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Using Hybrid Propulsion Autonomous Marine Vehicles to Better Characterize Geomagnetic Fields Offshore

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Abstract

We present a study conducted to develop and validate new capabilities for offshore geomagnetic surveying that employs the autonomous marine vehicle (AMV) to map the crustal magnetic field and monitor disturbance fields surrounding offshore drill sites. Knowledge of geomagnetic field direction and strength in the wellbore are essential parameters needed for directional drilling. To compute wellbore azimuth, the directional driller compares the magnetic field measurement provided by the measurement-while-drilling (MWD) tool with the geomagnetic field reference data to position the wellbore in real time while drilling. Correction for variations in the disturbance field is essential for accurate mapping of the crustal geomagnetic field. Unfortunately, land-based stations are not ideal for mapping the disturbance field in the offshore because of the distance of the station from the measurement site and the different electrical conductivity of the subsurface. To address the need for improved measurement of the disturbance field in offshore surveys, this study also investigated whether the new-generation, hybrid, wave- and electric-thruster powered AMV is suitable for use as a "base station" to monitor time variations of the geomagnetic disturbance field.

To conduct the study, we equipped two hybrid AMVs with towed marine magnetometers. Highly sensitive sensors established the minimum required separation between the AMV's electric thruster and the magnetic sensor payload. For validation as a base station, data collected by the vehicles from May 11 to May 14, 2015, was analyzed and compared with data obtained from the USGS Honolulu Geomagnetic Observatory (HON). To then evaluate the survey measurement system offshore, we compared data from a previous 2013 wave-powered AMV geomagnetic survey (Poedjono et al., 2015) with repeat data of the main, tie, and perimeter lines newly collected by the AMVs in this 2015 study.

Our results show that the AMV is ideally suited to carry out geomagnetic surveys in offshore remote locations, and a second AMV circulating at a fixed location provides a more accurate base station than a land-based station.

The hybrid AMV offers distinct advantages for geomagnetic data collection in offshore environments. The low cost compared to a seaborne or airborne vehicle allows AMVs to be deployed in tandem and collect data repeatedly over predefined areas, yielding accurate measurements to determine the disturbance and crustal magnetic fields. Use of the AMV solves the long-standing problem of how to accurately map the previously unknown geomagnetic reference field in offshore locations.