Imaging of the stagnant slab beneath the Philippine Sea by seafloor electromagnetic survey: Preliminary report on the observation phase

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We have run a seafloor electromagnetic survey project in the Philippine Sea in order to image the deep mantle slab stagnating in the transition zone and surrounding mantle in three dimensions. Seafloor observations at every 500 km or so is necessary to resolve the geometry of the slab because existing data sets are based on the observations by land geomagnetic stations and submarine cables, which are distributed coarsely and unevenly. Although it is difficult to establish a number of nearly permanent observation stations at seafloor, iterative maneuver observations using ocean bottom electromagnetometers (OBEMs) can acquire the data required to probe down to the mantle transition zone if observations are performed for several years.

The project iterates one-year-long deployment three times in northern Philippine Sea and western edge of the Pacific Plate (Fig. 1 and Table 1). Earthquake Research Institute, University of Tokyo and Institute for Research on Earth Evolution (IFREE), Japan Agency for Marine-Earth Science and Technology (JAMSTEC) have resourced the project with the OBEMs. In the first phase, we deployed 11 OBEMs in October, 2005 and recovered all of them successfully in November, 2006. R/V Kairei of JAMSTEC was utilized for both cruises. In the second cruise, we deployed another 12 OBEMs and started the second phase. The recovery of the OBEMs and the third initiation were successfully done in November, 2007 by using a special work vessel, Asean-Maru, of Dokai Marine Systems Ltd. The last recovery is planed in November, 2008. After successful end of the third phase

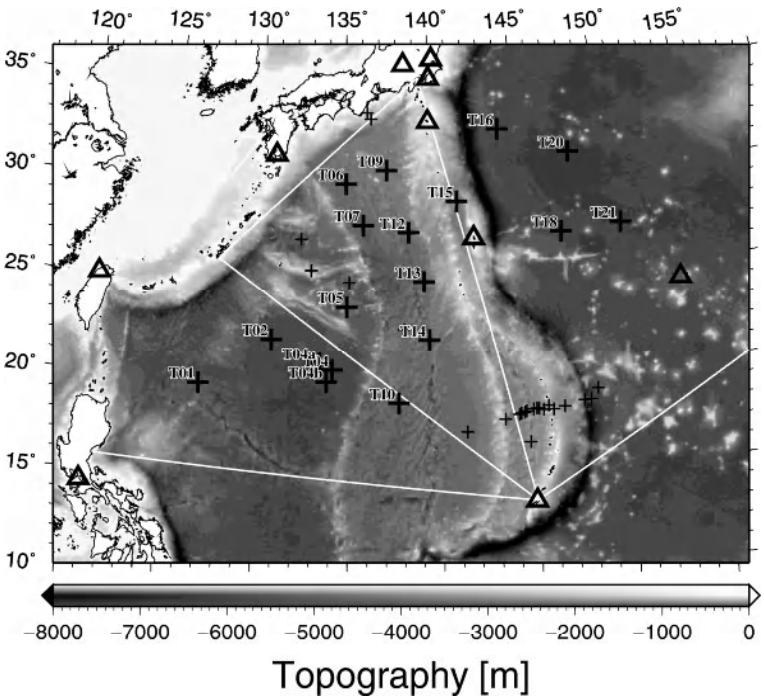

Figure 1. Site location on bathymetric map. Large crosses with label are the OBEM sites deployed in Stagnant Slab Project. Small crosses are the sites that the data were obtained by past experiments. Triangles are land geomagnetic observatories. Lines indicate submarine cables for long base-line electric field measurements.

Table 1. Site list that the OBEMs were deployed.

	T01	T02	T04	T04a	T04b	T05	T06	T07	T09	T10	T12	T13	T14	T15	T16	T18	T20	T21
2005.10~2006.11	x	x	x			x	x		x	x	x	x	x	x				
2006.11~2007.11	x	x	x	x	x	x	x			x	x		x			x		x
2007.11~2008.11	x	x				x	x	x	x	x	x	x	x		x	x	x	x

observation, we will obtain three-, two-, and one-year-long data accumulation for seven, four, and five sites, respectively (Table 1).

We have started to analyze the time series data obtained so far. The data quality is quite good for the most of the sites. There are only small number of spikes in the magnetic field data and noisy durations in the electric field data for a few sites, which are not crucial problems for the analysis. Drifts of the magnetic field are successfully corrected using the instrumental tilt records. Magnetotelluric (MT) responses are estimated after cleaning the spikes and the tilt corrections. Figure 2 shows the MT responses for site T14, which are obtained by processing only the first phase data (left) and processing both the first and second phase data (right). The data accumulation by the couple of the observation phases enable us to obtain better MT response estimate with high prediction coherences and smaller error estimates that are distinct for off-diagonal elements in longer period range and for diagonal elements in all period range (Fig. 2). Further improvement is expected by adding the third phase data.

After the completion of the observation, we will obtain final version of the MT responses. Geomagnetic Depth Sounding (GDS) responses and horizontal transfer functions (HTFs) will also be estimated. OBEM data obtained by past experiments in Philippine Sea are also available and are reanalyzed in this study. All the responses will be used for inversion analyses to image the mantle electrical conductivity.

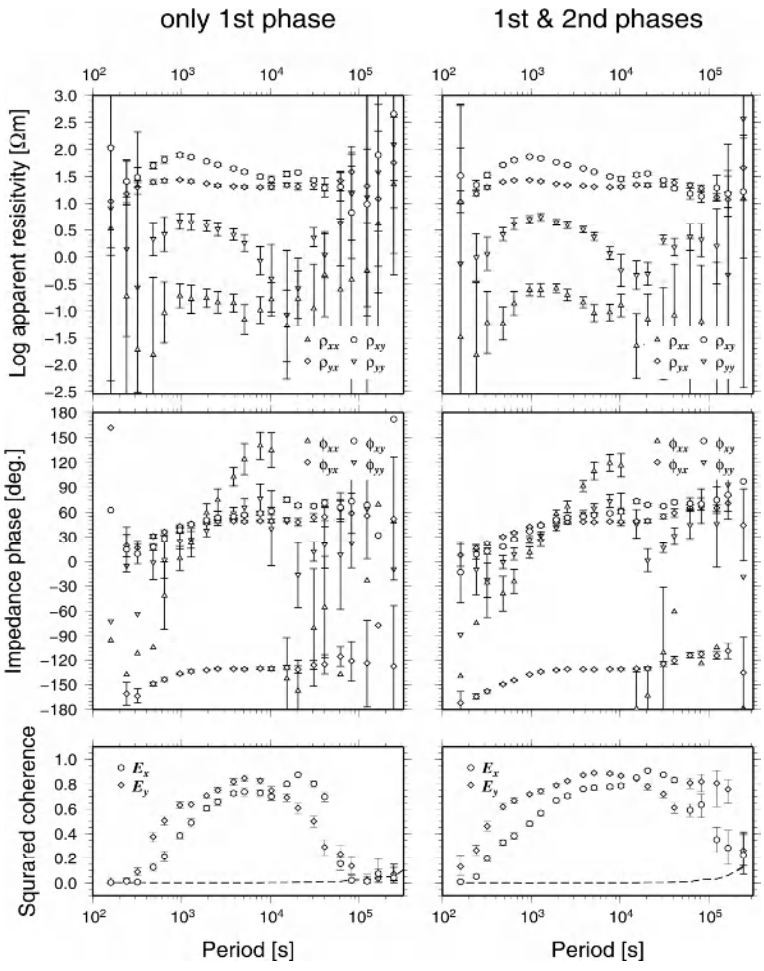

Figure 2. MT responses (apparent resistivity and impedance phase) for site T14 and prediction coherences (dash lines are theoretical zero coherences). The responses are obtained from the only first observation phase (left) and from both the first and second observation phases (right), respectively.