A106 Development of Soil Profiling Methods for Forensic Geographical Provenancing

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After attending this presentation, attendees will gain an understanding of the different techniques used in the chemical and biological analyses of soil, such as elemental and mineralogical profiling, plant DNA and pollen analysis. Attendees will also be able to observe the results of geographic information system (GIS) modelling for multiple variables across a region.

This presentation will impact the forensic community by introducing a novel method involving multiple parameters for soil analysis to allow the creation of a layered geographic information system (GIS) in order to predict the origin of soil samples.

Locard's principle that "every contact leaves a trace" suggests that everywhere we travel will be recorded by the geological materials retained on our shoes. In this way, the movements of a criminal or an instrument used to commit a crime can also be traced through the analysis of any soil residues found upon on them.

Geological samples, including soils, are frequently analysed by forensic laboratories, usually on a case by case basis, by comparing a suspect sample to an especially collected control. Unlike other materials that can be analysed and compared to a central database, soils as yet cannot be 'matched' to an area unless the area in question has already been identified. There is a need for a method of soil profiling that would allow an unknown sample to be tested and assigned a quantitative likelihood that it originated from a given region. Spatial models can then be created to house data relating to multiple variables and be used to map soils across geographical areas.

Generally, the more variables available with which to compare any two items, the greater the certainty a forensic analyst can have when asserting their similarity and the same applies to geological materials. This poster aims to highlight ongoing research at the Centre for Forensic Provenancing, England, involving the analysis of soil samples collected from across the county of Norfolk. A number of chemical and biological profiling methods will be used to build up a unique signature for soils from different locations. Elemental profiling by x-ray fluorescence spectroscopy (XRF) and inductively coupled plasma-mass spectrometry (ICP-MS) will elucidate any variations in major and trace element concentrations, while isotope ratio mass spectrometry (IRMS) and multi- collector inductively coupled plasma-mass spectrometry (MC-ICP-MS) analyses will determine the light and heavy isotopic signatures of the soils. Mineralogical examination of the samples will be undertaken using x-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR). Variations in the chemical composition of soils often correspond to changes in the underlying bedrock and soil parent material and these relationships could allow the prediction of values for soils, on the basis of their geographic location.

Biological components of the soil such as plant DNA and pollen can also be used to profile the soil. Although non-human DNA is not yet routinely used, it has helped to link suspects to crime scenes and aided in criminal investigations. Plant DNA from many different species both old and new to the area is often found within the soil; this can be extracted, amplified and then fingerprinted using various techniques such as microsatellites or terminal restriction fragment length polymorphism (TRFLP), to give a unique profile. Palynology, the study of pollen and spores, can also be used in establishing a link between crime scenes and suspects due to the uniqueness of pollen assemblages within a certain area. Pollen is a useful tool because the grains are extremely resistant (the outer walls of pollen grains are composed of sporopollenin, one of the most durable biological substances), and can be found in deposits in which other types of fossils have been diagenically destroyed. As well as pollen assemblages being exclusive to a specific area, pollen grains are produced in enormous numbers and can also be retrieved in great quantities making them an extremely important tool in soil profiling.

Once collected the data will be collated and modelled using geographical information system (GIS) software to map the area under analysis. This technique allows the visualisation of geographical relationships and the combination of different layers of data to determine the most effective parameters for the discrimination of soils. The use of multiple layers within the GIS should allow a greater degree of certainty when identifying the origin of the soil samples.

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