University of Cologne

Institute of Geophysics and Meteorology

St. Petersburg State University, Center of electromagnetic methods, MicroKOR Ltd., Russian Institute For Power Radiobuilding - RIPR, University of Cologne

Controlled-source radiomagnetotelluric method and the RMT-C system

Purpose. Controlled source radiomagnetotellurics (CSRMT) method is intended for application of the RMT technique in remote regions where there are no possibilities to measure enough radio-transmitter's signals to provide the standard RMT measurements in frequency range 10-1000 kHz and work is usually fulfilled in the frequency range 10-30 kHz in the VLF profiling mode. Using of controlled source (generator and grounded cable) allow us to realize work in the sounding mode. Because the lower frequency limit is downed from 10 kHz in the standard RMT method to 1 kHz the investigation depth with the developed RMT-C system reaches up to approximately 100 m for sedimentary sections (three times more than in the standard RMT method). RMT-C measurements results are presented as apparent resistivity and impedance phase curves used for the inversion procedures and obtaining of geoelectric sections.

Recorder of the RMT-C system

Parameters of recorder:

Number of synchronous channels of data acquisition	4
ADC, bit	16
Frequency range, kHz	1-1000
Internal memory, Mb	2048
Connection type with PC	Ethernet
LCD Display resolution	320x240 pix.
Keypad	18 keys
Build-in accumulator, 5 A*h, 12±2 V, operation time	8 hours
External power supply, V	12
Operation temperature, ° C	-20…+40
Dimensions and weight	340x295x160 mm, 5.0 kg

Parameters of generator:

Output voltage, V	120
Output power, kW	0.5
Frequency range	0.1 Hz -150 kHz
Weight, kg	9
External power supply	220 V, 50 Hz

Area of application: geological mapping, exploration, hydro geological and building construction works, environmental investigations.

Features of the CSRMT method and the RMT-C system:

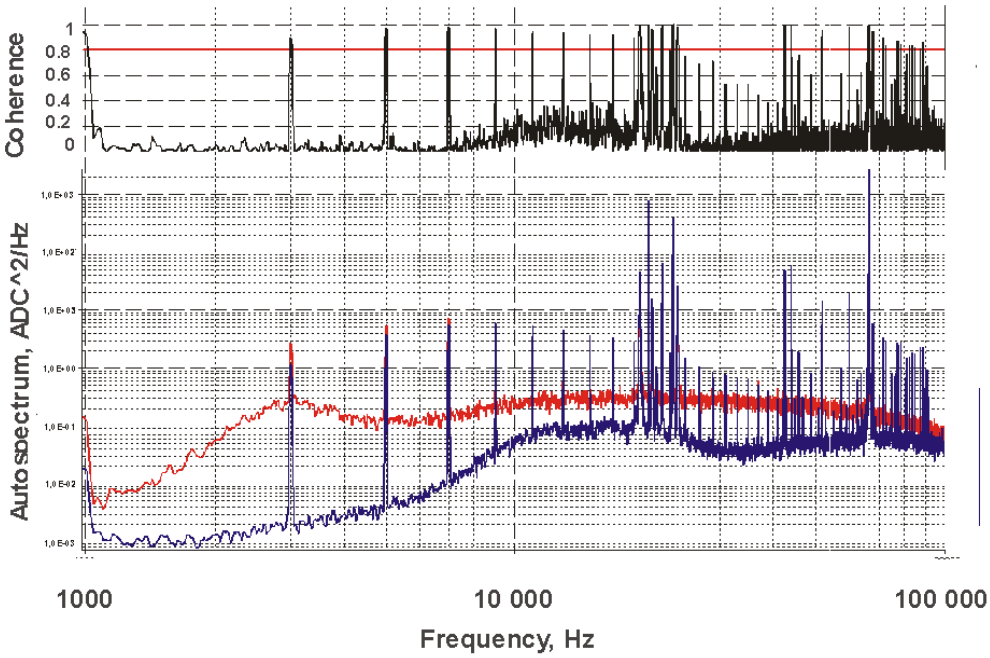
- recording of time series or spectrograms of electric and magnetic fields signals, apparent resistivity and impedance phase calculation directly in the recorder, visualization of spectral parameters at the display and estimation of data quality directly at a sounding station, data recording into built-in memory or external PC;
- settings of measurement parameters using both keypad of the recorder and external PC, coordinate and time determination using a GPS receiver;
- electric field measurements using grounded and ungrounded (capacitive) electric lines allow fulfilling works in winter time (on snow and ice) and in summer at the adverse for groundings conditions (asphalt, concrete, gravel);
- using of several (3-4) basic frequencies of the controlled source in the frequency range 1-150 kHz and their odd harmonics (7-9 ones from each basic frequency) provides measurements of detailed (35-40 points) sounding curves in 1 – 1000 kHz band;
- used plane wave model ensures the reliable data interpretation, well developed 1D and 2D inversion software tools allow us to obtain geoelectric parameters of different geological objects;
- depth of investigations is from 2-3 m to 100 m;
- RMT-C measurements are 80-100 sounding station per day - approximately 10 times faster than VES method of same investigation depth.

199034, Russia, St. Petersburg, Universitetskaya nab., 7/9,
Faculty of Geology SPbSU, Center of Electromagnetic methods,
tel./fax +7(812) 328-12-51, www.center-emm.ru, e-mail: info@center-emm.ru

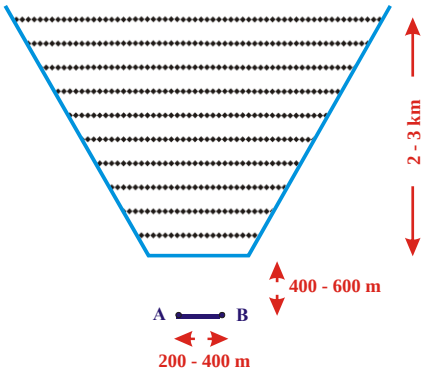
Measurements with the RMT-C system

Preparation of CS grounding (grounded cable).

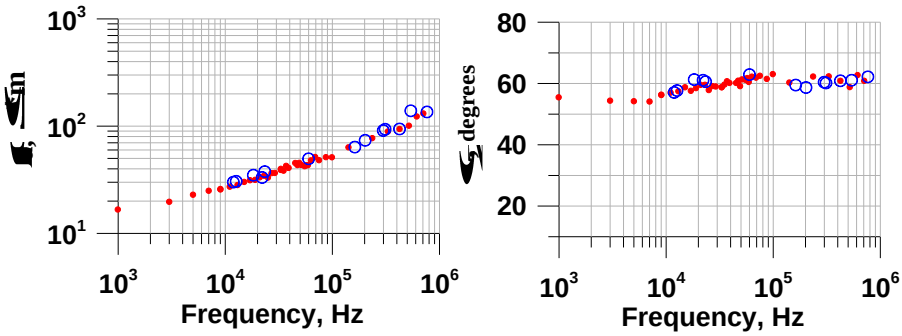
Field experiments with the CS generator



Autospectra (at the bottom) of electric (blue) and magnetic (red) field components and their coherence (at the top) in frequency range 1 -100 kHz at 1 km distance from the controlled source. Basic CS signal was 1 kHz, also one can see 9 its odd harmonics with the coherence level higher than 0,8.



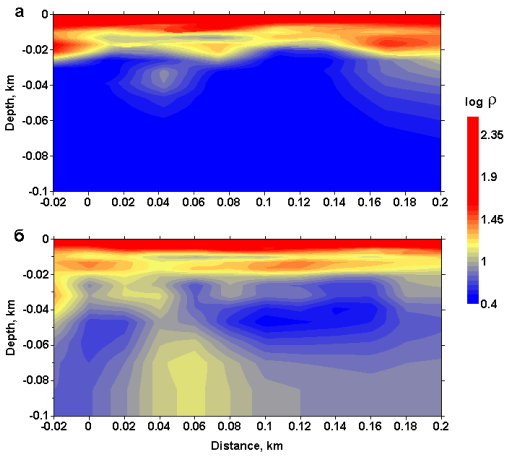
Working area for the RMT-C system.



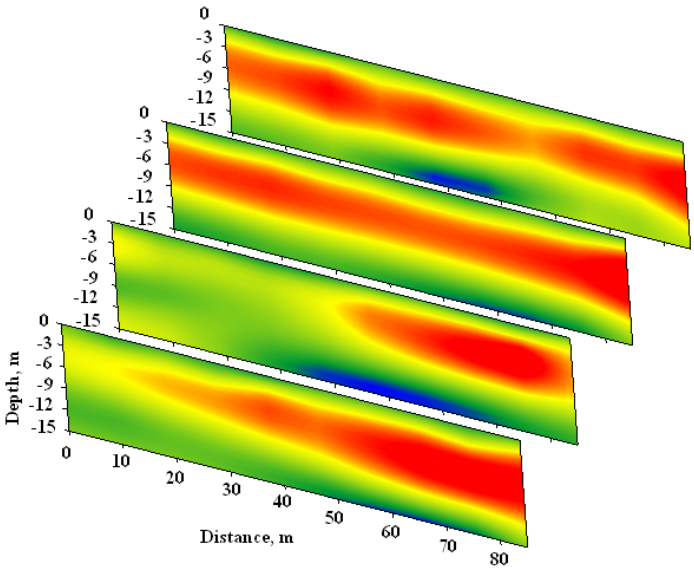
Example of RMT-C (red) and RMT (blue) sounding curves at 1 km away from the CS.

199034, Russia, St. Petersburg, Universitetskaya nab., 7/9,
Faculty of Geology SPbSU, Center of Electromagnetic methods,
tel./fax +7(812) 328-12-51, www.center-emm.ru, e-mail: info@center-emm.ru

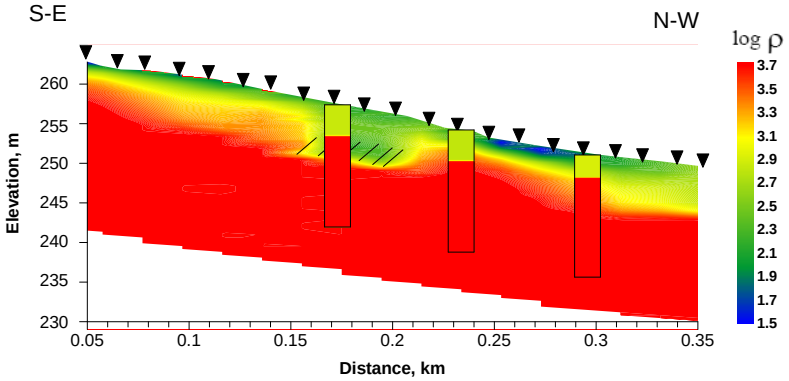
Examples of the RMT-C system application



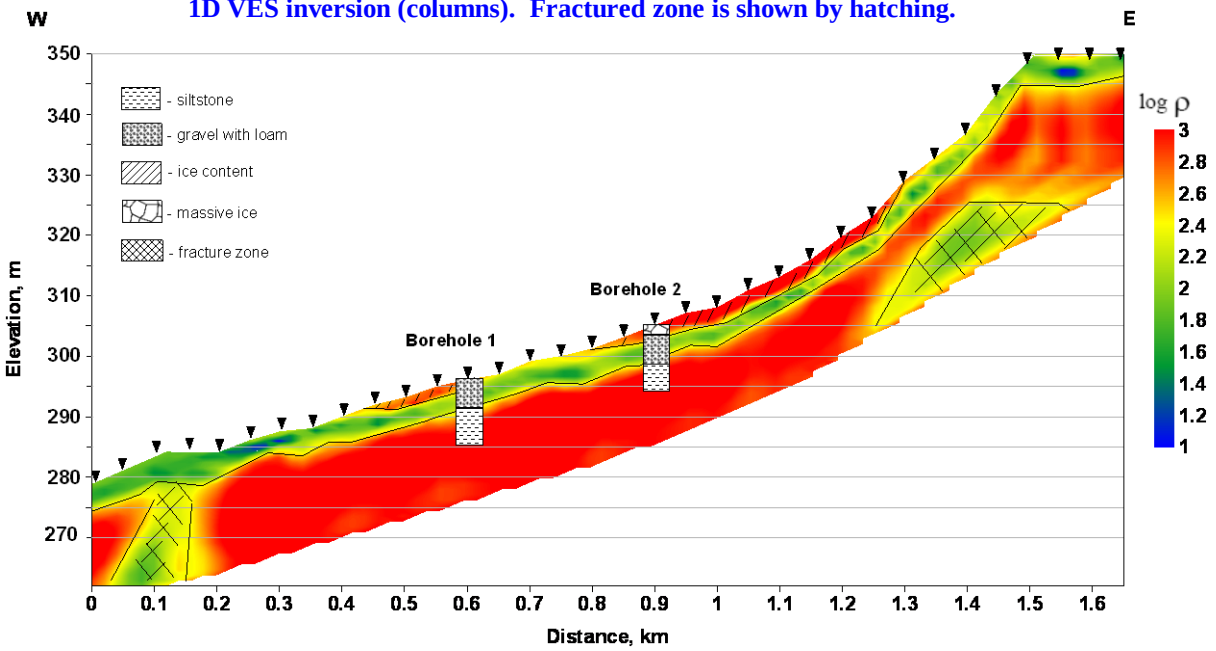
Comparison of 2D inversion results of the standard RMT method in 12-1000 kHz range (a) and the RMT-C system in 1-1000 kHz range (b).



Examples of RMT-C geoelectric sections



Comparison of RMT-C 2D inversion results (geoelectric section) with 1D VES inversion (columns). Fractured zone is shown by hatching.



Geoelectrical section according to the 2D inversion of RMT-C data (10-1000 kHz) and its comparison with boreholes data, obtained after RMT-C investigations. Ratio of horizontal and vertical scales is 10:1.

199034, Russia, St. Petersburg, Universitetskaya nab., 7/9,
Faculty of Geology SPbSU, Center of Electromagnetic methods,
tel./fax +7(812) 328-12-51, www.center-emm.ru, e-mail: info@center-emm.ru