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Enhanced Wellbore Placement Accuracy Using Geomagnetic In-Field Referencing and Multi-Station Correction

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Abstract

Reduced lateral spacing in congested oil and gas fields requires advanced techniques to prevent collisions while drilling. Anti-collision separation factors depend on the accuracy of the steering technology employed. Geomagnetic In-Field Referencing (IFR) with Multi-Station (MS) correction improves lateral steering accuracy by about 50% . This technique enables the drilling of straighter wellbores with fewer deviations and closer spacing.

Most horizontal wells are steered using measurement while drilling (MWD). The MWD tool in the bottom hole assembly (BHA) houses an accelerometer and a magnetometer to determine the inclination and magnetic azimuth of the drill bit. This magnetic azimuth is then converted into a true (geographic) azimuth using a global geomagnetic reference model. Inaccuracies in the global geomagnetic model and magnetic interference are the largest sources of error in wellbore positioning by MWD. Local crustal magnetic anomalies and interference from the drill string cause significant distortions in the strength and direction of the natural geomagnetic field. These distortions can be reduced significantly by using a local 3D geomagnetic IFR model and by subsequently applying an MS correction to the raw survey measurements.

IFR models are computed from high-resolution satellite and aeromagnetic measurements of the geomagnetic field. A new constellation of low-orbiting satellites provides accurate specification of the long-wavelength geomagnetic field. This information is complemented by local high-resolution airborne magnetic surveys. Once the natural geomagnetic field is accurately specified by IFR, magnetic interference from the drill string can be removed by the Multi-Station correction.

This paper highlights the benefits of IFR and MS corrections on specific examples from Texas and North Dakota. Azimuth corrections of 1 degree lead to changes in wellbore position of 200 feet and more at TD. Improved specification of the strength and dip of the geomagnetic field further enables tighter quality control of MWD surveys. The improved accuracy of the IFR+MS technique is quantified in the new set of Operator Wellbore Survey Group (OWSG) tool code MWD+IFR+MS. This tool code reduces ellipses of uncertainty by about 50%, thereby facilitating well planning and enabling closer spaced laterals and in-fill drilling.

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