Electrical Structure of Wulingshan and Middle Jiangnan Orogen by Three-Dimensional Magnetotelluric Data Inversion

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Funded by The National Key Research and Development Program of China, China Deep Exploration (Sinoprobe) and The China Geological Survey Project on 2009–2019, a large scale magnetotelluric sounding (MT) survey grid (Fig. 1) has covered whole south China, aiming to study the macroscopic electrical structure of the South China lithosphere, and to reveal the contact relationship between the Jiangnan orogen with Yangtze, North China and Cathaysian blocks. A preliminary three-dimensional MT inversion had been carried out on 2019, which had established a roughly basic resistivity framework for the whole South China (Fig. 1). However, it can be definitely summarized that this result was not good enough to distinguish the boundaries of Jiangnan orogen contacted with other blocks, and many circle-shaped low resistance abnormalities inside Jiangnan orogen might be caused by noised MT curves or too weak regularization during three-dimensional inversion process.

To improve the reliability and horizontal resolution of three-dimensional resistivity model, 12 ‘ 12 sites (Fig. 1) in Wulingshan and middle Jiangnan orogen zone was chosen to do more detailed data analyze and inversion. From the sub-dataset curve reviewing, we found many observed MT data curves have strong EM near-field effect or too high impedance (close to 90°) frequency band, which might be caused by factories and traffics near those MT sites (Fig. 2). The locations of noised sites are coherent with unclear Jiangnan orogen boundaries and bizarre low resistance abnormalities in old model (right part of Fig. 2), which is clearly relevant to un-predictable illegally data fitting for those near-field and wrong phase data points. Since near-field effect would result to illegal 45 degrees apparent resistivity uplifting as well as zero impedance phase in corresponding frequency band (blue boxes in Fig. 2), which represent infinitely high resistance layer in 1D MT asymptote theory, unreliable extreme high or low abnormalities would be shown up on inversion result if initial model depending on different chosen initial model for three-dimensional MT inversion. Thus, we masked all those near-field and doubtful MT apparent resistivities, impedance phases and tipper real & imaginary parts to relaunch three-dimensional inversion, which achieved a more reasonable and better data fitting (Fig. 2) on reliable frequency band, then furthermore obtained a more credible and detailed three-dimensional electrical structure model in this sub-area (Fig. 3). Additionally, a self-developed adaptive regularized quasi-Newton inversion code (AR-QN) was applied in this new inversion, with higher regularization parameter in beginning iteration stages and auto-decreasing based on converge rate of data misfit function, which had shown better stability and weaker initial model independency in model synthetic data inversion tests comparing to recent popular NLCG based three-dimensional MT inversion algorithm.

The new three-dimensional inversion result (Fig. 3) has clearly distinguished two boundaries between Jiangnan orogen with Yangtze and Cathaysian blocks, and eliminated all those weird very low resistance abnormalities in upper and middle crust. An alternating high and low resistance shallow belts are revealed on the Northwest of both 15 km and 38 km depth slice map (upper part of Fig. 3), which macroscopically reflect the East Sichuan folding zone in middle Yangtze block. Meanwhile, Jiangnan orogen area in the upper and middle crust shows an overall high resistance wide belt bended from NS toward EW direction. Comparing to Yangtze block, the high resistivity zones in Cathaysian block is more disorganized which related to the fact that more mantle source materials had invaded into upper and middle crust in this area. The SE–NW profile roughly reveals an almost 30 km Moho depth in Cathaysian block, while vertically unclear resistivity change on Moho both in Jiangnan orogen and Yangtze block due to long term subduction squeeze environment. With more ongoing tectonic and geodynamic interpretations based on our new electrical structure, a new project has been put on the agenda to re-survey some heavily noised MT sites in this area, then the whole South China MT dataset should be re-masked and re-inverted after experiences on this sub-dataset had been carefully concluded.

**Key words:** magnetotelluric sounding, three-dimensional inversion, near-field effect, regularized quasi-Newton inversion, Jiangnan Orogen

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Fig. 1. MT site locations inside research area (left) and 3D inversion result (right) of the China Geological Survey project DD20160082 final report on 2019.

Fig. 2. Final MT data fitting with new masked dataset 3D inversion, while masked data points may cause strange structure on former inversion on 2019.

Fig. 3. Final 3D electrical structure of Wulingshan and Middle Jiangnan Orogen area.

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References


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