The role of geoforensics in policing and law enforcement

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Geoforensics

Geoforensics (known also as Forensic Geology or Forensic Geoscience) is the application of geology to criminal investigations. Forensic geologists may assist the police in some types of crimes to help determine what happened, where and when it occurred, or to help search for homicide graves or other objects buried in the ground. In a law enforcement context, geoforensic specialists may support the police in two broad fields of geoforensics:

- Geological (trace) evidence
- Search

Geological (trace) evidence

This involves the collection, analysis, interpretation, presentation and explanation of geological evidence. Geological trace evidence can vary considerably and may include for example; rock fragments, soils and sediments, which occur naturally in the ground, artificial (anthropogenic) man-made materials derived from geological raw materials (such as bricks, concrete, glass or plaster board), or micro-fossils. These may be transferred onto the body, person or the clothing of a victim or offender. The huge variability of rocks and soils, particularly in the United Kingdom, is helpful in potentially placing an offender or item at a particular location.

Collection

These may be taken from a crime scene, human remains (for example from skin or fingernail scrapings), vehicles, clothing or other objects. A forensic geologist may be able to assist the police to eliminate potential suspects, in determining the possible location where a crime took place, linkage of the offender or items to a crime scene or victim or to assess the possible movement of human remains.

Geological evidence is based on the principal that when two objects make contact there is transfer of material from one object to the other. The transfer may be short-lived, or beyond detection, but nevertheless the transfer has taken place (known as the Locard Principle, 1929). The geological evidence may then be used to see if there could be an association between different items or objects. For example, does the soil in the footwell of a vehicle or on the shoes of a suspect originate from contact with soil exposed at a crime scene?

Analysis

There are a variety of techniques for the analysis of geological materials. The types of tests conducted will depend on several factors such as; what questions are being asked, for example, “Are the two samples similar?” Or, “Where did the sample originally come from?”. Ideally, the types of analysis should be non-destructive to allow repeatability, if necessary. The geological analysis will aim to describe, classify and identify the materials.

Evaluation

An evaluation will be conducted to determine if there is an association between the soil samples and/or rock fragments collected from the items/objects belonging to the suspect and samples collected from the crime scene.

Careful consideration will be required during the evaluation of analytical data. For instance, are the small size of the samples collected actually a true representation of the crime scene? Do soil samples adhere to certain types of materials than others? If the two mineralogical samples are identical, these cannot confirm whether they originated from the sample place, as there may be another unknown location which has the same mineralogy. An identical mineralogical association may be determined if however, two samples of a broken object (such as rock, brick, tile, or other man made object) are being compared.
Some geological techniques may be used to help the police search for locating (and sometimes the recovery of) objects buried in the ground, including for example, homicide graves, mass graves related to genocide, weapons, firearms, improvised devises, explosives, drugs, stolen items, money, coinage and jewellery.

These searches may take place in urban, rural and remote locations, in both the terrestrial (land) and marine environments.

A search is the application and management of systematic procedures, combined with appropriate detection equipment to locate specified targets (or objects). It is the skill of looking for a specific object and the art of finding it.

A search may be conducted to:-

(a) Obtain evidence for prosecution.
(b) Gain intelligence.
(c) Deprive criminals of their resources and opportunities.
(d) Locate vulnerable persons.
(e) Protect potential targets.
(f) Search for homicide graves and associated buried items or objects.

An offensive search is used to locate a specific item sought to obtain evidence or to restrict an individual’s room to manoeuvre and their operation. A defensive search is used to maintain freedom of action and movement for the public.

In order to find a homicide grave we must first understand what we are looking for.

The search for a grave is a pragmatic balance between a minimum acceptable standard and minimal expenditure.

Pre-search considerations may include for example:-

(a) What is the geology and ground conditions?
(b) What are the choices of search assets?
(c) What is the equipment availability and detection limiting factors?
(d) What are the financial, logistical and technical constraints?
(e) Is the search measurable, cost-effective and proportionate?
(f) Can the search achieve a minimum standard resolution for a high probability of success?
(g) What is the exit strategy?
(h) What other items may be associated with the deceased that could be detected?

Factors that may influence a search include for example:-

(a) Weather conditions.
(b) Type of terrain.
(c) Press and media interferences.
(d) Psychics.
(e) The public and communities.
(f) Victims family members and friends.
(g) Time frames involved.
(h) Search area.
(i) Whether the search is covert or overt.

A geoforensic search should be intelligence led based on facts that enables a hypothesis to be generated. A Standard Operational Procedure (SOP) should be applied to all searches. This provides an assurance of search consistency and enables peer and independent reviews. This should be in written format and forms part of the search documentation. Databases and ‘models’ may facilitate a search and include for example; offender profiling or geographic profiling, missing person, suicide, weapons, drug concealment and body deposition models.

Conceptual geological model for a homicide grave

As burial takes place in the ground, a reconnaissance visit to the crime scene/search area must be conducted by the forensic geologist and police officer, so a conceptual geological model may be developed. This will enable an estimation of the grave’s condition and this in turn will pre-determine the most likely choice of search assets, such as geophysics, to search for the grave. This also gives an estimate of what is likely to be found and the condition of the target. Conceptual geological models are best developed at the beginning of a search. It is a model to be tested, revised and tested again until it can be verified (at discovery) or proven otherwise.
An idealised conceptual geological model for a shallow homicide grave. The geological, geomorphological, geophysical, geotechnical and hydrogeology properties of the body, reinstated ground and undisturbed ground may change after burial. This type of model may assist in determining the most suitable suite of assets for conducting a search. This may include for example the deployment of geophysical surveys and specially trained cadaver dogs. (after Donnelly 2002, 2008, in Harrison & Donnelly 2008, 2009).

The development of a geological model for a homicide grave requires a specific understanding of the natural (geological) ground conditions and how these have been influenced by the activities of the offender (for example, digging and subsequent reinstatement of the disturbed ground). At any one location there are likely to be a number of interactive, dynamic, surface geological processes, which have affected the rocks, soil, groundwater and topography. These processes were active long before burial took place and are likely to have continued in the time which has passed since.

Diggability surveys

Since body disposal mainly takes place in soils or unconsolidated superficial deposits, the ease of which the soil can be dug (i.e. its diggability) and placed back into the grave (or reinstated) is significant. The offender is likely to choose a site where the soil is sufficiently thick and can be quickly dug then reinstated, preferably with no or little surface indication that digging has taken place. The diggability of soil depends on its geological properties. There is no generally accepted quantitative measure of diggability. This can only be determined by in situ ‘trial and error’ testing. In situ diggability tests may be easily performed before the main phase of the search (usually at the reconnaissance stage), involving either probing or digging using tools similar to those to which the offender is believed to have had access. This also provides the opportunity to inspect the soil structure and/or weathered bedrock and associated superficial deposits to determine whether it is granular (sand rich), cohesive (clay rich), organic (peat) or man-made.

These observations are important as they have critical implications on the efficiency of burial and the preservation or decomposition of human remains depending on the time elapsed since burial.
A diggability survey will:

(a) Provide geological information on the geology, soil characteristics, groundwater and rock types.
(b) Demonstrate the level of difficulty or ease and time required for a shallow grave to be dug and the depth which can be achieved.
(c) Demonstrate how effectively the soil can be reinstated and what visible topographical features may exist, to indicate the possible presence of the grave.
(d) Provide a prediction of the length of time it would take an offender to dispose of the body.

Search assets

Geoforensic searches can be carried out by one person, or a team and they may be non-invasive or invasive.

Police officers and a forensic geologist conduct a search for a murder victim’s grave in a remote, mountainous part of Eastern Europe (after Donnelly 2008, The Geological Society of London, Forensic Geoscience Group)

They are usually conducted from the macro-scale (covering many tens or hundreds of square metres) to the micro-scale (covering just a few square metres of ground) and may take hours to weeks, sometimes years to complete.

Typical geological assets and methods which may be used to search for a grave may include for example, geological and geomorphological mapping, remote sensing, analysis of high resolution air photographs, geophysics, hydro-chemistry & geochemistry, geological analysis of police intelligence, probing and trenching. Police dogs, often known as ‘cadaver dogs’, ‘victim recovery dogs (VRD), or ‘human remains dogs (HRD)’ are an essential asset for any search and are reliable in most, but not all, geological conditions. The science which underpins the deployment of police dogs is not yet fully understood or explainable.

Effective communication

Searches for graves may involve teams of multi-disciplinary experts. The geoforensic search adviser must be integrated into this multi-disciplinary team, usually co-ordinated and managed by a Senior Investigating Officer (SIO), Police Search Adviser (PoISA) or search strategist.

Similarly, the reporting of geological evidence for use in court by a prosecution team will be open to challenge. The forensic geologist will have a duty to communicate and report the results, often involving scientific principles and complex procedures to the police and/or court in a clear, fair, unbiased and impartial manner, be this verbally or written. Police officers are likely to have a limited knowledge of geology but must have the ability to learn quickly. The most valuable contribution a geologist can give a police officer or search strategist, is to ‘get the geology right’, be aware of his/her expertise and limitations and how their skills forms part of a much more complex police investigation.

Global perspective

Since 2002 there have been at least ten international meetings and conferences on geoforensics. Several papers, articles and books have also been published see for example (Geoforensics by Ruffell & Mckinley 2008, Evidence from the Earth by Raymond Murray 2004 or Criminal and Environmental Soil Forensics by Ritz, Dawson & Miller 2008).

The Geological Society of London, Forensic Geoscience Group and the International Union of Geological Sciences (IUGS), Geoscience for Environmental Management (GEM), Geoforensic International Network (GIN) are actively developing geoforensics and best practise.

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