First Results of CSRMT Measurements on LSV Radevormwald, Germany

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Introduction

Nowadays it is quite common to find hydrocarbon contamination which requires quick remediation due to the threat they pose to our everyday lives. In order to study the hydrocarbon contamination, many geophysical electromagnetic methods such RMT, DC have been applied since they are less expensive compared with boreholes. The drawback is that RMT method is effective in detecting conductive target and less effective for resistive target such as most hydrocarbon contamination. A successful application of RMT method to study hydrocarbon contamination can be found on [1]. However the RMT method have limitations in remote areas where there is not enough radio signal from distant transmitters to perform soundings. To overcome this problem, a transmitter is introduced. This modification is called Controlled Source Radiomagnetotelluric Method (CSRMT).

CSRMT Measurements in Radevormwald

A controlled source radiomagnetotelluric measurements were carried out in May 2017 to investigate a probable hydrocarbon contamination in Luftsportverein (LSV), a small airport, Radevormwald Germany (see Fig. 1 (a)). The receiver site in LSV Radevormwald is located on the Radevormwald/Leye gliding ground. The Radevormwald/Leye gliding ground is an airspace community, in which the two partner regions LSV Schwelm and LSC Wuppertal are participating. The airport is located in the heart of the “Bergisches Land”, surrounded by valleys, forests and interesting terrain.

Figure 1: (a) Location of Radevormwald. (b) A simple filling station in the LSV Radevormwald

The system of the filling station in the LSV Radevormwald is a simple one. The fuel dispensers are placed above the ground (see Fig. 1 (b)). In the past there was no concrete on the top of the filling stations to cover from possible spill to the ground when the plane was refueled.

The transmitter site located around 1.5 km from the LSV Radevormwald. The set up was L configuration approximately NS and EW, each arms is 200 m long (see Fig. 2 (a)). The contact resistance was around $200\ \Omega$ which was quite high even though a mixture of bentonite and salt was added to get it lower. The injected currents during the survey were 1.3, 1.2, 0.9 and 0.8 A for 0.5, 5, 50 and 105 kHz respectively.

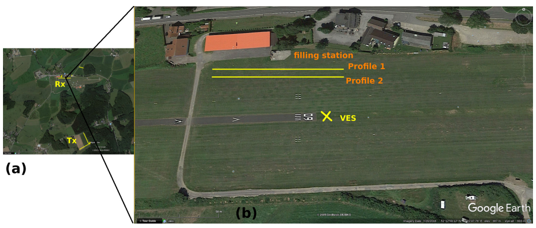

Figure 2: (a) CSRMT field set up. (b) Location of the CSRMT profiles and VES sounding on the LSV Radevormwald.

In the airport area, we set up two parallel 100 m profiles (see Fig. 1 (b)). On profile 1 there were 17 stations with distance 5 m in the middle part (from 20 -80 m) and 10 m in the outer part. While on profile 2 there were 11 stations each with 10 m spacing. The reference profile was 60 m long with 10 m spacing with NS transmitter only. Moreover a VES sounding was also carried out near the runway.

Data Processing

First the raw data were processed with SM25M software to obtain spectra. Afterwards the transfer functions were derived with scalar estimation in SFA software developed by the author (M. G.). Moreover to get better estimation and smooth transfer function, Siegel’s repeated median estimator implemented on MTS2DPlot [2] was applied. The transfer functions were evaluated 7 frequencies per decade and smoothing factor 1.5 was applied.

Due to the presence of cultural noise, the N-S data and D1 band (1 - 10 kHz) data on E-W were discarded in the modelling and interpretation. They show near field and transition zones behaviour (Figure 3 (a)). This phenomenon have been observed on MT data when a controlled source noise was on [3]. The “distortion” is confirmed by VES near the runway on N-S and E-W direction (Figure 3 (b), (c)). Unfortunately unlike our previous experience in Krauthausen area, the dominant cultural noise affecting the measured data is barely known.

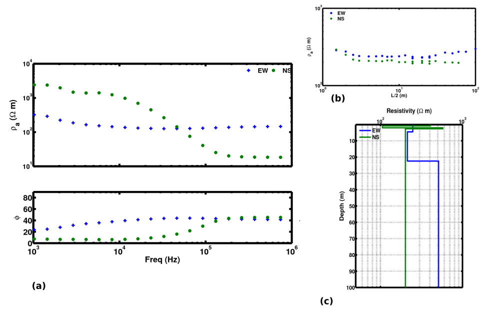

Figure 3: (a) An example of typical CSRMT data observed on all stations at LSV Radervomwald, (b) VES data near the runway, (c) 1-D VES model.

Modelling

The selected E-W data were modelled with Mackie code [4]. The starting model is homogeneous halfspace with resistivity 50 Ωm. To find the optimum trade off between data norm and model norm, L curve criterion was applied. It is found that $\lambda = 20$ gave the optimum solution for data from profile 1 and profile 2. The 2D model of profile 1 and profile 2 are given in Figure 4

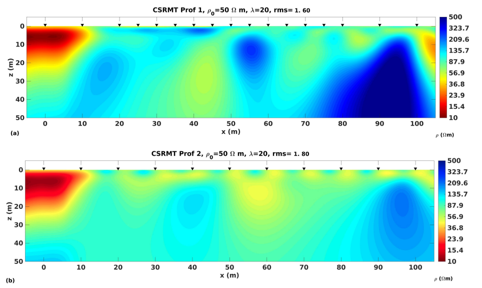

Figure 4: 2D models of CSRMT data from EW polarizations: (a) Profile 1, (b) Profile 2.

Conclusions and Outlook

- Conclusions:
  - The observed data from CSRMT measurements in Radevormwald on NS directions are contaminated with cultural noise.
  - One geophysical survey could not see the hydrocarbon contamination
- Outlook:
  - Modelling the observed data with a 3D algorithm considering source effect (SLDMEM3f).

References

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