# Natural Justice assisting in criminal investigations


**Professor Lorna Dawson**

Head of Forensic Soil Science

The James Hutton Institute

**Robert Gordon University**

**Chair, FGG. Treasurer, IUGS IFG**


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# The forensic application of soil in case investigations

- Forensic ecology, botany and soil science
- Context of forensic science
- Search (intelligence)
- Trace Evidence (evidence)
- Communication

# The Romans, c. 100 BC – c. 400 AD

- The Romans were the first known people to use soil and vegetation as a provenance tool

- They examined the soil on the hooves of captured enemy horses to identify where they had come from

# Sherlock Holmes
# Sir Arthur Conan Doyle

- Before Sir Arthur Conan Doyle became a writer, he was a doctor. In medical school he took "practical botany" and was fascinated by poisonous plants.

- While Doyle was writing between 1887 and 1927, Britain became the largest empire in history with newfound access to the planet's most potent plants. The Sherlock Holmes stories reveal the fascination and anxieties provoked by moving poisonous plants around the world.


# Sherlock Holmes
## Sir Arthur Conan Doyle

- Soil was used in *The Adventure of the Five Orange Pips, A Study in Scarlet, The Sign of the Four & The Hound of the Baskervilles*
- 1906. Conan-Doyle acts as a witness in the case of George Edalji, accused of mutilating farm animals
- A man who could not tolerate injustice, was captivated by yet another criminal cause célèbre. The Case of Oscar Slater, 1912

**Sir Arthur Conan Doyle (1859-1930)**

# A Study in Scarlet

***"Geology—Practical, but limited. Tells at a glance different soils from each other. After walks has shown me splashes upon his trousers, and told me by their colour and consistence in what part of London he had received them."***

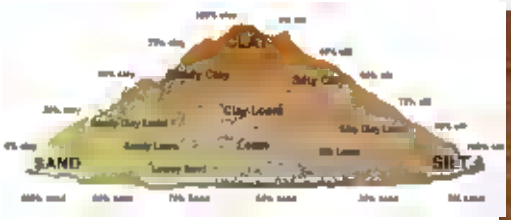
Chapter II, 1887

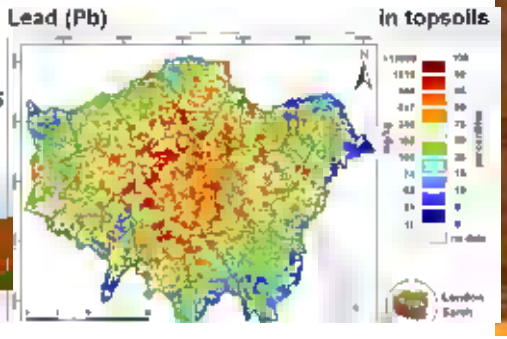
**Soil Color**

The most obvious property when looking at soil is its color.

Geologist officially recognize over 170 different soil colors.

But the most common color of soils are shades of black, brown, red and gray.




# Edmond Locard, 1910

*"Whenever two objects come into **contact**, there is always a **transfer** of material. The methods of detection may not be sensitive enough to demonstrate this, or the decay rate may be so rapid that all evidence of transfer has vanished after a given time. Nonetheless, the transfer has taken place" .*

# Trace evidence

- *Locard Exchange principle established, 1910*
- ***Every Contact Leaves a Trace** potentially linking items*
- *Locard described soil particles as 'dust' or 'dirt'*
- *Trace evidence can include blood, hair, fibre, soils, plants*
- *fragment, pollen, glass particles and any other minute particles at a crime scene*

# What is Soil ?

*“Soil is the living bridge between rock and life”*

*“We are to examine the construction of the present earth, in order to understand the natural operations of time past”*

# Not all soils are equal




**Soil has the properties of an ideal trace evidence:**
**Is highly variable**
**Has a high probability of transfer and retention;**
**Often nearly invisible**
**Can quickly be collected, separated, and concentrated**
**The merest traces are easily characterised and**
**Able to have computerised database capacity**

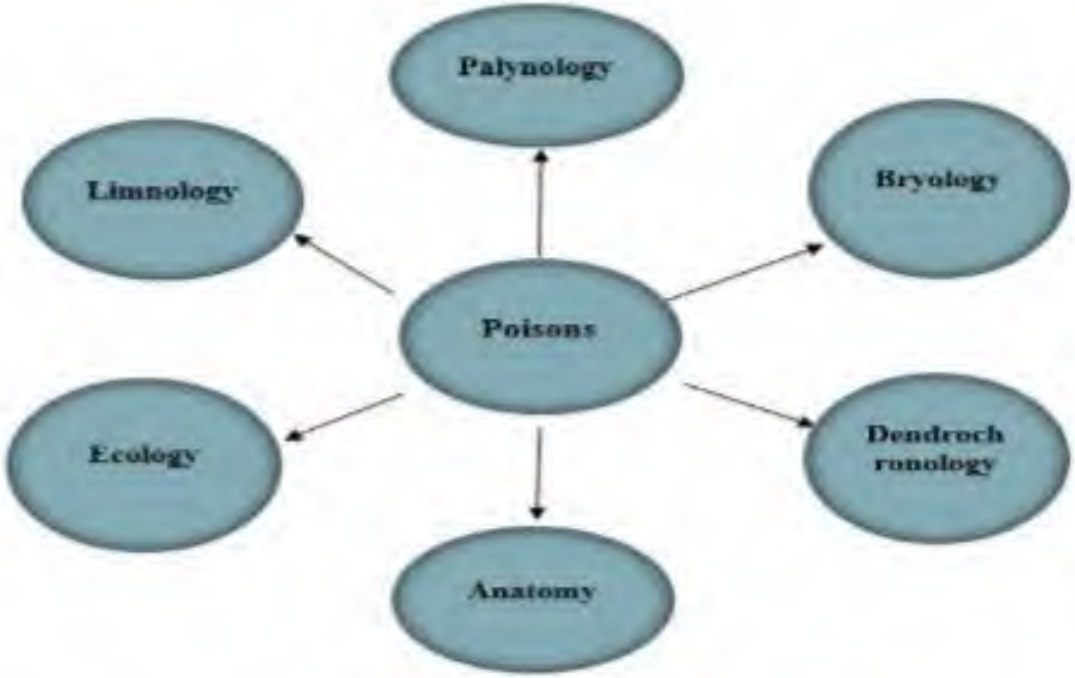
# Soil – trace material

- Soils cover most of the terrestrial surface
- People travel by foot / cycle / vehicle
- customarily some contact
- Unconsolidated
- Readily transferable

# Soil evidence

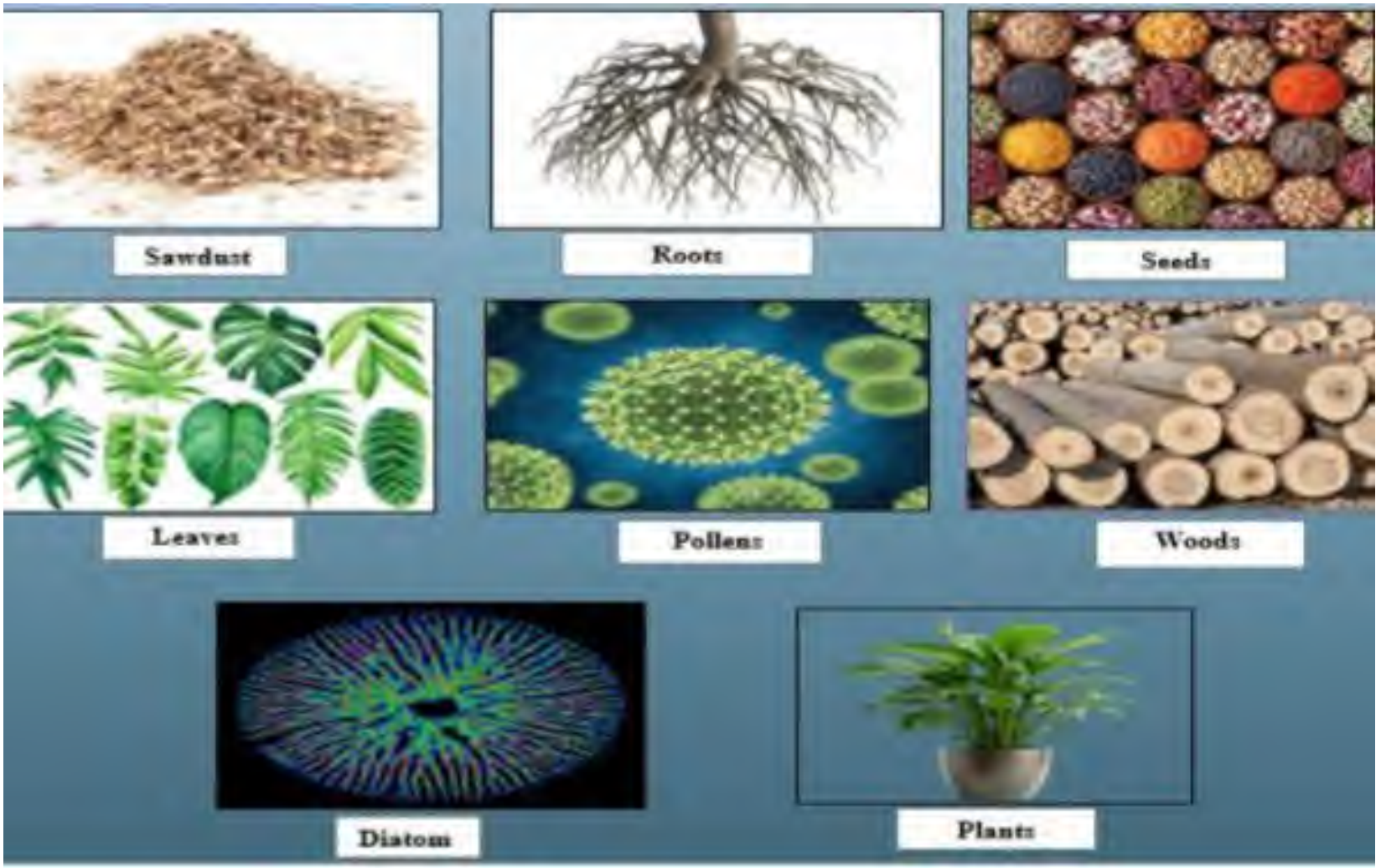
- Samples from clothing collected intact
- Analysis can be carried out on entire garment after a DNA swab taken
- Fingernail amounts can be analysed
- Washing machine filters can also provide useful soil evidence

# Botanical information




- Range of different ways plants can contribute to criminal investigations
- Identifying plants to recreate habitats
- Micro traces of pollen, diatoms and bryophytes
- Stomach content analysis and identification of plant derived poisons

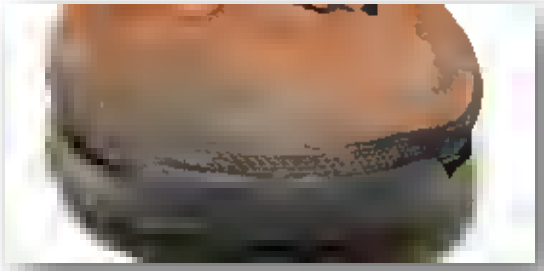
# Botanical Evidence

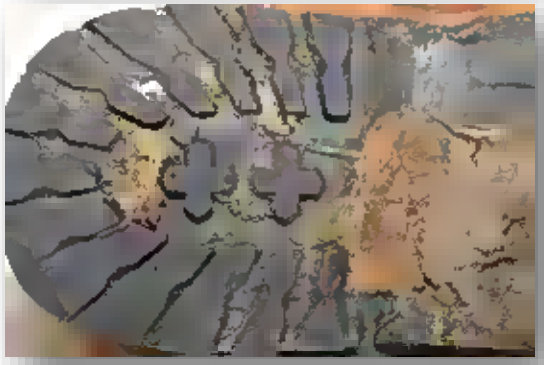


# Soil & Plant evidence: vehicles & tools


- Soil from wheel-arch is preserved in layers
- Soil from brake pedal/tyre can link a suspect to a location
- Samples taken from a boot can indicate where digging took place
- Tools may be found in the boot and may have various soil layers indicating several locations of burial

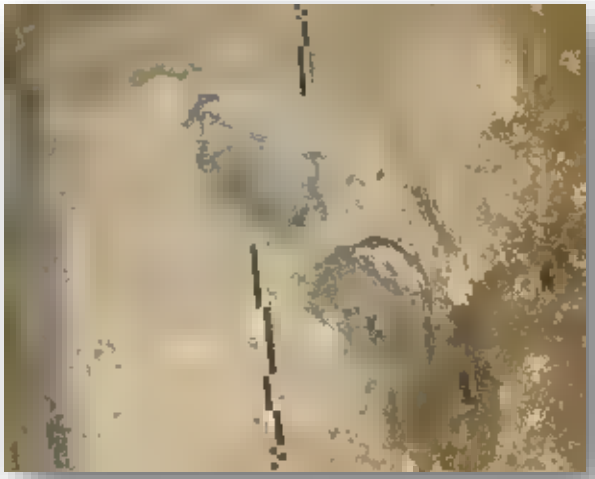
# Soil & Plant evidence: footwear





- Samples from footwear sampled *in situ* and in layers
- Analysis can be carried out on separate areas
- Vegetation embedded in and adhering to footwear can help identify contact locations
- Soil information can enhance mark evidence
- Contact location sampling can help direct evidential comparison/links tested

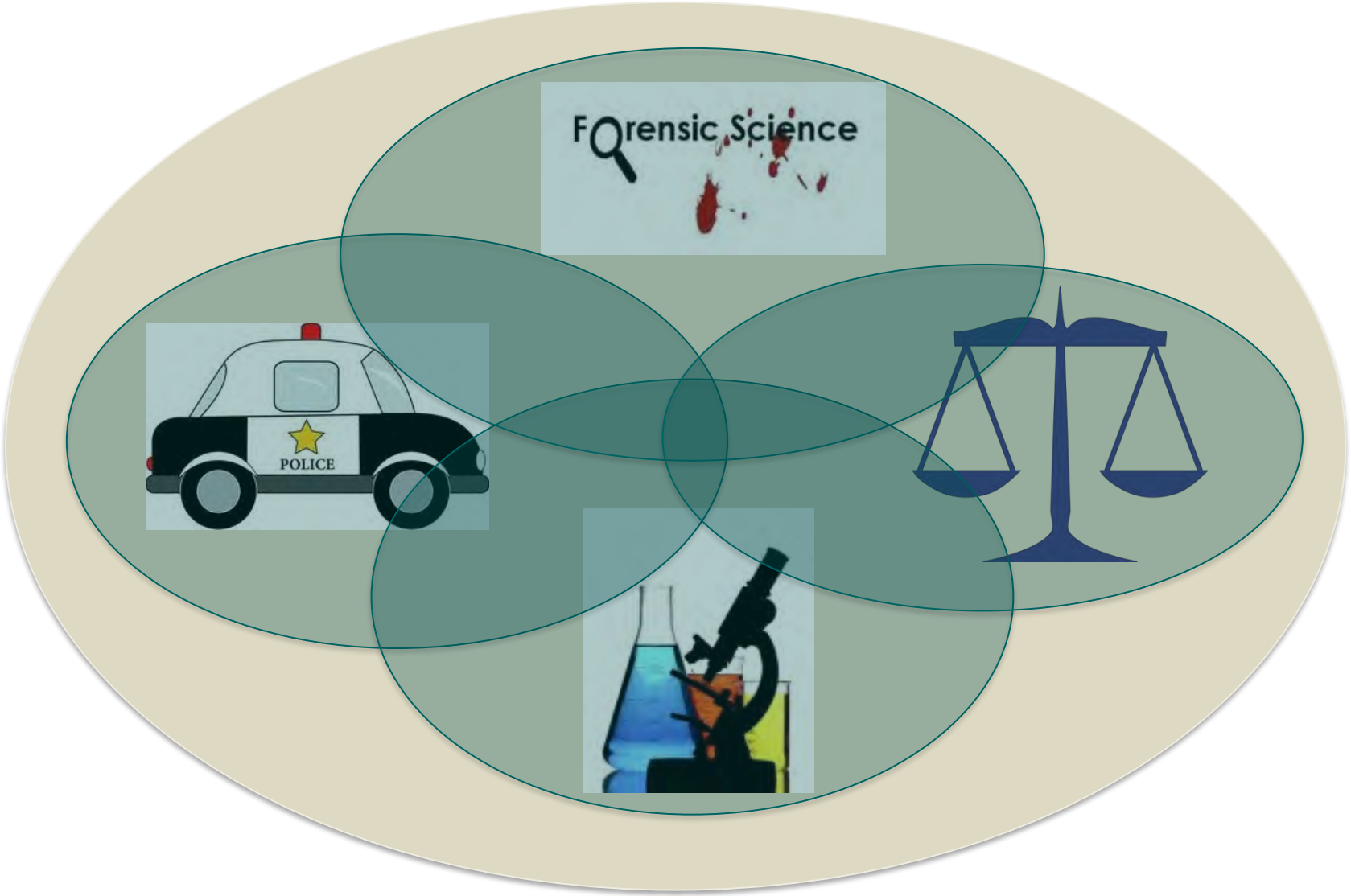
# Soil & plants: indicators



- Soil indicators of multiple burial
- Indicators of route of entry/exit
- Vegetation indicators of burial
- Organic indicators of time since burial


WHO was involved?
WHAT happened?
WHERE did it happen?
HOW did it happen?
WHEN did it happen?
WHY did it happen?

# Team work




**Soil science: the scientific study of soil as a natural resource**

**Forensic: pertaining to the law**

# The Interdisciplinary nature of Forensic Ecology


Pathology

Taphonomy

Geology

Entomology

Geography

Archaeology

Anthropology

Pedology/
Soil Science

Geophysics

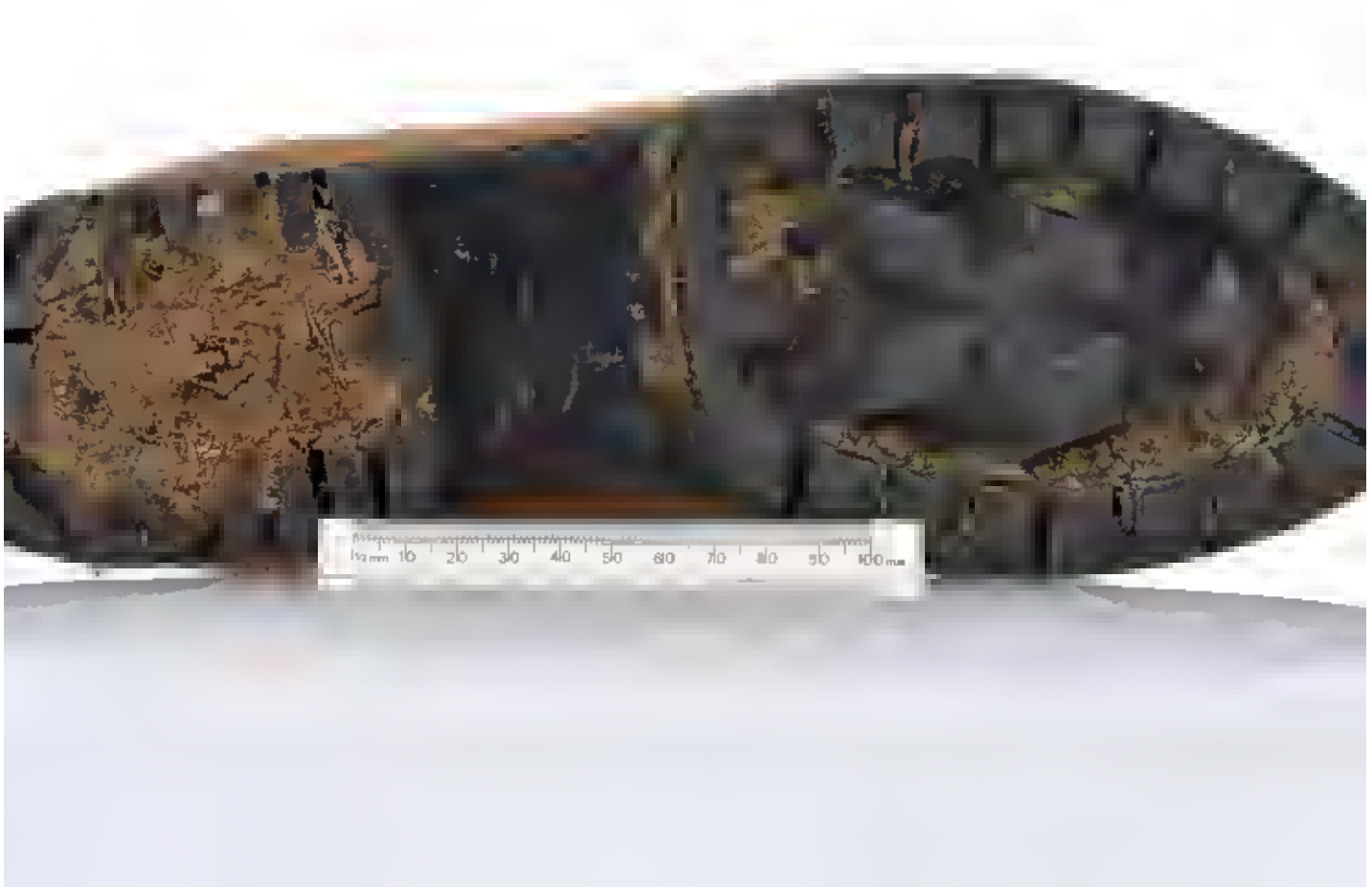
Ecology

Geology

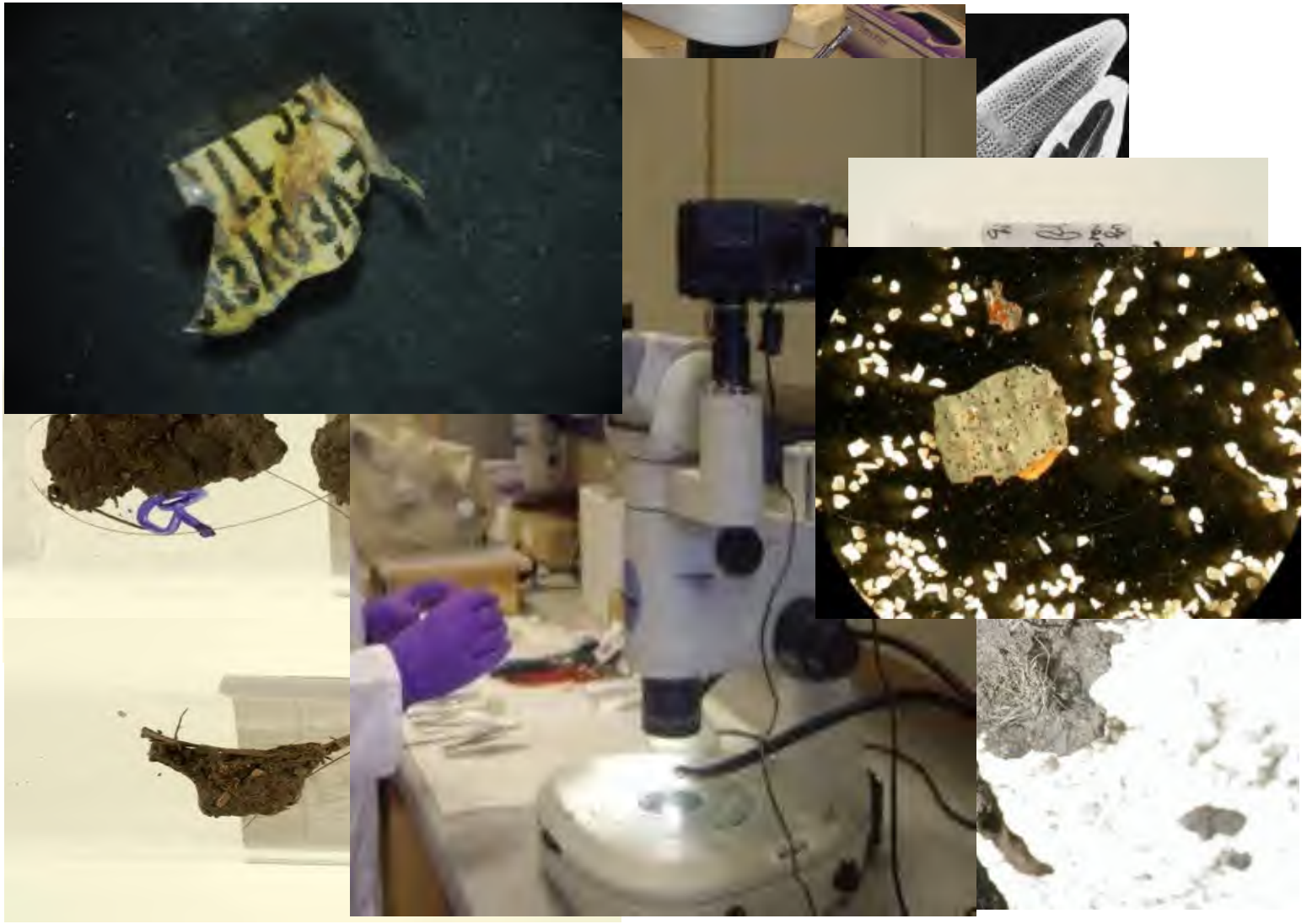
Palynology

Botany

# Questioned sample examination



# Clues within the soil



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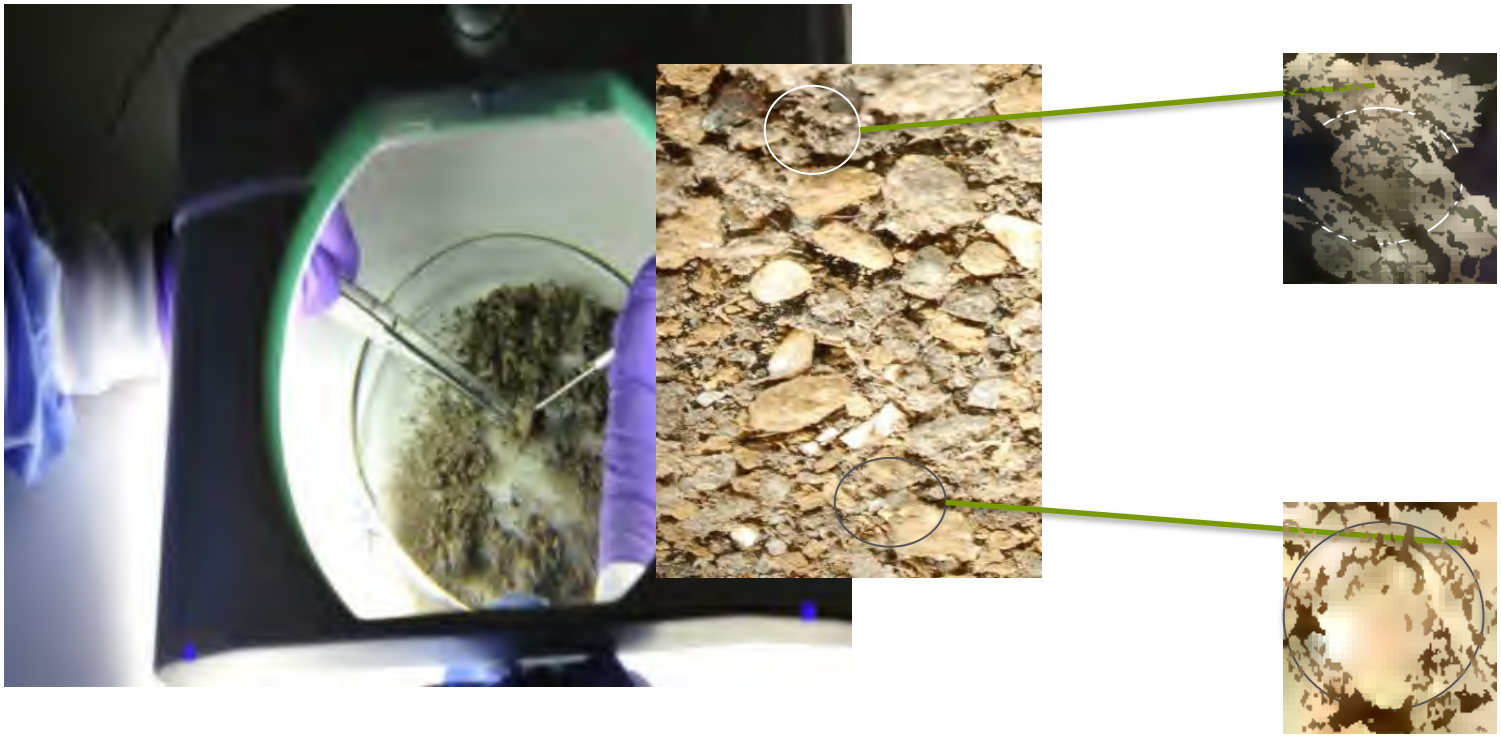
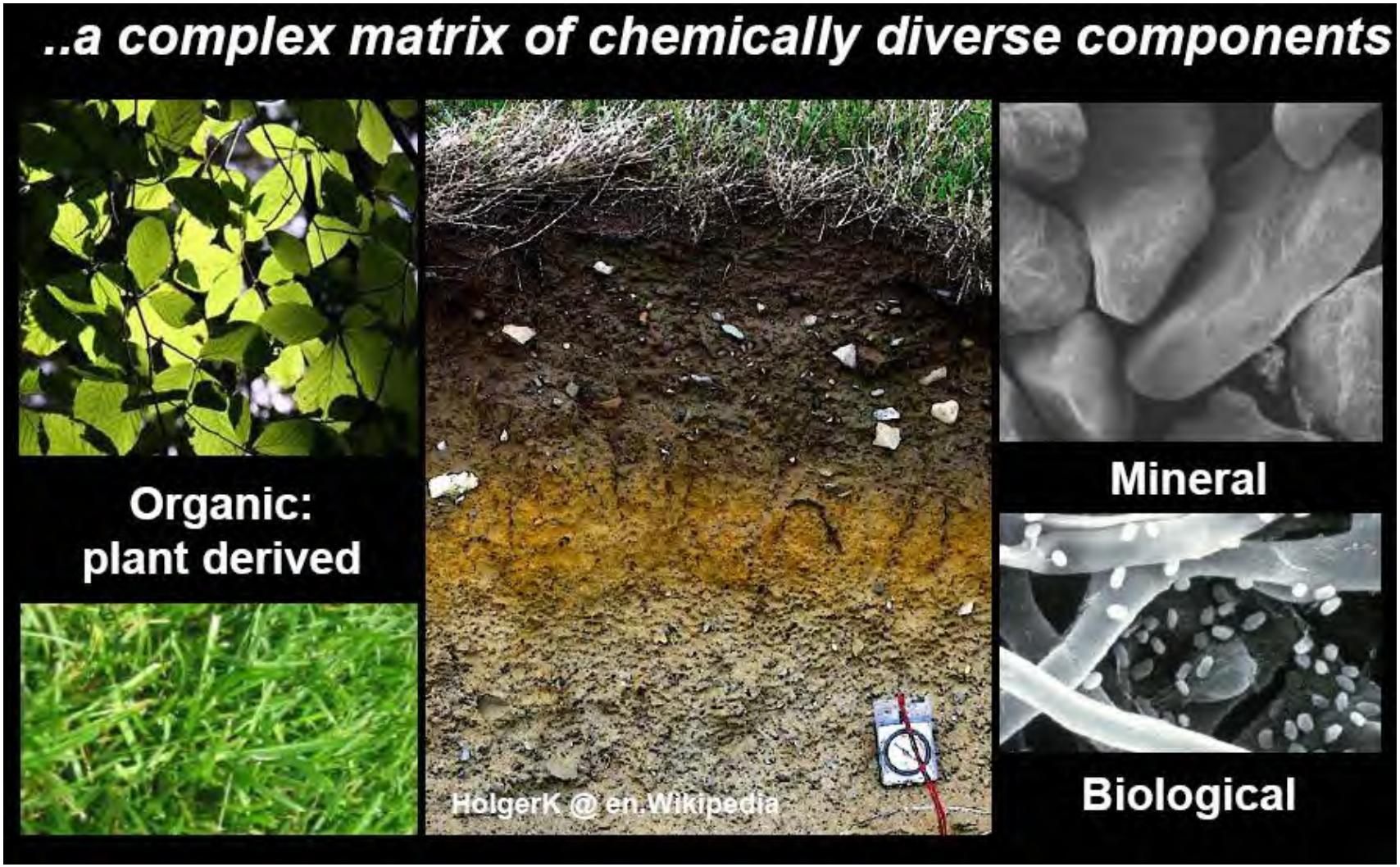
# Sampling of single source soil from questioned samples for analysis

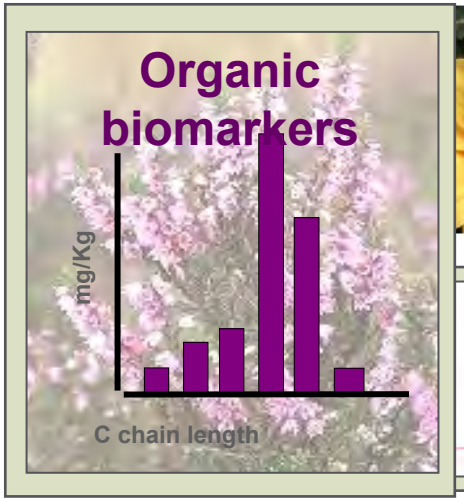


Approach used in court:
R *v* MUIR, Newcastle Crown Court, 2013: HM Advocate *v* SINCLAIR, Livingstone High Court, 2014;
R *v* HALLIWELL, Bristol Crown Court, 2016; R v McKie, 2017. HMA v WILLOX, Glasgow Crown Court, 2022,
HMA v PACKER, Glasgow Crown Court, 2024, Sheku Bayoh Inquiry, Scotland.

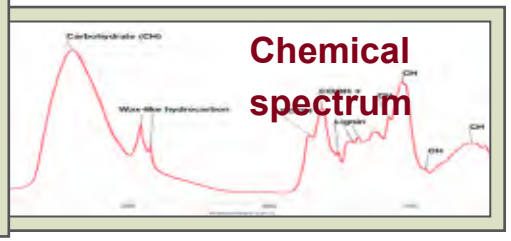
# Soil is a complex mix of diverse components

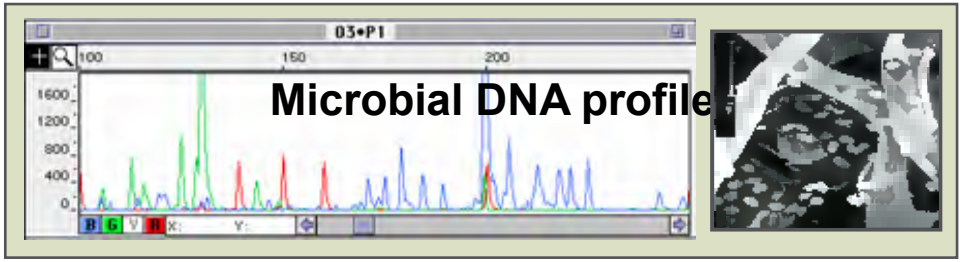


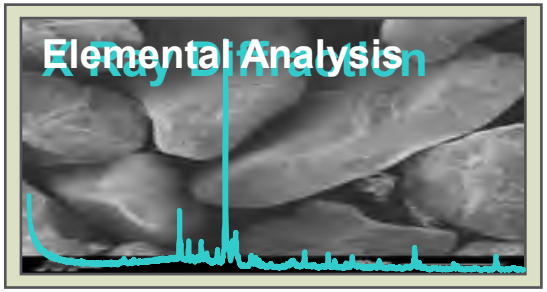
# Developing and Testing Methods in Soil Forensic Science

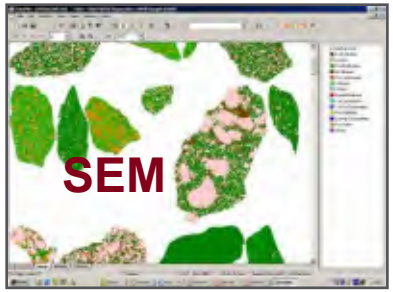





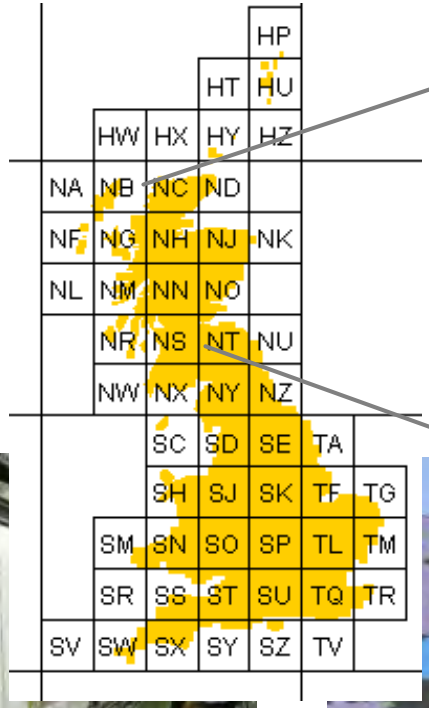


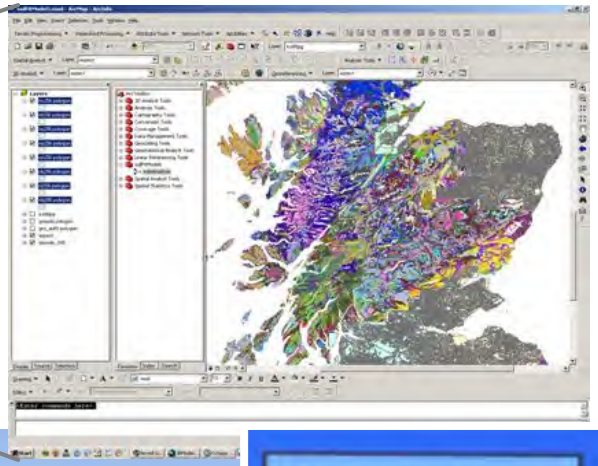



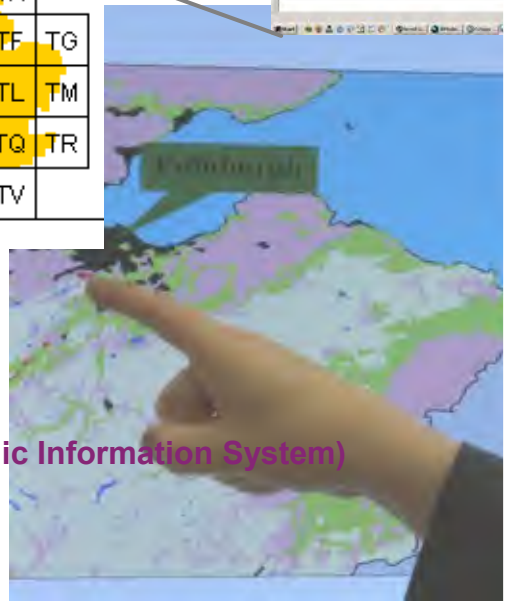
# Intelligence – search using GIS

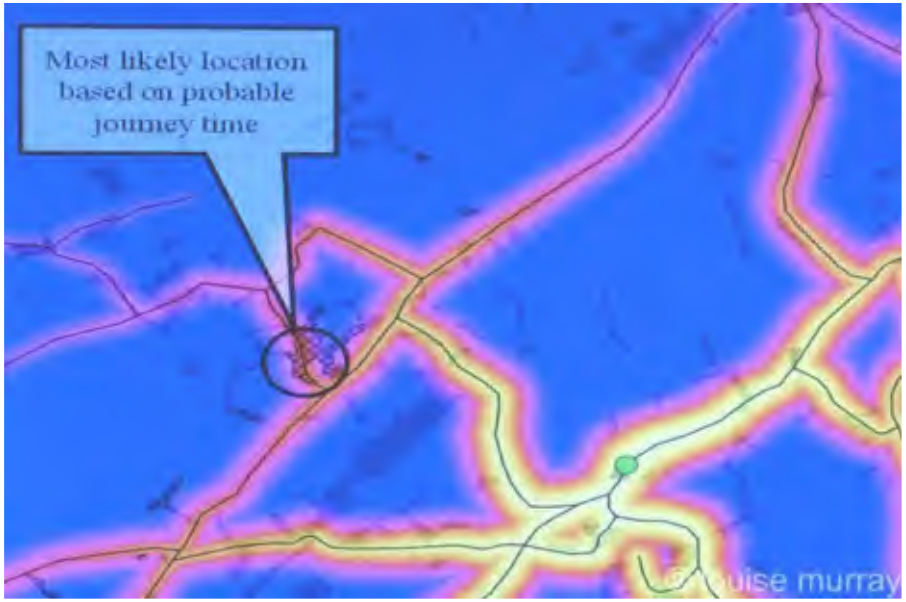


Soil, mud or vegetation on, or from, a vehicle or shoes may provide the clue that could point to a particular search location

(GIS – Geographic Information System)





# National Scottish Soils Archive


- > 40 000 soil samples collected over 60 years
- Samples from all Scotland's soils dating from 1930's to present

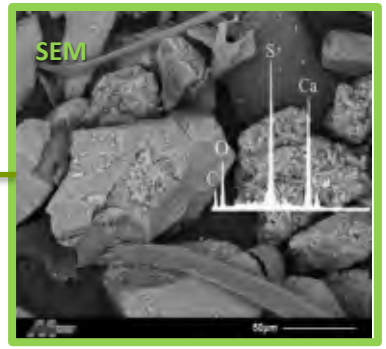
**Includes:**

- Systematic soil survey samples
- National Soils Inventory (1978-87) and NSIS 2 (2007-2010)
- Long term experiments, sludge experiments, grassland extensification, forestry, agroforestry, livestock and crop systems experiments
- New soil DNA archive from NSIS-2 (2007-2010) and long-term experiments

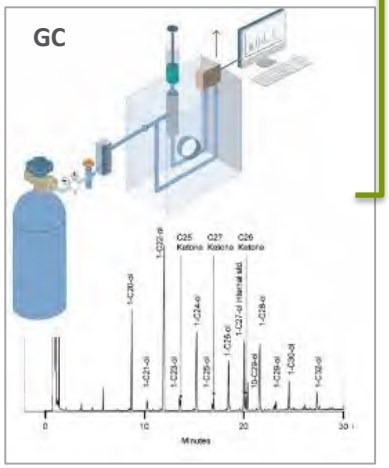
# Links to maps, GIS and databases

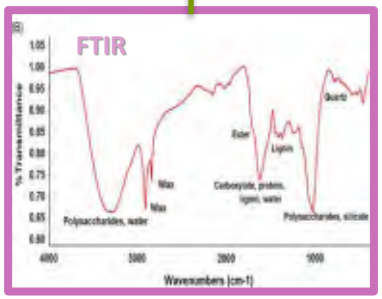
Soil Properties
Texture and colour

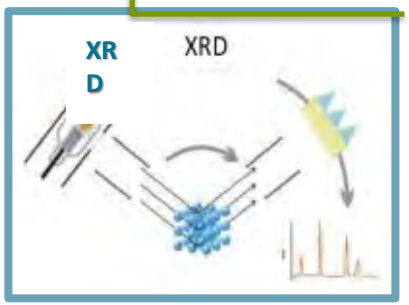
Soil Organics microbiology / DNA



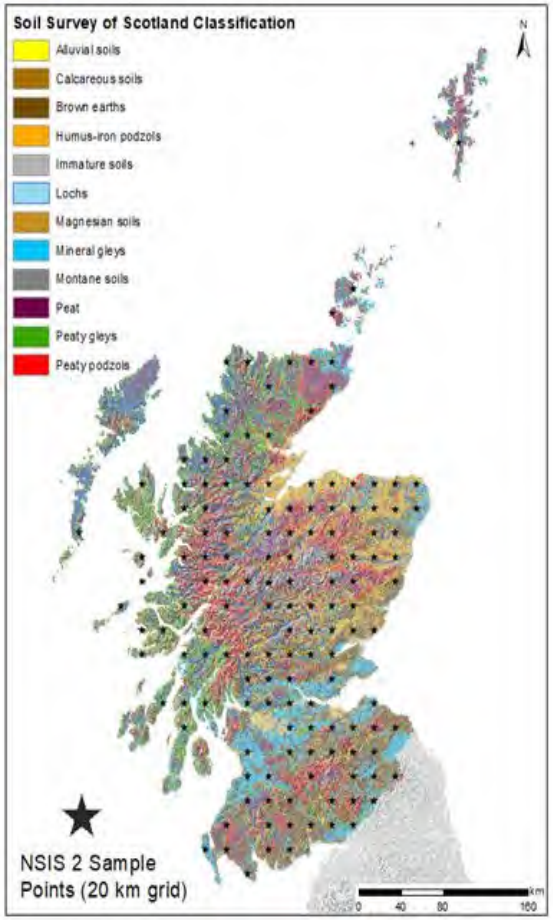




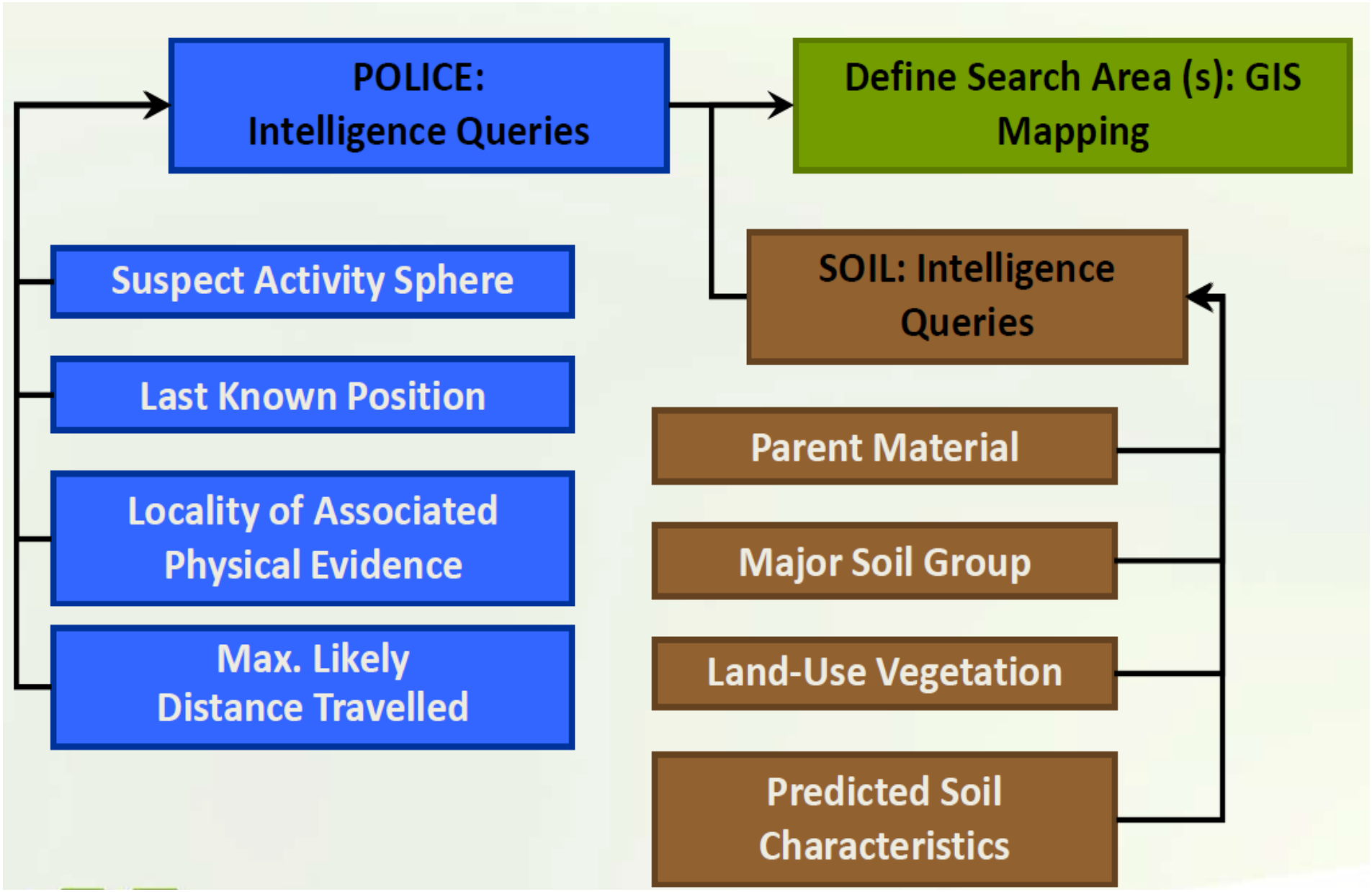



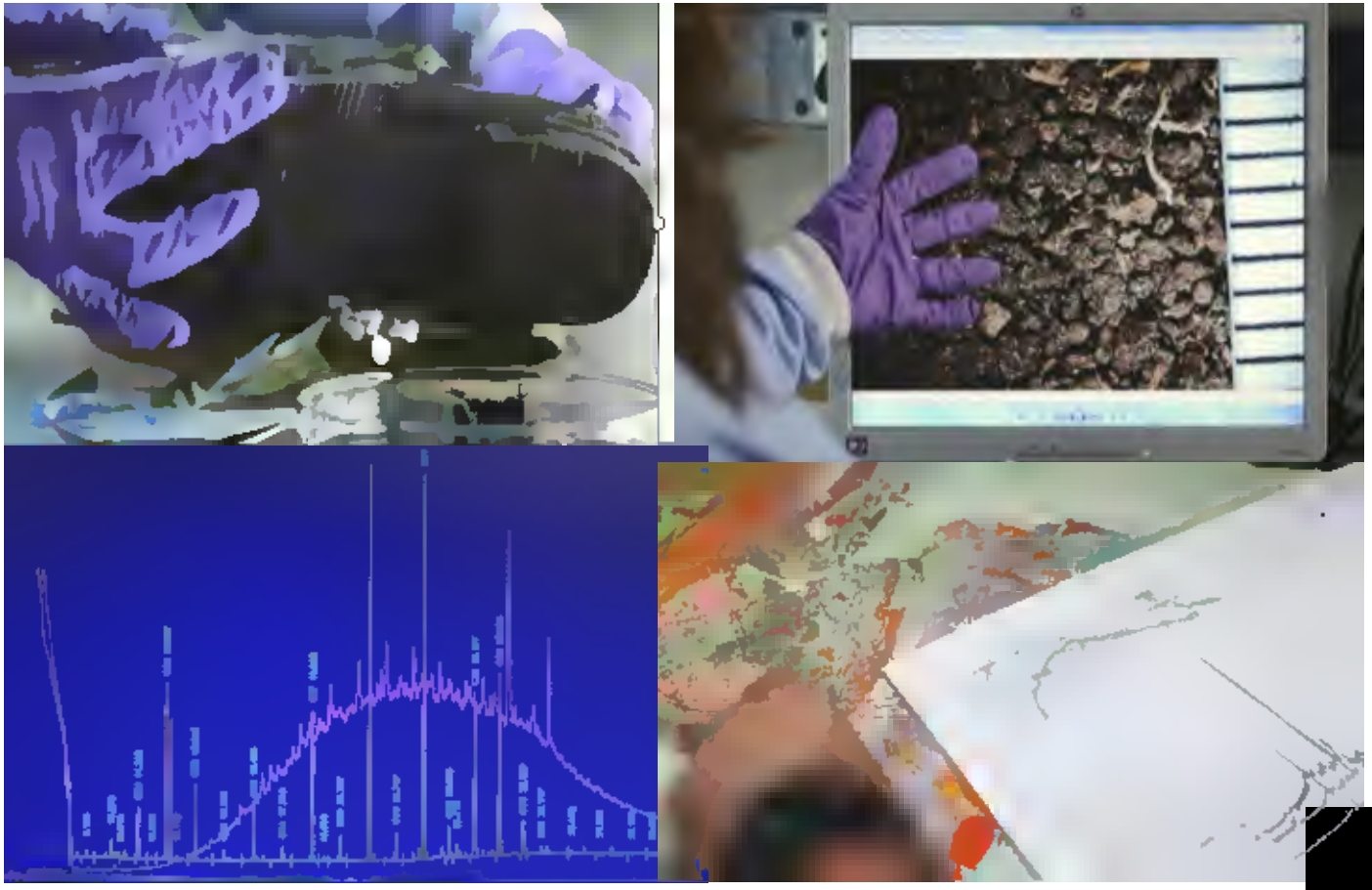

Spatial Data



# GIS Mapping Approaches



# Catching History's Criminals: Georg Popp & the where question?

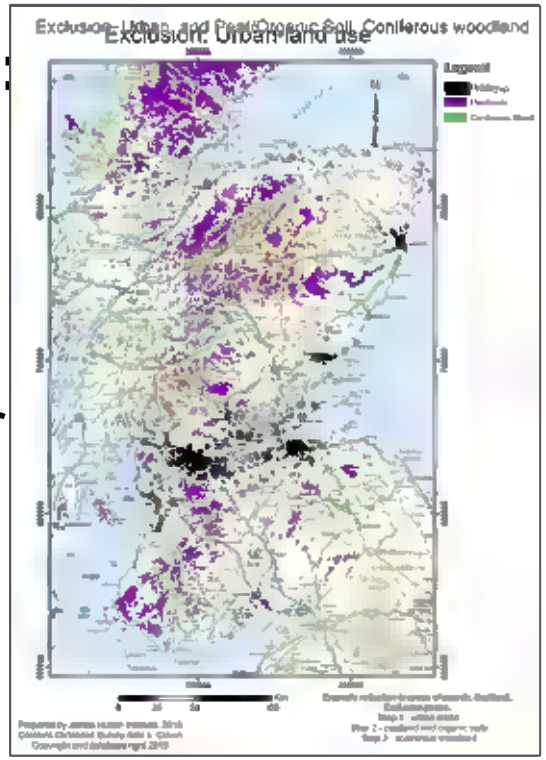


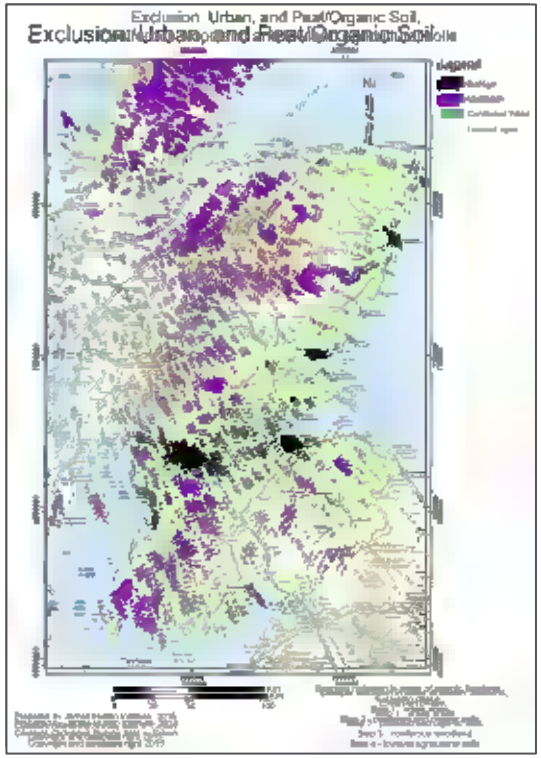
BBC4. https://www.bbc.co.uk/programmes/p02l4px7

# Exclusion

**Exclude:**

- Urban
- Peat
- Coniferous woods
- Arable



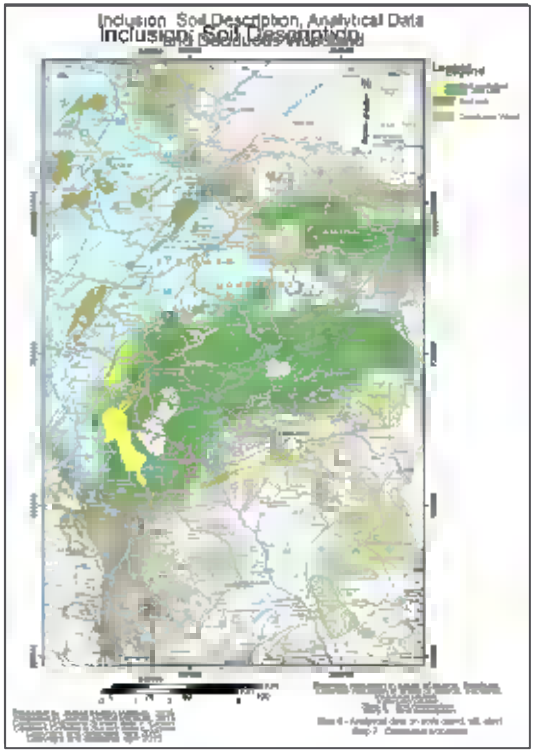



# Inclusion

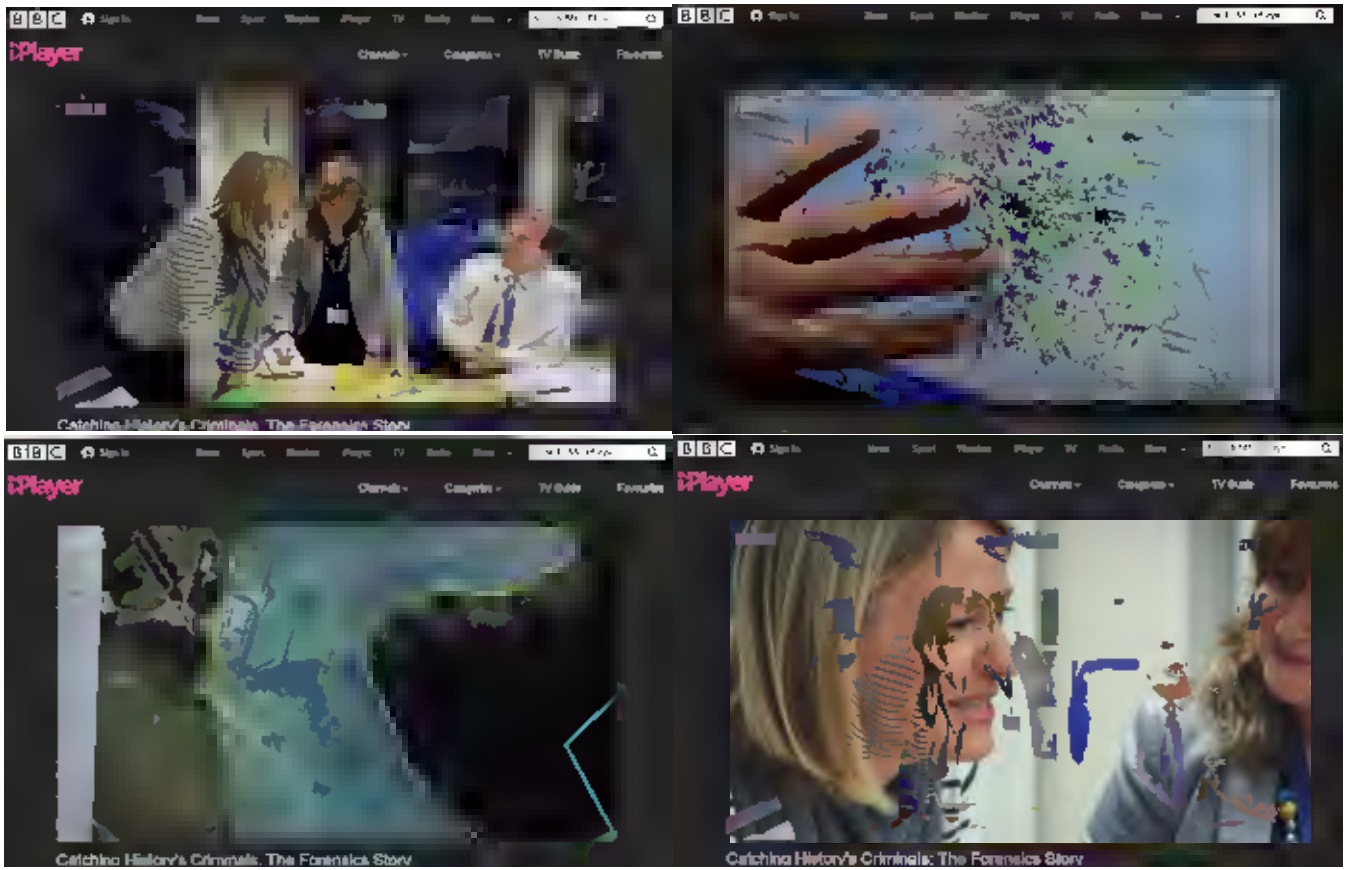
Soil filter – descriptive (structure, colour, pH and carbon content)

## Include:

- Soil description
- Analytical data
- Deciduous woodland
- Accessibility
- Identify the key possible areas of search




# Where did the presenter walk?

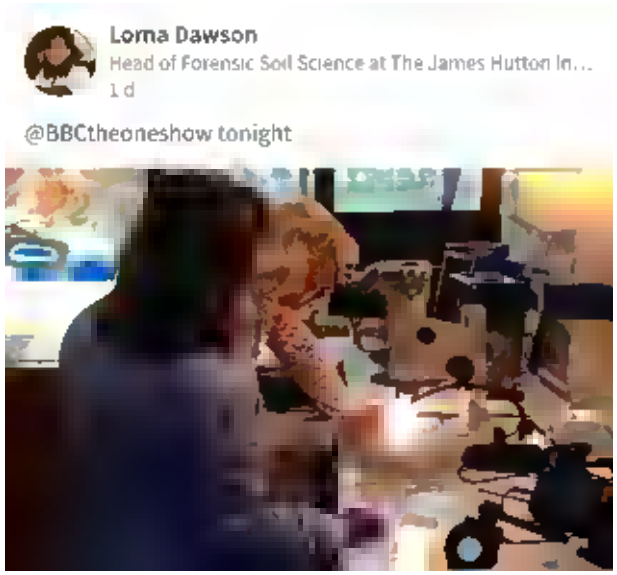


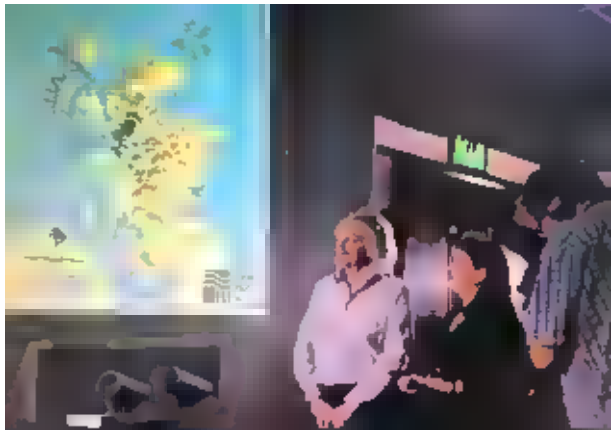

BBC4. https://www.bbc.co.uk/programmes/p02l4px7 Muddck Country Park

# BBC: The One Show
# Where had the presenter been?


the
one
show
BBC
one

# Dalmeny Estate, South Queensferry



# Uncertainty of Soil Evidence

| Level of Issue | *Phase of Enquiry* | |
|---|---|---|
| | ***Investigative*** | ***Evaluative*** |
| **Offence** | What was the offence? | Did Suspect X commit the offence? |
| **Activity** | What happened? | Did Suspect Y dig the grave? |
| **Source** | Where did the soil come from? | Did the soil come from the crime scene? |

# Soil Forensic Science

## INVESTIGATIVE/INTELLIGENCE:

- Where did the recovered soil come from ?
- **Comprehensive database of background information to inform the probability of observing the soil result(s)**
- **Exclusion and identifying areas for search**

## EVIDENTIAL/EVALUATIVE:

- What is the probability that the recovered soil came from location X ?
- **Appropriate combination of methods**
- **Comparison to case-relevant population of soils to inform the probability of observing the results given the circumstances**
- **Uncertainty**


# Managing the myths - the CSI effect in forensic science

While new forensic tools are becoming progressively available, we need to exercise **caution in their use** and in **communication** of their outcomes to both the investigator in the intelligence phase of an operation and to the lawyers and juries in court with evidence.

**Care, caution and clarity** are key rules of a forensic scientist whether at the crime scene, lab or court, while our fictional counterparts seem to take **speed, style and certainty** as their mantra.

https://www.microbiologysociety.org/publication/current-issue/microbiology-in-popular-culture/article/managing-the-myths-the-csi-effect-in-forensic-science.html

# Court

https://openss.qualtrics.com/jfe/form/SV_3pzVDRlIyvUrSwC.

The Open University

# Acknowledgments














lorna.dawson@hutton.ac.uk

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