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Drilling Three-Mile Laterals Tighter and Safer with a New Magnetic Reference Technique

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Abstract

Three-mile laterals have become more common over the last five years of onshore US drilling. They are especially commonplace in the Appalachian and Permian basins and are used to overcome limited surface access for drill pads and for economic reasons. These long laterals pose significant wellbore positioning and anti-collision challenges. Horizontal position error grows at 2% (or more) of the lateral length per degree of wellbore azimuth error. This work addresses these wellbore positioning challenges with a new and significant improvement in magnetic field determination. With this procedure, multi-well pads with tightly spaced three-mile laterals can be drilled without compromising anti-collision standards or horizontal placement goals.

Most commonly in the US land market, tightly spaced laterals are 1-2 miles in length and make use of In-Field Referencing (IFR-1) magnetic models built from airborne geophysical surveys to ensure proper positioning and avoid well collisions. For more challenging pad designs, such as three-mile laterals, a new method has been developed to combine an IFR-1 magnetic model with a near-well magnetic theodolite measurement to build a more precise magnetic model and positioning tool code. Specifically, the declination error terms in the ISCWSA (Industry Steering Committee on Wellbore Survey Accuracy) Error Model can shrink beyond the IFR-1 tool code specifications. This reduces the horizontal uncertainty in the ellipse of uncertainty (EOU) by upwards of 40% when compared to the MWD tool code standard.

A study was conducted on a typical well and pad design for three-mile laterals in the Marcellus Shale in Pennsylvania. We find that the horizontal uncertainty with the MWD tool code at two and three miles of reach to be 206 feet and 303 feet, respectively. With the new tool code enabled by this body of work, we calculate the horizontal uncertainty at two and three miles of reach to be 120 feet and 174 feet, respectively. These results clearly show that this technique enables three-mile laterals to be drilled more safely and more tightly together. It is preferable for well pad design and lateral spacing to be determined by drilling and reservoir economics rather than collision concerns. Well planners and reservoir engineers can now safely access more of the reservoir from a single pad with longer laterals.

This work is novel because it combines a ground based, near-well, magnetic measurement with an airborne derived IFR-1 model. This allows for a greater reduction in positioning uncertainty than has been available in the past. The application of this method to three-mile laterals is also new and has a profound impact on being able to plan optimally spaced wells and avoiding collisions.

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