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Case report

Maximising trace soil evidence: An improved recovery method developed during investigation of a $26 million bank robbery

Alastair Ruffell [a,*], Anna Sandiford [b]

[a] A Ruffell, School of Geography, Archaeology and Palaeoecology, Queen's University, Belfast, BT7 1NN, United Kingdom
[b] A Sandiford, The Forensic Group Ltd., P.O. Box 17-317 Greenlane, Auckland 1546, New Zealand

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ABSTRACT

Obtaining as much particulate material as possible from questioned items is desirable in forensic science as this allows a range of analyses to be undertaken and the retention of material for others to check. A method of maximising particulate recovery is described using a kidnap case, where minimal staining on clothing (socks) remained as possible indications of where the victim had been held captive. Police intelligence led to a hostage scene that was sampled. Brushing of the socks recovered about 50 sand grains with some silt: ultrasonic agitation and centrifuging recovered over 300 grains of sand, silt and clay. These were visually compared to scene and control samples, allowing exclusion of 52 samples and the retention of one comparison sample as well as other possibles, saving time and money, but maximising sample quantity and quality.

1. Background

The traditional use of geological analysis in excluding soil, sediment, or rock associated with suspects and victims from all but possible scenes of crime has used both large quantities (maybe large rocks used to weigh cadavers down in water) and small amounts (a few grains of quartz sand). As [1] demonstrate, small amounts of geological material (that may become legal evidence) is assuming importance in investigations, because of the forensically aware perpetrator carrying out preventative measures (wearing disposable clothing) or 'clean-up' operations (*sensu* Ruffell and McKinley, [2]). A major concern with small sample sizes (arbitrarily, less than a gram) is that conventional geological analyses (see the sequence of investigations recommended by [3] and [4], both summarised in Murray [5]) cannot be carried out, as such work requires more than a few grams of sample. The approach to trace materials is far more akin to the analysis of meteorite, moon-rock or precious materials: developments in this field include a dual-approach, starting with exhaustive, non-destructive tests. These include descriptions of color (visual and automated), texture, sorting, grain shape, in situ X-ray diffraction, Raman microscopy and Fourier-transform infrared analysis. This allows the retention of integrity, as well as gaining knowledge of what the trace material is, progressing to appropriate destructive testing [6,7]. However, with all such approaches an initial examination of the sample is paramount before any destructive analytical work, not least to ensure that other particulate materials (that may become evidence), such as hair, fibres, flakes of paint, etc. are recovered. An alternative approach is to choose, after examination, a sophisticated destructive technique that has been assessed by either: peer review; in a court of law; by experts appointed by the courts (depending on the legal system the scientist is working under); or a combination of the above. Examination by SEM [8] especially that with automated chemical analysis (SEM-EDX or the QEMSCAN system: see Pirrie et al. [9]) falls into this category. Non-destructive analysis provides a useful 'baseline' knowledge, after which samples may be split, for destructive analysis by prosecution and defence, both of whose results can be scientifically validated in order to test for inter-sample variations, analytical error or contamination.

2. Case synopsis

The criminal act being investigated was a bank robbery in which the equivalent to over $25 million was stolen. We have not used the local currency to facilitate international understanding of the magnitude of this robbery. The gang that carried out this cash robbery planned every detail with great precision. There are two key persons in the case as well as the thieves: a male worker at the bank and his female partner (the kidnapee: both lived in a small house (termed hereon as 'victim location') in a village some 15–20 km (around 10 miles) from the city in which the robbery

* Corresponding author. Tel.: +44 2890973407.
E-mail address: a.ruffell@qub.ac.uk (A. Ruffell).

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occurred. A third known person in the case was the absent female owner of the suspected hostage location. Late at night on a Sunday evening in December 2004, three masked men entered the kidnapee's home by shouting 'police, open up' from outside the front door. They tied the male bank worker up, blindfolded his partner (now the kidnapee), and took her in her own car to an undisclosed (hostage) location. She wore regular clothing (jeans, a cotton jacket, washed socks and worn trainers). At this location, she alighted from the vehicle and was told to remove her shoes (but not socks) on the outside concrete porch before entering the building. She noted that the flooring to the house was covered with plastic sheeting, as was the chair she sat on for the next 10 h, with escorted visits to the bathroom. She was told she would be killed unless her partner did as instructed the next day: he was also tied up until the early morning, when he was told to drive his own car to the bank. He was instructed to obtain money from the safe and take it to the rear door under threat of his partner being killed. He left the bank on a trial run with $1 million and then returned with a further $25 million. The pickup van departed and he was told to work as normal, even when the theft was discovered. Some time later, the kidnapee was taken from the house, given her wet (she is told they had been washed) shoes to wear and taken in her own car to a remote forest park, where she was told to stand blindfolded and not do anything until the kidnappers had left. Her car was set on fire, the kidnappers fled in another car and she went to a nearby house. From there she was taken to hospital, where police seized all her clothes and shoes. Two days later, police asked for her assistance in retracing the route from her house (the kidnap location), to the vicinity of the possible hostage location, which she did with some accuracy, becoming disoriented but nonetheless getting police to within a few miles and with only ~10 possible houses as the possible hostage location. The victim also recalled details of the house that excluded some. One house, the suspected hostage location, was owned by a single elderly woman whose water pipes had burst, causing a flood in November 2004, requiring her to move out while workmen carried out repairs, including cementing the hallways, laying new carpet and lining the hallways and rooms with plastic sheeting in preparation for further work on the kitchen. A possible hostage location was thus identified, but there was little to exclude or connect the victim to this house or its environment.

3. Geography and geology of the locations

Three locations were thus relevant to geological analyses undertaken.

(1) The kidnap location. Any association between this place and a suspect would be useful, except no suspect was identified. This is the most regular and last-visited location of the key victim prior to her kidnap, and thus any contact made between here and her clothing.
(2) The possible hostage location, thought by police to be one house in particular.
(3) The forest park location of release (and associated road and house), approximately 3 km west north west of the possible hostage location, where the victim's shoes allegedly contacted the ground.

A further location considered was the hospital, where the victim stood in her socks while shoes and socks were removed and seized by police.

All three outdoor locations (victim location, possible hostage location, release location) are positioned on Palaeozoic sandstone turbidites intruded by felsite and dolerite dykes. All lie within a glaciated region with drumlins, roche moutonee and other glacial landforms comprising low, rounded hills with rocky outcrops between glacial deposits of varying thickness. However, each location also comprised gritstone gravel driveways/roadways with differing environmental histories. (1) The kidnap location is a relatively new house, (2) the possible hostage location is an older farmhouse with extensive builder's products in the vicinity and had supposedly suffered a flood before the incident, (3) the release location is a roughly made forest park track and car-park located amongst pine trees.

4. The questioned materials

The victim's testimony was considered by police to be accurate and even if incorrect, excluding comparisons from the alibi locations was problematic as her story needed to be independently tested. Critical information includes the following allegations from the kidnapee. (1) Her trainers (but not socks) were removed on entry (via a concrete porchway) to the possible hostage location. (2) She wore her socks from this porchway in to the house, during the kidnap, back to the porchway, where her washed trainers were re-worn throughout her movement to the forest park release location. (3) From release, she walked to a nearby house, where she was collected by ambulance and taken to hospital. Thus, if the victim's testimony was accurate, her shoes would have been in contact with the hospital floor, ambulance, forest park (and surrounding roads) and contain pre-washing environmental history. However, again if her testimony is accurate, the last surface with which the socks had contact prior to recovery by the police was the hospital floor, the inner surface of her washed trainers, the plastic sheeting on the floor of the hostage location and a concrete porch at the hostage location. Three items of contact are of interest: the victim's socks (with some soiling noted on the toes and heel); the trainers, and the victim's car (burnt out). The socks thus remained as the best container of particulates that may become evidence from contact with the hospital, victim's home and possible hostage location. The other materials all formed part of the investigation, the treatment of the socks is described here for the novel way we increased sample quantity.

5. Purpose of the geological investigations

Examinations of materials were carried out in order to:

- Establish what geological materials were present on the victim's socks and shoes.
- Establish whether any such materials on the socks or shoes could be excluded or compared to (1) her home, the kidnap location, (2) the possible hostage location or (3) effectively a control location, the forest park release location, where her socks had not been in contact with the ground.

6. Sampling of locations

6.1. Kidnap location (1)

The main author visited this location in the company of police officers in order to examine and collect any materials that may be used when considering the victim's socks as well as future police seizures of case-related items. The driveway comprised a rough track of gravel and silt/mud where car tires had worn gravel away. The aggregate base of the driveway was similar throughout: worn areas with puddles had finer-grained material, unworn areas comprised aggregate. Using a clean plastic spoon (each sample) to extract the top 1 cm (or to firm base, if shallower), 5 samples were collected from the driveway adjacent to the front of the house where vehicles parked and people moved from car to house, as well