A investigation on the responses of conductive structures of Korean Peninsula using EM modeling

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Abstract

Korean Peninsula located between Japan and China where earthquakes frequently occur, have little geophysical observation despite its tectonic importance. This study suggests the inland conductive structures inferred from GDS data measured in Korean Peninsula and try to interpret induction arrows quantitatively with the aid of 2- and 3-D geomagnetic induction modeling. Ogcheon Belt (OCB) and Imjin River Belt (IRB) are regarded as main conductive structures in Korea Peninsula, the induction arrows for the period of 60 minutes show very weak anomaly due to sea effect, which is supported by the results of 3-modeling also. However, for the period of 10 minutes, induction arrows at YIN and ICHN show anomalous patterns considered as the effect of IRB in spite of sea effect. The results of 2-D modeling which simplify geological situations provide overall information on IRB

Geological setting

Korean Peninsula has been known to be seismologically stable in sharp contrast to Japan and China where seismicity is very active. The general geological characteristic of it is characterized by a NE-SW directional pattern. This pattern has been explained by various tectonic theories related with the tectonical continuation of Japan and China. However, many questions remain unsolved, especially for the Korean Peninsula, and there are disagreements on various geological situations. Therefore, Our discussions focus on the responses for two conductive structures, Ogcheon Belt (OCB) and Imjin River Belt (IRB), rather than the reveal on the tectonic setting of Korean Peninsula (Fig. 1).

IRS is thought as an extension of the Qinling-Dabie-Shandong continent collision, recent tectono-metamorphic study supports these proofs (Cho et al., 1995), and various results imply the possibility of the Imjin River Belt as the past plate boundary. OCB is a conspicuous structure including a deep and wide sedimentary layer (Cluzel et al., 1990), there is still no proven explanation of evolutionary process of the Fold Belt and related tectonic movement for this belt. But the fact that the wide sedimentary belt developed in such a large basin might cause the geomagnetic data to have conductive anomalies.

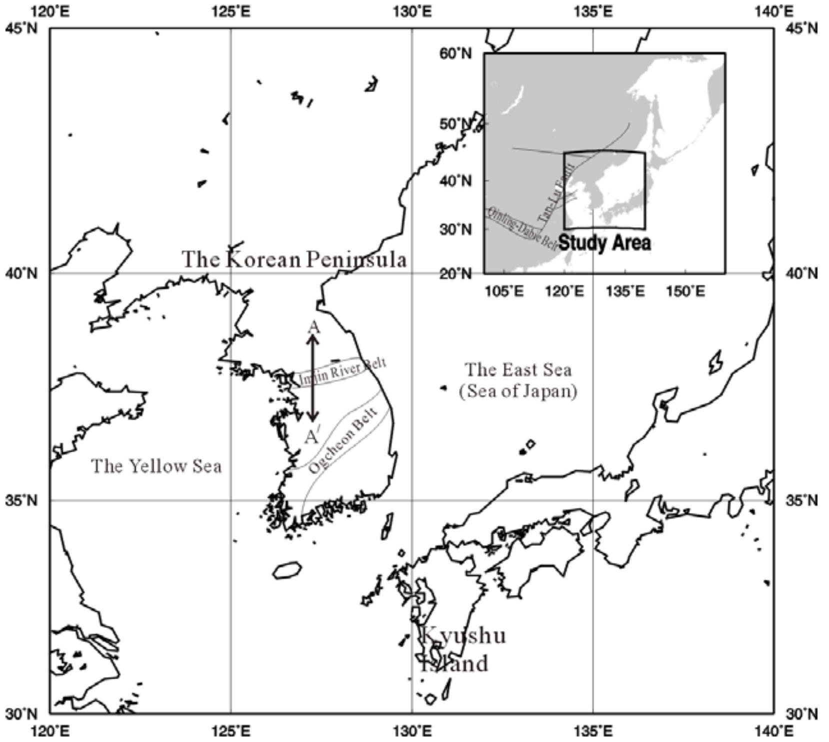

Fig. 1 Tectonic and location map showing the tectonic characteristics and profile for 2-D modeling in and around the Korean Peninsula. The box map represents the Qinling-Dabie belt and Tan-Lu fault in China. The two belts in the peninsula are included in the 3-D MT model. Compiled from the tectonic map of *Cho et al.* [1995], *Kim* [1970]

Modeling and Interpretation

Consideration of sea effect in peninsula region is very important. We adopt 3-D MT modeling technique suggested by Mackie et al. (1993) to calculate the sea effect (model S) and investigate the response of the model (SC) including two belts (IRB and OCB) and surrounding sea. Fig. 2 shows the 3-D input model to investigate the response of model SC. The overall structure of S is same to that of SC except for two belts. The modeling results are shown as induction arrows for the period of 10 and 60 minutes in Fig. 3, Obs, Sea and Cal represent observed real induction arrows, resultant real induction arrows of S and SC, respectively.

Ogcheon Belt

Ogcheon Belt (OCB) transverses the southern part of Korean Peninsula in NE-SW direction, the induction effects resulted from OCB are expected to appear in middle stations of southern Korea (CHY, DZN, HNS, and MWN). But for the period of 60 minutes, Obs, Sea and Cal point toward nearly east in middle stations. These directional patterns are due to the sea effect by the East Sea, which is about thirty times as deep as the Yellow Sea and surrounding sea(Chu et al, 2001). In addition, Sea and Cal show little difference in both direction and magnitude, these results mean that for the period of 60 minutes, the East Sea rather than OCB mainly affect induction arrows in middle stations.

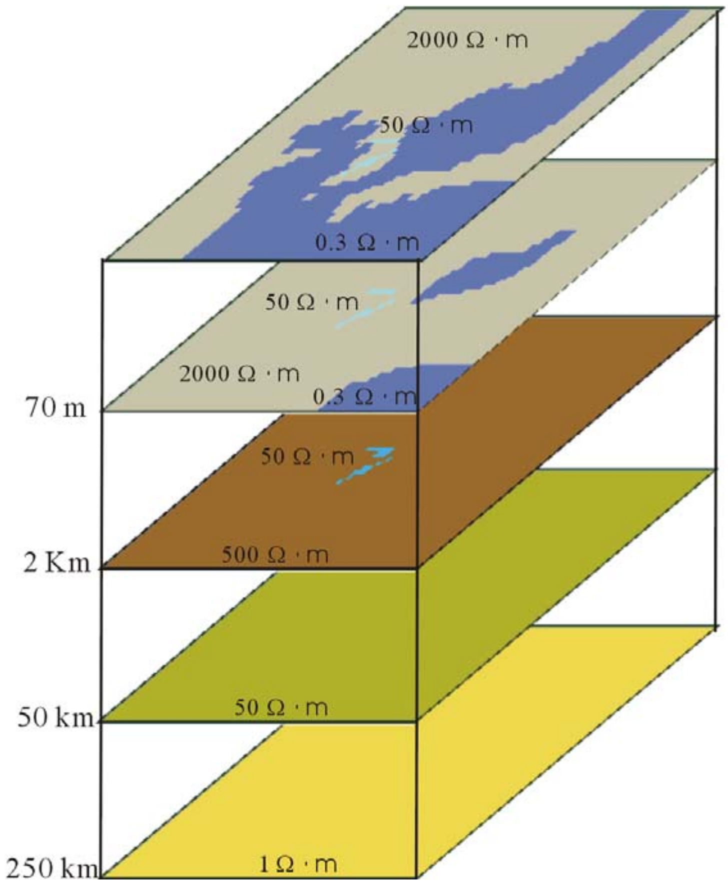

Fig. 2 The input parameters of 3-D model SC suggested for GDS induction arrow modeling in this study. The overall structures of model S is same to that of SC except for two belts.

As for the period of 10 minutes, Obs reflect the local environments so that Obs at HNS and CHY point toward to western-south due to the Yellow Sea, but little difference between Cal and Sea at DZN and MWN make some difficulty to convince the effect of OCB. In case of HDN and CHJ located at southern area of Korean Peninsula, Obs, Sea and Cal show no significant directional difference, which mean that the sea effect dominantly affects induction arrows. In terms of present data and modeling, the sea effect by the East Sea make some difficulty to confirm the induction effects by OCB in middle stations of southern Korea. More observations and high-resolution modeling contribute to get the detailed information for OCB.

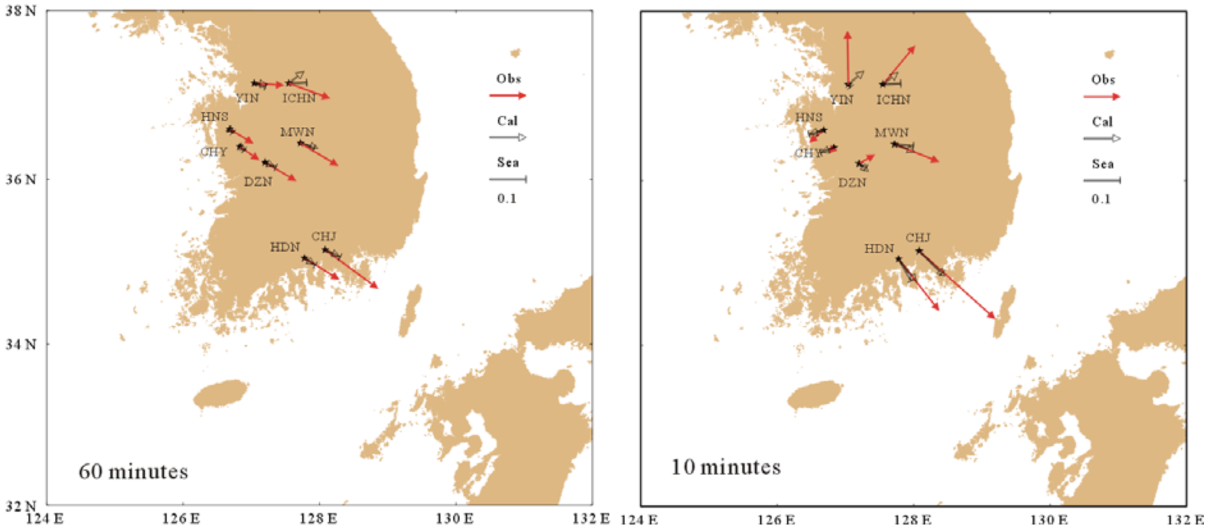

Fig. 3 The induction arrows by model S, SC and observations at seven sites for the period of 10- and 60-minutes. Obs, Sea and Cal represent the observed real induction arrows, resultant real induction arrow of model S and SC, respectively.

Imjin River Belt

The origin and evolution of Imjin River Belt (IRB) are still in debate, and there has been no objective geophysical result available for these areas. In this study, IRB is assumed to be located in the middle part of Korean Peninsula (Fig. 1), we expect that induction effects by IRB appear at YIN and ICHN. Shown in Fig. 3, for the period of 60 minutes, Obs at YIN and ICHN seem to be affected by the East Sea. But difference between Sea and Cal is shown at ICHN, which implies the possibility that the induction effect by IRB is apparent. For the period of 10 minutes, Obs at YIN and ICHN rotate to northward, especially, Obs at YIN shows a north direction. The patterns of Cal at two sites are similar to those of Obs. Seeing that the sea effect at YIN is so weak that induction arrow shows a solely response by inland conductive structure, IRB is considered to be located northern region of YIN. In case of ICHN, Obs seems to be combined effect of East Sea and IRB, comparison with Sea fully supports the existence of IRB, which is assumed to be located the northern part of ICHN. But Obs and Cal at YIN show a significant difference, which mean that the 3-D model parameters suggested in this study have to be modified.

In order to examine the effect of IRB more quantitative, we perform 2-D modeling for A-A line as shown Fig. 1. The results of modeling are shown as smooth curves in Fig. 4. In modeling process, we make a variation on conductivity of IRB as a conductance control in contrast to the fixed thickness of IRB. Further more, Obs at YIN and ICHN is presumed to be a purely combination of two effects (East Sea and IRB). Based on these conditions, we obtain two-dimensional responses of IRB as projecting Obs at YIN and ICHN to north direction. These resultant responses can be regarded as an entirely effect of IRB, the amplitude of those at YIN and ICHN are calculated to be 0.15 and 0.1 for the period of 10 minutes. As shown Fig. 4, to become 0.15 in amplitude of response, the distant from YIN to IRB must be closer than that assumed in our 3-D model, or the conductance of IRB must be larger than that of our 3-D model. Moreover, taking into account that YIN and ICHN are located at equal latitude, we can infer two possibilities from amplitude difference between YIN and ICHN. Firstly, if the conductance of IRB is fixed, distance from ICHN to IRB is as far as about 30 km than that from ICHN to IRB. Secondly, if the distance from YIN to IRB is same to that from ICHN to IRB as 40 km and the conductivity of IRB is fixed to 1/30 S/m, the conductance of IRB reduce as much as 400 S going from YIN to ICHN. Needless to say, the combination of two possibilities can be feasible. Finally, Figuring out the spatial location and conductance of IRB require additive observations around these sites, which is expected to modify and complement our model presented in this study.

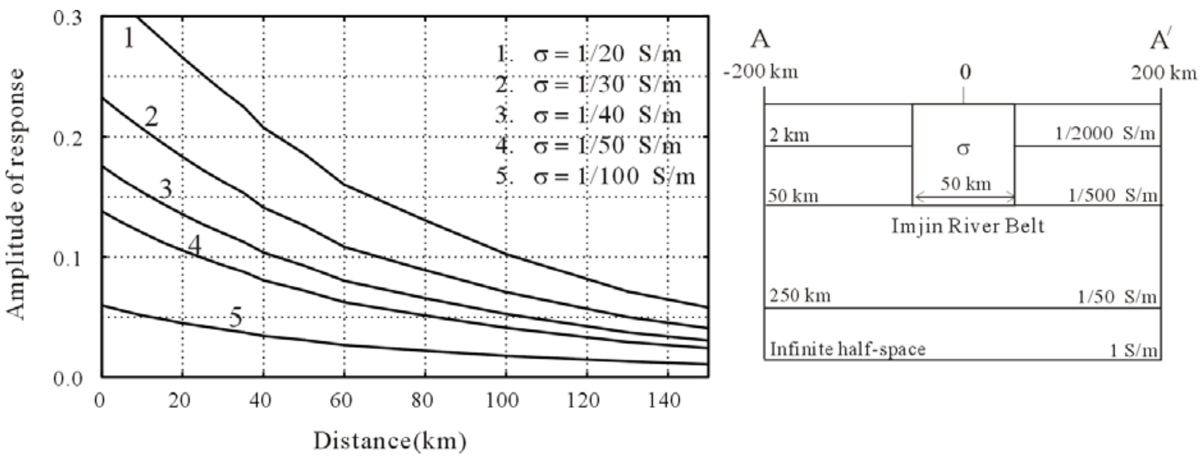

Fig. 4 The results of 2-D modeling along A-A line and 2-D model parameters used in this study (right panel). The spatial dimensions of Imjin River Belt (IRB) and 1-D structure in this model are same to those of 3-D model. Left panel shows the amplitude of responses, which is the real part of Hz/Hx (where Hz and Hx denote the vertical and horizontal magnetic field components), as a variation of the conductivity of IRB.

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