SPE-201740-MS

Empirical Analysis of Lateral Spacing Uncertainty in North America Due to MWD Survey Error

Shuba Love; Marc Willerth; Andy McGregor; Elizabeth McElroy

Abstract

Lateral spacing in unconventional plays can have a significant impact in the economics of field development (Bharali et al., 2014; Lalehrokh & Bouma, 2014). This spacing is most often verified using magnetic measurement while drilling (MWD) instruments. In well spacing studies, the distance between two laterals is typically assumed to be precise, however, MWD may have large uncertainties associated with their bottom hole locations (Williamson, 2000; Grindrod et al., 2016). Standard error models were built primarily using data from major service providers' offshore operations and assume a level of accuracy that may not reflect current practices for onshore drilling in North America (Love, 2019). This study better quantifies the positional uncertainties of MWD surveys in long laterals and uses those uncertainties to estimate well spacing uncertainty.

More than 35,000 MWD bit runs across more than 9,000 laterals wellbores in major basins across North America have been analyzed for survey errors. The observed errors are then tested in magnitude and distribution against assumptions of industry standard models. An empirical MWD error model for North America is generated, and additional area-specific analysis is performed for the Bakken, Denver-Julesburg, Eagle Ford, Marcellus/Utica, Permian/Delaware and Western Canada. The wellbore trajectories were analyzed to produce a prototypical wellplan for each basin studied, as well as an overall "North America" wellplan. Positional uncertainty calculations were performed for each wellplan using several industry standard positional uncertainty models as well as the empirical models based on real MWD data. Using the combined covariance method of wellbore separation, the uncertainty in lateral spacing is estimated for each wellplan at landing point, mid-lateral, and the toe.

A pair of typical North America long laterals (10,000ft step out, drilled parallel) were modeled using the empirically derived MWD error model. After accounting for geomagnetic correlations, there remained an estimate 350 ft of uncertainty in the separations (at 2-sigma) between the wellbores are the toe. This is significantly larger than the 160ft of spacing uncertainty that would be predicted using an industry standard MWD model or the 100ft theoretically achievable with standard survey management practices. A similar analysis was performed at a basin level, and in all cases the modeled uncertainty from common practice was larger than predicted by industry standards. The dominant error source that is impacting lateral spacing is magnetic drillstring interference (DSI). The 68th, 95th, and 99.7th percentiles for observed DSI magnitudes were 520, 1400 and 4200 nanotesla respectively. Creating a 95% confidence equivalent error model (2-sigma) requires and error magnitude more than 3 times greater than the industry standard. For companies that use greater than a 2-sigma limit when well planning, deviations even more extreme should be expected. Further discussion of the probability distribution and its impact on lateral spacing is included. Additional analysis compares how these uncertainties change for parallel wells drilled in opposite directions (anti-parallel) as opposed to drilled in the same direction.

MWD error models are routinely used as the basis for both safety critical and economically significant workflows in onshore North America operations, to date, there has been a lack of data collected regarding their suitability for this purpose. For drilling programs where lateral spacing will have an impact on economic performance, proper estimation of the spacing uncertainty will lead to better asset modeling. Further, it will enable better estimation for the marginal value provided by improvements in survey accuracy.

Copyright 2020, Society of Petroleum Engineers

Visit OnePetro to read the full paper