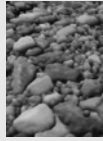




### Tales of the Crypt: Early History of Forensic Geology



Forensic Geology involves use of geological principles and methods to solve mysteries, especially those relevant to criminal activities



Issues to which forensic geological techniques can and have been applied:

- Determination of whether or not an individual was present at a particular location
- The sequence of visits by an individual to certain locations
- The location of bodies or buried objects
- The source of imported/smuggled items
- Cause of death
- Geographic origin of unidentified human remains
- Length of time a body has been present at a location (and length of time it has been buried there)
- Forgery of items (e.g. fossil specimens)

### Earth Materials as Trace Evidence

The most widely recognized application of forensic geology is the use of geological materials as *trace evidence* that may be valuable in linking a suspect to a crime scene

All locations on the Earth are slightly different in terms of their composition (and other characteristics). Most physical processes leave "geologic fingerprints" attesting to their origins

Techniques developed by Earth Scientists have also proven valuable in forensics (e.g. use of shallow geophysical prospecting methods to locate clandestine graves and objects such as drug caches and weapons)

### Early History of Forensic Geology

Uses of geological materials to deduce the activities of humans have been at least suggested in various stories throughout the ages

For example, one story describes how an enemy camp was located by identifying the rocks imbedded in horses' hooves

But the possible role of geology in solving crime was not seriously considered until physician-author Conan Doyle wrote a series of famous stories between 1887 and 1893 that featured one of the most remarkable characters in fiction...

### Sherlock Holmes – Detective Extraordinaire



Beeton's Christmas Annual containing the first Sherlock Holmes story – A Study in Scarlet



Basil Rathbone as Sherlock Holmes in Study in Scarlet

### Who was Sherlock Holmes ?

The Sherlock Holmes character is, of course, fictional but was probably based on professor John Bell who taught Doyle at university.

Bell was an expert in the use of deductive reasoning to diagnose disease. Conan Doyle was so impressed that he used these same principles when creating his famous detective.

Doyle provided the world with innovative ideas on how to solve crime mysteries- many of his ideas were later developed for use in actual crime cases

### *A Study in Scarlet* by Arthur Conan Doyle

Upon meeting Holmes, Dr. Watson, a retired military doctor writes "Therefore all the knowledge which he possessed was such as would be useful to him. I enumerated in my own mind all the various points upon which he had shown me that he was exceptionally well informed. I even took a pencil and jotted them down. I could not help smiling at the document when I had completed it. It ran in this way:

Sherlock Holmes--his limits

1. Knowledge of Literature.--Nil.
2. " Philosophy.--Nil.
3. " Astronomy.--Nil.
4. " Politics.--Feeble.
5. " Botany.--Variable. Well up in belladonna, opium, and poisons generally. Knows nothing of practical gardening.
6. Knowledge of Geology.--Practical, but limited. Tells at a glance different soils from each other. After walks has shown me splashes upon his trousers, and told me by their colour and consistence in what part of London he had received them"...etc.

So does life imitate ART ?

### Hans Gross (1847-1915)

Hailed as "founder of scientific criminal investigation"

Legal counsel and State's Attorney, Graz, Austria

Published Handbook for Examining Magistrates in 1893

- included discussions of forensic medicine, toxicology, serology, and ballistics, as well as forensic geology

-noted that "Dirt on shoes can often tell us more about where the wearer of those shoes has last been than toilsome inquiries"

Set the stage for the development of forensic geology as a scientific discipline



### Edmond Locard (1877-1966).

Forensic science also owes a great debt to French criminalist Edmond Locard

father of Poreoscopy - the study of pores that appear in the fingerprint ridge)  
worked for the French police in the years following 1910 and worked on many cases involving minerals

He provided us with the Transfer 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"*



### Georg Popp

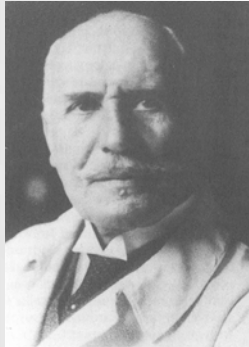
Chemist by training

Maintained lab in Frankfurt, Germany, providing chemical and microscopic services in areas of food studies, water quality, bacteriology and related fields

In 1900, a criminal investigator in Frankfurt asked Popp to examine stains on a suspect's trousers

From this point onward, Popp devoted much of his work to the development of forensic methods

Credited to helping solve the first criminal case using geologic evidence



### The Disch Case, 1904

First recorded criminal case solved via forensic geology

Place: Frankfurt, Germany

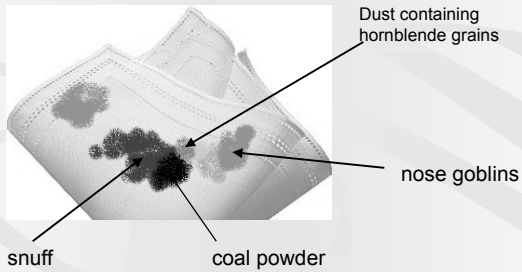
Victim: Seamstress Eva Disch strangled in farm field with her own scarf

Investigator: Georg Popp

Suspect: Karl Laubach

**Evidence:**

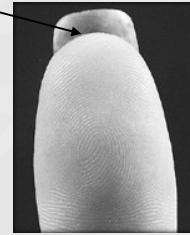
Crime Scene: A soiled handkerchief left at the scene - nasal mucus on the handkerchief was noted to contain particles of coal, snuff, and grains of the mineral hornblende



**On Suspect:**

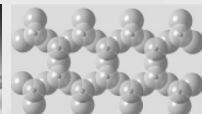
1. Popp found coal and mineral grains, particularly the mineral hornblende, under the suspect's fingernails. It was also determined that the suspect used snuff.

Coal, dust with hornblende, snuff found under fingernails

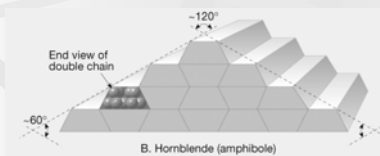


**An aside:**

Hornblende is a green to black-coloured mineral composed of silica plus iron and/or magnesium (with the horrendous chemical formula  $\text{Ca}_2(\text{Fe},\text{Mg})_2\text{Si}_8\text{O}_{22}(\text{OH})_2$  - no, we don't expect you to remember this formula !



Dark colour partly a function of iron/magnesium content



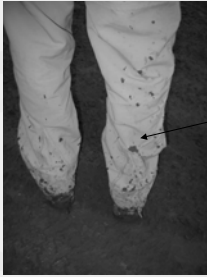
Characteristically breaks along weak areas of crystal structure (between double chains) Produces "cleavage" angles of 120° and 60°

**Another significant piece of geological information:**



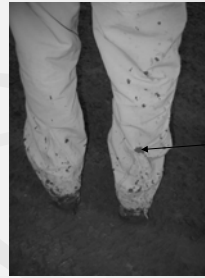
- Hornblende is a fairly common mineral in igneous and metamorphic rocks but breaks down rapidly when weathered.
- So...hornblende grains would be expected to be relatively common in areas where freshly broken rock is present
- But...soil, being highly weathered material would not be expected to contain significant amounts of hornblende

2. Examination of soil removed from Laubach's trousers revealed a lower layer in contact with the cloth whose minerals compared with those found in a sample collected from the place where the body of Eva Disch had been found.



Soil in contact with cloth:  
Mineral content same as  
in soil associated with  
body

3. Soil layer covering soil adhering to cloth: contained a minerals of same composition and grain size as soil on path that led from the murder scene to the suspect's home.

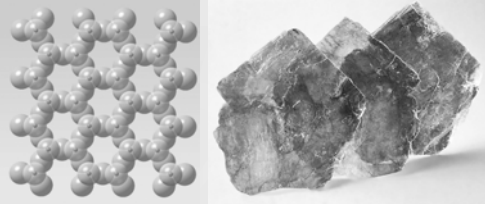


Soil on top of (and  
therefore picked up after)  
the soil in contact with  
cloth:  
Mineral content same as  
in soil on path (with  
characteristic mica grains)

#### Another aside:

Mica is a mineral composed of silica plus alumina (aluminum oxide), and iron, magnesium or potassium.

Mica characteristically breaks into sheets, due to strong linkages of silica units in a single plane (weaker forces hold the sheets)



Common in many rock types and is relatively resistant to weathering (can be common in some soils)

Additional evidence: Background of suspect revealed employment at a coal-burning gasworks and a local gravel pit (thus explaining presence of coal dust and hornblende grains on handkerchief)



Verdict: It was concluded that the suspect picked up the lower soil layer at the scene of the crime and that this lower, thus earlier material, was covered by splashes of mica-rich mud from the path on his return home. Hornblende grains were picked up from rock dust in gravel pit.



When confronted with the soil evidence, Karl Laubach admitted the crime.

## Forensic Geology and the FBI

The Federal Bureau of Investigation was one of the first forensic laboratories to use soil and mineral analysis in criminal cases

As early as 1935, the FBI was working with soils

In 1936 the lab used mineral analysis to solve a kidnapping case

By 1939, heavy mineral separations and mineral identifications were standard practice in soil cases

Remains one of the world leaders in research relating to forensic geology



Another famous fictional character

## Walter McCrone (1916-2002)

In 1956, Walter McCrone started McCrone Associates, a company that promoted the use of electron and light microscopes

McCrone's methods have been used extensively in the identification of explosives, particles, and food contaminants

Many of today's leaders in forensic geology were trained under McCrone



To appreciate the nature of materials relevant to medical and forensic geology, we must look at the origin and distribution of these materials

To accomplish this, we will investigate some fundamental aspects of geology. These include:

- Minerals
- Rocks
- Plate Tectonics
- Preservation of Organic Remains (using fossils as a basis for understanding post-mortem processes)



*End of Lecture*