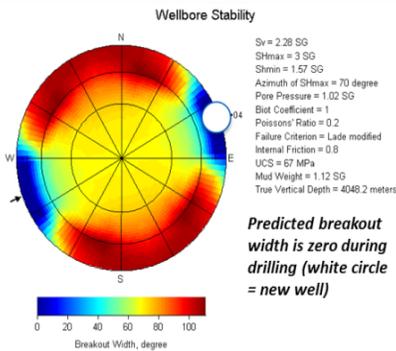
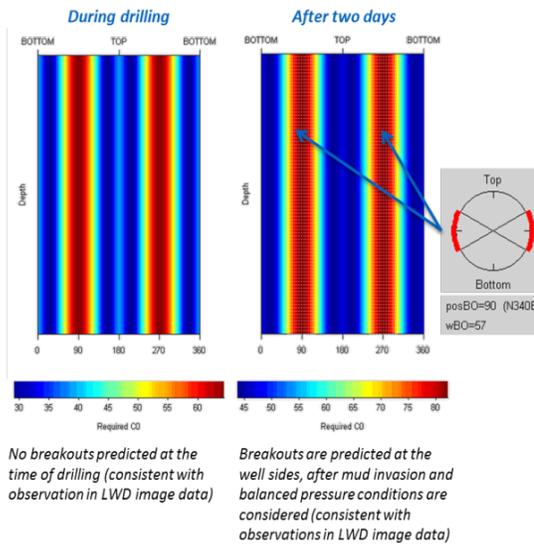




RiskGuard Stability solution reduced risk and NPT, saved 17 days and \$7 million USD



Stresses from pre-drill model were used together with rock properties determined from new well data



Modeling of wellbore failure was consistent with observations in image data. Comparing imagery while drilling to imagery 40 hour after reaching TD showed delayed wellbore deterioration.

An operator planned to drill a well in an offshore field in the Asia-Pacific region with varied and complex geology. On previous wells in the field, multiple operators had experienced tight holes, well kicks, mud losses, and stuck pipe in the upper 12¼-in. sections. While running liner into the lower 8½-in. sections, they tended to encounter dynamic losses, tight spots, and pack-off. Initially, the operator engaged Baker Hughes, a GE company (BHGE), to supply logging while drilling (LWD) services. It completed

its authority for expenditure (AFE) plan and job schedule by using assumptions for nonproductive time (NPT) and added costs for drilling problems previously experienced in the field. Seeing an opportunity to reduce risk, time, and cost for the operator, BHGE used data from previous well studies to generate an initial geomechanics-focused subsurface model. The model was then reviewed by drilling personnel with experience in the field, and by the various BHGE product lines involved in the project. The resulting

Results

- Completed drilling 17 days ahead of schedule
- Saved an estimated \$7 million USD in rig costs and drilling time
- Managed well kicks, mud loss, and wellbore instability
- Surpassed customer expectations for ROP and NPT in a challenging field
- Delivered a smooth, precise wellbore

Challenges

- Field-wide risks for kicks, mud loss, tight spots, and pack off
- Formation with natural fractures, bedded shales, and shaly sandstones
- Operator needed to maintain hole condition to enhance ECD management, reduce flat time, minimize delayed post-drill breakouts, and improve the cement bond

BHGE solution

- Delivered a comprehensive RiskGuard pre-job risk assessment, built by combining geomechanical data with experience gained in offset wells
- Used the RiskGuard Stability solution to match drilling technologies and techniques to well conditions in real time
- Deployed the AutoTrak steerable drilling system to place the wellbore with precision and control excessive vibration

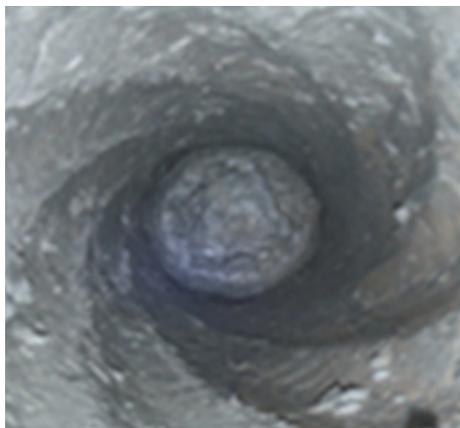
RiskGuard™ geomechanics-based operational assessment—the first phase in any RiskGuard analysis and risk management solution—included comprehensive strategies for managing wellbore stability problems in each geological sequence. For example, encountering hard stringers in the overburden, interbedded formations, and natural fractures can reduce the rate of penetration (ROP), increase torque, and cause excessive vibration when drilling through anisotropic formations. The cross-disciplinary BHGE team identified each specific risk, developed a strategy to manage it that assembled the appropriate technologies for execution, real-time monitoring, and ongoing model updates while drilling.

The BHGE team followed the **RiskGuard Stability solution**, which in this case included running the **AutoTrak™ steerable drilling system**, prescribed ideal mud weights, and used pressure-while-drilling (PWD) and LWD data to provide real-time geomechanical monitoring and analysis. In the 12¼-in. upper section of the well, the AutoTrak system delivered a smooth, precise wellbore without exceeding the maximum predicted pore pressure—modeled using resistivity logs and gas data—of between 1.45 and 1.5 SG.

In the 8½-in. lower section of the well, density images clearly identified high-angled natural fractures which caused high mud losses into the reservoir sands. Because the pre-drill model identified these formations up front, and because the drilling team had access to real-time monitoring data, the high levels of mud losses were managed by correctly sizing proppant and adding it to the drilling mud. This reduced the amount of loss-related NPT, and helped control the total cost for fluids, which were in the millions of USD on each well in this field. Natural anisotropies in the rock caused spiraling in the wellbore, which were minimized by running compatible drilling systems and bits. Despite the spiraling, the liner was run successfully to TD according to plan. After drilling was complete, an imaging run showed the AutoTrak system had delivered a straight, good-quality hole. 40 hours later, the imaging

tool was run again. It showed breakouts in interbedded shale formations that had not been observed on the initial imaging run, indicating that the hole was deteriorating over time.

The RiskGuard Stability solution anticipated and enabled the crew to effectively manage all wellbore stability problems encountered while executing the job. The operation concluded 17 days ahead of the schedule defined in the AFE, saving the customer an estimated \$7 million USD.



Spiraling caused by natural composition of the rock matrix was minimized, enabling the liner to be run to TD according to plan, despite facing time-dependent borehole deterioration.

bhge.com

© 2017 Baker Hughes, a GE company, LLC – All rights reserved.

Baker Hughes, a GE company, LLC and its affiliates ("BHGE") provides this information on an "as is" basis for general information purposes and believes it to be accurate as of the date of publication. BHGE does not make any representation as to the accuracy or completeness of the information and makes no warranties of any kind, specific, implied or oral, to the fullest extent permissible by law, including those of merchantability and fitness for a particular purpose or use. BHGE hereby disclaims any and all liability for any direct, indirect, consequential or special damages, claims for lost profits, or third party claims arising from the use of the information, whether a claim is asserted in contract, tort, or otherwise. The BHGE logo is a trademark of Baker Hughes, a GE company, LLC. GE and the GE monogram are trademarks of General Electric Company used under trademark license. RiskGuard is a registered trademark of Tempres Technologies, Inc.

77253

**BAKER
HUGHES**
a GE company

