Comparison of towed Transient electromagnetic with airborne electromagnetic and electrical resistivity tomography

*Pradip Maurya, Aarhus GeoInstruments formerly at Aarhus University, Denmark*

*Nikolaj Foged, Aarhus University, Denmark*

*Line Madsen, Aarhus University, Denmark*

*Anders vest Christiansen,* *Aarhus University, Denmark*

*Esben Auken, Aarhus GeoInstruments and Aarhus University, Denmark*

Electrical and electromagnetic methods are well suited for mapping the near subsurface electric resistivity and are used for a variety of applications such as groundwater exploration, surface-groundwater exchange, contaminated site characterization, and geotechnical investigations. Electrical resistivity tomography (ERT) and time-domain electromagnetics (TEM) are particularly popular for these investigations, and the two methods can provide comparable resolution and depth of investigation. Continuously TEM signals measured using a towed platform can generate 2D resistivity profiles similar to ERT imaging, but at much higher speed compared to the ERT method. However, the results of the two methods may differ due to fundamental differences in physical principles, sensitivity, system geometry, and instrumentation. The main objective of this study is to provide a direct comparison of a towed TEM system (the tTEM system), an ERT set-up, and airborne TEM (using the SkyTEM system). First, we performed the comparison of inversion results based on synthetic models. For all three methods, synthetic data were generated using a 1D forward response and inversions were performed using smooth-layer models in a laterally constrained inversion framework. For ERT, we used multiple gradient arrays with 5 m electrode spacing for both synthetic and field data.

Overall, the inversion results are comparable across the three methods, and they all capture the main features of the synthetic models, however, at few places differences in inversion models were observed. The ERT and tTEM cross-sections from two field cases show very comparable results, even in the upper 5 m where thin resistive layers are clearly imaged by both methods, but the resistivity of the resistive layer is better resolved using ERT compared to tTEM. This happens because the ERT method has more sensitivity near the surface. In the deeper part of the section, tTEM tends to resolve the boundaries of conductive layers (resistivity <10 ohm-m) better than the ERT method. Compared to SkyTEM, tTEM has better vertical and horizontal resolution, especially in the upper 20 m. The better tTEM resolution compared to SkyTEM is mainly due to the smaller footprint of the tTEM and the denser data sampling. Regarding the depth of investigation, the SkyTEM system is superior to the tTEM due to the larger transmitter moment,