CHOKE* modular drilling choke technologies, backpressure pump, flowmeter to serve as an early kick detection system, piping, and human machine interface.

The RCD together with the sealing elements sealed the annular space and deviated the drilling fluids coming out of the annulus toward the MPD choke, permitting the application of surface backpressure as necessary. Real-time hydraulics software adjusted surface backpressure automatically to changing drilling parameters. The backpressure pump enabled better control of the applied surface backpressure during connections and while tripping without circulation. It maintained the flow of drilling fluid through the chokes when the rig pumps were off, keeping the well full of drilling fluid at all times. The flowmeter that was placed downstream of the MPD choke provided early indication of fluid losses or influx by precisely monitoring small discrepancies between flow in and flow out.

Repsol used @balance services to drill three production sections in two wells in the same location. Additionally, managed pressure cementing (MPC) was used in the intermediate casing and production liner in the last well.

Mitigated risk of wellbore instability, fluid losses, and differential sticking
The MPD strategy was based on a geomechanical model and on past experience from offset wells. In the planning phase, comprehensive hydraulic simulations were performed with VIRTUAL HYDRAULICS* drilling fluid simulation software and Drillbench* dynamic drilling simulation software to predict the pressure profile along the wellbore in different operational phases, such as drilling, tripping in and out, and performing mud rollovers. The impact of parameter variations—including mud density, rheology, ROP, pipe rpm, bottomhole temperature, and bottomhole assembly design on the pressure profile—was studied to design the MPD strategy and make recommendations, mitigating risk throughout the job. The MPD strategy evolved from well to well based on lessons to optimize the MPD strategy for drilling the challenging production section in Sagari field.

Actual MPD Operating Window, Sagari 7D-ST1, 8½-in MPD Hole Section
10,010- to 12,700-ft MD



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