Preliminary results of magnetotelluric and audio-magnetotelluric data processing and modeling in North Huaiyang area, China

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Introduction

The MT data used in this survey was acquired in a Hot-Dry-Rock survey of the Chinese Geological Survey in 2016, and the AMT data was acquired in another geological resource survey in 2015. The main purpose of the MT and AMT exploration is to investigate the geological structure, structural characteristics of rock mass, fissure development characteristics, and the contact relationship between rock mass and cover.

Data Acquisition

Using the MTU-5A magnetotelluric system of Canadian Phoenix company, AMT data (frequency from 10.4 kHz to 0.35 Hz, Ex parallel to the profile direction, station spacing from 200 m to 1 km) and MT data (frequency from 320 Hz to 0.00055 Hz, Ex along the magnetic north , with an average station spacing of 2 km) were collected respectively along the profiles (Fig. 1). Remote reference stations for AMT and MT exploration were set up respectively. The remote reference station for MT exploration was located about 130 km to 200 km in the southeast (beyond the scope of Fig.1).

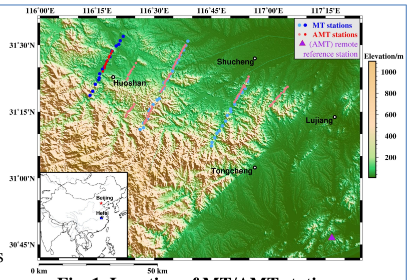


Fig. 1 Location of MT/AMT stations plotted on top of the topographic map

Data Processing

The AMT and MT impedance can be obtained by routine methods including time–frequency transformation, robust estimation of the impedances and remote magnetic reference method. In the case the sampling time is sufficient, the least noisy time series segment was selected for the impedance estimation. Furthermore the remote reference method was applied to effectively suppress local noise.

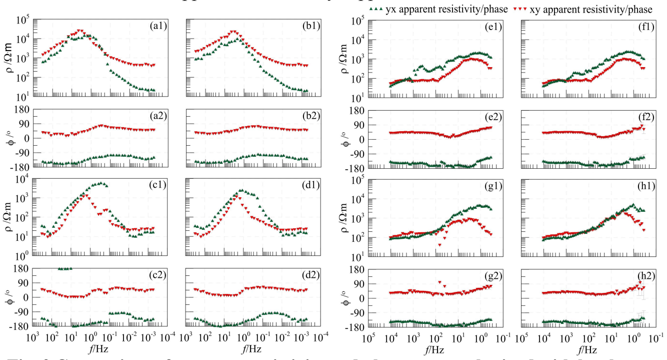


Fig. 2 Comparison of apparent resistivity and phases curve obtained with local magnetic reference (a and c for MT, e and g for AMT) and remote magnetic reference(b and d for MT, f and h for AMT)

Strike Analysis

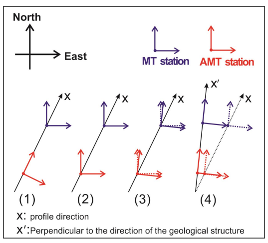


Fig. 3 Strike analysis process diagram, (1) profile direction and the direction of the measured electro-magnetic field components; (2) rotation of the AMT impedance to match the MT impedance; (3) rotation of all data to geoelectric strike direction; (4) projection of stations to the direction perpendicular to the geoelectric strike.

Since MT and AMT components were not measured in the same direction, we first rotated the AMT data to match the MT components. Then, the Q-function multi-site multi-frequency analysis was used to estimate the strike of the combined dataset. In Fig. 4, red and green colours are considered to be quasi-2D within 10% error on the impedance tensor, blue and purple significant 3D effects, or deviation from the strike .

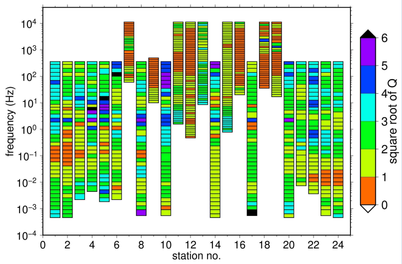
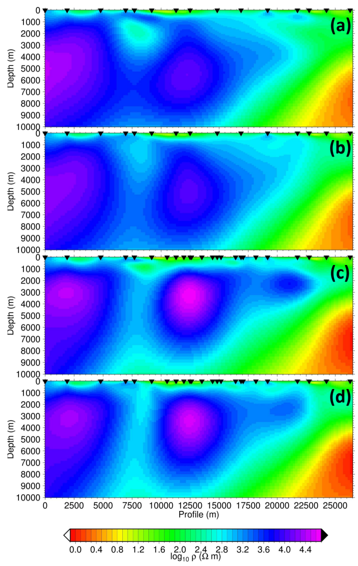


Fig. 4 Q-function estimate for all sites and periods along the profile for N84° W strike direction.

Inversion Models

2D inversion was performed using the EMILIA program (Thomas Kalscheuer, 2010). The first step is do Occam inversion. The λ that gives the lowest RMS misfit is then used as the fixed λ in an Occam inversion with additional Marquardt-Levenberg damping, and the model with the lowest RMS misfit as an initial model. For the same inversion parameters, the inversion results of only the MT data(Fig.5a, Fig.5b) and the inversion results of both the AMT and the MT data(Fig.5c, Fig.5d)， reveal a similar large scale electric structure. Including the AMT data reduced the RMS misfit and changes the details of the inversion model. After reducing the weight of noisy data and data with large fitting error at some sites and period bands , the inversion RMS misfit becomes smaller.



RMS: 4.36 App. Error floor: 10% Phase error floor: 2.8°

RMS: 3.84 App. Error floor: 10% Phase error floor: 2.8°

RMS: 3.70 App. Error floor: 10% Phase error floor: 2.8°

RMS: 3.15 App. Error floor: 10% Phase error floor: 2.8°

Fig. 5 2D inversion model of Occam inversion (a, c) and Occam inversion with additional Marquardt-Levenberg damping (b, d) with only MT data (a, b) or MT data and AMT data together(c, d).

Discussion

- There are generally 3D effects at some sites and period bands, so we can try to invert the determinant of the impedance tensor to mitigate 3D effects in the data on our 2D models.
- The noisy data at some sites and period bands greatly increase the inversion RMS misfit, the weight of these data should be greatly reduced, or they should be excluded from the inversion.

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References (omission)

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