3-D Geomechanical Modeling for Drilling Beyond Simplified Simulation Techniques

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Abstract

As a field development strategy, KOC is developing highly depleted reservoir. The field has been experiencing wellbore instability issues. Some recent wells have encountered stuck pipe and mud losses in clastic and carbonate sections. To reduce geomechanical related Non-Productive Time and rig days, it is important that combined effect of in-situ stress state and well trajectory on wellbore stability should be thoroughly investigated. Rock mechanical behaviours also need to be evaluated to optimize drilling practice.The growing appreciation of the effects of regional tectonics is making it crucial to move away from simplified characterisation of rock behaviour and to turn into advanced geomechanical modelling techniques to engineer better wells and fields. The advanced 3D coupled Geomechanical-Fluid-Flow modelling method combines input data of different origin, such as seismic data, petrophysical data, fluid-flow data and well logs. With such an integrated model, spatial variations of the in-situ stresses in the field are obtained due to reservoir structure, presence of discontinuities as we as because of reservoir depletion. The whole production history spanning seventy years was simulated.The 3D coupled geomechanical model was able to reproduce the observed wellbore instability events for fifteen wells drilled at different times and various reservoir depletion stages. Drilling instability events included tight spots, cavings and stuck pipe in major clastic sections; and mud losses in carbonate sections. Two blind tests for wells not used for model calibration were carried out to examine the mechanical properties, stress profiles and caliper logs within various formations. The match between the model prediction and the data was in good agreement. In addition, a 3D description of the mud weight was

computed, which allowed to obtain drilling maps across the field highlighting zones of high, medium and low drilling risks. Such drilling maps enabled optimizing placement of future planned wells and provide guidance in mud weight design. Nevertheless, drilling through faults requires careful attention due to the localized stresses concentration developing along their geometries. High resolution near wellbore stability analysis helped to optimize the drilling mud weight for wells crossing faults. The powerful combination of multidisciplinary domains into one integrated 3D geomechanical model improved the understanding of subsurface behaviour. With such an integrated model, complex technical challenges as drilling complexities in the study field can be achieved and hence decreases the Non-Production Time by avoiding problems prior to their occurrence. The calibrated model showed satisfactory predictability for the whole production period and thus is used as a mitigate problem measure to placement of new planned wells.

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