Long-term Research Visits (Project No.: 2019L-02)

Project title: Imaging the deep electrical resistivity structure of the western part of the North Anatolian Fault by long period magnetotellurics

Principal Investigator: Sabri Bülent Tank
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Name of DPRI collaborative researcher: Prof..Dr. Naoto Oshiman and Assoc.Prof. Dr. Ryokei Yoshimura
Name of visitor (Affiliation): Sabri Bülent Tank (Boğaziçi University, Kandilli Observatory and Earthquake Research Institute)

Period of stay: From May, 20th 2019 to June, 20th 2019
Location of stay: Kyoto University, Disaster Prevention Research Institute
Number of participants in the collaborative research: 4 (DPRI: 2 non-DPRI: 2)
- Number of graduate students: 0

Anticipated impact for research and education

> The project has an impact for exposing the major differences between electrical conductivity models developed using two- and three-dimensional modeling algorithms, particularly for the western part of the North Anatolian Fault.

Research report

(1) Purpose

The aim in this project was to examine the deep three-dimensional electrical resistivity structure at the western part of the North Anatolian Fault Zone by applying wideband (320 Hz – 1860 sec.: MT) and long period (20 sec. – 13000 sec.: LMT) magnetotelluric methods and numerical modeling. For this purpose, MT and LMT data collected in the vicinity of the İzmit Earthquake epicenter, at 32 and 18 site locations, respectively, were utilized together with the ModEM (Kelbert et al., 2014; Egbert and Kelbert, 2012), a sophisticated three-dimensional numerical modeling algorithm based on non-linear conjugate gradient technique.

(2) Summary of research progress

The dimensionality of the MT data was investigated by using common methods known as induction arrows (Parkinson, 1959) and phase tensors analyses (Caldwell et al., 2004). The dimensionality and thus the geoelectric strike direction were achieved for the study area for different periods i.e. different depths. During the inverse modeling of the MT data, various combinations of modeling parameters were applied such as Lagrange multipliers, step size etc. Furthermore, effects caused by the nearby conductive bodies (the Marmara Sea and the Black Sea) were implemented in the initial model as fixed features to realize the so called “coast effect”, a common issue faced in the analyses of the MT data. Comparisons were performed among the resulting models achieved by inversions of MT-only, LMT-only and MT+LMT datasets.

(3) Summary of research findings

The dimensionality analyses pointed out that the influence of the coast effect on both the MT and LMT data were not remarkable at this part of the study area. However, the resulting models developed by means of different combinations of datasets (MT-only, LMT-only and MT+LMT) suggested that the three-dimensional modeling algorithms fail to image the deep electrical conductor that has been detected by the earlier two-dimensional analyses (Tank et al., 2005).

(4) Publication of research findings

Tank SB, N.Oshiman, M.Karas, R.Yoshimura, Y.Ogawa, Electrical conductivity structure of the lower crust and upper crust at Eastern Marmara, Turkey by long period MT, *Japan Geoscience Union (JpGU) meeting, May 2019, Makuhari-Messe, Chiba, Japan*

References:

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- Egbert, G.D., Kelbert, A., 2012. Computational recipes for electromagnetic inverse pro- blems. Geophys. J. Int. 189 (1), 251–267.
- Kelbert, A., Meqbel, N., Egbert, G.D., Tandon, K., 2014. ModEM: a modular system for inversion of electromagnetic geophysical data. Comput. Geosci. 66, 40–53.
- Parkinson, W.D., 1959. Directions of rapid geomagnetic fluctuations. Geophys. J. Int. 2 (1), 1–14.
- Tank, S.B., Honkura, Y., Ogawa, Y., Matsushima, M., Oshiman, N., Tunçer, M.K., Çelik, C., Tolak, E., Işıkara, A.M., 2005. Magnetotelluric imaging of the fault rupture area of the 1999 Izmit (Turkey) earthquake. Phys. Earth Planet. Inter. 150 (1–3), 213–225.