By Robert A. Hayes, CPG

Earth Material as Evidence

Forensic geologists uncover evidence in soil and water

For most people, the word *forensics* conjures images of TV doctors like Quincy or lawyers from programs like *The Practice* who receive forensic lab results that change the focus of their case. When I tell people my profession is *forensic geology,* most are not sure what to think.

Simply, forensic geology is the scientific application of earth sciences to legal matters. This means that a forensic geologist identifies, analyzes, and compares earth materials, such as soil, rocks, minerals, and fossils found on or in a receptor (a suspect, a vehicle, or other medium of transfer, such as water) to possible source areas (a crime scene, an alibi location, or a point of disposal/release). The goal of these comparisons is to establish the degree of probability that the material was or was not derived from a particular location, thereby associating or disassociating a person or object with that location. In other cases, the comparison of earth materials or changes in materials is used to determine the time an incident occurred, the cause of an incident, or responsibility for an incident.

The earth is composed of igneous, metamorphic, and sedimentary rocks, each with a variety of minerals or fossils that originate in specific areas, and these rocks are often changed and redistributed to other locations by wind, water, biota, and humans. Overall, because the sizes, types, and distribution of earth materials are so varied, the probability is high that earth material at any location is unique. Therefore, the evidentiary value of earth materials is excellent in many cases. This value is further enhanced when other sciences, such as botany, paleontology, biology, and hydrology provide corroborating evidence.

Some attorneys and investigators, unfortunately, don't consider soil, water, fossils, rocks, or other earth materials (and sometimes manufactured materials) relevant to their cases, let alone important evidence. However, by analyzing a piece of industrial debris or coal, soil particles on shoes and clothing, types and concentrations of chemicals in groundwater, the type of gas in a water supply well or storm drain, type of rock, water chemistry, and other earth materials, forensic geologists often can help identify where, when, and how incidents occurred and who is responsible.

Conceptually, forensic geology is inherently no more beneficial to the plaintiff than the defendant. The following are examples of how forensic geology provided evidence for consideration by both parties:

- Earth material in the form of soil provided strong evidence against a rape suspect when a comparison of soil samples on each knee of his pants matched the soil types from the right and left knee impressions at the rape scene. In other cases, analyses of soil on clothing have been used to support alibis and show no connection of the suspect to the crime scene.
- By identifying the nature and extent of groundwater contamination, a forensic geologist determined when a chemical release contaminated water supplies, thereby identifying, among several insurance policies, the specific insurance policy in effect and providing coverage at the time of release. In another case, a similar analysis plus a chemical degradation analysis showed that contamination in groundwater at a company originated at another property and a different company was responsible for cleanup.
- By analyzing road maintenance records and the techniques used to sample an unpaved road, a forensic geologist impeached the validity of the opposition's roadway data and skid testing in a motor vehicle accident case. Geologic analyses of roadways in other cases have shown that unpaved roads were improperly constructed or improperly maintained.

Recent television programs, such as *Crime Scene Investigators,* lead most people to believe that forensic geology is a new science that originated in the United States. They are only partly correct. It is a relatively recent science compared to physics and chemistry, but it is not as new as they think, and it did not originate in the United States. European authors, such as Sherlock Holmes–creator Sir Arthur Conan Doyle and Austrian Hans Gross, author of the 1893 handbook *Criminal Investigation,* initially conceptualized forensic geology in their writings.

Later, these literary concepts were put into practice by Edmond Locard, the director of the Technical Police Laboratory in Lyons, France, who in 1929 set forth one of the fundamental tenets of forensic geology, known as Locard's Exchange Principle:

> *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.*

As today's high-tech methods of detection become more and more sensitive, the transfer of material is becoming easier to demonstrate. Typically, the forensic geologist looks for the unusual in a sample, such as an uncommon mineral, a microfossil, or a chemical. But simply matching soil, rocks, minerals, or fossils from a particular location or landform with a particular time to establish that an exchange of materials has occurred may provide assistance to investigators and evidence in civil and criminal proceedings. From something as basic as saving time during an investigation and collecting accurate information ("Dirt on shoes can often tell us more about where the wearer of those shoes had last been than toilsome inquiries," Hans Gross noted

"Trial Practice" appears regularly in the *Michigan Bar Journal.* This column is designed to provide advice and guidance on how to effectively prepare for and conduct trials.

in his 1893 handbook) to more dramatic uses, forensic geology covers a broad spectrum of applications:

Crime Scene Investigation

Hit and Run

Under-fender dirt and soil deposited on the road at impact with the victim was used to locate the car and driver. Matching the grease on the victim with the grease under the car provided supporting evidence.

Rape

Soil on the clothing of a suspected rapist was used to place the suspect at the crime scene and to eliminate the suspect's alibi. Small bits of coal in the soil sample from the suspect's pant cuffs provided additional evidence when historical aerial photographs showed that coal was stored at the rape location.

Murder

Soil and other earth materials found on murder victims has been used to determine the location of homicides, especially when the murder occurs at one location and the body is disposed of elsewhere. Using water-current measurements, forensic geologists have located bodies or objects thrown into water or, conversely, determined where the newly discovered body or object originally entered the water. Geologic techniques have been used to locate clandestine graves and buried weapons.

Assault

Identifying the type of rocks used as weapons led to the source of the rocks and helped locate and identify suspects, who were subsequently convicted.

Environmental Evidence

Groundwater Contamination

By determining the natural characteristics of a contaminated aquifer, the sources of contamination were identified and property owners at the times of release were identified and distinguished from subsequent owners who had no responsibility for contamination. In another case, a forensic geologist identified multiple parties who caused groundwater contamination when previously only one party was believed to be responsible.

Surface Water Impacts

Analysis of sediment in a river led to identification of parties responsible for water pollution and adverse fishery impacts. Soil erosion from construction activities was shown to have caused excessive lake sedimentation.

Wetlands

Geologic techniques were used to show when a wetland was illegally drained and filled.

Land Subsidence

Soil and construction material analyses identified the cause of a collapsing roadway.

Subsurface Investigations

Locate Buried Objects

Geologists have identified the location of buried objects, such as chemical drums,

storage tanks, vehicles, waste disposal trenches, bodies, and weapons.

Mineral Resources

Soil analyses and geophysical testing were used in several property condemnation cases to determine the value of mineral deposits.

Insurance Claims—Accidents and Personal Injury

Vehicle Accident

Analyzing the composition of a gravel road showed how it influenced a vehicle accident.

Excavation/Trench Collapse

Analysis of site-specific excavations and geologic conditions uncovered evidence that determined the party responsible for personal injury resulting from an excavation collapse.

Subsurface Explosion

Evaluating the possible causes of a sewer tunnel explosion during construction, a forensic geologist showed that human activities were the cause and that the explosive conditions were known and avoidable.

Insurance Claims—Property Damage

Vandalism

By analyzing the type of rocks thrown at new vehicles being transported on railroad cars passing through several states, a forensic geologist determined the likely location of the repeated vandalism. Authorities subsequently caught the vandals.

Flood Damage

Evaluation of groundwater hydraulics showed how a retention/detention pond caused increased basement flooding. Also, a forensic geologist provided evidence that showed the extent of property damage resulting from repeated flooding of a county drain purposely dammed by a riparian owner to damage an upstream riparian owner.

Chemical Exposure

Based on current chemical concentrations in the soil and groundwater, a forensic geologist calculated the original chemical concentrations to which workers were exposed.

Case Settlement

Dispute Resolution/Third-Party Expert

By acting as a third-party expert to provide independent technical analysis in disputes, mediation, and arbitration court actions, a forensic geologist has assisted in finding "common ground," win-win solutions, and alternative approaches when soil or water is a significant issue.

In the more than 70 years since Locard first formulated his exchange principle, investigators and scientists have applied the principle and other geologic concepts in developing evidence to support many types of court cases. Today, courts in the United States and other countries generally accept forensic geology as a valid source of scientific evidence. ✦

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REFERENCE

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