CHEMICAL PROFILING OF SOIL FOR FORENSIC APPLICATION

Lorna Dawson¹, Stephen Hillier¹, Lynne Macdonald¹,², Bob Mayes¹, Jasmine Ross¹ and Jean Robertson¹
¹The Macaulay Institute, Craigiebuckler, Aberdeen, AB15 8GH, ²CSIRO, Australia, Glen Osmond, 5064 + j.robertson@macaulay.ac.uk

INTRODUCTION
- Soil is a complex matrix, composed of a unique combination of mineral (inorganic), organic and molecular level signatures varying on different scales
- To date, the application of soil evidence in criminal cases has been largely under-utilised
- The SoilFit project investigated the potential of chemical profiling of soil, using advanced analytical methods
  – to provide soil forensic intelligence, such as geographical origin
  – to provide evidence

CHEMICAL PROFILING OF SOIL

City comparison study¹
- Soil was sampled from two urban areas of differing geology, Aberdeen and Milton Keynes
- Samples were taken from 3 common land-use categories (Flowerbeds, Grass lawns, Woodlands) from both cities

XRPD X-Ray Powder Diffraction (XRPD) characterises the mineral component, and provides clues to the underlying geology of a soil.
XRPD results from the city comparison study¹ are presented in Fig 1 and Fig 2. Soils from Aberdeen and Milton Keynes segregated strongly based on the mineralogy.

FTIR Fourier Transform Infrared (FTIR) spectroscopy provides an overall chemical signature of the organic and mineral components of soil.
FTIR results from the city comparison study¹ are presented in Fig 3, Fig 4 and Fig 5. Soils from the two cities differentiated from one another predominantly due to mineral regions of the spectra. The only land-use category that could be discriminated from the others was woodland soils from Aberdeen. However, FTIR is well suited for site specific comparisons.

Wax biomarkers, such as n-alkanes and long-chain fatty alcohols, are plant wax compounds that persist in the soil.
Wax biomarker profiles, determined using GC or GCMS, vary for different species of vegetation and can be related to the overlying vegetation and land-use history of a site, see Fig 6.

Study of gardens in the Aberdeen area²
The results from a study of soil from gardens in and around Aberdeen showed the potential for wax biomarkers to differentiate between gardens in the same urban area, see Fig 7 and Fig 8.

OUTCOMES
- Knowledge of the circumstances in which each chemical profiling method is most appropriate and the complementarities of inorganic and organic methods offers powerful potential in increasing the application of soil analysis for police investigation
- The combination of results from each of the profiling methods results in a range of attributes for a soil which increases both investigative and evaluative value