Marine electromagnetic survey off Lutzow-Holm Bay, continental margin of East Antarctica

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Break-up and formation of supercontinents are closely related to the driving force of plate tectonics and the mechanism of seafloor spreading through mantle dynamics. Lutzow-Holm Bay is located at the margin of Antarctica (69S, 37E) around the boundary between the continental and oceanic crust. This boundary is thought to be formed by the break-up of the Gondwana supercontinent. We conducted a marine electromagnetic survey off Lutzow-Holm Bay to image electrical resistivity, which is dependent on composition, water content, and temperature, of crust and mantle. Revealing the electrical resistivity structure of crust and mantle beneath this region will help to understand mechanisms of Gondwana break-up and the subsequent seafloor spreading process.

We used two Ocean Bottom Electro-Magnetometers (OBEMs) in the survey. The OBEMs were deployed and recovered by the ice breaker SHIRASE during the 47th Japanese Antarctic Research Expedition. Time-variations of three components of the magnetic field, four components of the voltage difference were recorded for about 90 days from December 2005 to February 2006 in two OBEMs. Two components of the tilting of two OBEMs were also obtained.

Three components of electromagnetic field time-variations were obtained by removing spiky noises, correcting the instrumental clock, calculating electric field from voltage differences, and detilting OBEM from the recorded data. One component of the voltage difference of one OBEM was very noisy during about 10 days (January 2006), therefore, this voltage difference data during this noisy term was not used in further analysis. One tilting data of both OBEMs were beyond the measurement range (plus and minus 8 degrees), therefore, these undetermined tiltings were estimated by comparing three components of measured magnetic field with IGRF (International Geomagnetic Reference Field) data at the stations.

We used the magnetotelluric (MT) method to analyze the electromagnetic field time-variations. MT responses were obtained after removing statistical outliers with the BIRRP program (Chave and Thomson, 2003, 2004). Calculated period of MT responses was from 240 seconds to 81920 seconds. The obtained MT responses of both sites have common features: (1) Off-diagonal and diagonal components of apparent resistivity are comparable at above several thousand seconds; (2) apparent resistivity is under 10 Ohm-m in all the periods and becomes smaller at shorter periods (1-3 Ohm-m at below 3000-4000 seconds). These features could result from three dimensional topography, three dimensional continental and oceanic electrical resistivity structure, and sediment layers around the stations. We will quantitatively show these effects using forward modelings, and discuss the electrical resistivity structure beneath off Lutzow-Holm Bay. We will also discuss effects of source magnetic field on the MT responses observed at high latitudes (around 67S).