

## *The long arm of the (geoforensics) law*

*A recent meeting in London considered both the conventional and unusual applications of geoscience to forensic investigation. Alastair Ruffell, Jamie Pringle and Ruth Morgan discuss the global expansion of forensic geoscience, and how this field is central to keeping geoscience at the forefront of science and public interest.*

The term forensic geoscience often draws to mind images of a scientist analysing dirt on a crime suspect's shoes. Important though such analyses are, the field has moved far beyond these humble beginnings and now includes work on spacecraft surfaces, remote sensing of mass graves relating to humanitarian crimes and much more. The Environmental & Criminal Forensics meeting, held at Burlington House, London in December 2018, explored how the regular 'dirt-on-shoes' type analyses have advanced, but also revealed the fascinating widening scope of forensic geology.

### **Global popularity**

The first two meetings on forensic geology took place at Burlington House in the early 2000s and opened many eyes to the uses of geology in serious criminal investigations. The importance and popularity of the field led to the formation of the Forensic Geoscience (specialist) Group (FGG) —with the emphasis now on 'geoscience' to reflect the widening interest and participation in the subject.

Since 2011 The International Union of Geological Sciences (IUGS) has also recognised forensic geology, with the creation of the IUGS

Initiative on Forensic Geology (IUGS-IFG) and the two groups are now closely linked.

### **Scope**

Forensic geology emerged in the 19<sup>th</sup> and 20<sup>th</sup> centuries with the application of analyses of traces of sand, sediment and soil to criminal investigations. The main questions answered by forensic geologists were in establishing whether a suspect could have been at a crime scene, or their alibi locations, and this type of analysis continues today. However, geoscientific techniques have also long been deployed in the search for buried or sunken items, as well as in the sampling of inorganic materials at crime scenes. Thus, in the last five years, forensic geology has evolved into the application of geoscience techniques to the 'search, scene and sample'. This broadening of definitions and applications was aptly reflected in the presentations at the December 2018 meeting.

### **Oceans, wildlife and fraud**

Geologists have long been involved in oceanography, but less so for forensic applications. A stunning presentation by Agathe Ribéreau-Gayon (University College London) and colleagues discussed the difficulties in searching for human remains on the Atlantic Ocean floor, from a sunken commercial airline flight that tragically crashed in June 2009. The use of geospatial technology to accurately locate the crash site, as well as individual human remains at such great depths depended on accurate oceanographic surveying. A combination of

remote sensing techniques meant that remains could be distinguished from the seafloor topography and other debris, and enabled the successful recovery of the remains of many of the victims. The research also highlighted just how little we currently know about the decomposition of human remains in the marine environment compared to the terrestrial. The challenges of working in these 'extreme' environments is further compounded when the complexity of assessing the taphonomic processes and establishing a post-mortem submersion interval (PMSI) in marine environments is addressed. Research in this study sought to establish the key variables in play in this highly variable environment (such as type of clothing, level of trauma pre- and post- mortem, and activity levels of scavengers) and assess how understanding them better can contribute to an evidence base for establishing a PMSI.

Geoscientific techniques have assisted investigations into wildlife crimes, such as badger baiting or the theft of bird's eggs, since the early 2000s. Typically in such cases, geochemical analyses are used to compare trace materials on equipment used in the crime with traces from the crime scene. However, Kris Wisniewski (Keele University & Staffordshire University) and colleagues showed that geophysical techniques can provide important insights too. They used ground-penetrating radar to plot the location of badger setts and determine which of the setts might have been intentionally—

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and illegally—filled in with slurry in an attempt to harm the badgers. Such data has the potential to serve as evidence in an investigation that can build a case that allows crime enforcement officers to prosecute suspects.

Investigations into mineral, metal and rare earth element fraud have increased in past decades, due to the financing of guerrilla warfare, the need for electronics components, and simple stock market manipulation. Examples that come to mind are blood diamonds mined in war zones and then sold to finance an invading army or insurgence, as well as the Bre-X scandal of the 1990s, where Bre-X Minerals Ltd. claimed to have discovered vast gold reserves in Borneo, sending stock prices soaring before the gold samples were found to be falsified. Nelson Eby (UMass, Lowell, USA) and colleagues highlighted this issue in a discussion of the trace element techniques that allow the source for emeralds to be traced, while Laurance Donnelly (IUGS) and colleagues provided a synopsis of the role forensic geology has in such cases.

### **Drones, faeces and ethics**

If the examples above are not enough to convey the widening remit of forensic geology, other presentations at the meeting discussed the use of geodetic and geophysical near-surface surveys to identify not just the location of illegally buried toxic waste, but also the volume and distribution relative to landownership

(Alastair Ruffell, Queen's University, and colleagues); the use of drones as a cost-effective approach to aerial photography and remote sensing in the search for clandestine graves (Rykkker Evers and Peter Masters, Cranfield University); the use of satellite and aerial image analysis, geophysical surveys and groundwater geochemical analysis to aid the interpretation of signals given by cadaver, or victim recovery dogs in the search for unmarked homicide graves (Laurance Donnelly, IUGS, and colleagues); and the

“**FORENSIC GEOLOGY HAS EVOLVED INTO THE APPLICATION OF GEOSCIENCE TECHNIQUES TO THE ‘SEARCH, SCENE AND SAMPLE’**”

analysis of unusual materials—in one case dog faeces—to establish intelligence in forensic reconstructions (Alastair Ruffell, Queen's university).

Samara Testoni (Federal University of Paraná, Brazil and James Hutton Institute, Scotland) and colleagues described the great advances being made in forensic soil science in Brazil, including the creation of a standard operating procedure, which describes the required steps for collecting

and analysing soil samples from crime scenes in Brazil. The analytical procedures involve investigation of the soil's physical, chemical, mineralogical and organic profile.

The talks wrapped up with Lorna Dawson (James Hutton Institute) and colleagues discussing 'geo-ethics' and the essential need for ethics training and accreditation systems for anyone working in the field of forensic geoscience. Lorna presented a white paper outlining the many potential pitfalls in the use of geoforensics from crime scene to court and how a set of guidelines could help prevent potential bias and unethical practices.

Several professional and innovative talks and posters were presented by research students. Their work extends the scientific and global reach of the field and represents the future of forensic geoscience. The visually-impactful poster of Rachael Carew (University College London) and colleagues on 3D Printing in Forensic Archaeology, which even included miniature 3D-printed models of human skeletons, was awarded the Best Student Poster.

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