

Potency of electromagnetic induction for pedological, quarternary-geomorphological and archaeological prospection.

Project funding: [FWO](#)

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Research hypothesis

The global hypothesis of the research project is that there is still unused potency to conduct detailed soil prospection with a specific soil sensor ([EM38DD](#)), based on electromagnetic induction (EMI). Therefore a number of alternative measurement configurations will be tested, eventually in combination with detailed information about the micro topography. We aim to evaluate applications situated in within-field soil mapping and in quaternary-geomorphological and archaeological field prospection.

Geophysical instrument

Electromagnetic induction (EMI) has been used for some time as a geophysical tool for archaeological and other research. In a transmitter coil a primary magnetic field is created that induces electrical currents inside the material under its influence. In their turn these currents generate a secondary magnetic field. The latter is measured in a receiver coil after zeroing it for the primary field. The in-phase response of the primary field measures the magnetic susceptibility of the soil, a measurement which is similarly sensed with a magnetometer. The quadrature-phase response is directly proportional to the soil electrical conductivity. So EMI sensors can measure two important physical properties at the same time. Moreover, the measurement is non-invasive and non-destructive. The depth sensitivity reaches 1.50 m and the horizontal sensitivity is ideal for detecting small features in the subsurface.

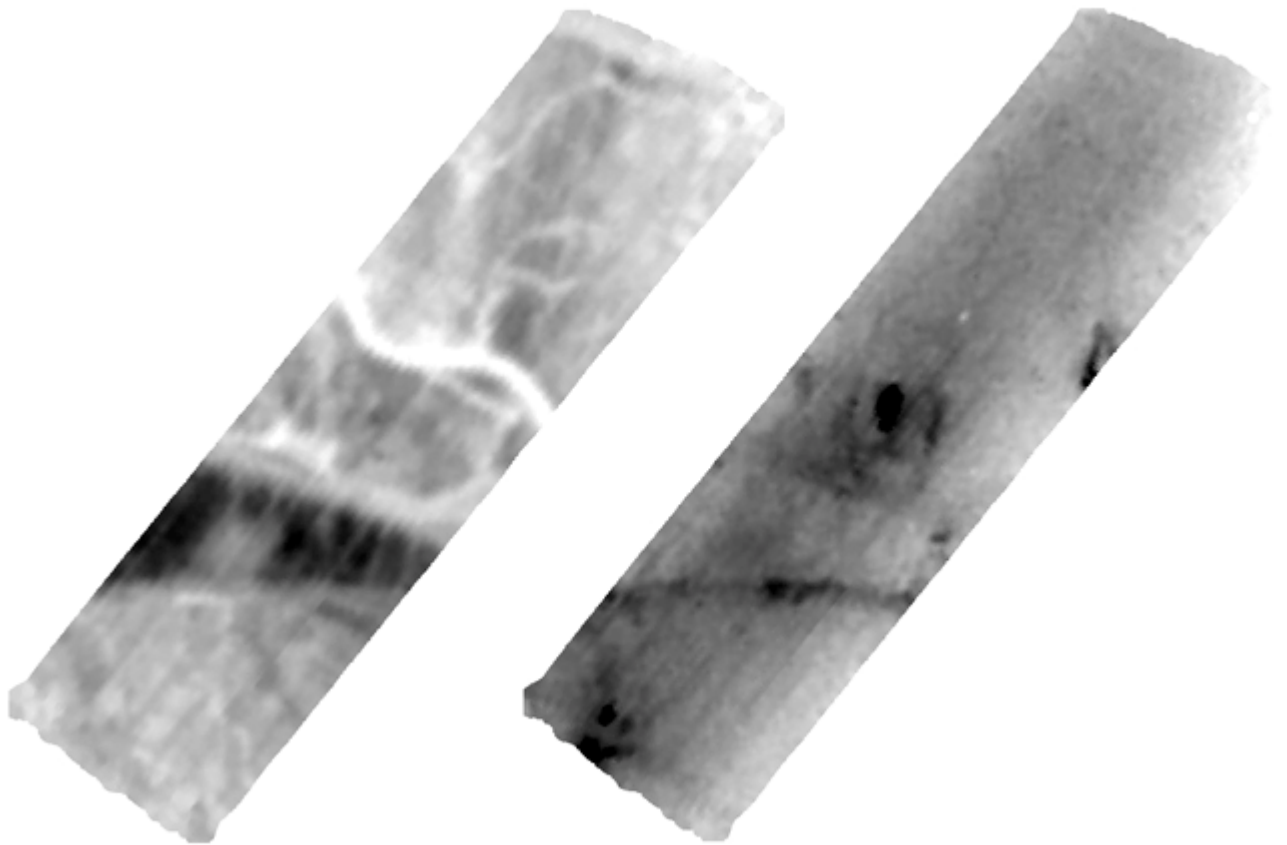
Optimizing operation

With our mobile configuration, we are able to measure 10 hectares in one day on a 2x2 m density or smaller areas up to 0.5x0.5 m density. The former density is ideal for geomorphologic research or exploratory archaeological survey. The latter can detect smaller structures related to archaeology. The data processing involves preparing the data for making maps, filtering for spatial structures and presenting in a GIS. Additional information is also integrated, like elevation, air photographs and soil sampling. By optimizing these techniques, the project aims to improve the interpretation of detailed spatial patterns.

Example



Aerial photograph of crop marks reflecting varying soil conditions, showing archeological features



Maps of EM38DD measurements on the same field of the aerial photograph.
 Left map showing the electrical conductivity or quadrature-phase response,
 right map showing the magnetic susceptibility or in-phase response.
 Both measurements taken simultaneously at a 2x2 m point density.

Conference and workshop contributions

- Saey, T., Simpson, D., Vitharana, U.W.A., Vermeersch, H., Vermang, J., Van Meirvenne, M., 2008. Reconstructing the paleotopography at the beginning of the Weichselian glacial stage using electromagnetic induction. Geophysical Research Abstracts, Vol.10, file: EGU2008-A-00121. EGU General Assembly 13-18th April 2008, Vienna, Austria (on CD).
- Vitharana, U.W.A., Van Meirvenne, M., Amakor, X.N.C., Saey, T. and Vermeersch, H. 2008. Use of proximal soil sensing to improve the thematic accuracy of a soil-polygon map. Geophysical Research Abstracts, Vol.10, file: EGU2008-A-09214. EGU General Assembly 13-18th April 2008, Vienna, Austria (on CD).
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- Vitharana, U.W.A., Van Meirvenne, M., Amakor, X.N.C., Saey, T., Simpson, D., 2007. Potency of proximal soil sensing to upgrade the soil map of Belgium: test case UGent experimental farm at Melle. Thematic Day 2007: Soil resources in Belgium - Current and future issues Soil Science Society of Belgium, 6th December 2007. Brussels, p. 10.
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- Saey, T., Simpson, D., Vermeersch, H., Vitharana, U.W.A., Vermang, J. and Van Meirvenne, M. 2007. Reconstructing the paleotopography beneath the loess cover using high-resolution electromagnetic induction measurements. Soil Science Society of Belgium, Thematic Day 2007: Soil resources in Belgium - Current and future issues, pp. 20.
- Simpson D., Lehouck A., Van Meirvenne M., Bourgeois J., 2007. Mobiele, niet-invasieve EMI-bodemsensor: een nieuw instrument voor archeologische prospectie. Archeologisch Forum 2007, Forum Vlaamse Archeologie, 30 April 2007. Mechelen.
- Vitharana U.W.A., Van Meirvenne M., Simpson D., Cockx L., De Baerdemaeker J., 2006. Influence of the topography on the within-field soil variability in the Loess region in Belgium. In: /2nd Global Workshop on Digital Soil Mapping : book of abstracts, Ed.: Mendonça-Santos M. et al., Rio de Janeiro, Brazil, 4-7 July 2006, p. 56. ISBN : 85-85864-21 (on CD).

Publications

- Saey T., Simpson D., Vermeersch H., Cockx L., & Van Meirvenne M., 200_. Comparing the reconstruction of the Interface Depth in a Two-Layered Soil with the EM38DD and Dualem 2,1S Electromagnetic Induction Sensors. *Soil Science Society of America Journal*, in press.
- Saey, T., D. Simpson, U. Vitharana, H. Vermeersch, J. Vermang, and M. Van Meirvenne. 2008. Reconstructing the paleotopography beneath the loess cover with the aid of an electromagnetic induction sensor. *Catena*, **74**: 58-64.
- Simpson D., Lehouck A., Van Meirvenne M., Bourgeois J., Thoen E., Vervloet J., 2008. Geoarchaeological prospection of a medieval manor in the Dutch Polders using an electromagnetic induction sensor in combination with soil augerings. *Geoarchaeology*, **23**: 1-14.
- Vitharana U.W.A., Van Meirvenne, M., Simpson, D., & Cockx L. , 2008. Agronomic consequences of potential management zones delineated on the basis of EM38DD measurements. *Near Surface Geophysics*, in press.
- Lehouck, A., Simpson, D., Vermeersch, H., Van Meirvenne, M., 2007. Geoarcheologisch onderzoek naar (post)midleeeuwse nederzettingstructuren in de ruilverkaveling Sint-Rijkers. Locatie Sint-Rijkers: verdwenen dorpskern. *UGent Archeologische Rapporten D/2007/3877/8*.
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- Simpson D., Lehouck A., Van Meirvenne M., Bourgeois J., 2007. Elektromagnetische inductiemetingen als prospectietechniek voor de reconstructie van middeleeuwse landschappen in het Vlaamse kustgebied. *Archaeologia Medievalis*, **30**: 200-204.

- Simpson D., Van Meirvenne M., De Baerdemaeker J., Vitharana U,W.A., Cockx L., 2006. Soil-crop-landscape relationships within an agricultural field in the loess region of Belgium. *Pedologia-Themata* 13, Soil Science Society of Belgium.