Controlled Source RMT Theoretical Modelling and Measurement in Vuoksa region Russia

Muttaqien, I.1, Tezkan, B.1
1Institute of Geophysics & Meteorology, University of Cologne, Germany. muttaqien@geo.uni-koeln.de

Introduction

Controlled source radiomagnetotelluric (CSRM) is a modification of the RMT method. It uses horizontal electric dipole with length varying from 200 – 700 m as a source emitting frequency from 1 – 1000 kHz. This method is mainly intended for application in the remote area where there is no enough radio transmitter available. By lowering the frequency to 1 kHz, the skin depth is triple than standard RMT.

We present 2D theoretical study of CSRMT data. SLDMEMIF of Druskin and Knishechum is used for forward modelling [1]. Inversion of synthetic data are done by using CS1D of Shlykov and Saravan [2]. The results of forward modelling and inversion show the effects of 2D conductivity structure.

Our first CSRMT measurement was made in Vuoksa Region, around 100 km north of St. Petersburg Russia. A 700 m dipole connected to GTS-1 transmitter was used as a source emitting rectangular signal with main frequency of 0.5, 11, 33, and 105 kHz. 97 in-line soundings were made along a profile starting from 10 m with 20 m spacing, with 3 soundings addition off the profile. Thus we have a complete data of near field, transition and far field zones. 2 components of electric field $E_i$ and $E_j$ and 3 components of magnetic field $H_i$, $H_j$, and $H_k$, were measured in each sounding using RMT-5 receiving instrument.

CSRMT Theoretical Modeling

A 700 m dipole in $x$ direction centered at $x = 0$ as shown in Fig. 2(a),(b), the soundings are made at 50 frequencies loglinearly spaced from 1 to 1000 kHz in 10 stations starting from 1410 m with 20 m spacings, the fault located at $x = 1310$ m, 5 stations are located in the left and 5 are on the right of the fault.

The response of forward modelling shown in Fig. 2(c). It is clear seen that near the fault both overthrust and underthrust are present. The 1D responses are shown for S1 (1410 m) and S10 (1590 m), while 2D effects are seen in S5 (1490 m) and S6 (1510 m).

CS1D is an inversion code for CSRMT data in 1D. Displacement current is allowed in the ground and in the air in solving the forward problem [2]. Inversion results of the synthetic data are below:

![Inversion results of S1, S5, S6 and S10.](image)

We see that for S1, S10, the inversion gives the correct model since they are located far from 2D structures, while for S5 and S6, the 2D structures effecting the synthetic data as shown in Fig 2(c) and also the inversion results.

CSRMT measurement in Vuoksa Region

Vuoksa region is located around 100 km north of St. Petersburg Russia. The profile in far field zone has been studied by RMT-F and RMT-M methods making this suitable for testing a new experiment method as well as new interpretation software. The profile is then extended to the direction of the source in order to have near field and transition zones data.

![Location of measurement in Vuoksa region, Russia.](image)

Data Processing

The data are processed by calculating the surface impedance from the horizontal mutually orthogonal components of the electric and magnetic fields with minimum coherence of 0.8. From the surface impedance apparent resistivity $\rho_a$ and phase $\phi$ are calculated. Only omitted frequencies and their subharmonics are considered in the processing (neglecting available radio frequencies in far field zone) to have smooth apparent resistivity and phase data.

![Power spectrum of CSRMT data processing.](image)

The pseudosection of far field data, (along RMT profile) is shown in Fig. 6. Inversion results of real data in 3 stations, as shown in Fig. 4 c. are below:

![Inversion results of data.](image)

1D inversion of far field data

Inversion results of real data in 3 stations, as shown in Fig. 4 c. are below:

![Inversion results of data.](image)

Conclusion and Outlook

- Conclusion: SLDMEMIF is a very fast and accurate in modelling 2D of CSRMT data.
- Outlook: 1D inversion in far field
- 2D modelling in near field and transition zones.
- Inversion (1D and 2D) of field data in all zones.

References: