Seafloor GDS analysis in the central Mariana area

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We have carried out a marine geoelectro-magnetic survey across the central Mariana subduction system. This project is a joint project between Japan, America and Australia and is one of the largest ever experiments of its type. The survey aims to obtain the electrical conductivity structure of the Mariana island-arc system extending from the Pacific Ocean to the West Mariana Ridge (remnant arc) through the Marina Trough. The Mariana subduction system is an exceptional example of an intra-oceanic arc, trench, and back-arc system. The survey, which spans three upwellings of serpentine diapirs, arc volcanism, and back-arc spreading, will address issues of hydration of the mantle wedge resulting from subduction and the nature and distribution of subsequent melting through estimation of the electrical conductivity structure. We deployed 33 Ocean bottom electro-magnetometers (OBEMs), 7 ocean bottom magnetometers (OBMs), and 7 ocean bottom electrometers (OBEs) at 40 sites on KR05-17 cruise in December 2005. We successfully recovered 28 OBEMs, 7 OBMs, and 6 OBEs at 35 sites on KR06-12 cruise in September 2006. The full length of the transect is about 700km. Site spacing in the fore-arc and Pacific ocean basin are several tens of kilometers. The spacing of the sites in the vicinity of the spreading center is finer, about a few km.

We have used geomagnetic depth sounding (GDS) responses, Tx, Ty (where Bz=TxBx+TyBy), as well as other responses such as MT to obtain the electrical conductivity structure. The GDS response has seldom been used for ocean bottom surveys but it has the potential to provide extra information useful for constraining electrical conductivity structure. The GDS responses were estimated for 24 sites where the magnetic field data are available. Eight responses from a previous study (Baba et al., 2005) are also used in the analysis. Periods of obtained GDS responses are typically from 10,000 to 100,000 seconds, but for some sites are from 200 to 100,000 seconds. This difference is associated with the water depth and probably with the local topography.

We classified features of the GDS responses in the periods from 10,000 to 100,000 seconds into three patterns; Tx, Ty, and induction vector. 1) Tx decreases and Ty increases with period and the induction vectors point to the east. This response is seen at sites on the Pacific plate. 2) Both Tx and Ty increase with period and induction vectors point to the east. This feature is seen within the fore arc. 3) Tx increases and Ty decreases with period and induction vectors point to the west. This feature is seen at many sites in the Mariana trough. The features of the GDS responses are attributed to both heterogeneities in the crust and mantle and sea floor topography. To estimate the electrical conductivity structure in the mantle more plausibly, it is essential to estimate the topographic effects accurately and to remove them. This removal will be the focus of future work.