ANN MODELING OF 3D CONDUCTIVITY STRUCTURE OF THE KOMAGATAKE VOLCANO (HOKKAIDO, JAPAN) BY MT DATA

V. SPICHAK[1], Y. Yamaya[2], T. Mogi[2]

[1] Geoelectromagnetic Research Institute, Troitsk, Moscow Region, Russia
[2] Institute of Seismology and Volcanology, Hokkaido University, Japan

Komagatake is a stratovolcano located in the south-west part of the Hokkaido Island. It is an active volcano the last eruptions (though, of small scale) being in 1996, 1998 and 2000. According to the results of the AMT survey provided in this area a 2-D resistivity model of the volcano along the SW-NE profile crossing the volcano perpendicular to the regional tectonic strike was constructed (Tanimoto and Nishida, 2000). However, the geological cross-section of the Komagatake volcano estimated in (Matsunami et al., 1995) basing on the drilling data and the results of the gravity survey indicates to the complex three-dimensional structure composed mainly from the vertical blocks.

In order to get more information about the volcanic zone the MT survey was carried out in 35 sites distributed over the volcano's surface using the Phoenix MTU5 system measured at 40 frequencies ranged from $5.493 \cdot 10^{-4}$ to 320 Hz. The preliminary result of the survey delineated the undulation of the basement layer and conductive duct just beneath the crater (Yamaya, et al., 2003, 2004). MT sounding of the volcanic interior followed by 3D imaging enables to detect the main elements of it's geological structure (Spichak, 2001). To this end we have used an Artificial Neural Network (ANN) approach applied earlier to 3D inversion of the MT data in terms of the earth macro-parameters (Spichak and Popova, 2000). The observed impedance data were used first to estimate their dependencies on the vertical coordinate using the Bostick transformation of the determinant apparent resistivity. The resulting data set was applied for teaching ANN to the correspondence between the data and the conductivity distribution in the volcanic area. The architecture of the ANN was optimized so that to provide the best convergence of the iteration process. It was found that the ANN consisting from two hidden layers supports a sufficiently fast convergence. The resulting net was tested by the data not used during the teaching process. The interpolation accuracy of the ANN was found to be about 5-10%, which allowed a reliable 3D imaging of the volcano and surrounding area up to the depth 30 km b.s.l. Figure 1 shows the vertical conductivity cross-section along the profile W-E crossing the volcano's summit.

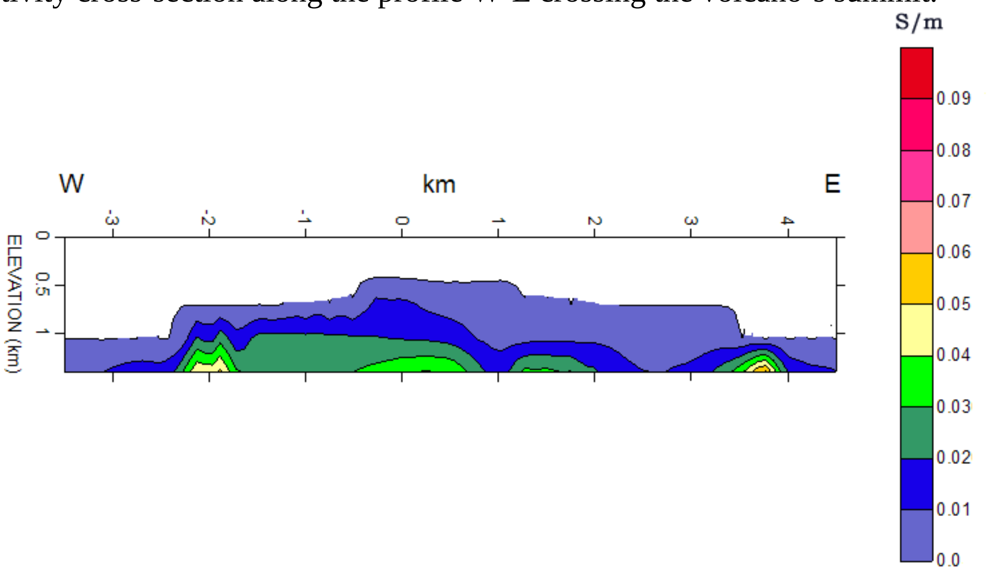

Fig.1. The vertical conductivity cross-section along WE profile revealed by ANN inversion of MT data.

It was found that the deep horizontal conductivity distribution has a sector shape and is more conductive in the west-southern and eastern parts of the studied area (Fig. 2). Another important finding is that beneath the volcano's edifice it is located a multi-folded system of conductive (0.1 S/m) quasivertical channels with two extremely conductive zones of 150-200 m diameter located approximately at the depths 5km and 10km b.s.l.

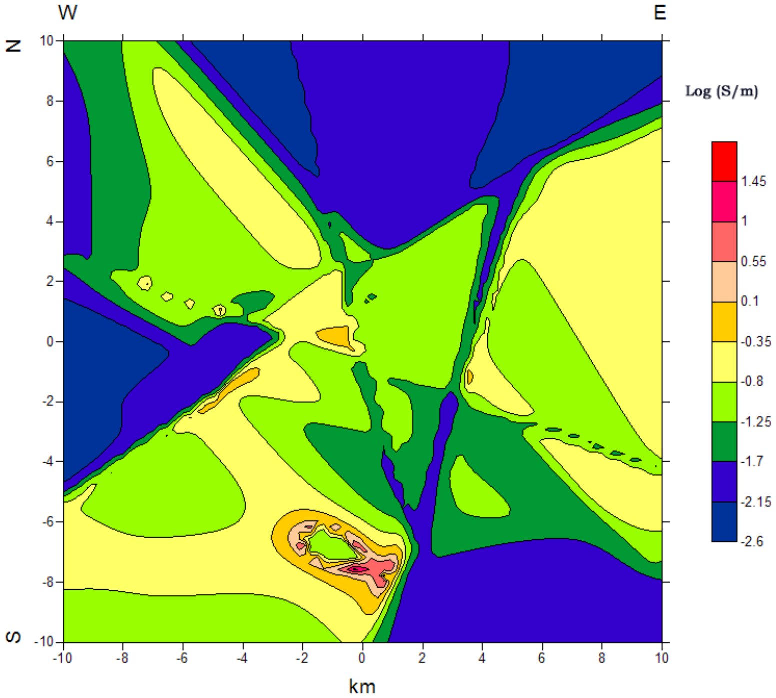

Fig. 2. Horizontal conductivity cross-section at the depth 5.25 km b.s.l.

The ANN taught by the MT data was also applied to the estimation of the correlation between the conductivity and the gravity anomaly data measured at the surface of the volcano. It was found that the correlation coefficient equals to 0.46. It is worth mentioning in this connection that the correlation between the subsurface resistivity distribution and the microseismic events' magnitudes detected during the preparation stage of the last volcano's eruption was estimated at the level of 0.30.

ACKNOWLEDGEMENTS

This work was made in the frames of the Visiting Professor position of one of the authors (V. Spichak) at the Institute of Seismology and Volcanology, Hokkaido University. The authors wish to thank Prof. Nishida, Hokkaido University, and his students for supporting the field survey.

REFERENCES

Matsunami, T., N. Okazaki, F. Akita, and H. Wakahama (1995). The hydrothermal system of Komagatake area in south western Hokkaido. Bull. of Geological Survey of Hokkaido, **67**, 1-40

Spichak, V.V. (2001). Three-dimensional interpretation of MT data in volcanic environments (computer simulation). Annali di Geofisica, 44 (2), 273-286.

Spichak V.V. and Popova I.V. (2000). Artificial neural network inversion of MT - data in terms of 3D earth macro – parameters. Geoph. J. Int., **42**, 15-26.

Tanimoto, K and Y. Nishida (2000). Volcano-electromagnetic study on Hokkaido Komagatake volcano. Abstract of IAVCEI General Assembly, Bali, Indonesia, 57.

Yamaya, Y., K. Tanimoto, Y. Nishida, T. Mogi, M. Miyahara, K. Yoshida, M. Saba, N. P. Singh, K. Takahashi, M. Shinya and K. Kikuchi (2003). MT survey on Hokkaido Komagatake volcano, Japan. IUGG General Assembly, Sapporo, Japan.

Yamaya, Y, K. Tanimoto, Y. Nishida, M. Saba, M. Miyahara, K. Yoshida, T. Mogi, T. Hashimoto (2004). Resistivity structure of Hokkaido Komagatake volcano using wide band MT method -The result of 1D inversion and the estimation of influences of the ocean. Geopys. Bull. of Hokkaido Univ., Sapporo, 67, 39-51.