NORD WEST

Geophysical
service company

Magnetotelluric data acquisition: Quo Vadimus?

View from a geophysical service company

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Cost estimation

	1	2	3
Acquisition	18%	11%	48%
Processing	6%	3%	6%
Interpretation (data analysis and inversion)	2%	1%	12%
Total geophysical costs (including MT crews salaries)	26%	15%	66%
Non-geophysical costs: Personal salaries (excluding MT crews), transport, base camp(s), temporary camp(s), accommodation and catering, mobilization and demobilization, communications, accessories and materials, EHS, insurances, etc.	74%	75%	34%

Ultra wideband MT (from 10^{-4} to 1000 sec) with overnight acquisition (16-20 hours)

A share of **depreciation** of instruments in "Acquisition costs" is **not greater than 30%**

1 .Subandino Norte (3300 MT sites, 30 MTU-5A, 12-14 crews, acquisition time about 8 months of field work, mountainous selva)

2. Itacaray (430 MT sites, 30 MTU-5A, 12-14 crews, acquisition about 1 month of field work, mountainous area)

3. Taymyr (3600 MT sites, 32 MTU-5A, 6-8 crews, acquisition time about 6 months of field work, tundra)

Some conclusions about MT survey cost

The share of instrument cost is really **very small.**
Thus, the cost of instrumentation is mostly **the price of “entrance ticket”.**

To reduce costs of commercial MT studies we need t**o reduce non-geophysical costs.** It could be done only by **increasing productivity** (reducing time needed to acquire data)

FYI: Instruments are in use about 150 days per year and the average service life is about 10 years.

How can we increase productivity?

1. **Reducing number of re-measured sites.** We need effective reliable **on-site quality control before and especially after acquisition**.

2. **Increasing the number of instruments**, which could be reinstalled during a working day by one field crew. Depending on environment (logistics and distance between sites) it could be from 2 to 5. We need **easy and fast MT instrument installation / retrieval.**

3. **Reliability and maintainability.** Intensive exploitation of instrumentation in tough environment always resulted in the permanent need of maintenance and repairing instrumentation. Therefore, it is better to have good contact with instrument producer/developer, who could provide **fast and cheap shipping of instruments and spare parts to survey area and flexibility in updating firmware.**

4. **Modern specialized software** for MT data processing (RRRMT) with user friendly interface able to provide (1) **on-site real-time QC** and (2) to process **big amount of data** (dozens of sites per day) in reliable time.

Requirements

Data logger (receiver)

One button robust (IP66-IP67, -40 + 70 Cº) system

Compact and low consuming

High dynamic range in all frequency bands (32 bits is here)

Automatic TF correction for poor grounding at high frequencies

Accurate and fast positioning.

On-line real-time control and data download (e.g. by WiFi connection).

Flexible acquisition timetable

Possibility for scheduled start / stop of acquisition

Requirements

Magnetic sensors

Different types of sensors (e.g. AMT and UWB) for flexibility.
Low noise level at all frequency bands is required.

Cables and connectors

Water, dust, mud and fool proof.
Reliability and maintainability

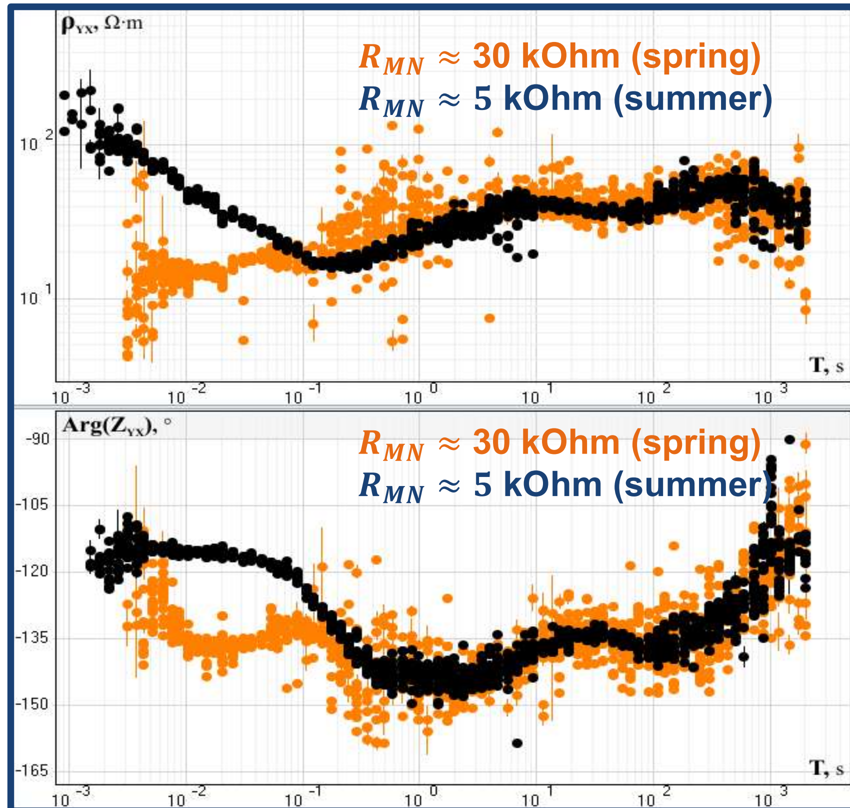
Electrodes

Low-cost and environmental friendly (graphite)
Easy to store, transport and import / export.
Small size and easy to install
Cheap (can be disposed of when broken).

Poor grounding

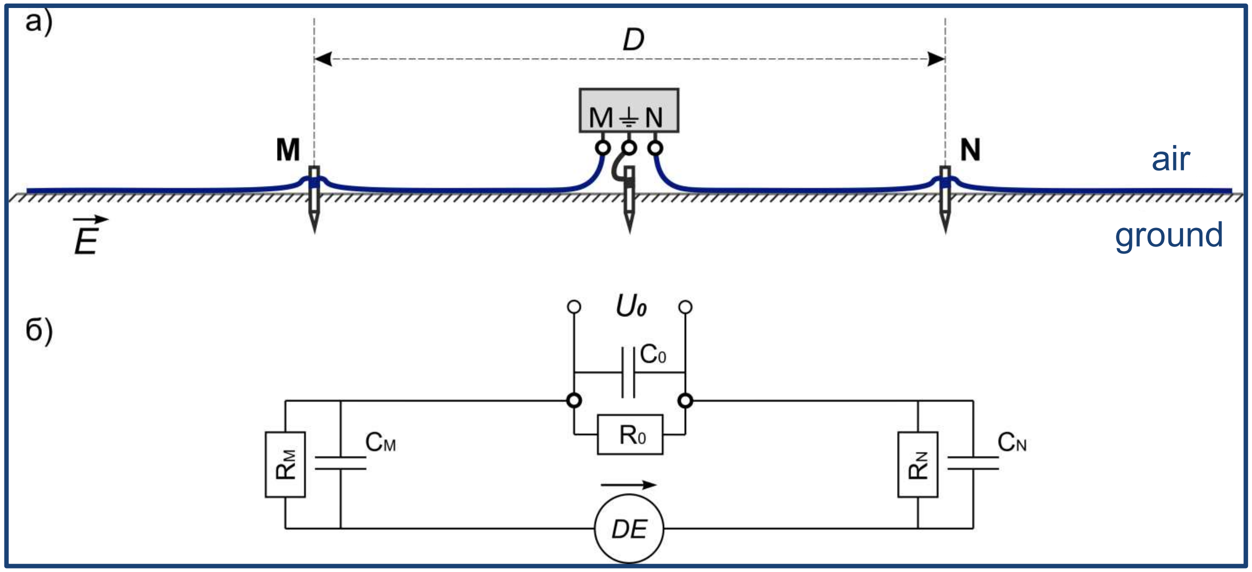
Poor electrical grounding leads to:
- Reducing of signal-to-noise ratio
- Distortions of impedance at high frequencies

Distortions depend on:
- Grounding resistance
- Input impedance and capacity of data logger
- distributed capacity of receiving lines



Distortions at frequencies >10 Hz
MT data from Yakutia (North-eastern Siberia)

Hybrid receiving lines

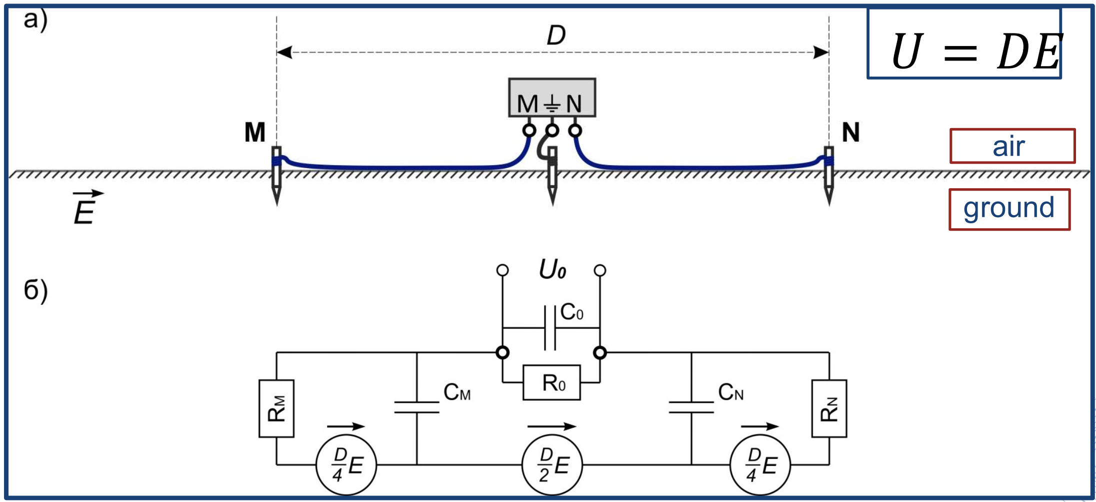


Zorin, N.I., Yakovlev, A.G. A hybrid receiving line for measuring the electric field in a wide frequency band. *Moscow Univ. Geol. Bull.* **76**, 639–645 (2021). https://doi.org/10.3103/S0145875221060090

TF correction

Updated scheme:

Zorin, N.I., Epishkin, D.V. Effect of electrode contact resistance on electrical field measurements. *Izv., Phys. Solid Earth* **58**, 727–733 (2022). https://doi.org/10.1134/S1069351322050147



Measured voltage:

$$U = \left(0.5 + \frac{0.25}{1 + i\omega R_M C_M} + \frac{0.25}{1 + i\omega R_N C_N}\right)\left(\frac{Z_0(\omega)}{Z_0(\omega) + Z_{MN}(\omega)}\right) DE$$

Capacitive leakage in receiving lines — Logger impedance effect

Future

Depends on the market ☹
Mineral exploration and monitoring?

Array acquisition will replace profile one (depends on Clients!)

New instrumentation will consist of a network of sensors and a few control / data logger units.

On-land measurements will be combined with airborne / drone measurements

AMT will be combined with CSMT

Self-burrowing electrodes and induction coils will appear ☺