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Improved BHA Sag Correction and Uncertainty Evaluation Brings Value to Wellbore Placement.

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Abstract

Recent well positioning uncertainties evaluation per SPE published ISCWSA model for MWD survey tools suggests that 80% of the inclination measurement error budget is a consequence of BHA sag.

BHA sag is the misalignment of the directional sensor with the borehole direction due to deflection of the MWD drill collar under gravity and borehole curvature. The magnitude of the error depends on BHA type and geometry, sensor spacing, hole size and several other factors.

This paper presents a new methodology based on modern 3D BHA/Hole interacting modeling for BHA sag corrections and residual error evaluation at each MWD survey stations.

11 different typical 17½" and 12¼" rotary and steerable motor BHA's with variable gauge stabilizers were computed in multiple configurations (borehole geometry, BHA settings, friction…) following a Monte Carlo process which involved more then a million simulations. Results of this study show that the residual BHA sag uncertainty as proposed by the ISCWSA model can be further reduced by as much as 50%.

A simplified software automated process was developed in order that Operations Support Centres can easily integrate the proposed methodology as part of near real time Survey Management advanced processing routines.

A sound BHA sag correction method along with a thoroughly analysed residual sag error, readily fit for use within the ISCWSA MWD well positioning uncertainty model (today's industry standard), appears essential in a wide variety of directional drilling applications including extended reach and horizontal drilling.

The proposed process contributes to improve significantly wellbore placement through the pay zone while drilling. Reduced trajectory positional uncertainties contribute to the construction of sound geological models for rational well target design, positioning and development pattern fine tuning during the drilling campaign. In turn reservoir management including mature fields shall benefit from improved Wellbore Placement as a multidisciplinary task by locating more accurately layer tops and contacts.

Introduction

ISCWSA presentation

Objectives

Wellbore positioning uncertainties[1] should be neither underestimated because of collision avoidance issues, nor overestimated in terms of target hitting. Therefore, confidence levels on uncertainties should be set. To take up these challenges, companies joinned their respective competences which has lead to the emergence of the ISCWSA : The Industry Steering Committee for Wellbore Survey Accuracy. The aim of this group is to "produce and maintain standards for the industry relating to wellbore survey accuracy". In 1999, H.S Williamson[2] highlighted the committee work and described a full MWD error model. With the gyro model[3] coming up, these two error models are today accepted as the new standard error models, continuously being maintained and improved[4].

Error model

Wellbore survey stations are modeled as three-element measurement vectors, the elements being along-hole depth, *D*, inclination, *I*, and azimuth, *A (D, I, A)*. The ellipsoid of uncertainty (E.O.U) is the result of numerous contributions of different error sources. Each error source is a physical phenomenon which leads in the model to an error term described by a name, a mean value, a magnitude and a weighting function : effect of the error on the measurement vector *(D, I, A)*. Errors from different error sources are considered statistically independent and have their own mathematical propagation mode, either Random (R), Systematic (S), Well by well (W) or Global (G). The main physical error sources are derived from magnetic compass errors, gyrocompass errors, tool misalignment errors, magnetic field uncertainty and along-hole depth error. Among these