Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

BBG21-P04 Room:Convention Hall Time:May 21 10:45-12:15

Crustal magnetic structure around the hydrothermal fields in the Southern Mariana Trough

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Seafloor hydrothermal systems are important in relation to global heat and chemical fluxes as well as habitat of microbial communities. Circulation of fluids within oceanic crust depends on the geometry of heat source, the composition of rock as permeable medium and seawater. The substantial variation of hydrothermal systems active in various tectonic setting has important implications for the magnetic structure of oceanic crust.

It has been very difficult to detect the geophysical signature of hydrothermal systems based on crustal properties because the small scale of hydrothermal systems compared to distance between surface and bottom imposes limitation of resolution on the sea surface observation. The advance of near-bottom survey methods using a submersible, deep-tow, ROV and AUV has made possible high resolution geophysical mapping around hydrothermal areas. Near-bottom magnetic survey can provide direct information on the magnetization of shallow part of oceanic crust, implying the hydrothermal alteration both in active and fossil vent sites.

Near-bottom three component magnetic measurements on submersible Shinkai 6500 were carried out at three hydrothermal fields in the Southern Mariana Trough, the slow spreading backarc basin. We investigated the magnetic structure of three hydrothermal systems (Pica, Snail and Archean) to clarify how the geophysical and geological setting controls the fluid circulation in the small scale here.

The 14 dive surveys ware conducted successfully during R/V Yokosuka YK11-10 and YK10-11 cruise. A fluxgate magnetometer was attached to Shinkai 6500. Four dives (dives 1218, 1220, 1227 and 1228) were devoted to the Snail site located in nearest to the backarc spreading axis. Among those dives, dive 1227 crossed the axial volcanic zone, providing a ˜2km long NW-SE transect. The other five dives (dives 1216, 1217, 1221, 1223 and 1224) were conducted around the Archean site, forming a ˜60m high mound at the foot of ridge crest. The remaining four dives (dives 1214, 1219, 1222, 1225 and 1226) were done at an off-axis seamount where the Pica site was located. Dives 1214 and 1219 mainly cover the northern slope of this seamount and lead to the discovery of a new vent site (Urashima Site).

The observed data were first corrected for the effects of induced and permanent magnetizations of the submersible, based on Isezaki [1986]. To find plausible correction coefficients, we adopted the dumped least-square method (Honsho et al., 2009). The International Geomagnetic Reference Field (IGRF) is subtracted from the corrected data to obtain the geomagnetic anomalies. The crustal magnetization will be estimated using the AUV-collected high resolution bathymetry.

Keywords: Southern Mariana Trough, backarc basin, hydrothermal system, near-bottom magnetic measurement, crustal magnetization