**Case History**

**Directional Drilling**

**Geo-Pilot® XL System for Soft Formations Saves Operator Three Days of Rig Time and Helps Increase Production by Over 47%**

Location: Bohai Bay, Offshore China

**OPERATOR’S CHALLENGE** – Deliver a fishbone well with an open-hole sidetrack for increased oil production in a very soft formation.

**HALLIBURTON’S SOLUTION** – Geo-Pilot® XL 7600 series rotary steerable system (modified for soft formation drilling), measurement/logging-while-drilling (M/LWD) suite and Geo-Pilot FMF3553 long gauge bit.

**ECONOMIC VALUE CREATED** – Saved over three days of rig time and helped deliver a 47% increase in production by delivering an open-hole sidetrack without a whipstock or a cement plug.

**FISHBONE WELL WITH OPEN-HOLE SIDETRACK** –

The China National Offshore Oil Corporation (CNOOC), one of the largest state-owned oil companies in China, as well as the largest offshore oil and gas producer, is using “fishbone” wells to increase oil recovery in their offshore Bohai Bay field. Fishbone wells can be an economical and optimal way to increase individual well production and optimize reservoir drainage by drilling one or more multilateral well segments that trunk off a main horizontal well. The very soft formation, combined with the reservoir dip angle upward 6 to 8 degrees, present a challenge to the successful delivery of the fishbone wells.

In a water depth of 25 m (82 ft), this particular well plan required horizontal drilling for approximately 100 m (328 ft) and then an observation as to what dogleg severity (DLS) was achievable in the soft formation. If the inclination angle could not be built as required, a whipstock would be run to drill the sidetrack where drilling would continue until the DLS was achieved, or until logging data indicated a good reservoir.

**GEO-PILOT FOR SOFT FORMATION DRILLING** –

Halliburton’s Sperry Drilling services deployed a Geo-Pilot XL 7600 series rotary steerable system (modified for soft formation drilling), M/LWD sensors and a long gauge Geo-Pilot bit from Drill Bits and Services. Drilling with a rotary steerable system in soft formations can be a concern, as building angle in weak formations can result in less steering response from the wellbore sidewall, limiting the maximum dogleg generation. However, the Geo-Pilot system can be modified to help eliminate many problems often associated with soft formation drilling, such as lower than expected build rates, strong walk tendencies and excessive housing roll. The Geo-Pilot system uses a stabilized lower housing, which helps enhance the build rates in soft formations, and also has a set of specially designed extended reach anti-rotation pads to minimize housing roll.

Bit hydraulics are also very important in soft formations to reduce the jet impact force and minimize hole washout at the bit. The hydraulic energy must be directed towards the center of
the wellbore, orienting the flow towards the centre of the bit to reduce hole enlargement due to erosion. To achieve this, a Geo-Pilot FMF3553 bit with a flow restrictor plate from Drill Bits and Services was used. By taking a systems approach to drilling, Sperry combined its rotary steerable tool with an extended-gauge bit to deliver optimized drilling performance and precise wellbore placement. The Geo-Pilot bits are stabilized and remain in the true center of the hole. Because the bit is centered in the hole, bit vibration is greatly reduced, allowing the bit to stay in good condition and drill at maximum rate of penetration (ROP) for the entire run.

The Geo-Pilot XL 7600 series system achieved 5.63°/30m (100 ft) DLS out of the shoe and delivered a 95.32 degree fishbone well, the first time in Bohai Bay that an open-hole sidetrack has been performed in the horizontal section at an inclination above 95 degrees. The 304 m (997 ft) open-hole sidetrack was delivered without a whipstock or a cement plug for kick off, and succeeded in increasing the reservoir exposure. Using the Geo-Pilot system also allowed installation of a mainbore liner in the high-angle well, something that would be difficult to achieve without the smooth wellbore delivered by the Geo-Pilot system.

**INCREASE OIL RECOVERY, DECREASE RIG TIME**

Increased reservoir exposure resulted in improved oil recovery, as evidenced by a 47.3% increase in production. In addition to the improved oil recovery, CNOOC saved at least three days of rig time when performing the sidetrack by eliminating a whipstock run, and also saved the cost of the whipstock. The successful delivery of the fishbone well has resulted in additional work awarded using this experience as an example for future wells.

**GEO-PILOT FOR SOFT FORMATIONS**

Sperry Drilling can be relied upon to deliver optimized drilling performance, accurate formation evaluation and precise wellbore placement. For this project, one striking ability demonstrated by the Geo-Pilot system was the ability to control and build angle in "soft" lithology or formations prone to washout. With a conventional rotary steerable system, the "push-the-bit" principle requires a competent formation to push against. In softer formations, the ability of the push-the-bit system to build angle or perform open-hole sidetracks is severely curtailed. Hole spiraling also tends to reduce the dogleg capability when using push-the-bit technology owing to the inconsistent nature of the wall against which the system is pushing. Conversely, the "point-the-bit" Geo-Pilot system can kick off from vertical and build angle successfully in soft unconsolidated formations without a cement plug, delivering an optimized drilling performance with additional cost savings to the operator.