Imaging of fault structures over land and sea areas by electric survey

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Geologic structures in the coastal zones are important for disaster prevention and mitigation against large earthquake that originates in latent fault movement in the sea area such as the Niigataken Chuetsu-Oki earthquake in Niigata during July 2007, identification of flesh/salt water boundary, and evaluation of nutrient loads on sea environments by groundwater discharge. However, a few of investigations in the coastal zones are carried out because of the difficulty in approach: coastal zones are often blank in accumulating investigation data. Thus, continuity of faults over the land and sea areas is not enough understood. To clarify this continuity, an electric survey was applied to by selecting a tideland in the Ariake Sea, central Kyushu as a study site. The role of fault as a path of groundwater discharge was also examined.

The Kumamoto Plain facing the Ariake Sea is well known for its rich in groundwater resources because of high mountains behind the plain such as Mt. Aso. The Ariake sea, one of the large closed seas in Japan, is elongated along north-south and shallow with an average depth just 20 m. Resistivity is an important physical property of geologic media, because it is related to porosity and water content of rocks and soils. Then, resistivity distributions down to 50 m depth were clarified by a combination of a submarine electric survey in the sea area and a dipole-dipole survey in the tideland. An inversion analysis was used to obtain the resistivity distribution from the apparent resistivity data.

Submarine electric survey uses a long cable that is sank on the sea bottom to set electrodes and towed by a ship. The cable is 200 m length in total with 96 m electrodes interval in it. Pole-dipole arrangement was applied in this measurements by considering the cable operation in the sea and enhancing the electric signals. The survey was carried out along the 4 measurement lines with 14 km length in total. More details of this survey are described in Koike et al. (2006). One measurement line with 1500 m length, which has a connection with the tideland electric survey, was set almost perpendicularly to the coastline along NNE-SSW. At a part in this line, discontinuous of the resistivity distribution was found: this feature seemed to appear an existence of submarine active fault, which may be an extension of the Kami-Oda fault, a small active fault in the Uto Peninsula.

The survey in the tideland used VIP-3000 and ELREC6 by defining the electrode interval as 10 m and the isolation coefficient as 1 to 10. One measurement line with 150 m length along the coastline was set so that the estimated fault location was on the middle of the line.

The apparent resistivity data by the submarine electric survey were analyzed to reduce the influence of seawater with an extremely low resistivity. Almost the constant resistivities around 1.0 ohmm are distributed from the sea bottom to the 5 m depth, and the resistivities decreases to 0.3 - 0.5 ohmm in the lower layer. The above active fault feature appeared in the 10 m depth. Another remarkable feature is a high resistivity zone of 0.8 - 1.0 ohmm at the 400 m distance from the coastline, which may be a path groundwater discharge.

As for the resistivity distribution along the measurement line, it was able to be divided into two layers (top and bottom layers) at 5 m depth as well as the sea area. A flesh/salt water boundary was detected at the 20 m depth from the resistivity distribution. It is noteworthy that the large change of resistivity was appeared at the extension of the Kami-Oda fault. Consequently, the continuity of the fault over the land and sea areas and its important role for groundwater path were detected.

References

Koike,K.,Hidehiko,T.,Kaneko,H.,Yoshinaga,T.,Shimada,J.,Inoue,M.,Takaoka,H.and Asaue (2006):Evaluation of submarine groundwater discharge by resistivity survey on the sea bottom floor of Ariake and Yatsushiro seas,Japan,Proc.