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ABSTRACT

Exceeding the Geo-steering Technology Limits in Trinidad

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Introduction

Petrotrin-Trinmar Operations ("Trinmar") initiated a comprehensive candidate selection study on the North Soldado Field in 2003. This study identified six new drilling locations and two sidetracks as candidates for production improvement. Two of these candidates, P524 (S854) & P363 (S869) were to be horizontally placed in the Marker 40 sand, a thin near-shore sand deposit overlying the Manzanilla unconformity. Thin reservoir sands such as the Marker 40 exist in many areas of this mature field and are a known, yet still untapped, resource. These thin sands were historically bypassed as primary objectives since they were considered too small to be commercially viable in vertical wells and too difficult to drill with horizontal wells due to the inherent difficulty of geo-steering within such tight tolerances. Though the results of the study were promising, these horizontals were bypassed as they were considered too challenging to drill with the technology available at the time.

The introduction of new well placement technology, specifically designed to improve the exposure to the hydrocarbon interval, provided sufficient optimism for Trinmar to geo-steer the first attempt at placing a lateral in the Marker 40 sand. This new service provides measurements of distance and orientation to neighboring boundaries and facilitates proactive geo-steering decision in real "Real-time". Trinmar was the first company in North and South America to accept a proposal to utilize this cutting edge technology and the second to use it. The geo-steering challenge for the first well (S854) was a 1200 ft lateral with a high net to gross sand count; this well would be used by Trinmar to gauge the technology and to validate the feasibility of drilling marginal reserves.

Case Study S854

Drilling operations commenced in August 2005 on the S854 well (candidate P524).

The 8 ½” lateral used the new Well Placement service to geo-steer the drilling assembly within the thin Marker 40 sand. As the job commenced, the benefit of the service became quickly apparent. A continuous map of the top of the sand was produced, thus eliminating any interpretation risk inherent in conventional geo-steering modeling. The trajectory stayed a few feet from the top of the sand even as sand thickness varied from above 10 ft to as low as only 3 ft thick. This allowed the drilling assembly to stay within the sand with only a single exit, a result of an inability to rapidly change the well path within a particularly severe dip change. Even in this case, the amount of lateral section lost was minimized as a responsive steering decision was made before actually exiting the sand, not possible with conventional geo-steering technology.

Prior to drilling the well, Trinmar’s expectation was that 300 ft of sand would be drilled. This was based on past experiences in this field using conventional technology. Using the new well placement service, a total of 1325 ft of net pay sand was obtained at an 88% net to gross ratio.

The success of the S854 lateral paved the way for next well, S869 (P363) to be drilled with the same technology.

Case Study S869

Drilling operations commenced in October 2006 on the S869 well (candidate P363) with the now proven geo-steering technology.

S869 proved to be much more challenging than its predecessor primarily due to sharp dip changes observed while drilling. With dogleg severity (DLS) limitations of both the bottom hole assembly and completions string, it was impossible to stay in the primary Marker 40 reservoir when formation dip changed rapidly. The reservoir was exited after 265 ft of exposure.

Based on the exit angle, the dip of the Marker 40 sand and DLS restrictions, calculations showed that the trajectory would require another 800 ft to re-enter the primary objective from below, assuming the current dip remained constant.

Up against these uncertainties the call of TD may have been imminent with conventional technology. However, the new well placement technology was indicating another high resistivity zone 5 ft below the current well trajectory. In an attempt to salvage the well, Trinmar decided to exploit this interval, which corresponded to a smaller secondary Marker 40 sand that also maps across the field. This secondary thinner sand contributed another 380 ft of pay to give a total of approximately 865 ft of net pay at a 60% net to gross ratio.

The drilling process for both wells was hailed as successes. Indeed, new geo-steering technology has made it possible to exploit these marginal Marker 40 sands. More wells targeting this reservoir are planned utilizing the newest technology for well placement.