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Marine Controlled-Source Electromagnetic Survey with ROV for Imaging Near-Seafloor Structure in the Pacific

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The Pacific plate at the seaward slope of the Japan Trench is very old and should have low heat flow values. However, recent dense heat flow measurements indicate high anomalies seaward of the Japan Trench (Yamano et al. 2008). In order to elucidate the source depth of high heat-flow anomalies, we conducted hybrid marine EM surveys on the Pacific plate. In this study, we present the preliminary results of new marine controlled-source electromagnetic (CSEM) survey using ocean-bottom electromagnetometers (OBEMs) and the electric source dipole attached to a remotely operated vehicle (ROV). The oceanic crust with high fluid content and sub-seafloor groundwater circulation can yield both high heat flow and high electrical conductivity anomalies. Our CSEM exploration with the ROV system will allow us to image the electrical conductivity structure near the seafloor with depth of tens to hundreds meters, and has possibility to detect the source depth of heat flow anomalies.

At the cruise named KR09-16, by JAMSTEC R/V Kairei, we conducted marine CSEM surveys in the northeastern Pacific ocean (far off Sanriku) in November, 2009. Two sites with water depth of 5200-5700m were selected: a site near high heat-flow anomaly, and another one located further south as a reference. We used a new controlled electromagnetic (CSEM) system operated by the ROV "Kaiko7000 II". A 20m-length cable and a transmitter unit were attached to the vehicle of ROV. During Dive#461-#463 of Kaiko7000 II, the transmitter on the Kaiko vehicle sends the artificially controlled electric current (with squared waves) on the seafloor using the 20m-dipole cable extended horizontally. An OBEM (ocean bottom electromagnetometer) receive the EM signal, and then we can estimate the apparent resistivity at the seafloor. Since the seawater conductivity is measurable with the CTD sensor attached to the Kaiko vehicle, we can obtain the electrical conductivity distribution below the seafloor. Also, the electrical potential field generated by artificial current can be measured by the ROV itself using many electrodes attached to both the cable and the ROV frame. Those short-range received values can be used for imaging the shallow sediments just below the seafloor.

As a result, the electric signal sent from the ROV was properly received by the OBEM on the seafloor with source-receiver separation of 58-420m. This experiment, the ROV-CSEM survey, is a first trial and success in the world. The data analysis is now undergoing and will allow us the discussion about near-seafloor resistivity structure of the Pacific plate. We will present the preliminary results together with introduction of our CSEM system.