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Time-Dependent Anisotropic Wellbore Stability across the Qusaiba Shale; Northern Saudi Arabia

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ABSTRACT

Shale stability is still one of the most important problems faced during drilling. This paper demonstrates the role of geomechanics knowledge while drilling to address wellbore stability related problems and help in drilling risk management for the North Arabia Qusaiba shale formation. In the north Arabia region of Saudi Arabia, a thick Qusaiba shale was drilled frequently. Wells being drilled have the Qusaiba Member combined in one hole section with the underlying sandstone reservoir of the Sarah Formation. Although recent drilling does not usually encounter major problems in the Qusaiba Member, some wells were sidetracked or abandoned due to wellbore instability. Geomechanics investigations indicated that Qusaiba shale is characterized with probably the highest anisotropy, a property of being directionally dependent. Rock anisotropy can influence failure, either by its effect on stress redistribution or through rock-strength anisotropy. The anisotropy often contributed to formation instability; constrained with mud weight density, time and number of casings strings. Wells need to be drilled and cased as quickly as possible to prevent fluids invasion that would increase the near wellbore pressure, reduce the effective stress and collapse the wellbore with cavings. Overcoming unstable behavior of the Qusaiba shale, a working methodology to minimize wellbore stability problems has been established with a time dependent anisotropic mechanical earth model while drilling. The model simulations provide output accounting for a wide range of input parameters such as well inclination, mud chemistry, rock mechanical properties, field stresses and pressures, formation anisotropy and shale mineralogy. The model output can subsequently be used to design drilling operations. The model allows selection of proper fluid density to drill through Qusaiba shale at any inclination but also constrain the number of casing strings necessary with the maximum time required to safely drill, log and set casing before wellbore deterioration. This has provided the additional benefit of formation damage prevention across the target Sarah reservoir.