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Universität Stuttgart · WAREM · Pfaffenwaldring 7a · 70569 Stuttgart

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Master Thesis Presentation

of Tarig Bukhary

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Field Evaluation of Spectral Electrical Impedance Tomography (EIT) Measurements at the Krauthausen Test Site

In recent years, several advanced imaging techniques, such as Electrical Resistivity Tomography (ERT), have emerged, which expanded the applicability of electrical resistivity methods to hydrogeological and engineering problems. The utilisation of sophisticated numerical inversion algorithms in these techniques allows producing detailed images of the electrical properties of subsurface materials. Spectral Electrical Impedance Tomography (EIT) is an extension to the Induced Polarisation (IP) and the ERT methods with the improved capability of impedance spectroscopy. The advantage of spectral EIT method compared to its standard equivalent is the possibility of employing a broad range of measurement frequencies, which often lies within the mHz to KHz range. Therefore, spectral EIT outstands as a powerful tool for non-invasive characterisation of materials and as a very promising candidate for near-surface characterisation.

Recent developments have made possible correcting for inductive and capacity coupling effects on spectral EIT measurements involving boreholes. Furthermore, the recent data processing and inversion strategies have opened the path to a better parameterisation of the spectral EIT measurements data errors, thus improving the quality of obtained measurements and subsequently, achieved results.

The aim of this study is to evaluate recent developments in spectral EIT within the context of field application at the Krauthausen test site. In particular, the evaluation includes the utilisation of recently developed correction methods for inductive coupling effects as well as data processing and inversion strategies to obtain subsurface images of the complex electrical resistivity. In addition, this study aims to provide a systematic evaluation of how inductive coupling between wires and cables affects field spectral EIT measurements and associated measurement errors.

The results showed that inductive coupling contribution to the measurement data error is only relevant for measurements using current and potential electrodes that are spread over two electrode chains. The results obtained from spectral EIT calibration measurements demonstrated the dominance of inductive coupling errors over other measurements errors. The spectral EIT calibration measurements also showed a clear proportional dependence of inductive coupling contribution on the electrical current frequency and the length of used measurement cables. The results further demonstrated that correcting for inductive coupling has no significant influence on the relative and absolute measurement data errors of real and imaginary part, suggesting the inapplicability of correcting inductive coupling errors through higher error during the inversion of measurements data. The results showed; however, that correcting for inductive coupling errors has a significant positive effect on the obtained images of the complex resistivity, especially for higher frequencies (i.e. 100 Hz to 10 KHz). The analysis using the so-called pole-pole matrix, which is part of a new calibration strategy, showed that the handling of borehole electrode chains has insignificant influence on calibration measurements obtained therefore, sug-

gesting a reasonable repeatability of calibration measurements with little variation between different datasets.

It was concluded that spectral EIT has matured to such an extent that routine applications nowadays have the potential of obtaining satisfactory representation of the subsurface properties and structure characterisation with a reasonable accuracy depending on the equipment used and its set up.

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WAREM Students and other interested parties are cordially invited.