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Data filtering methods for broadband spectral electrical impedance tomography (sEIT) measurements to reduce electromagnetic coupling effects

Haoran Wang[1], Johan Alexander Huisman[1], Egon Zimmermann[2], and Harry Vereecken[1]
[1]IBG-3, Forschungszentrum Jülich, Germany
[2]ZEA-2, Forschungszentrum Jülich, Germany

Spectral electrical impedance tomography (sEIT) is a non-invasive geophysical method to image the complex resistivity distribution of subsurface materials in a broad frequency range. Laboratory studies of spectral induced polarization (SIP) have prompted the application of sEIT at the field scale in recent years. However, electromagnetic (EM) coupling effects including both inductive and capacitive coupling can affect the accuracy of sEIT measurements, especially at higher frequencies. With the development of advanced measurement equipment and the use of shielded cables, EM coupling effects can be reduced to a large extent and the remaining EM coupling is mainly due to the use of long cables. The aim of this work is to develop filters to remove sEIT measurements with large inductive and capacitive coupling effects and to conduct inversion without correction of the data. Inductive coupling is independent of soil properties and can be quantified by the mutual inductance determined from known cable positions. It is the most important source of EM coupling in conductive environments. Previous work proposed correction methods for inductive coupling in sEIT measurements. To achieve inversion without correction, we propose an index called inductive coupling strength (ICS) to evaluate the inductive coupling for a given measurement configuration. Capacitive coupling is more complicated to correct and avoid, and it is the dominant source of EM coupling in resistive environments. Previous studies showed promising correction results by integrating the capacitances in the forward modelling. However, the proposed correction method was not sufficiently accurate for high frequencies in resistive environments. To achieve inversion without correction, we propose an index called capacitive coupling strength (CCS) based on sEIT modelling with capacitances and leakage currents to quantify the influence of capacitive coupling on each measurement configuration. To evaluate the use of ICS and CCS for data filtering, we use two field sEIT datasets. The first dataset was acquired in a conductive environment and the second dataset was acquired in a resistive environment. We found that reliable inversion results over a broad frequency range up to kHz can be obtained without correction for EM coupling effects by using a 5% threshold value for ICS and CCS to filter out measurements with significant EM coupling effects.