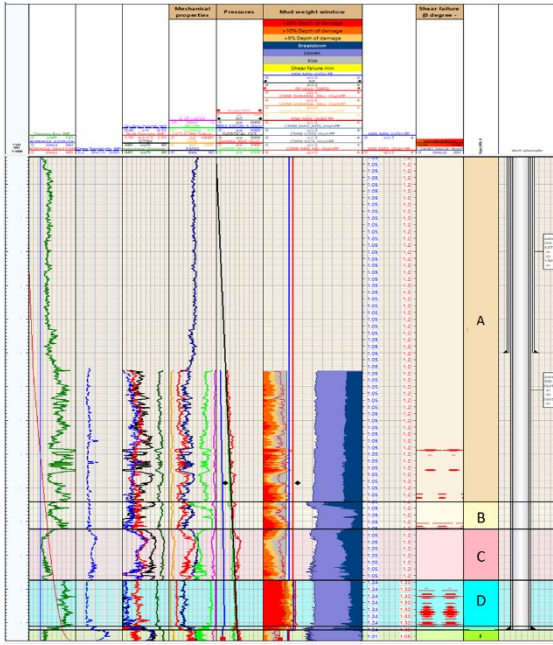


1D Geomechanics, Wellbore Stability Analysis

Enabled Customer to Drill First Horizontal Well in Gas Field Targeting Eocene Formation in Pakistan



Pre-drill wellbore stability model of the target well.

Objectives

- Construct a pre-drill 1D Geomechanical Earth Model (GEM) for wellbore stability (WBS) focusing on rock mechanical properties and stress field for the target well.
- Determine the possible causes of drilling risks related to wellbore instability.
- Establish recommendations for preventing, mitigating, and avoiding drilling risks on the target well.

Our Approach

- Weatherford geomechanical experts conducted the study across three phases.
- Stage I involved gathering data in accordance with all QA/QC protocols and loading the data into the system. The drilling events of three offset wells were analyzed, while 3D well prediction techniques were used for data propagation and filled the gap in the offset and target well. These analyses helped define the lithology (mechanical stratigraphy) and calculated the overburden stress, the magnitude and directions of horizontal stresses (Sh min and SH max), pore pressure, and geomechanical elastic and plastic properties.

LOCATION
Pakistan

WELL TYPE
Horizontal

FORMATION
Carbonate

HOLE SIZE AND ANGLE
22 in. (vertical)
12.45 in. (vertical)
8.5 in. (horizontal)

MEASURED DEPTH
4,921 ft (1,500 m)

PRODUCTS/SERVICES

- 1D Geomechanics modeling (1D GEM)
- Wellbore Stability Analysis (WBS)



1D Geomechanics, Wellbore Stability Analysis

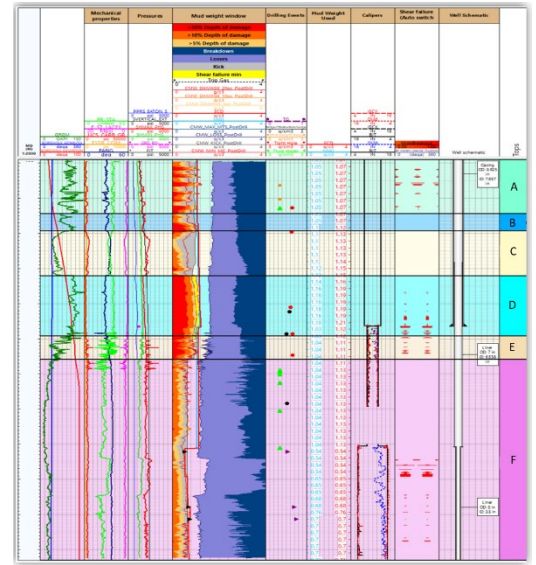
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Our Approach (continued)

- Stage II centered on the post-drill 1D GEM and WBS analysis of the offset wells.
- Stage III focused on the pre-drill wellbore stability modeling of the target well, and real-time WBS model update.
- The well was drilled with no nonproductive time (NPT) until the 9 5/8-in. casing. Besides the recommendation of Weatherford, the customer started to drill the reservoir section with conventional mud and, due to unexpected geological changes caused by the shale formation, the customer requested for the real-time WBS analysis after encountering the losses in carbonates.
- Weatherford experts again suggested the customer place the casing to avoid further losses and drill the well with underbalanced drilling (UBD). Their drilling team was not convinced and continued drilling with the same mud weight. At a certain depth, they encountered losses and became differentially stuck.
- After another recommendation to place the 7-in. liner and start drilling with UBD, the customer finally approved the drilling plan derived by Weatherford's WBS model. The well was then successfully completed.

Value to Customer

- The Weatherford geomechanics study also suggested using the UBD technique for drilling the reservoir because of the low pore pressure and the significant risk of differential sticking.
- The operation confirmed the pre-drill sensitivity analysis: the formation can be drilled with a lesser mud weight, approximately 1.10 g/cm³, with a deviation of more than 35°.
- The experience in this one operation provided the customer with greater insight on future drilling jobs, including the optimal methods to avoid differential sticking and ways to predict downhole pressure and wellbore trajectory to minimize wellbore stability risks.



Post-drill wellbore stability model of the target well.

