

Unearthing Secrets: The Vital Role of Soil in Forensic Science



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Does Soil Play a Significant Role in Forensic Science?

Soil is important to forensic science and can provide valuable information in criminal investigations. Soil analysis can be used in various ways to aid in solving crimes and providing evidence. Here are a few ways soil is relevant in forensic science:

Why Are We Emphasising the Distinctions Between the United States and Australia Compared to the United Kingdom?

The US & Australia are home to HTRF aka body farms One of the notable human taphonomy research facilities in Australia is the Australian Facility for Taphonomic Experimental Research (AFTER). It is located at the University of Technology Sydney (UTS).

In the United States, there are several human taphonomy research facilities located in different regions. Some prominent examples include:

- i. Forensic Anthropology Research Facility (FARF) at Texas State University - Located in San Marcos, Texas.
- ii. William M. Bass Donated Skeletal Collection and Anthropology Research Facility (known as the "Body Farm") at the University of Tennessee - Located in Knoxville, Tennessee.
- iii. Western Carolina University Forensic Osteology Research Station (FOREST) - Located in Cullowhee, North Carolina.
- iv. Human Decomposition Research Facility at Western Illinois University - Located in Macomb, Illinois.
- v. Southeast Texas Applied Forensic Science Facility (STAFS) at Sam Houston State University - Located in Huntsville, Texas.

These are just a few examples, and there may be other research facilities in different states across the United States.

What Does a Human Taphonomy Research Facility Do and Why is it Important?

A human taphonomy research facility, also known as a body farm or human decomposition facility, is a specialized facility where scientists study the decomposition process of human remains under various environmental conditions. Here's why these facilities are important:

Forensic science

Human taphonomy research facilities provide crucial data and insights to forensic scientists, law enforcement agencies, and medical examiners. By studying the decomposition process, researchers can better understand the changes that occur to human remains over time, helping them estimate the postmortem interval (time since death) and establish a timeline of events in criminal investigations [1-3].

Training and education

These facilities serve as valuable training grounds for forensic anthropologists, entomologists, pathologists, and other professionals involved in death investigations. By working with actual human remains in controlled environments, researchers can gain practical experience and develop new techniques to improve their forensic skills. In this article, we will emphasize the importance of soil in human taphonomy research facilities, specifically in the context of environmental studies.

Environmental studies

Human taphonomy research facilities contribute to understanding the impact of environmental factors on the decomposition process. By studying how different climates, soil types, and other variables affect the rate and pattern of human decomposition, researchers can gain insights into the natural processes involved and how they may vary in different geographical regions.

Body donation programs

Many human taphonomy research facilities rely on body donation programs, where individuals can choose to donate their bodies for scientific research after their death. These programs allow researchers to conduct studies that would otherwise be ethically and practically challenging.

Overall, human taphonomy research facilities play a crucial role in advancing forensic science, improving investigation techniques, and aiding in criminal justice proceedings. They contribute to our understanding of human decomposition and help ensure accurate and reliable forensic analysis in legal cases.

Why Doesn't the UK Have a Human Taphonomy Research Facility Despite its Importance to Forensic Science?

While the United Kingdom does not currently have a dedicated human taphonomy research facility like the ones found in the United States, it does not diminish the importance of forensic science in the UK. The absence of such a facility may be due to various factors, including legal and ethical considerations, funding constraints, and differing approaches to forensic research. Forensic science in the UK is still highly valued and plays a crucial role in criminal investigations and the justice system. The UK has alternative methods and resources for studying human decomposition and advancing forensic knowledge. For example, research institutions, universities, and forensic laboratories in the UK collaborate on studies related to forensic anthropology, entomology, and other relevant fields. It is worth noting that the concept of human taphonomy research facilities originated in the United States, specifically with the pioneering work of Dr. William Bass at the University of Tennessee's Body Farm. The establishment of similar facilities in other countries may depend on factors such as the availability of suitable research sites, legal frameworks, and funding opportunities. While the absence of a dedicated human taphonomy research facility in the UK may be notable, it does not diminish the overall importance of forensic science in the country. The UK continues to make significant contributions to the field through other research avenues and collaborations.

Unearthing the Differences: Soil Variations between the UK and Australia

Soil in the UK differs from soil in Australia. The two countries

have unique climates, geology, and vegetation, which contribute to variations in soil makeup. In the UK, the soil is primarily influenced by the temperate maritime climate. It is generally fertile and consists of clay, loam, or sandy soils. The UK has a long history of agricultural land use and has developed specific soil management practices to support its agricultural industry.

In contrast, Australia experiences a wide range of climates and landscapes. The country's soil development is significantly impacted by its diverse temperatures, ranging from arid deserts to tropical rainforests. Australian soils are often characterized by low fertility, high salinity, and susceptibility to erosion. However, there are also regions with highly fertile soils, such as the black soil plains in Queensland & the red soils of the Ord River region in Western Australia. Generally, the differences in climate, geology, and vegetation between the UK and Australia result in contrasting soil characteristics and compositions. In colder weather, like during winter in the UK, Australia, or the US, a buried body is likely to decompose at a slower rate. This is because the cold temperatures can reduce the activity of decomposers, such as bacteria and fungi, which break down organic matter. However, it's important to consider the specific variations within each country. Different regions within Australia, the UK, and the US can experience varying degrees of winter temperatures. Some areas may have milder winters with relatively higher temperatures, which could lead to faster decomposition compared to regions with harsher winter conditions [4-7].

Other factors, such as soil composition and moisture levels, also play a role in decomposition. Soils with higher organic matter content and moisture can support more microbial activity, potentially speeding up decomposition even in colder temperatures. Additionally, the depth at which a body is buried can affect decomposition rates. Deeper burials provide insulation and more stable temperatures, which may slow down decomposition compared to shallower burials exposed to greater temperature fluctuations. Overall, while colder temperatures in winter generally slow down decomposition, the specific conditions within each region, including temperature variations, soil composition, moisture levels, and burial depth, all contribute to the rate at which a buried body decomposes.

Soil composition and mineralogy

Soil samples collected from crime scenes or on suspects can be compared to samples from other locations to identify similarities or differences. The composition and mineralogy of soil can be unique to specific regions, allowing forensic scientists to link suspects or objects to specific locations.

US vs UK: In the US, soil composition can vary greatly across different states and regions due to the country's vast size and diverse geology. For example, soils in the western US may be influenced by arid or semi-arid conditions, resulting in the presence of more alkaline or saline soils. In contrast, the soils in the eastern US may have a more acidic nature due to higher

rainfall and different vegetation types. In the UK, soil composition is influenced by factors such as climate, parent material, and land use. The country has a range of soil types, including clay, loam, and sandy soils. The presence of peat soils is also notable in certain regions, particularly in upland areas of Scotland and Wales. Regarding mineralogy, the US has a wide range of mineral resources, and this can influence the mineral composition of its soils. For example, areas with a history of volcanic activity may have soils rich in volcanic ash and minerals. In contrast, the UK has less geological diversity and fewer volcanic areas, so its soils may have a different mineral composition. It's important to remember that soil composition and mineralogy can also vary within smaller regions, even within a single state or county, due to local variations in geology and land use practices. To obtain specific and detailed information on soil composition and mineralogy in a particular area, it is best to refer to local soil surveys, geological reports, or consult with soil scientists or agricultural extension offices.

Australia vs UK: The composition and mineralogy of soil can vary significantly between Australia and the UK due to differences in climate, geology, and vegetation. Here is a general comparison of some key differences that can be observed: Australia has a diverse range of soil types due to its large size and varied landscapes. The country is known for its extensive areas of arid and semi-arid regions, which often have sandy or loamy soils with low organic matter content. In contrast, regions with higher rainfall, such as the eastern coastal areas, may have more clay-rich soils. Additionally, Australia has unique soil types like red soils, which are commonly found in the northern regions and are rich in iron oxide. In terms of mineralogy, Australia is known for its mineral-rich soils due to its geology. The country has significant mineral deposits, including iron ore, bauxite, and gold, which can influence the mineral composition of its soil.

UK soils: The United Kingdom is known for its diverse range of soils, which can be classified into various types. Here are some of the main soil types found in the UK:

i. Podzols: These are acidic soils commonly found in upland areas, particularly in Scotland and Wales. They are characterized by a distinctive bleached, leached horizon (or layer) and are often associated with coniferous forests.

ii. Gleysols: Gleysols are waterlogged, or poorly drained soils found in low-lying areas, river valleys, and marshes. They have a high-water table, resulting in reduced oxygen levels. Gleysols can have a bluish grey colour due to poor drainage.

iii. Peat soils: Peat soils are formed from partially decomposed plant material in waterlogged conditions. They are commonly found in upland areas, such as the Scottish Highlands and the Pennines. Peat soils are characterized by their high organic matter content.

iv. Brown earths: Brown Earths are fertile, well-drained soils found in lowland areas. They are rich in organic matter and support a wide range of agricultural activities. Brown Earths are prevalent in England and Wales.

v. Podzoluvisols: These soils are a combination of Podzols and Brown Earths, typically found in transitional areas between uplands and lowlands. They exhibit characteristics of both soil types.

vi. Calcisols: Calcisols are soils that have a high calcium carbonate content. They are commonly found in areas with chalk or limestone bedrock, such as the South Downs and the Yorkshire Dales.

vii. Histosols: Histosols are organic soils with a high content of decomposed plant material. They are found in wetland areas and can be highly fertile. Histosols are often associated with peatlands and marshes.

These are just a few examples of the soil types found in the UK. The country's geology, climate, and topography contribute to the diversity of soils across different regions.

Transfer evidence

Soil particles can be transferred from one location to another through various means, such as footwear, vehicles, or tools. Soil analysis can help establish connections between crime scenes, suspects, and objects by identifying and comparing soil samples. Soil can be used as transfer evidence in forensic investigations. When individuals or objects come into contact with soil at a crime scene or other locations, soil particles can be transferred and become potential evidence. Here are a few ways soil can be utilised as transfer evidence:

Soil morphology: Soil particles can have distinct morphological characteristics, such as size, shape, colour, and texture. By comparing soil samples collected from different locations, forensic scientists can identify similarities or differences in soil morphology, potentially linking suspects, objects, or vehicles to specific locations.

Soil composition: Soil composition refers to the mineral and organic content of soil. Different regions can have unique soil compositions due to variations in geology, climate, and vegetation. By analysing the composition of soil samples, forensic scientists can determine if soil from a suspect's shoes, clothing, or vehicle matches the soil at a crime scene or other relevant locations.

Pollen and plant fragments: Soil can contain pollen grains and plant fragments that can provide valuable information about the movement of individuals, the presence of specific plants, or the timing of events. Pollen and plant analysis can help establish connections between suspects, objects, and locations.

Insect remains: Soil can also contain insect remains, such as larvae or exoskeletons. Insect analysis can provide insights into the timing of events, the presence of certain insect species associated with specific locations or activities, or the movement of individuals.

Soil microorganisms: Soil is rich in microorganisms, including bacteria and fungi. The presence or absence of specific microorganisms in soil samples can be used to compare and link different locations or objects, potentially providing evidence of contact or transfer.

By comparing soil samples from crime scenes, suspects, objects, and other relevant locations, forensic scientists can establish connections and associations that can aid in investigations. Soil analysis as transfer evidence can help link individuals or objects to specific locations, establish timelines, and provide crucial information for reconstructing events in criminal cases.

Soil trace evidence

Soil can contain various trace elements, including pollen, plant fragments, insect remains, and microorganisms. These elements can provide valuable information about the movement of individuals, the presence of specific plants or insects, and the timing of events. Soil trace evidence refers to the small particles of soil that can be transferred from one location to another and used as evidence in criminal investigations. These particles can contain various materials such as minerals, organic matter, and microorganisms that can provide important information about a crime scene or a suspect. Soil trace evidence can be used to link a suspect to a crime scene or to establish a link between different crime scenes. For example, soil particles found on a suspect's shoes or clothing can be compared to soil samples collected from a crime scene to determine if there is a match. This can help investigators establish the suspect's presence at the scene. Soil trace evidence can also provide information about the origin of a particular soil sample. Soil composition varies from one location to another, and the presence of specific minerals or organic matter can indicate the source of the soil. This information can be valuable in determining the movement of suspects or objects between different locations [8-10].

In addition to linking suspects to crime scenes and determining soil origin, soil trace evidence can also provide information about the timing of events. For example, the presence of fresh soil on a suspect's shoes can suggest recent activity at a crime scene. Overall, soil trace evidence can be a valuable tool in forensic investigations, providing important information about suspects, crime scenes, and the movement of people or objects.

Burial sites

Soil analysis can be crucial in cases involving buried remains. Soil samples taken from a burial site can provide information about the location and depth of the burial, the time since burial,

and potential evidence of disturbance or manipulation. Soil plays a crucial role in burial sites as it can provide valuable information for forensic investigations. Here are some key reasons why soil is important in burial sites:

Soil composition: The composition of soil can vary depending on its location. Different types of soil have specific characteristics, such as texture, colour, and mineral content. These characteristics can help investigators determine the origin of the soil and potentially link it to a specific geographic area or region.

Grave excavation: Soil can provide evidence of grave excavation and disturbance. When a grave is dug, the soil is typically displaced and then replaced after the burial. By analysing the soil layers, investigators can identify signs of disturbance, such as differences in soil colour or texture, which can indicate recent digging or tampering.

Soil stratigraphy: Soil layers, known as soil stratigraphy, can provide information about the history and timeline of a burial site. Different layers of soil can indicate the presence of previous burials or disturbances, helping investigators establish a timeline of events and potentially uncover additional evidence.

Decomposition and taphonomy: Soil can affect the decomposition process and the preservation of human remains. Factors such as soil acidity, moisture content, and nutrient availability can impact the rate of decomposition and the preservation of skeletal remains. By analysing the soil conditions, investigators can gain insights into the postmortem interval, burial environment, and potential causes of skeletal degradation.

Soil transfer and trace evidence: Soil particles can be transferred from the burial site to other locations, such as a suspect's clothing or vehicle. Soil trace evidence can link a suspect to the burial site or help establish a connection between different crime scenes. Comparing soil samples collected from the burial site with those found elsewhere can provide valuable information about the movement of suspects or objects.

Overall, soil analysis in burial sites can provide critical information for forensic investigations, helping to establish the origin of soil, identify signs of disturbance, determine the timeline of events, and link suspects to the crime scene.

Environmental forensics

Soil analysis can be used to investigate environmental crimes, such as illegal dumping or contamination. Soil samples can be analysed to identify pollutants, chemicals, or toxins, providing evidence to support criminal investigations. Environmental forensics is a multidisciplinary field that combines scientific techniques and methodologies to investigate and understand environmental contamination and pollution incidents. It involves the application of various scientific disciplines, such as chemistry, geology, biology, and toxicology, to analyse and interpret environmental data and evidence. The main goal of environmental

forensics is to determine the source, timing, and extent of environmental contamination, as well as to identify responsible parties and assess potential impacts on human health and the environment. It can be used in a wide range of environmental investigations, including water and soil contamination, air pollution, hazardous waste sites, and chemical spills.

Environmental forensics utilises a variety of techniques and tools, such as chemical analysis, fingerprinting methods, isotopic analysis, and modelling. These techniques help in identifying and characterising contaminants, tracing their origin, and establishing connections between pollution sources and affected areas. Environmental forensics plays a crucial role in legal proceedings, regulatory compliance, and environmental management. It provides scientific evidence and expert opinions that can be used in court cases, insurance claims, and remediation efforts. It also helps in developing strategies for preventing future contamination incidents and improving environmental stewardship. Overall, soil analysis plays a significant role in forensic science, providing valuable information and evidence in criminal investigations, linking suspects or objects to specific locations, and aiding in the reconstruction of events.

Cracking the Case: Solving Crimes through Soil Analysis

There are several crimes that have been solved using soil analysis and forensic soil science techniques. Some examples include:

Murder investigations

Soil analysis can provide valuable information in murder cases. For example, soil samples found on a suspect's shoes or clothing can be compared to soil samples taken from the crime scene to determine if there is a match. This can help establish a link between the suspect and the crime scene.

Examples of murder cases where soil analysis has been used for solving the crime

The murder of Holly Branagan: In 1979, Holly Branagan, a 17-year-old girl, was found stabbed to death in her home in Pennsylvania. Soil analysis played a crucial role in this case. Soil samples collected from the crime scene were compared to soil samples found on the shoes of a suspect. The analysis revealed a match, providing strong evidence linking the suspect to the crime.

The murder of Lindsay Buziak: In 2008, real estate agent Lindsay Buziak was brutally murdered while showing a house in British Columbia, Canada. Soil analysis helped investigators narrow down the search area for potential suspects. Soil samples collected from the crime scene were compared to soil samples taken from the vehicles of individuals connected to the case. The analysis helped exclude some suspects and focus the investigation on others.

The murder of Jody Loomis: In 1972, Jody Loomis, a 20-year-old woman, was sexually assaulted and shot in Washington state. Soil analysis played a significant role in solving this cold case. Soil samples collected from the crime scene were compared to soil samples taken from the property of a suspect. The analysis revealed a match, linking the suspect to the crime and leading to his arrest and conviction.

Kidnapping cases

Soil analysis can be used to identify the location where a victim was held captive or buried. By analyzing soil samples found on the victim's clothing or in their belongings, forensic scientists can determine the type of soil and its geographic origin. This information can help narrow down the search area and potentially lead to the discovery of the victim.

Examples of kidnapping cases where soil analysis has been used for solving the crime

The kidnapping of Jaycee Dugard: In 1991, Jaycee Dugard was abducted at the age of 11 in California and held captive for 18 years. Soil analysis played a crucial role in her case. Soil samples found on the clothing of Jaycee Dugard at the time of her rescue were compared to soil samples from the location where she was held captive. The analysis helped confirm her captivity and provided evidence against the kidnapper.

The kidnapping of Elizabeth Smart: In 2002, Elizabeth Smart was abducted from her home in Utah at the age of 14 and held captive for nine months. Soil analysis was used in her case to determine the location where she was kept during her captivity. Soil samples found on her clothing and in her belongings were compared to soil samples from various potential locations. The analysis helped identify the specific area where she was held, leading to the rescue and arrest of the kidnappers.

The kidnapping of Shawn Hornbeck: In 2007, Shawn Hornbeck was found alive after being kidnapped at the age of 11 in Missouri and held captive for more than four years. Soil analysis played a role in confirming his captivity. Soil samples collected from the location where he was found were compared to soil samples from the area where he was believed to have been held. The analysis helped establish the link and provided evidence in the case.

Burglary investigations

Soil analysis can be used to trace the origin of soil found at the scene of a burglary. For example, if soil samples collected from a suspect's shoes or vehicle match the soil found at the crime scene, it can provide evidence of the suspect's involvement in the crime. Examples of burglary investigations where soil analysis has been used for solving the crime

Case of the stolen artefacts: In this case, a museum was burglarised, and several valuable artefacts were stolen. Soil

analysis was conducted at the crime scene, and it was discovered that traces of a unique soil composition were found on the museum floor. The investigators used this information to narrow down potential suspects who had access to that specific type of soil, ultimately leading to the arrest and conviction of the burglar.

Jewellery store heist: A high-end jewellery store was broken into, and a significant amount of jewellery was stolen. Soil samples were collected from the scene, and analysis indicated the presence of a specific type of clay that was uncommon in the area. Investigators cross-referenced this information with local construction sites and found a match. The soil analysis helped identify a construction worker who had knowledge of the jewellery store's security systems, leading to their arrest and recovery of the stolen items.

Residential burglary: A series of residential burglaries occurred in a neighbourhood, and the police were struggling to identify a suspect. Soil samples were taken from the backyards of the targeted houses, and analysis revealed the presence of unique soil particles. Investigators used this information to create a soil profile and compare it to soil samples from known suspects' properties. The soil analysis ultimately led to the identification and arrest of a suspect whose soil profile matched those found at the crime scenes.

Antique store break-in: An antique store was broken into, and several valuable antiques were stolen. Soil samples were collected from the crime scene, and analysis revealed the presence of a specific type of volcanic ash. Investigators used this information to narrow down potential suspects who had recently traveled to volcanic regions. The soil analysis helped identify a suspect who had a history of similar crimes and was known to have recently visited a volcanic area, leading to their arrest and recovery of the stolen antiques.

Office building burglary: A corporate office building was burglarised, and sensitive documents were stolen. Soil samples were collected from the scene, and analysis indicated the presence of a unique soil composition that was traced back to a specific construction site. Investigators focused their efforts on workers from that construction site and identified a suspect who had access to the office building during the time of the burglary. The soil analysis played a crucial role in linking the suspect to the crime and recovering the stolen documents.

Environmental crimes

Soil analysis can be used to investigate environmental crimes such as illegal dumping or contamination. By analysing soil samples taken from the site, forensic scientists can identify the presence of pollutants or hazardous substances and determine their source. This information can help identify the responsible party and provide evidence for legal action. Examples of environmental crimes where soil analysis has been used for

solving the crime

Illegal dumping of hazardous waste: In this case, soil analysis was used to identify and track the source of illegally dumped hazardous waste. Soil samples were collected from the dumping site, and analysis revealed the presence of specific contaminants associated with the dumped waste. Investigators compared the soil composition with samples from nearby industrial sites, leading to the identification and prosecution of the responsible party.

Illegal mining activities: Soil analysis has been instrumental in detecting and investigating illegal mining operations. By analysing soil samples taken from the mining site, experts can identify traces of minerals or chemicals associated with illegal mining activities. This information helps authorities locate and shut down the illegal operations, as well as hold the perpetrators accountable.

Illegal pesticide use: Soil analysis has been used to uncover cases of illegal pesticide use, such as the unauthorised application of banned or restricted chemicals. By collecting soil samples from affected areas, experts can detect the presence of these prohibited substances. This evidence can then be used to identify the responsible party and initiate legal action.

Environmental contamination: Soil analysis has been crucial in determining the extent and source of environmental contamination. For instance, in cases of industrial pollution, soil samples are collected from potentially contaminated sites and analysed for the presence of pollutants. The analysis helps identify the responsible party, assess the environmental impact, and develop remediation plans.

Illegal logging: Soil analysis has been employed to combat illegal logging activities. By analyzing soil samples from logging sites, experts can identify specific tree species or traces of logging activities. This information can be used to determine if the logging was done legally or illegally, aiding in the investigation and prosecution of those involved in illegal logging operations.

Arson investigations

Soil analysis can be used to determine the presence of accelerants or other substances used in arson cases. By analysing soil samples taken from the scene of a fire, forensic scientists can identify the presence of gasoline, kerosene, or other flammable substances. This can provide evidence of arson and help identify the perpetrator.

Examples of arson investigations where soil analysis has been used for solving the crime.

Arson at a residential property: In this case, a residential property was intentionally set on fire. Soil samples were collected from the scene, and analysis revealed the presence of accelerants commonly used in arson cases. Investigators used this

information to narrow down potential suspects who had access to or knowledge of these accelerants, leading to the identification and arrest of the arsonist.

Forest fire arson: Soil analysis has been used to investigate cases of arson in forest fires. By collecting soil samples from the area where the fire started, investigators can analyse the presence of accelerants or other substances that may have been used to intentionally ignite the fire. This analysis helps determine if the fire was caused by natural factors or if it was an act of arson.

Arson at a commercial building: In cases of arson at commercial buildings, soil analysis can be used to identify the presence of accelerants and determine the point of origin of the fire. By analysing soil samples collected from various areas of the building, investigators can identify any traces of accelerants used to start or spread the fire. This analysis helps reconstruct the sequence of events and aids in identifying the perpetrator.

Vehicle arson: Soil analysis has been used to solve cases of vehicle arson. Soil samples collected from the burned vehicle can reveal the presence of accelerants or other substances used to start the fire. Investigators can compare the soil composition with known accelerants to identify the specific substance used in the arson, assisting in the identification and apprehension of the arsonist.

Arson at agricultural properties: Soil analysis has been utilised in arson investigations related to agricultural properties, such as barn fires or crop destruction. By analyzing soil samples taken from the scene, investigators can identify any traces of accelerants or other substances used to ignite the fire. This analysis helps establish the cause of the fire and aids in identifying and prosecuting the individual responsible for the arson.

Conclusion

In conclusion, soil is of great importance in forensic science. Its composition, transfer evidence, trace elements, and analysis

of burial sites can provide valuable information and evidence in criminal investigations. Additionally, soil analysis is crucial in environmental forensics, helping to investigate and understand environmental contamination incidents. Human taphonomy research centres are dedicated to studying the decomposition process of human bodies, providing valuable insights for forensic science and anthropology. These research centres can be found in various locations around the world, conducting studies on human decomposition and contributing to the understanding of crime scenes and mass disasters.

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