Mantle structure beneath the back-arc region of southwest Japan: An ocean-locked view by newly acquired seafloor EM dataset

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Seafloor electromagnetic (EM) observations were conducted off southwest Japan together with magnetotelluric (MT) measurements on land. The seafloor and land observations were to investigate the electrical conductivity structure beneath the back-arc region of southwest Japan. Epicenters of earthquakes in that region are known to distribute within a zone of about 4-9 km wide parallel to the coast line of the Japan Sea, whose focal depths are mostly shallower than ˜10km. In the seismic zone, several large earthquakes of M6.2-7.4 occurred in 1943, 1983 and 2000. In addition, quaternary volcanoes, such as Daisen and Ohginosen Volcanoes are also located in the seismic zone.

Wide-band land MT observations have been made along a number of north-south profiles since 1998 so as to reveal high conductivity regions beneath the seismic zone along each MT profile. It is noteworthy that the earthquakes seem to occur on the boundary between the upper resistive crust and the highly conductive body in the lower crust. The high conductivity regions found beneath each wide-band MT profile may constitute a conductive zone extending in an almost E-W direction. Spatial correlation between the hypocenter distribution with the upper surface of the conductive zone as well as the presence of deep low-frequency events suggests that crustal fluid must play some roles in creating the high seismicity.

In order to clarify the relation among the mantle dynamics in the back-arc region, the lower crustal conductor found on land, the distribution of the hypocenters and the volcanism in southwest Japan, we have conducted seafloor EM observations in each year from 2006 through 2008. The observations were conducted over a volcanic ridge including the Oki Islands that are quaternary volcanoes like Daisen, Ohginosen and Sanbesan and non-volcanic regions in the east and west of the volcanic ridge. The seafloor EM observations were indispensable so as to electromagnetically image the subducting Philippine Sea plate, a possible source of the crustal fluid.

The intent of this paper is to make a summary report on the seafloor EM data acquired so far with a special attention to low-frequency EM responses recently derived at sites on the non-volcanic regions. The seafloor EM sites can be classified into two parts: two long-term observation sites and short-term sites with mostly 8 Hz sampling. The sampling interval at the long-term sites is 60s with duration of 6 months for the 2006-2007 observation and 8 months for 2007-2008. The majority of the observation sites (10 out of 12) are occupied by the short-term sites including 4 electric-only sites where fluxgate-type vector magnetometers have not been deployed. Typical duration of the short-term sites is between 1.5 to 2 months.

The MT responses at the two long-term non-volcanic sites turned out to be very similar to each other, which implied that the electrical structures beneath the two non-volcanic basins may also resemble with each other. This enables the following hypothesis: The electrical structure beneath the back-arc region of southwest Japan can be interpreted by a volcanic overprint on a background wedge mantle. However, it should be noted that this does not necessarily mean the volcanic overprint being created by the slab-melting and/or the fluid released from the subducted Philippine Sea plate alone. The volcanism related to the Oki Islands and to Daisen or Sanbesan should be rigorously distinguished because they are different in terms of age and volcanic rocks produced. Furthermore, it should be confirmed by analyses of the short-term sites whether the interpretation is consistent with the presence of the lower crustal conductors found on land.