1

Background to the work, organization of the text and history of research

This book has at its core the application of selected geoscience techniques to criminal (domestic, international, terrorist, humanitarian, environmental, fraudulent) investigations of what happened, where and when it occurred and how and why it took place. The book’s opening ought to have a more precise definition (than that above), but it does not because the applications of Earth science methods to different problems (of a criminal, humanitarian, disaster-related nature) are so wide-ranging that the definition would probably end up being as long as the book itself. The text is not a book on criminalistics, geography, geophysics, or microfossils. As a result, specialists in any one of these fields are going to be disappointed or angry that the discipline they work in is not covered comprehensively enough. Many of the chapter topics fall into this bracket: in more than one case we have issued the challenge to such cynics – please write a review article, or a short or long book on your discipline. Only then will they see the challenge we have (perhaps foolishly, but let’s ask the non-specialist ‘users’ of this book) taken on. If we had 10 or so review articles on the topics we have discussed then this book would not exist: we could merely set up a web site with a link to each topic review and within a few minutes the interested party would have a selection or comprehensive collection of ‘geoforensic’ articles for very little cost. Unfortunately, not one review of the specific application of one geoscience discipline to criminalistics exists at the time of writing. If any book or review article exists entitled: ‘Forensic Geophysics’; ‘Forensic Remote Sensing’; ‘Geological Trace Evidence’; ‘Microfossils in Criminalistics’, etc., then our literature searches are very poor or the article is published in too obscure a journal! Conversely, as we state above, specialists in each area are likely to be disappointed by the cursory manner we discuss their disciplines, in which case we offer a gift with our challenge: write the review you would like to see published and a large number of citations are guaranteed: Ruffell and McKinley (2004) is still one of the most highly cited articles of Earth Science Reviews.
BACKGROUND, ORGANIZATION AND HISTORY

In this text we have tried to be as comprehensive as possible while maintaining the overall structure of the work. Various wider-ranging and very specific reviews do exist, and these are vital resources, cited at appropriate locations in the text. Some of the geological topics covered here (in Chapters 7 and 8) are covered by Murray in his fantastic Evidence from the Earth (2004) and in Pye (2007). Various aspects in this book, excepting details on Remote Sensing (Chapter 4) and Geographic Information Systems (Chapter 5), can be found in scientific paper form in the edited volumes of Pye and Croft (Forensic Geoscience: Principles, Techniques and Applications (2004)) and Mildenhall, Wiltshire and Bryant (2006: on palynology).

The sequence of chapters in this book is arbitrary and many can be read alone, as cross-references will occur to previous and subsequent chapters. Within chapters, major divisions of text are indicated by numbered headings in bold text, with case studies and examples denoted by section headings in smaller, unnumbered bold text. Minor subdivisions occur in italic font. Key points are emphasized by use of italics within the text, and instructions or warnings by UPPER CASE.

This book presents different types of case study. These can be summarized as: (i) descriptions of investigations into criminal activity, locations and materials; (ii) published articles on techniques and their possible application to cold or historic cases); and (iii) a synopsis of a relevant published paper, book chapter or report that is relevant to the chapter section. In the latter case, we hope not to have offended those not included – this is unintentional, merely a product of how the works ‘fit’ with the way our chapter is developing. Published case studies have the author’s names in the section title: those from the author’s personal files have no author names. Case studies carry a warning! They are specific and thus cannot be used as a template for another investigation. Information from other cases will help, but each case must have its own, evolving, investigation.

Three books have influenced the style we have developed. Haralambos et al. (1990) have individual sections summarizing and providing a critique of what they consider to be key sociological works. Murray (2004) uses case studies to illustrate the use of each technique: we do the same. Both works make for easy, memorable reading, especially useful to students. Canter (2003) is a blend of these two texts, with few, illustrative figures and well-constructed, focused sections of text. We use all three types of format in this work. Although our style is derivative of this rather elective collection of texts, our content is a blend of our own case studies and experiences, published papers and four important books that the reader may consider reading in order to obtain a fuller picture: Hans Gross’s¹ (1891 System der Kriminalistik (Criminal Investigation) or any of the later editions to 1907, or


Criminal investigations and enquiries into disasters are required because one or more facts or pieces of evidence are unknown: it is the job of the forensic scientist to produce theories about this missing information, and the job of the investigator to assimilate these theories into a story of what happened and why. Missing information may comprise the scene (the original location of the crime is not established), the victim (covertly buried or hidden by disaster, or missing above ground), materials (vehicles, clothes, weapons, drugs, contraband) or the suspect (yet to be apprehended, or in custody). The geoscientific methods described in this text can assist in providing information to the investigation on all four of these aspects.

This book aims to show how various geoscience techniques may be used in investigations, regardless of any background. Geoscientists are trained in their discipline: it is for us to apply this training to assist investigations. These enquiries will be generated, monitored and reported differently in various parts of the world, with, for example, North America; Russia and Europe; the UK, Australia and New Zealand; Japan; India; and many countries of the Middle East having different legal and social requirements. Geoscientists must take advice on the constraints imposed on their activities, analyses and reporting from the investigators in each country. Behind this, the internationally recognized scientific method must proceed. These may come to conflict, but ultimately, we would be remiss in not stating early on in a text such as this, that geoscientists apply their method to an investigative problem first, and adhere to the method of reporting and court appearance in the country thereafter.

Two messages run through this text. First, we face an increasingly litigious society, where accurate, contemporaneous recording and reporting of anything that may end up in court, enquiry or tribunal is essential. What better way to increase awareness of this than through the application of well-known disciplines to forensic science? Second, forensic pertains to the law, and in all the chapters that follow, data or materials are collected and analysed. At this point geoforensics diverges from the regular pursuit of science, in that original data is stored and sealed (digital media, photographs) to be processed and analysed later, or samples are sealed, labelled and their origin described. Each examination and analysis of data or materials thereafter, the same procedure must be conducted, with a record of what has been done. Most crucially, as we shall see later in the book, some of the most robust analyses of data and material are carried out by different, comparative means. This requires a multidisciplinary approach, often involving different analysts. Thus the chain of custody (who gave what sample to whom and when/where) becomes as important as what analyses and interpretations are made. There are now specialist groups and expert panels at scientific meetings (https://rock.geosociety.org/meetings/2007/pf-bios.htm) who work with police officers and other law enforcers (e.g., environmental agencies) and investigators (e.g., structural and civil engineers) to advise on such matters.
1.1 The scene

Identifying a possible scene of crime or other activity from a sample soil, sediment or rock remains one of the great challenges in Geoforensics (see Chapter 7). Yet bizarrely, this application was one of the first applications of microscope-based comparison of sand from suspect materials back to its likely source. Below, we outline how Conan-Doyle, Gross and Popp can each lay some claim to developing methods of the classic geoforensic technique of comparing soil on a suspect’s clothing or footwear to a possible source that excludes the suspect from, or compares him or her to, a scene of crime. The comparison of sediment in a sample of unknown origin (the provenance of the questioned sample) was undertaken some 40 years before Conan-Doyle wrote his famous Sherlock Holmes stories. The 1856 (Volume 11) issue of *Scientific American* has the following section called ‘Curious Use of the Microscope’.

Recently, on one of the Prussian railroads, a barrel which should have contained silver coin, was found, on arrival at its destination, to have been emptied of its precious contents, and refilled with sand. On Professor Ehrenberg, of Berlin, being consulted on the subject, he sent for samples of sand from all the stations along the different lines of railway that the specie had passed, and by means of his microscope, identified the station from which the interpolated sand must have been taken. The station once fixed upon, it was not difficult to hit upon the culprit in the small number of employees on duty there.

Christian Gottfried Ehrenberg was a famous zoologist and geologist (1795–1896) from Leipzig in Germany, a correspondent of Humboldt and Darwin and an expert on diatoms, although whether Ehrenberg ever used these micro-organisms in other geoforensic studies has yet to be established. What can be concluded from the above account, is the re-positioning of Ehrenberg, through the high academic standing of *Scientific American*, as a predecessor of Conan-Doyle, Gross and Popp in the application of geology to forensic casework.

**Hans Gross (1847–1915)**

Hans Gross published his *System der Kriminalistik (Criminal Investigation)* in 1891, in which geographical and geomorphological maps were used to show possible covert locations for activities (forests, brothels, hidden areas) or storage/dumping (ponds, wells, streams, forests). Gross recommended that investigators new to the job or area should visit and familiarize themselves with such places: he did not give an explicit rationale as to how a search should be conducted, but this was obviously his meaning. Perhaps he was intentionally vague, as each case is different, so that deploying standard methods might thwart innovation or open-mindedness, or perhaps the method of his search, emanating from last-seen locations, suspect dwellings, and then focusing on the sorts of places mentioned above, was so ingrained in Gross’s psyche that he did not see the need to explain the obvious.
Gross, writing in the late 1800s said ‘if we compare a recent [late-1890s] scientific work, with an analogous book written some decades ago, we shall notice a great difference between them arising almost wholly from the fact that the work of today is more exact than that of yesterday’ (Gross, 1891). It is testament to GIS (Geographic Information Systems, some say Geographic Information Science, depending on context) and laboratory technology that Gross’s words are providential, and yet damning of all the works cited in this text (including all the authors), that Gross’s ethos, recording, warnings and advice are as good, if not better than ours of the present-day. One probably leads to another: over-reliance on the machine’s ability to record information makes the investigator sloppy.

Following Gross, few works specifically on the geography of the scene have been published. However, identification of the unknown scene is implicit in many of the historic cases recounted by Murray (2004), who shows how questioned materials have led to identification of a definite or range of probable scenes. These are somewhat exceptional cases (as we shall see): the underlying tenet being the ‘holy grail’ of forensic soil and geology studies – the case where one sample (typically, ‘a lump of mud’, but equally, mud-stained clothes and vehicles) has such diagnostic properties that a location, or range of locations may be provided. Rawlins et al. (2006) test the possibility of this predictive power (see Chapter 7). Another means by which possible scenes are identified may be remote sensing and geophysics: these are intimately associated with covertly hidden objects, especially victims, and will be dealt with below. Should the hidden materials be subsequently moved, so these methods assist in providing search locations for the scene alone. Remotely sensed aerial or satellite data, disturbed ground and vegetation may provide information on the movement of vehicles or people that have long-since gone from a scene.

1.2 The victim and materials

If absent from an investigation, information concerning a missing victim or missing (possibly hidden) materials is either achieved at the macro-scale of remotely-sensed data (photography, geophysics, search dog indications), or at the micro-scale of providing possible contact locations between trace evidence and the suspect. Very little has been published on the range of macro-scale search methods (see Chapter 9), although the cumulative works discussed in Chapters 2 and 4 show how changes in landform, vegetation and geophysical response have identified search locations or shown them to be not worth examining. Murray’s (2004) account of the case of USDEA (United States Drug Enforcement Agency) officer Enrique Camarena is a good example, where the soil on his clothes, following exhumation (at the behest of the US government, who suspected a cover-up), did not compare to the given burial location, suggesting a previous burial location and thus an earlier scene of crime. Block (1958) describes the work of Oscar Heinrich (‘The Wizard of Berkeley’) who identified sand on a shovel thought to be associated with possible kidnappers, to be beach sand. This led to coastal searches and the recovery of the body of Father Patrick Heslin, who had been killed but a ransom still demanded.
1.3 The suspect

Comparing the suspect to the scene (or his or her alibi locations) is the oldest and best-established of the forensic geology and soil science techniques. It extends back to the stories of Arthur Conan Doyle and the fictitious work that his character, Sherlock Holmes, did using soil and stones, an early example being the 1887 publication of ‘A Study in Scarlet’, followed by ‘The Five Orange Pips’ (1891) and ‘Through the Magic Door’ (1907), which all included Holmes relying on evidence provided by soil and rock (Conan-Doyle, 1988). Following Doyle’s work, but partly overlapping, Hans Gross (1847–1915) published his System der Kriminalistik (Criminal Investigation) in 1891, which included discussions of forensic medicine, toxicology, serology, and ballistics, as well as forensic geology. The latter included the use of microscope petrography in the study of materials, such as soil recovered from shoes, to link suspects to scenes of crime or routes, which Gross combined with geography and geomorphology. To what extent Gross was influenced by Conan-Doyle’s writing, or vice versa, is perhaps unknown. In 1912 Gross opened one of the first specialist forensic laboratories in Europe at Graz in Austria. Georg Popp (1867–1928) used geological evidence in a criminal case for the first time, the now-famous case of the murder of Eva Disch and how a handkerchief (dirty with coal, snuff and hornblende mineral grains) was used to associate a suspect (one Karl Laubach) to a killing by strangulation. Popp is in a unique position as a founder of forensic biology and microbiology as well as forensic geology: his role is sometimes underplayed in that Conan-Doyle was so famous, and Gross’s book has been reprinted so often. Yet Popp published some important works on geology and botany (1910, 1939). Of course, other early workers used such evidence, but Popp used it conjunctively. The Heidelberg Mayors Murder of 1921 started when the Mayor of Herford (Germany) and his friend failed to return from a walk, and a diligent (some might say nosy) landlady spotted papers belonging to the mayor in the room of a lodger (one Leonard Siefert). More of the missing mayor’s personal belongings were found in Seifert’s possession. When students found the shot and bludgeoned bodies of the mayors nearby, Siefert denied involvement, claiming to have had the mayor’s belongings planted on him while on a train. Popp noted resin, snail slime, hazelnut shells, mosses, leaves from different beech tree varieties and other organic debris both adjacent to the crime scene (in a probable ambush location) as well as adhering to Siefert’s clothing. Popp successfully denied Siefert’s alibi reasons and he was convicted.

August Bruning was trained by Popp for two years (1910–12) and in June 1913 proved his credentials by solving a robbery case using what we would now term a conjunctive approach, examining tool marks and material adhering to the tool as well as the marks and host material at the scene (Bischoff, 1966).

Edmond Locard (1877–1966)

Edmond Locard is best known for his generic Exchange Principle, which states that:

- whenever two objects come into contact, there is always a transfer of material.
- The methods of detection may not be sensitive enough to demonstrate this, or
the decay rate may be so rapid that all evidence of transfer has vanished after a given time. Nonetheless, the transfer has taken place.

(Locard, 1929)

Pye (2007) makes an interesting analysis of this apparent quote from Locard, explaining that the literal translation from Locard (in French) places a slightly different emphasis on the Exchange Principle. For a discussion of the interpretation of Locard’s explanation of the Exchange Principle, the reader is referred to Pye (2007), who translates directly from French and considers Locard’s words to be more about the actual transfer of materials, rather than the more open-ended concept of all contacts leaving trace evidence.

Whatever the literal translation or derivation thereof, Locard’s ideas are as relevant to soil, mineral dust and micro-organisms, as they are to hairs, fibres and biological material (Corre, 1968). Locard’s words were truly providential, as we can see in the present-day with historical DNA evidence being used in criminal cases that took place decades ago. In Chapter 8, the nature of earth trace evidence assumes greater and greater importance, also demonstrating how Locard was ahead of his time. Published accounts of using geological materials to compare a suspect to a scene reach a hiatus following Gross’s work, although it is known (Murray & Tedrow, 1975) that with the establishment of the FBI in the 1930s and various European crime laboratories (before and after), geo-forensic work continued (Chisum & Turvey, 2000). Locard published his most comprehensive examples of the Exchange Principle in 1930, not long after many American academics had begun using all manner of trace materials in establishing suspect to scene comparisons (see below). The lack of published material in this period is a product of wartime secrecy (as we shall see in later chapters, geology, geomorphology and soil studies have been used extensively by military tacticians); the importance of the work to criminalistics; and lack of an appropriate vehicle for publication. By the 1970s, Murray and Tedrow’s (1975) Forensic Geology: Earth Sciences and Criminal Investigation partly redressed this hiatus, although few papers were published on geo-forensics around this time. Murray and Tedrow (1975) described the rationale for their work, as well as providing scientific background and case studies. In recent years, the importance of geography, geology and geophysics to military operations and intelligence has also been publicized: the CIA (Central Intelligence Agency) website (www.cia.gov<http://www.cia.gov>) has extensive pages on the role that geography (human and physical) plays in its operations. Even the casual reader will find it interesting that such a dry-sounding subject as geography can be key to a nation’s security.

The Berkeley scientists (1914–1940)

August Vollmer typifies the ‘Forrest Gump’ ethos of the American Way: a mailman who through hard work rose to become the Chief of Police in Berkeley, California during World War I. Like Conan-Doyle and Popp or Gross, we cannot ever be sure of what each personality knew of the other’s work around this time. Nonetheless, according to Thorwald (1967), Vollmer applied scientific methods
to criminal investigations for the first time in North America, not long after his European counterparts. Vollmer was astute in collaborating with a professor of law (Alexander Kidd) and a biochemist (Karl Schmidt, Kirk’s teacher), both at Berkeley, making an investigative, legal and analytical team. One pities any criminal operating in California in the time around World War I! The team was joined by one Oscar Heinrich, a 1908 chemistry graduate of Berkeley who lived in Tacoma and Denver before returning to California and eclipsing his senior colleagues through the 1920s and 30s with some seminal cases. Heinrich was the master of scene and trace evidence analysis, although it is the latter that he pioneered, along with his then state-of-the-art microscopes, often combining the two (how does trace material on the suspect or victim relate to the crime, alibi or control scene?). Block (1958, p. 42) recounts a theoretical conversation between ‘people who pressed him to explain his mode of operation’ and Heinrich himself:

‘How do you attack a crime problem?’ they enquired. ‘How do you begin? What questions do you ask yourself?’ Heinrich liked to answer. Always he spoke in his slow, calculating way, measuring words carefully. Often he drew a pencil from his pocket, pointing it for emphasis as he talked. ‘Understand this first,’ he usually said. ‘Crime analysis is an orderly procedure. It’s precise and it follows always the same questions that I ask myself. Let’s consider what they are: Precisely what happened? Precisely when did it happen? Precisely where did it happen? Why did it happen? Who did it? The average investigator seems to give immediate attention to the why and who but takes what happened for granted’.

1.4 The scope of geoforensics

Type into a web search engine ‘definition geoforensics’ or a similar phrase and, if your experience is similar to ours, about 20 to 30 ‘hits’ will be displayed, with roughly a half devoted to engineering-related problems and the other 50% to psychology, offender profiling and geographic profiling. This might be interpreted as Earth scientists (geologists, mineralogists, micropalaeontologists, geophysicists, archaeologists) letting their important role in investigations be dominated by other disciplines. It could equally mean that environmental engineers and psychologists have advertised and practised their legal work for longer and more effectively than Earth scientists. As we shall see in later chapters, psychology, criminal geographic profiling, environmental crime and legal investigations of engineering problems have a very strong role to play in how the ‘geo’ disciplines can be applied to legal and criminal matters. These disciplines and applications have to be integrated with others in the ‘geo’ family, so that fit for purpose methodologies and philosophies²

²The conjunctive use of trained personnel and equipment is embodied in what Earth scientists do. The geologist (and geophysicist) is trained to look for materials in the ground (oil, gold, gems) and has skills suited to the search. The archaeologist is trained in excavation and interpretation of the past, ideal for the recovery of buried remains and objects. The palaeontologist and mineralogist use appropriate equipment to discover the makeup of materials; their skills are in excluding samples from locations, and thence comparing suspect to scene. All three disciplines should work together: the analyst needs to know how the sample was found and how it was recovered. The implication is that one cannot train as a ‘geoforensic’ scientist: better to deploy skills to the problem than develop skills for the problem.
are applied to investigations, appropriate multi-disciplinary methods are used and no one group dominates the application of their science to investigative casework for criminal, environmental or humanitarian purposes. The first pages of Murray and Tedrow’s (1991) important text on Forensic Geology includes a number of sub-disciplines (soil science, sedimentology, microbiology and micropalaeontology, stratigraphy) that provide roughly half of the scope of what we are embracing as geoforensics. These applications are mainly concerned with the historically-important, well-set in legal precedent concepts of comparing a suspect to a scene, locating an original death location of a moved body, verifying alibi locations and tracing the movement of goods. Most use physical materials such as soil, sand, industrial products in a comparative, exclusionary or predictive (where did the material come from, where has the suspect/victim been?) mode.

An alternative way of expressing what geoforensics is all about is to avoid the narrow definition and relate how suitable materials and analytical methods can be examined by the ‘geo’ specialist to provide additional information for investigators. Examples include geological industrial products, or innovative uses of remote sensing and geophysics in areas not traditionally subject to such scrutiny. The paper by Graham et al. (2004) in Pye and Croft’s Forensic Geoscience on the examination of impact marks on spacecraft surfaces is a classic example of such innovative thinking. Who would have thought that macro and microscopic impact marks made in space could be usefully studied by methods used routinely in geology and physical geography?

Geology as a subject in North America tends to include what many Europeans would term physical geography. Although all the sub-disciplines of geography (physical, human, geomorphology, social, cartography, GIS) have been written about from the point of view of criminal, humanitarian or civil investigations, the geography word is rare in books or titles of scientific criminalistic, forensic, environmental articles, except (as we state above) geographic profiling. Thus one aim of this book is to summarize and integrate established forensic geology with the other ‘geo’ words that ought not to be separate any longer. Why? Because geophysics cannot be understood without soil science, nor remote sensing without geomorphology, or sampling without geostatistics. As Croft and Pye (2004) demonstrate with regard to traditional soil and sediment evidence, using a number of analytical methods to compare samples ensures good science, and provides convincing testimony to the courts. This book has an integration of many ‘geo’ disciplines at its heart. Some are covered lightly, if at all, as we can never be comprehensive. Similarly we know that forensic biology, toxicology, chemistry, psychology and the work of search and rescue (dogs and personnel), drug and explosive/munitions monitors, health and safety workers can all be integrated with our ‘geo’ disciplines to provide better understanding of the ‘what, where, when and how’ questions. A common misunderstanding is that geoforensics is about using soil and rock dust adhered to a suspect’s shoes to link them to a scene of crime: the new, 21st century application of the various ‘geo’ disciplines to human activity includes many other materials than soil or rock, uses all our analytical techniques to establish the guilt or innocence of suspects, and is applied to aspects of criminal, terrorist, war-crime, genocide, environmental and legal investigation. Jago’s (2002) definition, that ‘Geoforensics
is all about helping the police’, is thus narrow and incorrect. Geoforensics is the application of Earth science to problems of criminal, humanitarian, war crime and environmental nature, especially with regard to assisting the pursuit of truth and justice, be it for prosecution or defence. Following on from this is a major reason for writing this book, because since the authors’ first experience of applying geology to criminal investigations over 10 years ago, a recurrent snobbishness from some practitioners permeates the geoforensic arena. This is exemplified by a ‘what I do is more important’ attitude, expressed as defensiveness concerning casework. At a recent forensic science meeting the following conversation was overheard: Person A: ‘I assisted in tracking down a serial killer – you don’t know what real forensic work involves’; Person B: ‘So what? Pollution in the case I just completed cost the lives of over 2,000 people’. There are two ways of looking at this conversation (and underlying attitude). First is that any suspected harmful act, be it genocide, intentional pollution, corporate negligence, murder, requires a fair and just investigation based on rigorous science. Second is that of course money pays for expert time and analyses and less finance will be available for less serious criminal investigations, mirrored by media attention. While accepting the ethos of the first and reality of the second points of view, arguing about the status of one’s work belittles the greater scientific good expounded in this text: the sharing of experiences, methods and ideas between practitioners can only be of benefit. Hans Gross recounts cases concerning ‘The Larceny of Tomatoes’ and the ‘Larceny of Fowls’. We may well scoff, but for those whose livelihoods depended on tomatoes or fowls, full and proper investigation was essential, and in addition provided Gross with yet more experience of the geoforensic crime scene. Personal experience demonstrates how investigators into illegal waste tips in the eastern Mediterranean did not concern themselves with continuity of evidence; those searching for mass graves did not know about some technology used to find illegal waste tips; homicide investigators had not heard of methods of trace evidence assessment developed by drug squad/narcotics investigators. The cynic will respond: ‘maybe they did not need to know about these other methods/investigations: necessity is the mother of invention’. Again, experience shows that such close-mindedness will be exploited by the legal system to develop a weakness; best explained using a case study (below). The inclusion of environmental crime is not only a reflection of popular concern for the environment, but that activity is now causing such extensive health (death, disease), financial and global climate change problems that INTERPOL now include such matters in their discussions (Suggs & Yarborough, 2003).

Case study: Geologists and engineers

High-value, ornamental stone was stolen from a stonemason’s yard, where only some off-cuts remained. The stolen material was recovered from a competitor’s yard, who maintained that his material was purchased legally over many years (so no receipts existed). The materials were compared using a range of geological analyses such as thin section petrography linked to image analysis and multivariate chemical analysis. The defence employed an engineer as an expert witness, who used different methods entirely such as material tensile strength, manufacturing method and availability of
similar materials. The jury understood the expert witness engineer far better than the geologist, delivering a ‘not guilty’ verdict. We hope that this story enrages many geoscientists, who respond ‘our methods are far more exacting than the engineers’ and ‘we are trained to compare and exclude materials’. Why should they be angry? Should they not have learnt from this – to use available experts/methods where available, include them on their applicability to the case, exclude them for good scientific reasons (‘fit for purpose’) and use them effectively in court? An excellent example of the all-embracing attitude is included on the web site of Dr Robert Hayes, the owner and president of www.geoforensics.com, whose range of work embraces many of those cases explored in this text. They include using geological, chemical, geomorphological and engineering analyses and experts in each field for a range of applications. These include: identifying where chemical pollutants were released into a river; testing the grip provided by a roadway following a fatal road accident; comparing a hit-and-run driver to a scene; comparing a suspected rapist to a scene; re-locating a body at the murder scene following removal; comparing riverside construction activities to a fish kill; locating the cause of a collapsed roadway (following a fatal crash), among many others. These serve to demonstrate how wrong Jago (2002) is in writing ‘geoforensics is all about helping the police’. Geoforensics is all about the appropriate use of geoscience in assisting the course of domestic, international (genocide, war), terrorism-related and environmental justice.

Never write a report, investigate a problem or go to court using methods of which you are not confident, and if such methods are included, comment on only those aspects of which you have experience.