TITLE OF THE SOLUTION GIVEN TO THE CLIENT

Description of the problem or background

- The Paleocene (Kolosh) shales above the Shiranish formation, **in Kurdistan Region of Iraq**, are potentially time dependent and reactive. Stability and dispersion analyses" were performed on samples to fully understand the behavior and chemical composition of these argillaceous rocks and thus design the optimum fluid type to drill through this section on future wells.
- Several wells were drilled using the KCl/Polymer/Polyamine system successfully but with many wellbore instability problems. Due to the nature of these shale formation, where they are mostly fractured and laminated, a sealing mechanism is required to minimize/prevent fluid invasion into these very small fractures and prevent destabilizing them. Asphaltic materials were used with mixed degree of success

- Based on the tests done on shale cuttings, and historical successful experience in Sudan and elsewhere, KCl- Silicate system was deemed to be beneficial to drill and stabilize these formations till they are cased off and cemented.

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Methodology or Proposed solution

As the Silicate mud was never used in Iraq before, all operators were wary to try it, but an Operator, who had drilled a couple of wells in very difficult Kolosh/Tanjero formations with every other inhibitive WBM, agreed to take up the challenge and took up the existing vertical well for Side-track through Kolosh/Tanjero with KCl-Sodium Silicate mud and drilled from 985m to 1845m MD, inclination 73.4°, to the section TD successfully.

Pictures of fully inhibited cutting samples as received on shakers during drilling

Figure 1: Depth 1108m, Inclination 15º; Kolosh T1.MW 11.0 ppg; Silicate Mud. Bit marks clearly visible, a mark of cuttings integrity.

Figure 2: *Depth 1314m; Inclination 28º; Kolosh T3. MW 11.5ppg of Silicate Mud. Bit marks clearly visible, a mark of cuttings integrity*

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Results

Riding on the successful trial of first side track they planned and drilled three more similar side-tracks but with varying degree of stratigraphic, geometric tortuosity and instability well bore challenges as the highly tectonically disturbed formations in Kurdistan vary every foot of its surroundings

In total, four highly deviated wells were drilled successfully with KCl-Sodium Silicate mud system and some more are in the pipeline.

Following typical data summarizes the 04 wells statistics:

Hole diameter (Inch)	12.25 /8.5
Section length (m)	550 to 1119
Maximum Inclination (deg)	64 to 74
Mud Density (ppg)	11.0 to 14.3
Flowline Temperature °C	60-80
Sod. Silicate content (% v/v)	10.0 to 11.0
KCl content (% w/v)	5 to 7
Section drilling days	6 to 18
Formation Losses (bbl)	Moderate to heavy
Cost of Fluid (US$/bbl)	$53.5 to $79.2

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Conclusions

1. Sodium Silicate mud has proved to be very efficient to seal the natural micro-fractures and inhibit the highly reactive Kolosh and Tanjero formations in Kurdistan.
2. Almost all the wells drilled were highly inclined and faced the problem of achieving and maintaining the planned wellbore trajectory. Despite tortuosity of the wellbore and very fragile bedding planes of the shales to drill, the sections were drilled successfully with Silicate WBM.
3. Maintaining 5-6% w/v Potassium Chloride in the WBM having 10-11% v/v Sodium Silicate, the system provides adequate inhibition.
4. Addition of 2-3% ID--FURY, 3-4 lb/bbl Graphite and 2-3 lb/bbl ID-TEX helped in providing additional wellbore stability by micro-sealing the natural fractures and additional lubricity to the system.
5. The system seems to develop high rheology issues once the Mud density approaches 14 ppg and mud circulating temperature goes beyond 65-70° C.