CASE STUDY

HALLIBURTON

Norway

# Operator drills troublesome clays with inhibitive water-based mud

BaraHib® Gold trackable inhibitive water-based fluid system delivers wellbore stability in reactive clays

## CHALLENGE

- Drill and case off reactive Pliocene and Upper Miocene shales
- Prevent gumbo attacks
- Prevent bit balling and downhole losses
- Prevent shale swelling to allow casing strings to be run and cemented at depth
- Achieve effective hole cleaning in largebore intervals

## SOLUTION

- Custom BaraHib® Gold fluid system to inhibit reactive shales
- Extensive qualification process to validate fluid capabilities to suppress shale swelling, accretion, and erosion performance

## RESULT

- Drilled the first water-based mud section in the field in more than 20 years
- Drilled 17- x 20-in. section with limited flow rate and solids control equipment
- Hole slick and cased off

## Overview

The Pliocene and Upper Miocene shales in a mature Norwegian oilfield had not been drilled with water-based mud (WBM) for more than 20 years. Historical offsets noted the abrupt end of use for these fluids after well sections experienced severe shale stability problems. Challenges included gumbo attacks and bit balling. These operational issues added time and compromised drilling objectives because of induced losses and poor cement jobs. Sidetracks were needed to reach the reservoir.

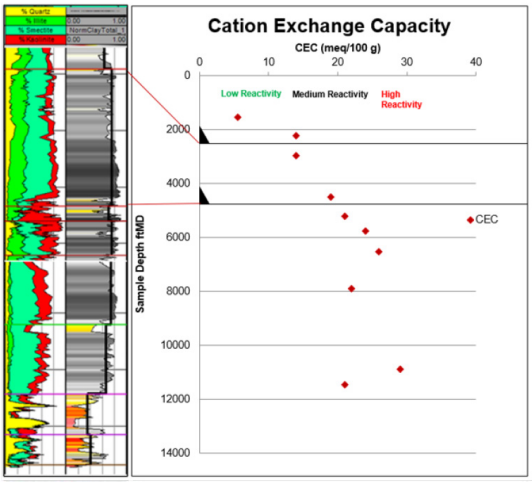


Figure 1: CEC values for well profile.

The Pliocene section is a large-diameter interval that requires a fluid density of 10.2 ppg. The 16-in. section requires a density of 12.9 ppg to remain above the collapse gradient as the section builds to an inclination of 50 degrees at target depth (TD).

Although non-aqueous fluid (NAF) systems are well suited for drilling such a highly-technical field, they can incur a host of operational expenses for slops and cuttings waste associated with containment, transport, and treatment phases. These costs have continued to increase in magnitude over time and offset some of the economic gains from added field production. In this case, the remote wellhead platform was located away from the main field's cuttings injection infrastructure. This prompted the operator to trial Halliburton's BaraHib® Gold high-performance water-based drilling mud (HPWBM) system in an attempt to reduce NAF waste management costs.

## Challenge

Shales in these zones include hydratable clays — composed of between 30-50% smectite, 10-30% illite, and 10% kaolinite. Cation exchange capacity (CEC) tests indicated results between 5 and 20 meq/100 g, with increased reactivity with depth (Figure 1). This meant that an inhibitive WBM design would be required, and the field maintenance practices during drilling would have to ensure the levels of key inhibitor components were maintainted.

Additional infrastructure challenges were also encountered. These challenges required adaptive engineering practices and close attention to detail:

- One mud pump was out of service and limited flow rates.
- The centrifuge was out of service, so there was increased solids content as drilling progressed.
- Critical rig equipment broke down at the end of the 16-in. section and resulted in the suspension of operations until it could be fixed.

## Solution

An extensive fluid qualification process was initiated at Halliburton's Tananger laboratory.

A customized BaraHib® Gold fluid system was developed for each section and qualified against formation samples obtained from previous activity. Capillary suction time analysis of various KCl brine concentrations aided in the determination of the optimum salt concentration for the base brine. The BaraSure® W-674, BaraSure® W-546, and GEM™ GP package was optimized to give low shale accretion values (less than 1% by weight on the most reactive shales), while shale swelling was controlled at 11% or less.

Figure 2: Drilled cuttings shown on shaker deck.

The final formulations were approved by the customer, and the well was designated a critical first well to ensure global focus. In addition to the qualification process, BaraSure® W-674 concentrations were tracked to control depletion and maintain optimum concentration while drilling. The cuttings (Figure 2) were dry inside and had visible cutting marks on their exterior to demonstrate high levels of inhibitive performance.

## Results

Both sections were drilled with expected and unexpected challenges. The liners were run and cemented without a problem. As a result of this successful trial, the concept for the use of HPWBM for remote drill centers was approved. This reduced NAF cuttings handling and disposal expenses. The estimated future savings are calculated to be $500,000-$1,000,000 less per well, compared to oil-based mud.

This first-time trial demonstrated to the client that problematic upper sections can be drilled with HPWBM. Two remote wellhead centers will be exploited in the future with the BaraHib Gold solution, with the potential to realize significant savings for the operator of between $4,000,000-$8,000,000 for a planned eight-well campaign.