深海地磁気異常から推定した背弧拡大域海洋底の磁化強度変化

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Absolute magnetization of oceanic crust on the back-arc spreading axis constrained from near-bottom magnetic anomalies

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The near-bottom survey using a submersible, deep-tow, Remotely Operated Vehicle (ROV) and Autonomous Underwater Vehicle (AUV) make it possible to conduct high-resolution magnetic mapping and understand detailed magnetic features, for example hydrothermal alteration zones and geomagnetic paleo-intensity variation [e.g. Gee et al., 2000; Tivey and Johnson, 2002].

To detect signals from hydrothermally altered rock and fresh pillow lavas, we conducted near-bottom three component magnetic measurement using fluxgate magnetometer attached to the submersible Shinkai 6500 in the back-arc spreading axis of Southern Mariana Trough, where is active back-arc basin with five active hydrothermal vent field. Fourteen dives were carried out with 1 - 40 m altitude in 2010 during YK10-10 and YK10-11 cruises.

We carefully correct the effects of induced and permanent magnetizations of the submersible by applying the dumped least square method [Honsho et al., 1999] based on the general observation equation [Isezaki et al., 1986]. After subtracting the IGRF from the corrected data, we successfully obtain geomagnetic vector anomalies along each track in geographical coordinate.

Moreover we calculate synthetic magnetic anomaly due to rectangular prism-shaped with arbitrary polarization using the three dimensional forward modeling technique by Bhattacharyya [1964] to estimate absolute magnetization intensity. Absolute magnetization is calculated by the technique of linear transfer function in the Fourier domain using observed and synthetic magnetic anomalies [Honsho et al., 2009].

The distribution of estimated absolute magnetization shows low magnetization around hydrothermal vent sites. This character is common among five hydrothermal vent sites and consistent with equivalent magnetization map estimated by previous AUV survey data. These results suggest that low magnetic signals are due to hydrothermal alteration zones where host rocks are demagnetized by hydrothermal circulation [Tivey et al., 1993; Rona, 1978]. Moreover, the horizontal scale of low magnetization zones around the off-axis vent sites is about 10 times larger than those around the on-axis sites. We consider that the longer duration time of hydrothermal circulation in off-axis sites makes the alteration zone larger.

In another interesting results, the absolute magnetization intensities of our data show extremely high magnetization on neo volcanic zones (NVZ) and relatively low magnetization 2 - 5 km away from the NVZ. These resultant values are almost consistent with the values of NRM on basalt samples. These results show low temperature oxidation of host rock reacted with seawater has completed within a few km distance from the spreading axis.

We concluded magnetization of uppermost oceanic crust decreases with age due to hydrothermal rapid alteration process and low-temperature gradual alteration process.