

# K-12 IYS Activity



## Summary

Students will attempt to solve a “cold case” crime based on evidence from the suspects and the crime scene in the form of soil samples. By analyzing the soils samples and comparing those from the suspects with the sample from the crime scene, students will try to determine which suspect can be linked to the crime scene.

## Learning Objectives/ Outcomes

1. To identify what soil forensics is and the importance of soil and geological analyses in criminal cases.
2. To apply basic methods of soil analysis to compare samples from various scenes within the investigation, involving samples from the suspect, victim, and reference samples from the crime scene.

# CSI: Forensic Soil Analysis

## Materials

Each laboratory station should be equipped with the following items:

- Plastic vials with caps
- 1 Plastic spoon
- Paper plates
- 1 Pipette or small graduated cylinder
- Soil sample(s) (The instructor should collect three different types of soils that differ in some of the following ways: pH, color, texture, and/or structure. Label them as Suspect 1, 2, and 3, and take some of one of them to label as the Crime Scene sample).
- 1 Marker
- pH color chart
- Munsell soil color chart (available for purchase, or download common colors here: <http://wgharris.ifas.ufl.edu/SEED/Handy%20Ref%20Materials.htm> )
- Soil textural triangle and flow chart (available at [www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/kthru6/?cid=nrcs142p2\\_054311](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/kthru6/?cid=nrcs142p2_054311) )
- Universal Indicator

## Ages of Audience

Middle school to high school

## Recommended group size?

Less than 20

## Where could you offer this?

Local school

## What type of room do you need?

Lab/work benches

## Type of Lesson (may be more than one)

1. Hands-on
2. Experiment

## Time Needed

About 60-90 minutes

## Background

*Forensic Soil Analysis* is the use of soil science and other disciplines (e.g., geochemistry and geology) to aid in criminal investigations. Since each soil possesses unique properties that serve as identification markers, soils can be traced and matched to each other. For example, clay embedded in the sneaker of a criminal can be traced back to a specific clay type found along a lake where a murder victim was discovered.

Each soil type has unique characteristics that provide important clues about its history, formation and location of origin, such as *color*, *texture* and *structure*. For example, the color of a soil indicates its history as well as the compounds present in the soil. White or gray soil may contain lime or have been leached, while black or gray soil indicates that the soil contains organic materials and/or moisture. Red, brown or yellow soil usually indicates the presence of iron compounds.

Sometimes *horizons* can form in soils, which are layers of soil that are distinguished from each other by their unique physical and chemical properties. The creation of such a “layer cake” is often referred to as a soil profile, which is a record of soil formation over time.

## References

Adapted from the CSI Challenge at Forensics World. <http://www.forensicsworld.com/csi-challenge/2011/Docs/soil.pdf>

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# CSI: Forensic Soil Analysis

## Forensic Soil Analysis Student Handout

### The Crime Scene

The body of a murder victim was located by police buried in a forest in the year 2000. Three possible suspects were taken in and questioned with hopes of a confession from one of them. They all had alibis, however, and none of the suspects' alibis could be disproven, so they were released. Fifteen years later the case was revisited as a cold case after the development of forensic soil techniques. You and a team of forensic soil scientists are asked to re-examine the pants and shoes of the three suspects, which have been kept by police since 2000. You and your team have carefully collected and prepped the soil samples that came from the suspects' belongings. All that is left to do is analyze the samples, but the clock is ticking and the judge needs to know who the real suspect is by the end of the day!

### Are You Up for the Challenge?

It's time to analyze the evidence. Be sure you have some soil representing these 4 collected soil samples:

- Crime Scene
- Suspect 1
- Suspect 2
- Suspect 3

### Procedure

#### STEP 1: DETERMINE THE COLOR, TEXTURE, AND STRUCTURE

The first step in your forensic soil analysis is to determine the color and texture of the soil samples recovered during your investigation.

#### Background:

Soil color is classified according to the Munsell Color Chart which specifies colors based on three color dimensions: hue, value (lightness), and chroma (color purity). The Munsell color scheme is the official color system for soil research in the United States.

Soil texture is determined by the relative proportion of sand, silt and clay found in a given soil.

- *Sand* is gritty to the touch and the individual grains can be seen with the naked eye. Sandy soils are coarse in texture and are the largest of the three size classes.
- *Silt* is smooth and slippery to the touch, like flour or baby powder. The individual grains are much smaller than those of sand. These individual particles can only be seen with a microscope.
- *Clay* is sticky when wet. It can easily be rolled into balls between the forefinger and thumb. The individual particles are extremely small and can only be seen with an electron microscope. Clay soils are the finest in texture and the smallest of the three size classes.

Structure is another unique soil property. Some soils are composed of single grain particles, while other soils may include cementing agents, such as calcium carbonate ( $\text{CaCO}_3$ ), iron (Fe), or organics, which hold the soil particles together. These particles adhere to each other to form different-shaped peds or clumps (e.g. blocky or platy) that occur within the soil.

- *Blocky peds* are small multi-grain conglomerates (i.e. clumps of grains)
- *Prismatic or columnar peds* are vertical columns.
- *Platy peds* are flat, sheet-like conglomerates.
- *Granular* soil is crumbly.
- *Single-grained* soil lacks peds.

#### Laboratory Method:

Follow these steps to determine the color, texture, and structure of each soil sample:

- Using the plastic spoon, scoop a small amount of soil from the crime scene bag and place it on a paper plate.
- Use the Munsell Color Chart to determine the color of the soil sample. Record the results.

- Next, determine the texture of each soil sample using the flow chart and textural triangle provided. Record your results.
- Next, determine whether the structure of your sample is single grain, blocky ped, or platy ped using the descriptions above. Record your results.
- Note anything unusual present within your sample, such as vegetation, roots, hair, fibers, shell, etc., and record your observations.

Repeat for the other samples.

#### STEP 2: CONDUCT A CHEMICAL TEST

The second step in your forensic soil analysis is to determine the pH of your samples.

#### Laboratory Method:

- Using a marker, label your plastic vial.
- Add a small amount of soil directly into the vial.
- Using the pipette or graduated cylinder, add 6 milliliters of distilled water to the vial.
- Place the cap on the vial and turn the vial upside down for 2-3 seconds. **DO THIS ONLY ONCE. DO NOT SHAKE!!**
- Let the solution settle for 1 minute.
- Next, add 10 drops of Universal Indicator to the vial.
- Place the cap on the vial and turn the vial upside down for 2-3 seconds. **DO THIS ONLY ONCE. DO NOT SHAKE!!**
- Wait 5 minutes.
- Using the pH color chart, determine the color and pH range of the soil sample in the vial. Record the results as, for example, "Red, pH=1-2."
- Repeat for the other samples.

#### STEP 3: DETERMINE IF THERE IS A MATCH TO THE CRIME SCENE SOIL

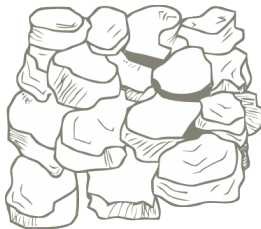
Refer to your results to determine if one of the soil samples from the suspects matches the soil from the crime scene.

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## CSI: Forensic Soil Analysis



**GRANULAR:** Resembles cookie crumbs and is usually less than 0.5 cm in diameter. Commonly found in surface horizons where roots have been growing.



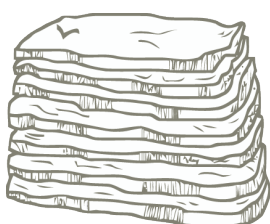
**BLOCKY:** Irregular blocks that are usually 1.5–5.0 cm in diameter.



**PRISMATIC:** Vertical columns of soil that might be a number of cm long. Usually found in lower horizons.



**COLUMNAR:** Vertical columns of soil that have a salt “cap” at the top. found in soils of arid climates



**PLATY:** Thin, flat plates of soil that lie horizontally. Usually found in compacted soil.



**SINGLE-GRAINED:** Soil is broken into individual particles that do not stick together. Always accompanies a loose consistence. Commonly found in sandy soils.

This figure illustrates the different types of soil structure.