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Crustal resistivity structure in the Inland Sea by MOSES method

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Resistivity (the reciprocal of conductivity) is one of the methods that suggest the inner structure of the earth. The electrical resistivity of the seafloor depends primarily on the amount of seawater within the crust, its spatial distribution, and its temperature and salinity. Because of this dependence, measurements of seafloor electrical resistivity can give an idea on the circulation in the shallow crust. Magnetometric Off-Shore Electrical Sounding(MOSES) method is a control source technique that involves two components: a source which is a vertical bipole, and receivers which are remote seafloor magnetometers (Ocean Bottom Magnetometer; OBM). In the presence of a layered seafloor, the magnetic field generated by the bipole source falls off with distance from the source approximately as 1/R2. In the case we know the current passing between the electrodes, the magnetic field amplitude measured by OBM will give the mean resistivity under the seafloor. Experience has shown that the depth of resolution of MOSES method is about 1/3 the maximum source-receiver offset.

The first experiment was carried out on board of the 'Onokoro' ship (8.5t) that belongs to Kobe University in May 2001. Study area is onshore of Kobe city, eastward of Akashi Bridge, in Inland Sea of Japan. One three-component sensors OBM deployed at a water depth of 22m, measured the magnetic field every second. A 40A current with a rectangular waveform of 16s period was passed between the upper electrode in the ship and the lower electrode just above the seafloor for about 30 minutes. Because the ship was driven by sea currents, source-receiver offset was changing. During the experiment, the position of the ship was determined using GPS settled on the ship. OBM-ship offset was decided by sounding.

To estimate the resistivity structure, lower electrode-OBM offset(R) and the amplitude of the varying magnetic field are needed. Longitude and latitude of OBM and the ship are necessary to determine R. Those of OBM were calculated from OBM-ship offset at about 25 sites only. However, computing a (T,R) curve allowed us to resample the R distance every second. The value of R is varies from 50 to 300m. For the analysis of the magnetic field variation amplitude, we focused on the two horizontal components. The vertical component has no influence since the applied current was viretical. Analytical procedures are as follows: 1. Computing the difference between the measured value and the average of the measured values for every component. 2. Computing the powerspector by Fourier transformation using a 64s window (which is a multiple of the current period). 3. Using the two measured horizontal components, we estimate the powerspector of the resultant horizontal component. 4. Transformation from powerspector to amplitude of magnetic field. The reference wave is a rectangular waveform with a given amplitude and 16s period. 5. Change the dataset from time series of amplitude and time series of R to amplitude for R. 6. A simple 1-D smooth inversion of resistivity model [Constable et al., 1987] was estimated.

This model can infer 1-D resistivity structure under the seafloor to about 100m depths. It shows about 5.24ohm m average resistivity, and a little reduction with depth. The data can be divided into 2 kinds of datasets from 50 to 80m: data acquired when the ship was close to OBM, and data acquired when the ship was far away from OBM. We estimate the different resistivity about 5.28ohm m and about 5.8ohm m, respectively, with an average the about 5.6ohm m. These results suggest that the upper oceanic crust is not 1-D resistivity structure and require 2-D and 3-D modeling.

In the future, an increase in the number of OBM and sites of source and receiver will give a better resistivity structure. Furthermore, we are trying to develop 2-D and 3-D programs. This will infer patterns of hydrothermal circulation at Suiyou seamount.