Analysis of large scale multidimensional electrical resistivity and induced polarization data from the Kropfmühl graphite deposit, Bavaria/Germany

S. Schiebel[1], W. Mörbe[1], P. Yogeshwar[1], B. Tezkan[1], T. Günther[2], M. Tauchnitz[3]*

[1] Institute of Geophysics and Meteorology, University of Cologne *Contact: sschieb1@smail.uni-koeln.de, www.geomet.uni-koeln.de
[2] Leibniz Institute for Applied Geophysics, Hannover, Germany, [3] terratec Geophysical Services GmbH & Co. KG, Heitersheim

University of Cologne

Introduction

In the framework of the DESMEX2 project funded by the BMBF, measurements with a novel semi-airborne EM (sAEM) system were performed over a graphite anomaly in the Bavarian Forest/Germany. For the determination of IP-effects in the sAEM data, terratec Geophysical Services collected HIRIP data beforehand. The data are evaluated using the two-step inversion approach based on Seigel's method[1] implemented in a HIRIP class used by pyGIMLi[2].

Geology and Field Survey

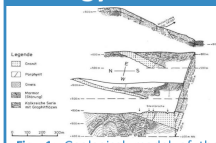

Fig. 1: Geological model of the survey area[3]. It is characterized by the "Bunte-Schichten-Modell" consisting of granite, gneiss and disseminated graphite.

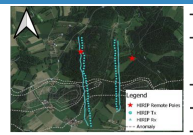

Fig. 2: Field setup. The two HIRIP profiles (blue) perpendicular to the strike direction of the graphite anomaly (grey).

- Pole-Dipole array
- 50m distance of Tx-, Rx-line
- ΔRx: 20m
- ΔTx: 50m
- HIRIP P1 (West): 1780m
- HIRIP P2 (East): 1450m

High Resolution Induced Polarization (HIRIP)

- Simultaneous mesasurement: DCR & TDIP
- High quality data from great depth
→large Tx-signal
→problem: coupling effects
→solution: separated Tx- & Rx- line
- HIRIP pseudosection (cf. Fig.3): main-diagonal: shallow structures, forward/backward measurement in positive/negative x-direction.

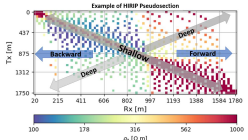

Fig. 3: Example of visualization of HIRIP data for profile HIRIP P1. (x-axis: Rx-stations, y-axis: Tx-stations)

Acknowledgment

Many thanks to the terratec Geophysical Services for the provision of the HIRIP data set and to the BMBF for the funding of the project (BMBF grant number: 033R130EN).

2D & 3D Resistivity Simulations with Synthetic Data

- Model: dike (10Ωm) at z=100-500m, x=850-1200m, background (100Ωm)
- y=4000m (only for 3D)
- 3% Gaussian noise added
→aim: determination of the influence of the separated Tx- Rx- line.

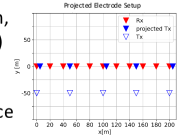

Fig. 5: Projected electrode setup for 2D simulations. The original positions of HIRIP P1 are used for the 3D case.

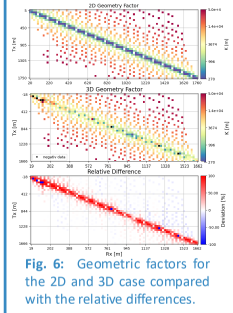

Fig. 6: Geometric factors for the 2D and 3D case compared with the relative differences.

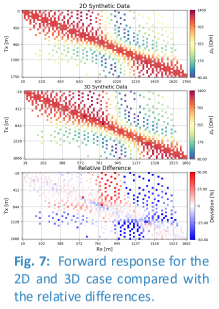

Fig. 7: Forward response for the 2D and 3D case compared with the relative differences.

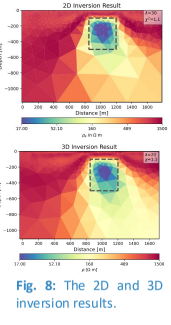

Fig. 8: The 2D and 3D inversion results.

- Fig. 6 & Fig. 7: Rx-stations are on the x-axis, Tx-stations are on the y-axis.
- The separated Tx-Rx-line has a strong influence on geometric factors for small electrode spacing
- No significant correlation between geometric factors and forward response
- Inversion results for both cases: A conductive anomaly is at the expected location and the boundaries (black dashed lines) are resolved

References

[1] Adrian, J. (2017), Interpretation of DC and IP Time-Domain Data Observed on a Copper Deposit in Turkey using a Newly Developed 2D Finite Element Inversion With Unstructured Meshes, PhD-thesis, University of Cologne.
[2] Rücker, C., Günther, T., Wagner, F.M., 2017. pyGIMLi: An open-source library for modelling and inversion in geophysics, Computers and Geosciences, 109, 106-123, doi: 10.1016/j.cageo.2017.07.011.
[3] Troll, G. (1981). Mineralevorkommen im oestlichen Bayerischen Wald.Bildung, Inhalt und Bergbaugeschichte.

Data Processing of HIRIP P1

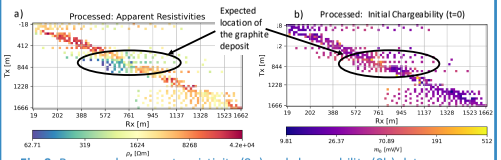

Fig. 9: Processed apparent resistivity (9a) and chargeability (9b) data.

Preliminary Results for HIRIP P1

- Two-step inversion → Seigel's approach[1]
- 2D inversion with 3D forward operator
- Polarized material → Measuring increased ρ_a[1]
  1) pure DCR inversion
  2) TDIP inversion

→ $f(m^k)$: double forward calculation of k-th iteration

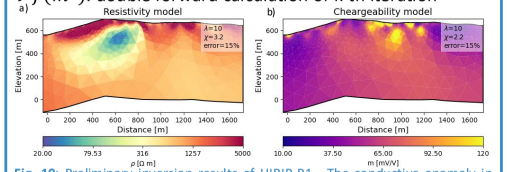

Fig. 10: Preliminary inversion results of HIRIP P1. The conductive anomaly in Fig.10a) is associated with the graphite. The chargeability model (10b) with its strong anomalies shows no correlation with the resistivity model and requires further investigation.

Outlook

- Simulation studies: Include topography & compare 2D results with ResIPInv2D[1]
- HIRIP P1: Further investigation of IP data
- Inversion of HIIRP P2 & joint inversion of HIRIP P1 & P2