TEM Investigation of a Waste Site in Cologne, Germany

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Introduction

The investigation of old waste deposit areas has become increasingly important as they are a potential threat to the environment and, furthermore, impact the planning of future land use and development.
In the Northwest of Cologne a waste deposit area has been investigate with different geophysical methods. On this poster the results of a first 1D Transient Electromagnetics (TEM) measurement are being presented.
Aim is the evaluation of the depth and structure of the waste site as well as investigation of the TEM-Tipper ($\dot{H}_x/\dot{H}_z$ or $\dot{H}_y/\dot{H}_z$). The waste can easily be distinguished from the surrounding undisturbed geology by its low resistivity. This makes this location as an good target, especially, for further 2D electromagnetic investigation.

Location and Setup

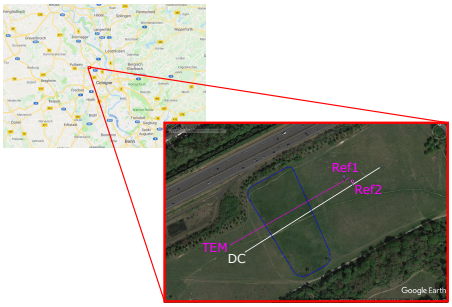


Figure 1: Location of the waste Site in Cologne, Germany. The TEM profile is marked in pink and a DC profile is white. Two TEM stations used for comparison are marked with Ref1 and Ref2. The area of the waste deposit is framed with the blue dotted line. *source: Google Maps/Google Earth*

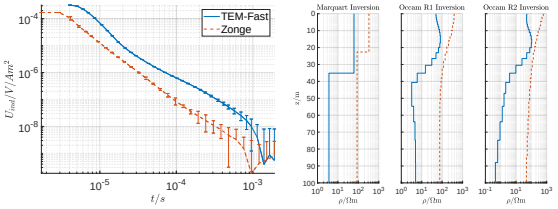
Survey design for the measurement:

- one loop used as transmitter and receiver
- length of loop edges: 25 m
- spacing: 12.5 m
- profile length (midpoints): 225 m
- total number of soundings: 19

The TEM-Fast device was used to conduct the measurement.

Comparison of TEM-Fast and Zonge

- compare performance of TEM-Fast device (borrowed from BGR) to the TEM device (Zonge Engineering) of the University of Colonge
- test measurements with Zonge have already been taken prior this survey



(a) Transients. (b) Models of three different inversion scemes.

Figure 2: Comparison of transients and 1D inversion results of the TEM-Fast and the Zonge.

Results:

→ the transients are shifted to each other
→ additional test at a different location featured the same behaviour
→ Zonge measurement are in better agreement with knowledge of the geology

1D Inverion results

Inversion:

- Inversion programme: EMUPLUS of the University of Cologne → Calculation of Marquardt and Occam Inversions
- tests showed that the assumption of a linear turn-off current with the duration of 1.5 μs is sufficient to describe the effect of the real behaviour of the current
- termination criterion:

$$\chi = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(\frac{d_i - f(m)_i}{\Delta d_i}\right)^2}$$

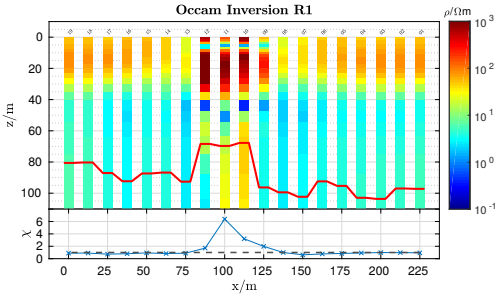


Figure 3: 1D Occam R1 inversion model of the TEM profile. The depth of investigation is displayed as a red line. In the lower panel the data fit χ is presented.

Results:

→ good data fit ($\chi \approx 1$) except of in the waste aera
→ waste body can be detected
→ surrounding subsurface model meets expectations with a 2-layered structure

Comparison to DC

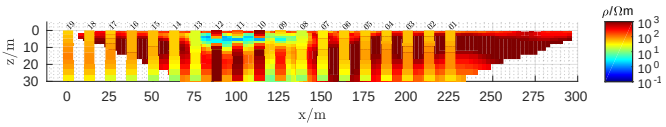


Figure 4: 1D Inversion results of TEM measurement plotted on the 2D inversion of the DC data obtained by a Wenner array.

→ general structures show good agreement
→ resistivities are much higher in the DC model

2D Simulation

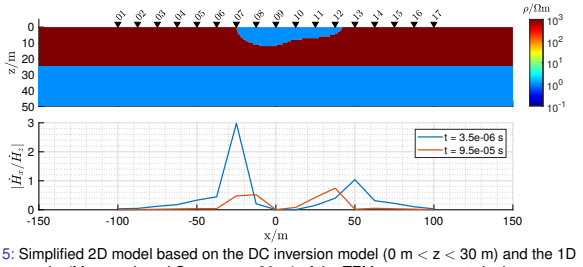


Figure 5: Simplified 2D model based on the DC inversion model (0 m < z < 30 m) and the 1D inversion results (Marquardt and Occam, z ≤ 30 m) of the TEM measurements in the upper panel. The other shows the absolute value of TEM-Tipper for two different measuring times.

→ high TEM-Tipper values close to the borders of the waste site

Conclusions

→ waste body could be detected
→ Wenner and TEM models are in good agreement
→ TEM-Fast measurement results deviate from results of other devices
→ huge 2D effect near the waste deposit body