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Electrical structure beneath the spreading center in the central Mariana Trough using MMR method

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We researched a hydrothermal vent site, the Alice Springs Field (18-12.9N, 144-42.5E, 3600m deep) in the central Mariana Back-Arc Basin using R/V Kairei, JAMSTEC from October 28 to November 12, 2002. The MMR method is a magnetic technique and involves two components; a source and receivers. The source is a dipole which is made from two electrodes: one is just under the sea surface, the other is near the seafloor. The receivers are ocean bottom electromagnetometers (OBEMs). The MMR method is useful for estimation of the oceanic crust resistivity structure, and resistivity is sensitive for temperature and water content.

We deployed 6 OBEMs and supplied the electric current around the Alice Springs Field.We used six Kobe type OBEMs (R1-6) for the MMR experiment All the OBEMs can measure three components of magnetic field variation, two components of instrument tilt and temperature. Two OBEMs (R2,5) can also measure three components of electric field variation and have pipes for attaching electrodes.

Fluxgate type magnetometer, voltmeter, and tilt meter are packed in a withstand pressure glass sphere for each OBEM. The OBEM has another one glass sphere which contains both the battery and transponder. Five silver-silver chloride electrodes are attached to the tips of pipes. The clock of the OBEM was set to GPS clock, and was compared again after the recovery and will be used for the time correction.

We deployed 6 OBEMs at the OBEM sites which are arranged on the two lines perpendicular to the direction of the ridge axis. The OBEMs were launched from the deck, and then sank to seafloor by self-weight. They drifted away from the position we originally planned on the way to seafloor due to oceanic currents. The positions settled on the ocean bottom are estimated by acoustic ranging at more than 3 points surrounding the position deployed.

The MMR experiment consists of two important parts; one is to supply the electric current whose wave form is rectangular, and the other is to estimate the position of the bottom electrode.

The power unit supplyed the electric current. We supplied the electric current along four lines. In case of the LINE1 to 3,Kairei stopped at every source point and the electric current was supplied for about 30 minutes. After that,Kairei transits the next source point without supplying the electric current.

We used the Kairei SSBL system and the acoustic unit to estimate the position of the lower electrode. A transponder used for SSBL was fixed 1m above and the acoustic unit was fixed 100m above from the bottom electrode. The acoustic unit measured altitude from the seafloor, depth of the acoustic unit, and slant ranges from the ship and from each OBEM. We controlled altitude of the bottom electrode at about 20 meters.

We recovered five OBEMs by sending release commands. The OBEM at site R6 did not leave from the bottom, even although it responds the release command several times.

We can get complete data from the three OBEMs at the site R2, 4 and 5. The OBEM at the site R3 recorded data for about 3.4 days. The OBEM at the site R1 recorded the data for only 1 minute.

We analyzed the data along Line1, 2 and 3 and estimated apparent resistivity structure in 2 dimensions. Beneath the spreading axis, the apparent resistivity is low, about 2 ohm m from 0 to 700m depth. The resistivity is smaller if the porosity is bigger or/and the temperature of sea water in the crust is hotter. It means that the deep part of spreading axis is very hot if porosity is smaller in deep part than in shallow part. At the frank of ridge, we find very resistive zone, 16 ohm m, at 150 m depth. If porosity is small in the shallow part of the crust, very cold sea water exists in this resistive zone. It indicates the aperture of cold seawater to hydrothermal circulation.