# 3D Inversion of Loop-Source Time-Domain Electromagnetic Data - Application to Synthetic & Field Data

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Abstract

Multi-dimensional inversion of Transient electromagnetic data is a computationally expensive task. Only few developments and practical interpretation tools exist. Here, we present a multi-dimensional inversion framework for loop source time-domain electromagnetic data. The developed algorithm is a robust, efficient, and user-oriented tool for the multi-dimensional inversion of typical loop source time-domain electromagnetic configurations. A time-domain finite volume discretization and the direct solver MUMPS are utilized to solve the 3D TEM forward problem. An iterative Gauss-Newton optimization method is implemented for the inversion kernel. The code is parallelized for calculating multiple sources simultaneously to accelerate the inversion. Based on exploration tasks, different configurations exist for commonly used loop source TEM configurations and typical field scales. Synthetic examples are used to verify the effectiveness and benchmark the developed 3D algorithm. Considering that TEM data is often gathered along profiles, adjusting the model roughness along the different modeling domain directions, sufficiently constrains to allow for 2D imaging. In addition to the vertical signal components, we also included horizontal components for large scale fixed loop applications. Subsequent to synthetic validation, the inversion algorithm is further verified using ~120 dense TEM soundings collected over a clay pan site in the Atacama Desert, Chile, to provide bedrock geometry information and suitable coring sites. The 3D inversion result provided an excellent depth estimate of sedimentary infill as well as the bedrock topography and was later confirmed by deep coring. Another interesting site is the Roter Kamm impact crater in Namibia. Our preliminary results obtained from largescale multi-component fixed loop TEM data reveal a sedimentary infill down to ~300 m depth. In conclusion, our presented 3D inversion code is capable to handle data from various exploration scenarios and provides a robust tool for advanced EM interpretation.

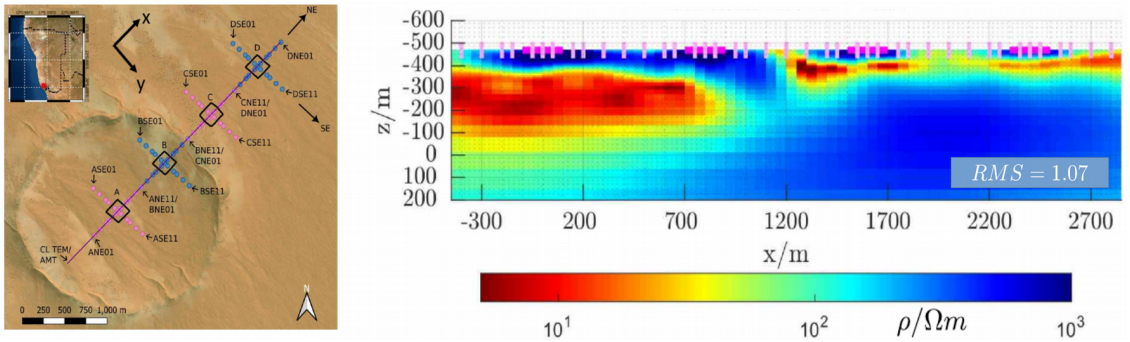


*Figure 1: Fixed Loop TEM survey design at the Roter Kamm Impact Crater in Namibia and 3D inversion results of Uz component for 4 sources with 21 receivers each.*

Reference / more information

Liu, Y., Yogeshwar, P., Peng, R., Hu, X., Han, B., & Blanco-Arrué, B. (2024). Three-Dimensional Inversion of Time-Domain Electromagnetic Data Using Various Loop Source Configurations. *IEEE Transactions on Geoscience and Remote Sensing*.