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Origin of Magnetization High at the Yokoniwa Hydrothermal Vent Fields, the Central Indian Ridge

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Measurement of near bottom magnetic anomalies is an effective method to reveal the spatial extent of hydrothermal alteration zone and to find buried hydrothermal vent fields because hydrothermal alteration processes can change crustal magnetization by destruction and creation of magnetic minerals. In the Yokoniwa vent field (YVF), which is located at the top of the non-transform offset massif, called the Yokoniwa Rise, in the southernmost part of the Central Indian Ridge, a high magnetization zone was discovered by AUV r2D4 in 2009. Basalts and ultramafic rocks were found around the YVF, however the origin of positive magnetization and the relationships between high magnetization and hydrothermal activity are remains to be investigated.

In order to constrain the origin of magnetic source near the YVF, we conducted deep-sea geological observation and magnetic measurements using submersible Shinkai 6500 during the R/V Yokosuka cruises, YK09-13 and YK13-03. Vector geomagnetic field were successfully obtained along the all dive tracks at an altitude of ˜10 m. The distribution of crustal magnetization is estimated by vertical and horizontal components of magnetic anomalies using the 2-dimesional forward modeling technique and frequency analysis.

In the southern slope of the Yokoniwa Rise, serpentinized-peridotites were discovered and absolute magnetization shows entirely low (˜6 A/m). On the other hand, just around the YVF, hydrothermal sulfide deposits, tiny dead chimneys, shimmering and talc were observed and absolute magnetization shows relatively high (9 A/m). This magnetization contrast between the YVF and the surrounding area may be attributed to the difference in amount of magnetite, controlled by the degree and the temperature of serpentinization. One of the serpentinized-peridotite recovered during the cruises showed large amount of magnetite and high natural remanent magnetization. However, the highest absolute magnetization (20 A/m) was discovered at pillow basalt area with thin sediment just ˜700 m away from the YVF, implying recent off-axis volcanic activity. Therefore basaltic intrusion beneath the YVF is also possible for the origin of high magnetization. In addition, magnetic iron sulfide (pyrrhotite) grown during hydrothermal circulation, which is proposed at the Rainbow hydrothermal vent field, is also possible.

Consequently, we proposed three possibilities for the origin of high magnetization at the YVF; serpentinized peridotites with high temperature hydrothermal alteration, basaltic intrusion bodies, and pyrrhotites concentration. All of these hypotheses are related to hydrothermal activity. For the further inspection, recovering subseafloor rocks and inspection of rock magnetic properties are absolutely necessary.

Keywords: Seafloor hydrothermal activity, Mid-ocean ridge, Ultramafic rock, Deepsea magnetic anomaly, Off-axis volcanism, Oceani lithosphere