

## Investigation of the Garzweiler coal deposit, Germany using central loop and fixed loop transient electromagnetics

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### SUMMARY

The transient electromagnetic method (TEM) is widely applied for the detection of mineral deposits, geothermal reservoirs, and other earth resources such as coal-bearing layers. The study area, Garzweiler, is located on the Rheinland Lignite deposit in Germany and is close to the actively operating Garzweiler open-pit mine. Our main objectives were the validation of using MT loggers (KMS-820 system) for TEM surveying, comparing different TEM configurations as well as applying a novel 3D inversion scheme. From a geoscientific perspective, we aimed at the detection of the thickness and depth of the coal-bearing layers as well as providing information about faults and water-bearing layers since both serve as key information in a mining safety context. We applied dense central and large fixed loop TEM configurations using two receiver components for the latter. Three fixed loops with different loop sizes were deployed along a 2 km-long survey line. Both time derivatives of the strong Bz and Bx components were measured. The observed data is of high quality, with low stacking errors spanning roughly three decades in time. Due to the setup geometry, systematic sign reversals are observed for the fixed loop data outside of the transmitter loop. Initially, 1D resistivity depth models are derived using conventional Occam and Marquardt-Levenberg techniques. Quasi-2D resistivity depth sections are created by stitching 1D models together.

Due to the large transmitter footprint and out of loop measurements, the fixed loop data may not be interpreted adequately in 1D. Therefore, we subsequently inverted the fixed loop data using a novel 3D TEM inversion algorithm. To use the algorithm for profile data and enforce 2D reconstruction, a large smoothness constraint was set for the assumed strike direction. The inversion parameters were chosen based on synthetic tests. The derived 2D model agrees largely with the derived one-dimensional models but also introduces scattered features that may be artifacts. However, the inversion result highly depends on the inversion parameters.

An initial geological interpretation showing the coal intrusion and possible fault locations was based on 1D models. It is not possible to resolve individual coal layers well, since the clay and coal layers alternate and exhibit comparable resistivity values in the Garzweiler region. Moreover, as the fixed loop data does not provide early time information, the uppermost resistive layer is not well resolved as compared to the central loop data. However, a deep conductive layer is resolved.

**Keywords:** transient electromagnetic method (TEM), fixed-loop TEM, multidimensional TEM inversion, coal-detection.

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