THE MACAULAY LAND USE RESEARCH INSTITUTE

SoilFit

SOIL INTELLIGENCE AND EVIDENCE FOR CRIMINAL INVESTIGATION

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INTELLIGENCE (INVESTIGATIVE) AND EVIDENCE (EVALUATIVE)

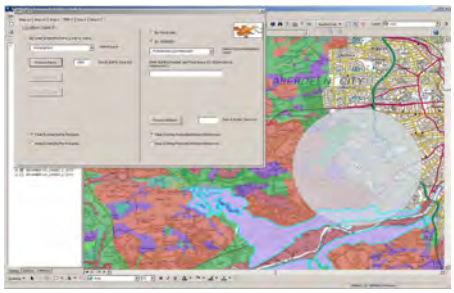
A trace of dirt on a shoe could link to a footprint at a scene of a crime….or a patch of mud on a spade could guide police investigators to an undiscovered grave.

Our understanding of soil, provided by robust scientific research, has led to the development and direct application of soil forensics in criminal investigations. Guiding police intelligence and providing evidence are the two main areas of the criminal justice system where soil forensics can play a key role.

Research at the Macaulay has focussed on understanding how we can use the multiple signatures of soil to help find a likely location for an 'unknown' soil sample and how we can associate (link) or disassociate (eliminate) soil on an object or person with a particular scene.

From a **search** perspective we have developed software-based comparison and geographic information system (GIS) tools, capable of comparing a 'questioned' forensic soil sample to a larger background soil property database, providing map outputs which geospatially provenance such samples.

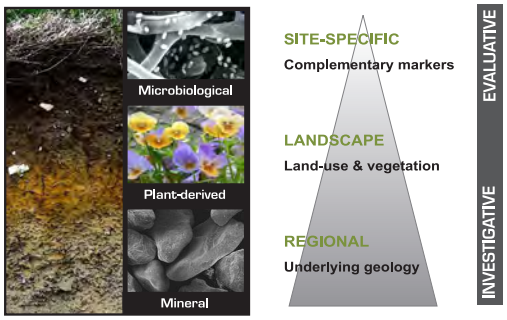
From an **evidential** perspective, our understanding on variability in mineral, organic and soil DNA signatures and the impact of transfer and mixing on items such as footwear and fabric has led to vastly improved and relevant methodological approaches.



GIS software tool.

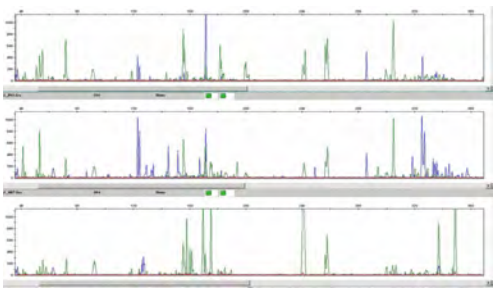
Each place on this earth has a unique biogeochemical signature. Soil is a particularly valuable type of trace physical evidence as it is composed of two main unrelated particulate components – organic and inorganic. The combined analysis signatures provide great potential for provenance dependent soil characterisation.

The discriminatory power of a range of methods varies in relation to **spatial scales**. The inorganic part of the soil will be composed of naturally occurring mineral grains from the underlying bedrock geology and its weathering products along with minerals from overlying superficial deposits, making it an excellent 'location finder' for an unknown soil.



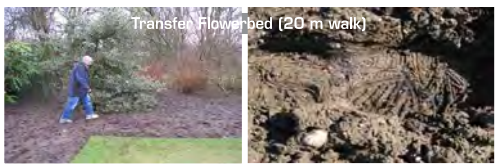
Within localised areas, where mineralogical variation tends to be small, soil organic matter characterisation is important to the discrimination of the soil source. There may be introduced materials, of both an organic and inorganic nature, which can add to the individualistic representation of a sample and can strengthen the evidential link.

The organic component can include pollen, spores, diatoms, wax marker molecules and plant fragments. The waxy surfaces of plants, which consist of complex mixtures of discrete aliphatic compounds, are incorporated into the soil, leaving a complex organic signature. The mix of marker compounds persists in the soil for thousands of years, leaving behind evidence of their existence at that location.Soil DNA, as characterised by multiplex TFRLP, also provides an organic signature, reflecting the vegetative and soil habitat suitable for that mix of soil organisms to survive.



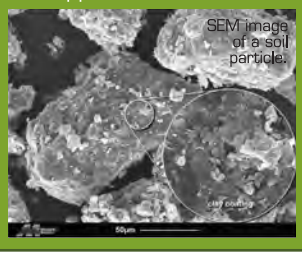
DNA fingerprints of three soils showing differences in fungal (blue) and bacterial (green) profiles measured using multiplex TRFLP.

Research demonstrates that such novel biochemical and molecular analysis **(organic) strongly complement the mineralogical (inorganic)** level information. In a crime scene study involving soil recovered from footwear, we assessed the sensitivity of biogeochemical and molecular soil analysis to post-transfer effects. Certain signature characteristics may be sensitive to post-transfer interference, with important implications for data interpretation particularly in an evidential manner.



Where evidential samples are minute, *in situ* non destructive and miniaturisation procedures can be used. XRD and IR are two such methods. These can provide a rapid 'fingerprint' of soil to compare with a database or reference sample in a rapid and cost effective way.

In common with most types of forensic evidence, soil biogeochemical profiles are unlikely to provide categorical answers, since clear deductive reasoning and classification beyond doubt is generally not possible. However, through careful implementation of a balanced approach, consideration of a combined sequential analysis, and by taking uncertainty into account, soil forensic information available to investigating officers and the legal system has now become more robust. Soil based forensics has now reached a higher 'profile' within the UK, and the world.



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