北海道東部の内陸地震発生帯における三次元比抵抗構造と MT 法における異常位相についての考察

市原 寛 [1]; 茂木 透 [2]; 山谷 祐介 [1]
[1] 北大・院・理; [2] 北大・理・地震火山センター

3-D resistivity modeling and anomalous MT phases in intra-plate earthquake area in eastern Hokkaido

Hiroshi Ichihara[1]; Toru Mogi[2]; Yusuke Yamaya[1]
[1] Earth and Planetary Sci., Hokkaido Univ.; [2] Inst. Seismol. Volcanol., Hokkaido Univ.

Clarifying heterogeneous subsurface structures in intra-plate earthquake areas is an important element in understanding mechanisms of the intra-plate earthquakes, i.e. how/where the stress concentrates and how/where the fault ruptures. In this paper, we focus on intra-plate earthquake area at the Teshikaga region, eastern Hokkaido district, northern Japan, where there had been occurring 12 large earthquakes (M>5) during 1938 and 1967 (Hirota, 1969). Teshikaga region is located in a volcanic belt formed along the northern margin of the fore-arc sliver of the Kurile arc.

In order to image heterogeneity of the crustal structure, we performed wide-band MT surveys and analyzed 2-D resistivity structures around the intra-plate earthquake areas (Ichihara et al, 2006). The 2-D images clarified a high resistivity (300 ohm-m) body at 0-5 km in depth with a horizontal width of 10-20 km, in the focal area of most of the 1938-1969 earthquakes. On the contrary, conductive zones are imaged close to the seismogenic zone the in back-arc side.

However, the 2-D images include a few problems. One is that the 2-D images are not consistent each other. For example, the conductor in back arc is not clearly imaged in a cross-section which crosses parallel and close to the above mentioned cross-section. In addition, the 2-D images which direct different direction show serious inconsistent at their intersection. Other problem is that anomalous phases over 90 degree were observed on many MT sites at long period. There is no study to explain the anomalous phases in 1-D or 2-D models. In order to solve above problems, we need to consider 3-D resistivity image.

Thus we construct 3-D resistivity structure using 44 sites of magnetotelluric data. Off-diagonal components of apparent resistivity and phase were explained for the observed data. These impedances were calculated using a 3-D forward code developed by Fomenko and Mogi (2002).

The 3-D image demonstrates existence of a back arc conductor (10 ohm-m) from several km to 20 km in depths. Seismic tomography (Wang and Zhao, 2005) shows that low S wave anomaly beneath the conductor, which indicates existence of upwelling flow from dehydrated subducting slab. Thus this conductor probably indicates fluid-rich zone supplied from the upwelling flow. On the other hand, resistive zone, which is inferred as rigid volcanic rocks (Ichihara et al., 2006), is imaged in the seismogenic area. These features indicate that the earthquakes occurred around boundary between rigid and water-weaken zone. (i.e. Stress concentration due to the heterogeneity might trigger the earthquakes)

In addition, discontinuous zone within the resistive body is imaged along the 1938 earthquake fault. We inferred that the discontinuous zone is the pre-existing structure due to seismic activities in Miocene mentioned by Kimura (1986). Thus, the 1938 earthquake might occur using the discontinuity as weak zone.

The 3-D image also explains the anomalous phases exceeding 90 degree. Thin elongated conductor which generates ""reversed"" strong current channeling produces the anomalous phases at long period (>100 s). The axis of elongated conductor is parallel to the 1938 fault. It implies existence of fault related conductor (e.g. fault gauge) along the fault.