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Using Autonomous Marine Vehicles to Enable Accurate Wellbore Placement in the Arctic

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Abstract

This paper describes a study using an autonomous marine vehicle with satellite communications, to accurately collect and deliver in real-time magnetic measurements, to calculate Total Magnetic Intensity in marine environments in the absence of Earth magnetic observatories.

New capabilities in the monitoring of auroral electrojet disturbances allow improved well placement for increased oil and gas recovery in the Arctic, and provide operators accurate geomagnetic reference values, enabling tighter quality control of MWD equipment, enhancing safety and reducing nonproductive time.

In the Arctic, Measurement while drilling (MWD) processing must include corrections for rapid changes in the geomagnetic field caused by auroral electrojet currents. The auroral zone is a region where the electric field of the magnetosphere precipitates along magnetic field lines into the ionosphere. Converting the magnetic azimuth to a true azimuth requires accurate knowledge of the geomagnetic field at the point of measurement downhole at the drill bit. Equipped with this information lateral uncertainties can be reduced by 50%.

At higher latitudes, the strength of the horizontal component of the geomagnetic field shrinks, which exacerbates any error sources that accumulate while surveying. This has an enormously negative effect on surveying accuracy at high latitudes. Data from Earth magnetic observatories and variometer stations can be analyzed to characterize the auroral electrojets and compensate for the disturbance. Knowledge of the spatial structure of the electrojets' magnetic signature is essential for deploying a ground network of monitoring stations in the Arctic. This network provides the real-time geomagnetic infrastructure essential to support MWD operations, making it the most cost-effective technology available to achieve accurate wellbore placement in horizontal, relief well, and extended reach drilling. However the number of Earth magnetic observatories is limited in the Arctic.

Autonomous marine vehicles can now be deployed for geomagnetic surveying. In recent testing, two autonomous marine vehicles were equipped with towed magnetometers. To investigate the accuracy of the measurements, the two vehicles surveyed exact-repeat profiles. The measurements of the two vehicles agreed to within 2nT, exceeding even the stringent 5nT standard for geomagnetic observatories. This test demonstrates the utility of autonomous marine vehicles to carry out crustal magnetic surveys and monitor disturbance fields in support of offshore directional drilling operations.

Note: This paper is a consolidation of 2 papers, Poedjono et al, OTC-25228 and OTC 1726418

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