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Steering Response for Directional Wells in Soft Formations in Deep Water Developments

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Abstract

In the search new for oil and gas fields great water depth is explored. One of these areas with large water depth is the south Norwegian Sea where the water depths exceeds 1000 meter. One identified drilling challenge in such areas is the deep water combined with soft overburden sediments. To ensure correct penetration of the reservoir rotary steerable systems will be used to drill deviated well paths. However, the behavior of rotary steerable systems in soft formation was a concern because building in weak formations gives less steering response from the wellbore sidewall which limits the maximum dog leg generation.

A method for calculating the rotary steerable systems steering response in different formations was developed by correlating the rotary steerable systems maximum response setting to the rock strength. This correlation was used to give guidelines to determine which sections were most likely to give good response when building angle.

The sedimentary rock strength analysis indicated low values in the ranges of 2-8 MPa which call for careful directional planning. Attention with respect to the planning of the wellpaths maximum dog leg severity had to be integrated with the rock strength profile. The maximum dog leg severity obtainable in the overburden was estimated to be 2° to 2.5°.

The first deviated wells from the field have given the anticipated steering response. This method should be applicable for other areas planning deviated wells in deep water with soft overburden.

Introduction

Directional wells are often the preferred solution when developing offshore fields. Especially since offshore wells have to be drilled from the same template below the (future) production platform or sub-sea production unit. It is critical to place wells correctly to reach reservoir target and to obtain the desired reservoir section length. When the reservoir targets tolerances gets tighter it is even more important that the actual well path follows the planned well path. In addition to follow the planned well path, the uncertainty in the geological prognosis makes it sometimes necessary to adjust the well path real time based on geological information collected while drilling, referred to as geosteering.

Rotary steerable systems (RSS) are one of the various technologies in use to change well directions, and RSS are widely used today. Some of the available RSS use pads or stabilizers in contact with the formation to create directional change at the bit face. The directional change is controlled by directing the mudflow through the tool. The effect is controlled by the amount of controlled flow given in %, typically in steps on 20%, defined as % active steering. Since, the systems rely on contact with the borehole wall to get directional control hole stability problems such as washouts, key seats and breakouts can negatively impact the directional performance on these systems (Schaaf et al. 2000). Drilling experience with RSS in directional wells has also shown that some geological formations give less response to directional change. Therefore different formations need more active steering to obtain the same directional change. The level of resistance a formation shows when direction changes are attempted by using a RSS is defined as directional response steerability (steerability). Formations with high steerability will enable rapid directional changes. While less steerable formations gives less directional change. Directional change itself is reported as dog leg severity (DLS), defined as the directional change (in degrees) per 30 meter or 100 feet. To predict formation steerability, already drilled directional wells can be used to back calculate an average formation stiffness factor. However this method requires that there are existing directional wells in the area. This is often not