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Recognition of magnetic anomalies in Ground Conductivity Meter soil surveys: a high-resolution field experiment

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Ground conductivity measurements are widely used in soil surveys, where the objective is to map an element or property, which gives a strong conductive signal compared to the surroundings. It can be used in mapping of soil contamination, mineral exploration and soil mapping, where properties like porosity, clay-content and salinity of groundwater are explored. However, interpretations get poor, when too many variables, e.g. metals, affect the measurements.

To improve interpretation of the GCM dataset, we investigated confounding signals from buried metals as magnetic anomalies by a magnetometer. The small field test site in Illerup Ådal, Denmark (2 ha) was situated on peat and clayey soil, where buried metal was expected due to previous archaeological investigations. Both GCM and magnetometer measurements were on-the-go behind an ATV and logged together with DGPS positioning. Instruments were a DUALEM-21 and a Geometrics G-858 Caesium magnetometer. Data were collected in separately runs, since close proximity of the instruments can affect the magnetometer data. Data were collected on 12 lines, which were spaced 5 m apart. The frequency of readings was 4 times s^{-1} at a speed of approximately 12 km h^{-1}. A 1D multi-layer model was used for the inversion of EM data, providing detailed information of the resistivity structure in the upper 2-3 m of the soil. All 12 lines were driven in both directions during sampling of magnetic data, to check if measurements are influenced by the direction of the magnetometer. Time for collecting both datasets was 90 minutes.

The combined dataset showed one area (200 m^2) with a magnetic anomaly, which correlated with a relatively low apparent resistivity (approximately 27 Ohm m), while the adjacent areas had a higher apparent resistivity (>50 Ohm m). The inversion model showed that a relatively low resistivity (20-30 Ohm m) was present at all depths in the area with the magnetic anomaly. However, the model showed even lower resistivity in other areas of the site (10-20 Ohm m) in all of the modelled layers. Therefore, this area would easily be interpreted wrong in GCM surveys, since it does not appear as an outlier in the EMI dataset.

By making a combined survey with both EMI and magnetic susceptibility measurements, it is possible to identify small areas with high magnetic anomalies. Here caution should be taken in interpretation of GCM survey in relation to the element or property of interest.