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Forensic Soil Science and Geology

Edited by

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and

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International Union of Geological Sciences, Initiative on Forensic Geology, UK

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Dedication

Ray Murray studied geology at Tufts University and received his PhD in geology from the University of Wisconsin. Early in his career, he worked for Shell Research in Houston, Texas, and The Hague, and taught at the University of New Mexico. He first encountered forensic soil science and geology while Chair of the Geology Department at Rutgers University in 1973, when an agent from the Bureau of Alcohol, Tobacco and Firearms walked into his office with a bag of soil, looking for answers.

Dr Murray, when approached, immediately supported the establishment of the Geological Society of London, Forensic Geoscience Group (FGG) in 2006. In 2010, he became the first recipient of the FGG award. He later became the Honorary Committee Member to the International Union of Geological Sciences (IUGS), Initiative on Forensic Geology (IFG), when this was established in 2011. The Chinese government bestowed honours on Dr Murray for his major contributions to the field of crime detection through soils and geology.

Dr Raymond C. Murray died on 7 April 2018 at the age of 88. His legacy and global contributions to forensic soil science and geology will continue for generations.

The title of ‘Founder of Forensic Geology and Soil Science in the twentieth century’ can be credited to Dr Raymond C. Murray in view of the impact of his first textbook Forensic Geology – Earth Sciences and Criminal Investigation, which was published with John C.F. Tedrow in 1975. In 2004, Murray published a general audience book entitled Evidence from the Earth, followed by a second edition in 2011. These books present several high-profile legal cases in which a vast range of soil and geological materials and methods contributed significantly to solving complex cases from around the world. Ray Murray emphasized that overcoming a potential recognition problem is best accomplished by making police, law enforcement, forensic and other crime scene specialists aware of the value of soil and geological materials as forensic evidence by sharing successful case examples. These seminal books have been used in numerous trials across the world, often resulting in excluding improper methods, such as the use of the density gradient column as a major examination tool, and in several cases eliminating unqualified examiners. These works also inspired many universities, practitioners and forensic agencies across the world to offer courses in Forensic Soil Science and Geology.

References


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This Special Publication contains 20 papers on forensic soil science and forensic geology. Collectively, these provide a representative, overview of the exciting and rapidly developing applications of soil science and geology to assist the police and law enforcement agencies so they can investigate crimes around the world. These include the use of soil and geological materials (known also as ‘earth materials’) in the search for burials and the provision of physical trace evidence.

Earth materials include minerals, particles, rock fragments, microfossils and natural soils. These also incorporate human-made (anthropogenic) materials that are derived from geological raw materials such as: bricks, bitumen, concrete, tiles, plasterboard, glass and corrosion products from engineering and construction such as wire fencing and steel. As such, earth materials have been shown to be highly individualistic in that there is an almost infinite number of different types. Earth materials have been demonstrated to provide powerful, perhaps ideal, contact trace evidence in many criminal investigations. What is more, unlike other forms of evidence (e.g. body fluids, such as blood) the presence and potential relevance of soils, as potentially providing incriminating physical evidence, is less understood by offenders and criminals. A variety of real, live, operational police and law enforcement cases from around the world are included to elucidate the complex and important role that soil science and forensic geology play in using earth materials to help police and law enforcement investigate and solve crimes. Significantly, many operational forensic cases have used reference earth material, collected at crime scenes, from soil and subsequently compared to geological maps and earth material archive collections to assist in making comparisons.

The papers in this Special Publication have been grouped broadly into four sections. Firstly, an introductory section focuses on the background and importance of the role and value of the wide range of different earth materials to assist with a search and as trace evidence in solving criminal investigations. In this section, the fundamental principles are presented, supported by numerous examples of high profile, operational cases, drawn from our case-work experience and from the wider scientific published literature. We highlight the importance of understanding the variety of possible transfer mechanisms, which need to be considered together with direct primary contact transfer of earth materials. This includes the secondary contact transfer of individual particles by the wind or water. We also discuss the value of using state-of-the-art analytical techniques and methodologies. These enhance the traditional analytical methods to better quantify complex mixtures of natural and human-made earth materials. The results of these investigations help to locate potential crime scenes or burials and discriminate between crime sites and link suspects and/or objects to crime scenes or a specific geographic provenance and location. Finally, we emphasize the critical importance of forensic soil science and forensic geology being connected to mainstream forensic science.

Secondly, there is a section on the design, implementation and management of ground searches for burials, which comprises of crime scene searches that have been conducted in Europe (England, Northern Ireland and Italy) and South America (Colombia, Venezuela and Brazil). Of particular importance in this section is the applications to a homicide case of the new and innovative Geoforensic Search Strategy (GSS). GSS developed over a 25-year period during the search for a homicide grave in Northern England (the Moors Murders) (ongoing). This blended approach combined geological (mineral exploration and engineering geology) methods with conventional police and law enforcement search tactics. GSS was applied to search for the remains of a victim that had been buried some 15 years earlier in an unmarked grave. A standard operating procedure (SOP) is also provided for the collection and analysis of soil from beneath and in the vicinity of a homicide grave. Potentially, this has applications for the detection of volatile organic compounds (VOC) and leachate associated with human decomposition from a shallow, unmarked, homicide grave.

Thirdly, there is a section based on the trace evidence with operational case studies using multidisciplinary approaches comprising samples of questioned, control and alibi earth materials collected in Europe (the Netherlands), South America (Colombia, Venezuela and Brazil), Asia (China and South Korea), Australia (Western Australia and South Australia) and Africa (South Africa). Papers included here discuss the use of trace element profiling of gold as a technique to help solve crimes that take place in the minerals, mining and metals industries. Another paper discusses a case involving fine crushed rock used as substitution material for stolen zinc ingots in an investigation of fraud and theft of the zinc ingots. Two papers discuss the use of advanced synchrotron µ-X-ray diffraction techniques to characterize extremely small (<0.5 mm diameter) earth material particles recovered from clothing in operational case studies.

Fourthly, a section discusses emerging research and developments, which include studies from
Europe (Italy, Scotland and England), USA and Australia involving new field and laboratory methods to better characterize earth materials. The techniques and methods range from field geophysical investigations to micro-scale laboratory studies of the mineralogical, geochemical and DNA properties of earth materials.

This Special Publication has pulled together a wide range of contributions, which firmly establishes forensic soil science and forensic geology as a flourishing sub-discipline of soil science and geology. This merits broadest exposure across the academic and corporate geosciences, the police and law enforcement. These sub-disciplines borrow heavily approaches and techniques from a broad variety of specialist fields including: pedology, mineralogy, geophysics, mineral exploration, engineering geology and mathematics, to name but a few.

The establishment of the International Union of Geological Sciences (IUGS), Initiative on Forensic Geology (IFG) has significantly developed, enhanced and promoted forensic geology around the world. IUGS-IFG brought together, for the first time, forensic geologists, forensic soil scientists, police and law enforcement in the investigation of crimes. The global network of IUGS-IFG stakeholders has also facilitated practitioners and researchers from many other different scientific backgrounds, including mining, civil and geotechnical and environmental engineers, mineral traders, lawyers, politicians, schools, universities, learned societies, public, journalists and the media to work together to answer many common questions in this rapidly developing field. The success of IUGS-IFG has provided the basis for the future development of agreed standards, protocols, standard operating procedures, teaching, training and running international conferences in forensic geology.

Finally, we would like to thank the IUGS Executive Committee and many people from around the world who contributed to the final form of this Special Publication.

Prof Robert William Fitzpatrick
Vice-chair, IUGS Initiative on Forensic Geology

Dr Laurance John Donnelly
Founder and Chair, IUGS Initiative on Forensic Geology

Founder and First Chair, Geological Society of London
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