Using forensics to inspire the next generation of regolith, soil and clay scientists

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Introduction

These days we need to work harder to attract students to study regolith, soil and clay science because they have a somewhat dry and dusty image or muddy and smelly, but this stereotype can be far from reality. Regolith, soil and clay science expertise was used to solve a double murder by identifying the similarities between regolith, soil and clay assemblages on a shovel and also from a quarry. The soil-regolith material and clay mineralogy had a common provenance and revealed the location of two buried bodies. This successful case led to the formation of the Centre for Australian Forensic Soil Science (CAFSS) in 2003. Since then, the centre has advised on over 98 criminal and environmental forensic investigations.

Forensics is attractive to students - just look at the popular television shows X-files, CSI and countless others. And the rise in courses geared towards producing forensic scientists. CAFSS was formed in recognition that soil, regolith and clay expertise is not part of the forensic scientist's repertoire. With a focus on our first and most public case, the double murder, we have developed the following educational exhibit / interactive display, which explained how soil, regolith and clay scientists successfully used soil-regolith material and clay mineralogy expertise in helping solve a double murder case in Australia.

Example Case studies

Overcoming a potential recognition problem is best accomplished by making crime scene personnel aware of the possible value of soil, clay and regolith science evidence and sharing successful case examples. Several case studies, which have successfully used soil, clay and regolith science evidence to help solve legal cases, are likely attributed to the systematic methodology of crime scene sampling, processing and soil characterisation/interpretation.

Investigators are trying to establish linkages or associations between the victim, suspect, crime scene, and individual items as with any form of evidence. To draw attention to this somewhat underutilized forensic tool, some important ways, which soil, clay and regolith science evidence has already proven useful in helping to solve criminal, civil and environmental cases will be presented in an interactive poster display (e.g. Fitzpatrick 2006) and summarised below. This case study demonstrates how innovative ideas, methods or applications of field and laboratory approaches have been critical in

developing coherent, predictive, soil-regolith models from landscape to microscopic scales, to solve difficult soil-based investigations at a range of scales involving highly complex issues.

As well, Dr Raymond Murray in his book entitled "Evidence from the Earth" (Murray 2011) presents several high-profile legal cases in which geological materials and methods have contributed significantly to solving cases from around the world.

Two missing persons

Neighbours reported disturbance at the home of two woman to police. When the police arrived at the home in the Adelaide Hills, South Australia, the women and their car were missing. The missing vehicle and suspect was found over 200 km away by police. A shovel with soil attached was found in the in the boot (trunk). The soil on the back of the shovel was found to be compacted and smeared indicating the shovel was used to pat down moist soil. Based on knowledge of local soils and geology forensic soil scientists determined that the soil on the shovel came from one of the local industrial soil gravel quarries. The mineralogical composition of the soil on the shovel narrowed the search down to a small group of gravel quarries. Samples from these quarries were collected and one located in the sump or wet area of the quarry produced identical mineralogy to the soil on the shovel, which helped identify the burial site of the 2 bodies. The suspect was convicted and received a life sentence.

This case illustrates many of the issues regarding comparing soil, clays and regolith materials, which involved the integration and understanding soil-landscapes, soil types, geology and the systematic implementation of field sampling, detailed soil-regolith characterization, especially X-ray diffraction (XRD) and use of soil/geological maps (Figure 1). The questioned and control samples were indistinguishable and the soil-regolith evidence was unequivocal in terms of all comparison criteria used, thus revealing the location of the two buried bodies. This success led to the establishment of the Centre for Australian Forensic Soil Science (CAFSS) in 2003. The Centre maintains a critical mass of expertise in soil forensics, to help protect Australia from crime, terrorism and environmental pollution.

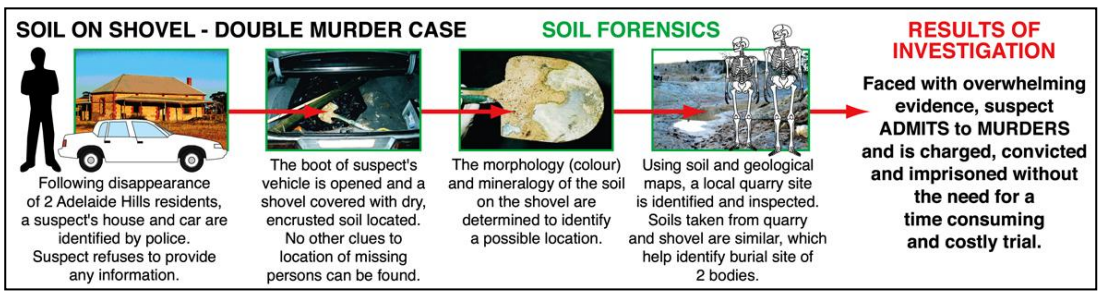

Fig. 1. Similarities between soil found on a shovel taken from a suspect's vehicle and soil located in a gravel quarry helped locate the bodies of two victims, and helped cement the importance of soil science in criminal investigations in Australia.

Results and discussion

The educational display is presented in the style of a newspaper article using old style typewriter fonts to report the major points under the following headings:

- The Crime & Evidence – *wife, mother and son missing; with locality map.*
- Enter The Scientists – *soil clues on the shovel found in the suspect's car.*
- Closing in on the Site – *evidence from soil / geological maps and field survey narrowed the search down to a small group of gravel quarries.*
- Case Solved – *samples from quarries were collected and one located in the sump or wet area of the quarry produced identical mineralogy to the regolith on the shovel, which helped identify the burial site of the 2 bodies. The suspect was convicted and received a life sentence.*

The display illustrates how the following soil / regolith clues were used to help solve a baffling crime:

- Visual observations (colour, texture, structure and particle shapes) of yellowish-pink fine grained regolith material with inclusions of many small angular quartz particles and a few three-millimetre white fragments or flakes on the shovel.
- Chemical (pH, electrical conductivity) and mineralogical evidence (X-ray diffraction).
- Soil and geological maps and field soil survey investigations.

Photographs of the front and back of the original shovel used by the suspect to bury the two victims are displayed. Alongside the display stands a replica shovel with regolith adhered from near the burial site using clear epoxy resin. Clear epoxy resin was used to impregnate the yellowish-pink fine grained regolith material containing quartz particles and three-millimetre white fragments from the quarry. Four small clear epoxy resin blocks were made to highlight the following regolith features observed on the shovel and from the quarry: (i) yellowish-pink fine grained regolith material with inclusions of quartz particles and white fragments, (ii) yellowish-pink fine grained regolith material only, (iii) angular quartz particles, manually extracted from soil-regolith material and (iv) white clay-rich fragments, manually extracted from regolith material. These blocks are placed on the display using fabric hook-and-loop fastener tape. The blocks can be removed in order that the individual particles and fragments can be closely observed with the naked eye or magnifying glass supplied. These features can also be viewed in detail on the replica shovel.

Conclusions

This educational display is on permanent exhibit at several research institutes, forensic science centres and museums in the USA, UK, Europe and Australia.

The shift from traditional soil science and geology to forensic soil science and geology is not straightforward and requires a wide understanding of crime scene protocols, the evidential

requirements of forensic workers, and the nature of legal constraints within which forensic work takes place. It is important to understand and know the different kinds of natural and human-made soils and how they form; and especially how to carefully sample and analyze them because this helps to make accurate forensic comparisons.

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Relevant Website

Centre for Australian Forensic Soil Science (CAFSS) website: http://www.clw.csiro.au/cafss/