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Successful Drilling of Horizontal Well in Minimum Horizontal Stress Direction: Drilling Against the Norm

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SUMMARY

Saudi Aramco is developing several gas fields in the Eastern province of Saudi Arabia by drilling horizontal wells in pre-Khuff tight sandstone formations. To-date, several wells have been drilled in the maximum horizontal stress direction in Unayzah formation. In such wells hydraulic fractures are mostly longitudinal and in some cases communication between different stages could be possible resulting in premature screen-out and damage to previous stages. Wells drilled in direction of minimum horizontal stress could be potentially more productive as larger contact area is achievable with multiple transverse fractures. Only one well had been drilled in the minimum horizontal stress direction, which encountered several drilling problems, such as stuck pipe and side-track. A study was proposed to investigate feasibility of drilling a horizontal well in the minimum horizontal stress direction so that transverse hydraulic fractures could be created during stimulation to maximize reservoir contact area and increase productivity of the low quality reservoir.

The key objectives of the study were to define safe mud weight program for the horizontal section of the planned well X-1 by conducting a wellbore stability study, and to determine strategy to mitigate and/or manage wellbore instability problems.

The Mechanical Earth Model (MEM) incorporates all logs and rock mechanical properties propagated from the pilot well X by curtain section based on the direction survey and proposed formation tops of the planned horizontal well X-1. The MEM spans the interval from kick-off to TD, which covers Base Khuff formation and Unayzah-A reservoir. The main objective of developing the MEM for the planned well X-1 was to optimize the mud weight program for drilling the well. A minimum safe mud weight of 91pcf was recommended to drill the planned well X-1 to minimize drilling problems due to wellbore instability. The well was successfully drilled with a mud weight of 92-93 PCF. The drilling of the well was continually followed on a daily basis. The NPT experienced while drilling this well based on the recommendations from the study was significantly less than the previous well. The four-stage completion string was successfully landed.

Based on the azimuth in which the well X-1 was drilled, relatively high breakdown pressure is expected during the hydraulic fracturing operation. The MEM was later updated with actual logs taken along the trajectory.

This project has successfully demonstrated the value of mechanical earth modeling workflow for mud weight optimization to decrease NPT and has brought great value to the operations. Multistage transverse open-hole hydraulic fractures in Unayzah-A reservoir are designed based on the stress profile generated after updating the MEM.