Deep mineral exploration using semi-airborne electromagnetics: Investigation of a graphite deposit

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The overarching goal of the collaborative project DESMEX-II is the development of methods for efficient exploration of deposits at great depths (~1000 m). Within the framework of the project, a large scale semi-airborne controlled source electromagnetic (CSEM) survey was conducted over a graphite deposit in eastern Bavaria, Germany. Due to the presence of graphite, an additional focus of this survey is the investigation of induced polarization effects on electromagnetic data and subsequently the development of suitable interpretation schemes.

At the ground, several horizontal electrical dipole transmitters with lengths between 1-3 km were deployed, utilizing a rectangular current function with a base frequency of 11.9 Hz. Sensors installed in a helicopter-towed bird measure the EM field on flight lines with a dense spacing and within several overlapping flight areas, covering offsets of several km to the ground-based transmitter. In addition, multi component magnetic as well as electric field measurements utilizing a low transmitter base frequency were conducted at the ground. Additional measurements of electric field data inline with the transmitter deliver complimentary information. After data processing, high quality transfer functions for frequencies between several Hz up to 8 kHz could be obtained.

Here, we will present the concept and first results from the conducted survey, including 2D and 3D inversion results of the semi-airborne EM dataset using multiple transmitters. The resulting inversion models exhibit strong conductivity contrasts. Shallow regions of high conductivity can be correlated with the occurrence of graphite and agree with high frequency helicopter borne EM measurements. The applicability of performing 2D inversion of single flight line data for interpretation is investigated. Effects of topography are analyzed with synthetic modelling studies and show a considerable large influence for high frequency data. Obtained ground based electric field data is evaluated in time and frequency domain and is utilized to identify effects of induced polarization on the EM dataset and to improve the overall modelling resolution of the semi-airborne CSEM data.

Keywords: DESMEX, semi-airborne CSEM, 3D Inversion, Induced Polarization