In Situ Stress Pattern and Its Impact on Stable Drilling Operation - A Sensitivity Study

Islam, Md. A.[1]; Skalle, Pål [1]; Mondol, Nazmul H.[2] (1) Department of Petroleum Engineering and Applied Geoscience, Norwegian University Of Science and Technology, Trondheim, Norway. (2) Department of Geosciences, University of Oslo, Oslo, Norway.

There has been an increasing demand by the petroleum industry for more sophisticated well trajectories to drill deviated or multi lateral wells in a tectonically complex area. Up until now, the drilling plan is followed by routines based on direction mapping, relative in-situ stress magnitudes, borehole breakout analysis and well path optimization derived from inversion technique. This study investigates such issues in corporation with influences of in-situ stress system into wellbore stability. The main objectives are to demonstrate the theoretical models to reproduce hypothesis of stable borehole condition under in-situ stress regimes and to develop and investigate analytical models to confirm hypothesis. An M-C failure criteria is used to develop stability margin model which determines well direction and borehole collapse risk however,hoop stress accounting at borehole determines the optimum well inclination. Both of these models worked on relative stress magnitudes ratio (i,e, rH =σH/σV and rh= σh/σV).MATLAB codes were developed to simulate the models. The physical model incorporates with developed analytical models.

Results show that adding tectonic complexity in well trajectory with respect to in-situ stress distribution poses a major uncertainty in directional drilling. In normal fault area, if horizontal stress is isotropic (low rH & increase rh), optimum well path value ("γ") drops sharply which implies that vertical well is more favourable and the impact of rH itself on 'γ' is consistent and 'γ' increases (diverted vertical to deviated) with increasing rH. For strike slip stress regime, the sensitivity of changing rh to 'γ' is almost similar to the normal fault case but 'γ' decreases with increasing rH. However, under reverse fault area, the scenario is just the opposite to that of normal fault case where deviated borehole is choice. The sensitivity analysis shows model is sensible not only on stress pattern but also dependent on material intrinsic failure properties (i.e. friction angle and cohesion) along with pore pressure. The reliability of the model also depends on collapse & fracture pressure. The outcomes of this study help to understand borehole geomechanics and will contribute significantly in the future research.