The Interface of Geophysical & Geochemical Survey in Archaeological Prospection

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NATURAL ENVIRONMENT RESEARCH COUNCIL

Introduction

Geophysical and geochemical techniques tend to be used independently of each other in archaeological prospection. However, their interaction (or interface) can help in understanding the complex and inter-related factors (chemical, physical and environmental) associated with the soil environment in which archaeological features are buried.

These soil properties are fundamental in controlling the contrast between negative archaeological features (*e.g.* a ditch) and the soil matrix, making them potentially detectable by geophysical means. Also, they characterise the superficial deposits overlying archaeological features influencing their detection. Hence, the analysis of these soil factors becomes crucial when surveying sites in challenging soil environments.

The Challenges

- **Sites with difficult superficial deposits (e.g. wind blown sand).**
- **Sites with low magnetic contrast.**
- **Sites with variability in data quality**

***Figure 1**: (a) An example of a low magnetic contrast site, the prehistoric cropmarks at Forteviot (see Case Study Sites). (b) Very weak magnetic anomalies of a double ditch enclosure (gradiometry, 0.5m traverse separation-ts by 0.125m sample interval-si) and its approx. location.*

The Questions

- Which geophysical technique or combination of techniques gives results that are most useful for archaeological interpretation?
- What is the impact of the soil on the geophysical results and/or their variability? What are the specific soil factors involved in creating the contrast?
- Are there any strategies that can help us to plan a more confident geophysical survey strategy at these types of site?

Project Goal

This NERC PhD project is using both geophysics and geochemistry to understand the soil properties that influence the results of geophysical techniques at five challenging study sites in Scotland.

The Objectives

To assess the capabilities and limitations of five geophysical techniques.

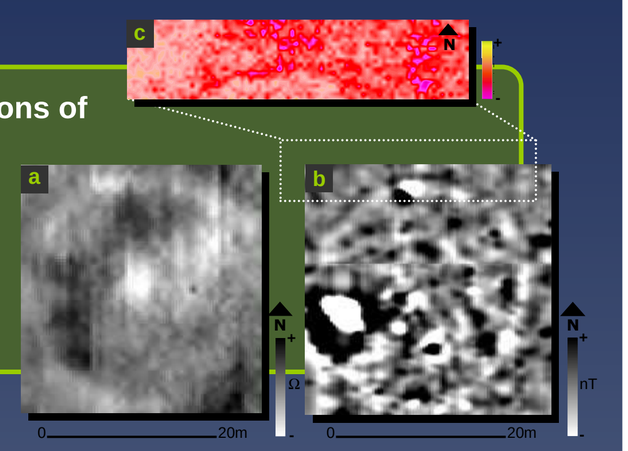


***Figure 2**: Different geophysical responses of the enclosure at Forteviot (Fig 1). (a) Earth resistance, 0.5m ts by 0.5m si. (b) Gradiometry, 0.25m ts by 0.125m si. (c) Ground-penetrating radar-GPR (0.5m ts by 0.05m si, 8-22 ns time window) and its approx. location.*

To experiment with sequential geophysical surveys & soil sampling.

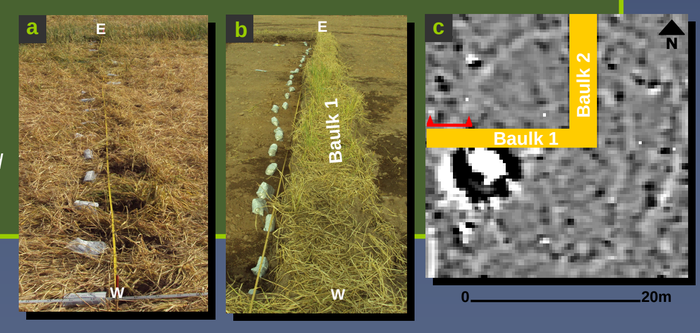
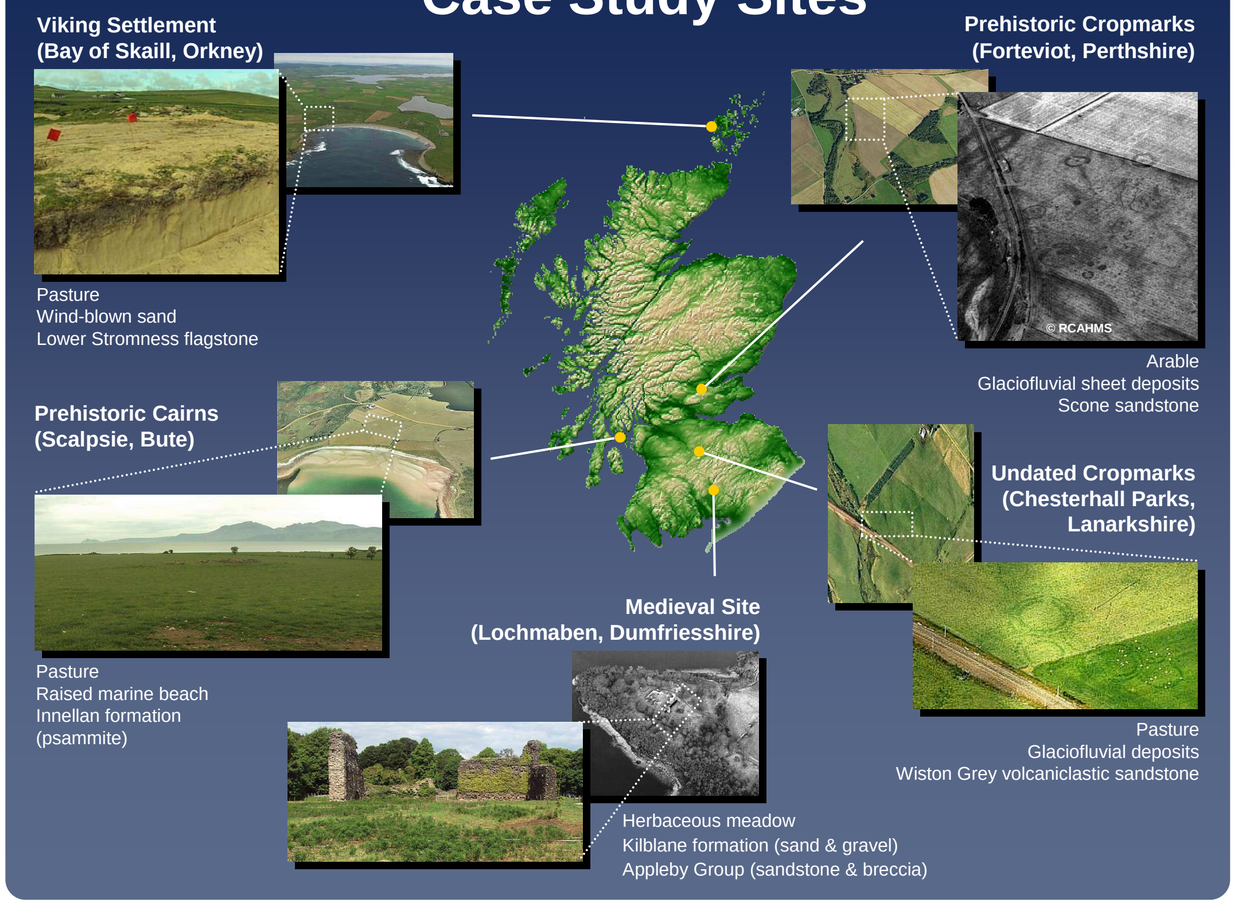


***Figure 3**: Soil sampling before (a) & after (b) topsoil stripping of the enclosure at Forteviot. (c) Gradiometer data, 0.25m ts by 0.125m si over the same feature after topsoil stripping. (c) Baulks (in yellow + b) left to experiment with GPR & the exposed section (in red) for soil sampling.*

To characterise the geophysical response of archaeological features & soil matrix in terms of chemical composition & other soil properties.

***Figure 4**: (a) Section soil sampling of the outer ditch of the enclosure at Forteviot. Examples of the soil characterisation analysis carried out with these soil samples: (b) X-ray Fluorescence-XRF & (c) Phosphate-P.*

Case Study Sites



Methods

Archaeological study site selection

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Integration of existing data (GIS)

- Geology, soils, land use
- Previous geophysics, excavations,…
- Aerial photography

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Archaeological target identification

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Geophysical survey over target

- Gradiometry
- Magnetic Susceptibility
- Earth Resistance
- GPR & Conductivity

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Ground-truthing

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Sequential Soil Sampling & Geophysical Surveys

← **Weather monitoring & Bulk Density Coring**

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Geochemical analysis & soil characterisation
(P, ICP-OES, XRF, pH, particle size, bulk density)

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Data integration & correlations

Expected Outcomes

A series of field/lab-based strategies will be produced to help in the planning of geophysical surveys, in order to:

1. Understand the potential of different geophysical techniques at a given site.
2. Allow a more meaningful interpretation of the geophysical results.

→ **This should allow a more confident prediction of the most appropriate survey strategy at a given site.**

Much progress has been made in this on-going PhD project, which started in November 2008. A total area of 11.5 hectares has been surveyed and *c*.300 soil samples gathered during the 2010 fieldwork season. The project, currently at the geochemistry and soil characterisation stage, will finish at the end of 2011. This project has already benefited several on-going archaeological projects in Scotland, and its findings will greatly assist in evaluating the potential of geophysics across Scotland and beyond.