3D Electromagnetic imaging of the deep structures and North Anatolian Fault in the Marmara Sea

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In this study, we perform 3D modeling of the electromagnetic data to investigate major tectonic structures beneath the Marmara Sea. The Marmara Sea and surrounding region located in northwestern Turkey were formed as a result of closure of the Tethys Ocean and following extension and strike-slip regimes. This region accomodates the northwestern branch of 1600 km long North Anatolian Fault (NAF) that represents the main transform boundary in Turkey. NAF runs parallel to the northern coast of Turkey and reaches to the Marmara Region as three branches. Historical seismicity catalogues suggest a westward migrating pattern of destructive earthquakes along the NAF as well as a seismic gap within the Marmara Sea. Following the last two devastating earthquakes (1999 Izmit and Duzce earthquakes) that occurred at the eastern edge of the Marmara Sea, an increase in seismic energy on the Marmara Sea branches of the NAF have been monitored. Although the NAF and its branches on land are well investigated, their lateral and vertical extension within the Marmara Sea still remains elusive. Our knowledge of the continuation of tectonic structures in the Marmara Sea has a crucial role on understanding stress accumulation and geodynamic evolution after closure of the Tethys Ocean that has not been well uncovered yet. Earlier on- and off-shore magnetotelluric (MT) studies showed that MT method could be very efficient tool for the investigation of electrical resistivity variation that is now considered to be an important parameter to reveal tectonic structure of the Marmara Sea. Thus, we performed the MT method using ocean bottom electromagnetic (OBEM), wide-band and long period MT data set collected within and around the Marmara Sea. Totally at 27 sites continuous electric and magnetic fields were recorded. Phase tensor analysis and induction arrows show complexity of the structure especially at shallow depths and indicate that a 3D analysis of the data is required. They also represent existence of conductive anomalies beneath the Marmara Sea. 3D modeling results indicate high conductive anomalies, which are separated by resistive zones laterally, at crustal and upper mantle depths. Locations of these resistive–conductive boundaries clearly imply the trace of the NAF on land. Conductive and resistive zones can mark the regions with fluid rich and fluid free zones, respectively, and those regions are considered either to triggger easily a large earthquake or accumulate stress in the brittle zone of the crust. Resistivity variations resolved in this 3-D MT modelling study imply a continuation of the tectonic zones underneath the Marmara Sea in a similar fashion as observed from earlier 2-D modelling of land stations in the east.

Keywords: Magnetotelluric, Marmara Sea, North Anatolian Fault, Resistivity, Crust/upper mantle, Tectonic

