9th Biennial International Conference
& Exposition on Petroleum Geophysics

"HYDERABAD 2012"

P-522

Geomechanical Study To Evaluate Wellbore Stability In Planned ERD Wells in Western Offshore, India.

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Summary

Drilling high deviation extended reach wells intersecting thick shale sections are involved with high risk.

Geomechanical evaluation of drilling risk is of high value in order to reduce non productive time (NPT) related to wellbore instability.

Keywords: *Geomechanics and Wellbore stability study.*

Introduction

Directional drilling through thick stress sensitive shale formations is involved with high risk. Understanding the orientation and magnitude of in-situ stresses, pore pressure and rock mechanical properties of formations is of importance in order to evaluate wellbore stability predictions for any planned well trajectory. During extended reach drilling (ERD), multiple failure mechanisms play role to induce wellbore instability. Understanding the impact of hoop stresses around the bore hole, time sensitive failure mechanisms on formations and taking appropriate measures through implementing suitable mud weights and drilling practices are essential to the success of ERD wells.

Theory and/or Method

The basis for predicting wellbore stability successfully and accurately lies in the understanding of a sound geomechanical model. The principal constituents of the geomechanical model are three principal stresses (vertical stress (S_v), Maximum principal horizontal stress (S_{Hmax}) and minimum principal horizontal stress (S_{hmin}), pore pressure (P_p) and the rock strength (UCS)). When the horizontal stresses are not equal (a frequent condition in the Earth's crust) a stress anisotropy is created and wellbore instability can be pronounced as wells are direction and deviation sensitive. Pore pressure is a very important parameter in the geomechanical model and can be directly related to fracture gradient, especially in depleted formations. Rock strength is also a major input in the calculation of wellbore collapse. When these parameters are known, a geomechanical model can be created and subsequently utilized for various applications that include evaluation of wellbore stability, fracture permeability, sand/solids production prediction etc.

Geomechanical Evaluation of Drilling Risk: Offshore Field, India.

Performing a geomechanical study for a clastic reservoir sequence in Western offshore of India resulted in understanding potential risks involved while drilling extended reach wells. Used available open hole geophysical logs, borehole image logs, drilling and mud reports to build geomechanical model and calibrate them with actual drilling experience from offset wells. In-situ stress regime in this Western offshore field appears to have influence on wellbore stability. Calibrated geomechanical models are helpful in predicting mud weights for planned deviated wells. In addition, geomechanical study also provided inputs with necessary drilling practices to overcome challenges offered by formation due to wellbore instability. An important aspect of risk assessment in ERD wells is to identify key mechanisms that are going to play role in inducing wellbore instability during and after the drilling. Upon understanding the risk, designing the drilling fluids and practices in accordance with identified risk is of importance in order to implement relevant action plans into drilling program.

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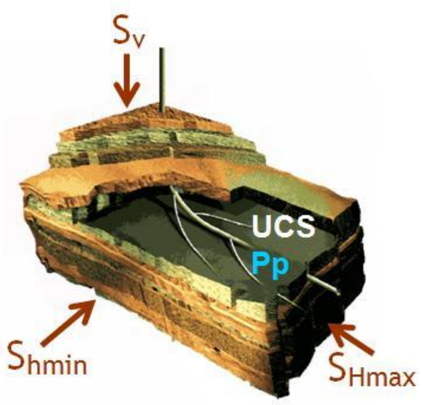

Figure 1: Geomechanical Model comprises in-situ stresses, rock properties and pore pressure.

Using the geomechanical models built with help of geophysical well logs and drilling reports, multiple scenarios were developed to estimate wellbore stability at different assumed conditions and casing policies.

Considering the uncertainties with data inputs to the model, Monte-Carlo simulations were also performed with appropriate range of input parameter values to estimate their influence on resulting mud weights.

Parameter	Data
Vertical stress →	$S_v(z_0) = \int_0^z \rho g \, dz$
Pore pressure →	$P_p \Leftarrow$ Measure, sonic, seismic
Least principal stress →	$S_{hmin} \Leftarrow$ LOT, XLOT, minifrac
Rock strength →	Lab, logs, modeling well failure
Stress orientation →	Orientation of wellbore failures
Max. Horizontal stress →	S_{Hmax} magnitude $\Leftarrow$ modeling wellbore failures

Figure 2: Geomechanical models are built by integration of several data sets coming from diverse sources.

Conclusions

Application of Geomechanics resulted in understanding the mechanisms involved with wellbore instability prior to drilling challenging ERD wells.

The study helped the Drilling team to prepare with appropriate measures to improve drilling practices in order to overcome challenges arising from the formation.

Wells drilled in different deviation/orientation can have different levels of risk and also required different mud weights.

Overall, the study provided comprehensive due diligence for well planning.

Acknowledgement

The author thanks Mr.Amit Desai, Dr.Bandyopadhyay, Mr.S.C.Soni and many other ONGC officials who supported this study with their involvement, discussions and approvals. The author also thanks Baker Hughes for approving this study to present at SPG India conference.