



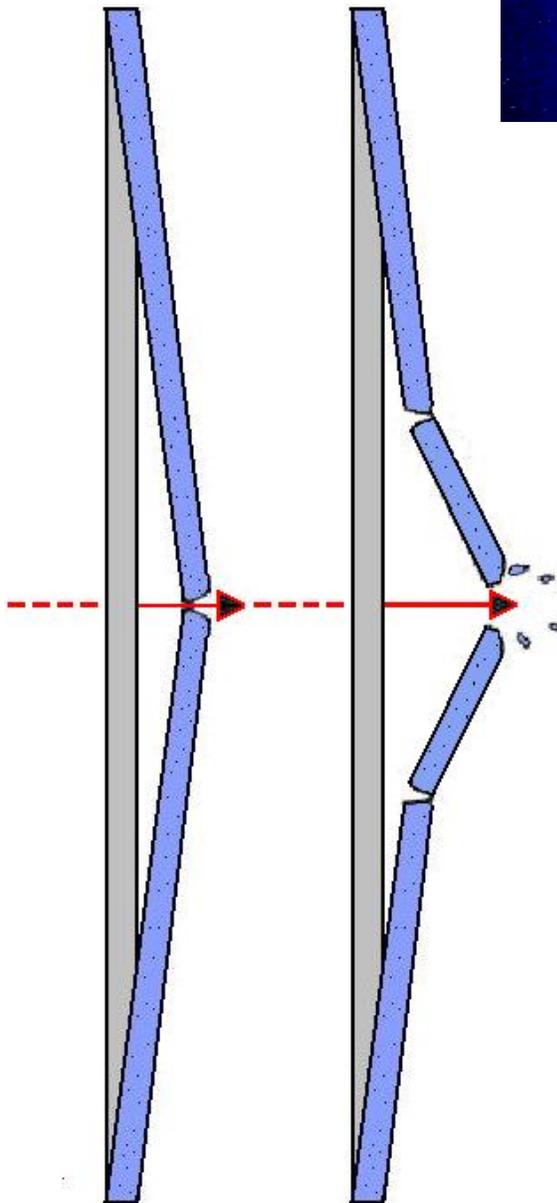
## Glass Fractures

Glass bends in response to any force that is exerted on any one of its surfaces. When the limit of its elasticity is reached, the glass will fracture. Frequently, fractured window glass will reveal information that can be related to the force and direction of an impact; such knowledge may be useful for reconstructing events at a crime scene.

The penetration of ordinary window glass by a projectile, be it a bullet or a stone, produces a familiar fracture pattern. Cracks radiate outward and encircle the hole, as shown above. The radiating lines are appropriately known as *radial fractures*, and the circular lines are termed *concentric fractures*.

Often it is difficult to determine from the size and shape of a hole in glass whether it was made by a bullet or by some other projectile. For instance, a small stone thrown at a comparatively high speed against a pane of glass will often produce a hole very similar to that of a bullet. On the other hand, a large stone can completely shatter a pane of glass in a manner closely resembling the result of close-range gunfire. However, in the latter instance, the presence of gunpowder deposits on the shattered glass fragments does point to damage caused by a firearm.

A projectile hole is inevitably wider at the exit side, and hence its examination is an important factor when determining the direction of impact.

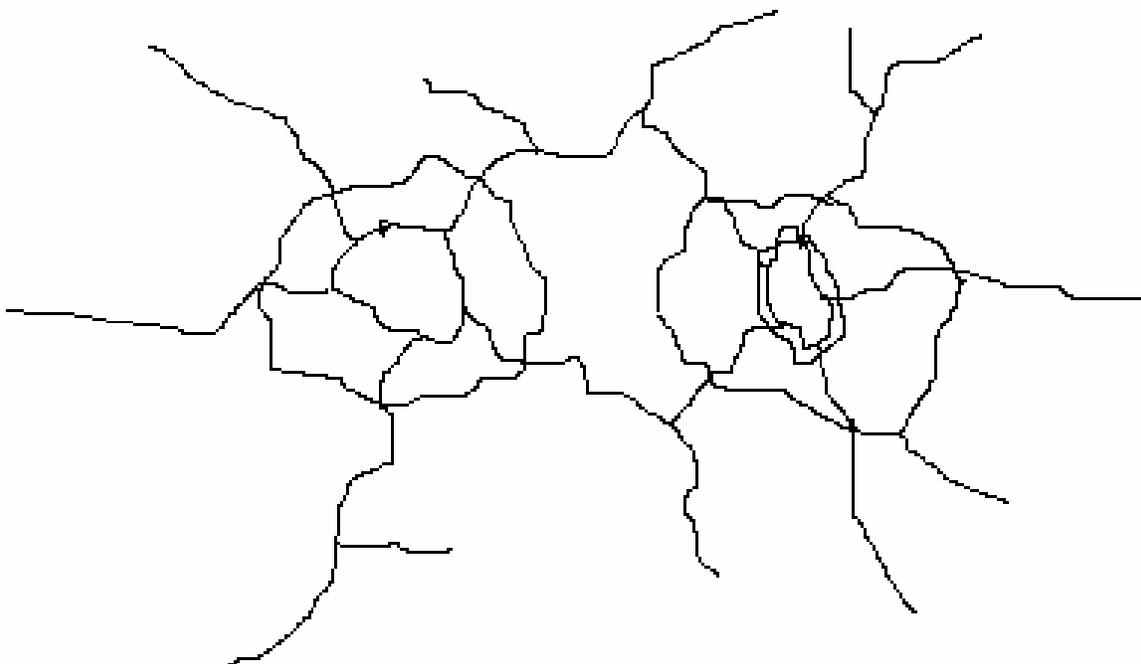


When a force pushes on one side of a pane of glass, the elasticity of the glass permits it to bend in the direction of the applied force. Once the elastic limit is exceeded, the glass begins to crack. As seen at left, the first fractures form on the surface opposite that of the penetrating force, and these fractures develop into radial lines. The continued motion of the force places tension on the front surface of the glass, resulting in the formation of concentric cracks. An examination of the edges of the radial and concentric cracks frequently reveals stress markings whose shape can be related to the side on which the window first impacted.

## Stress Marks



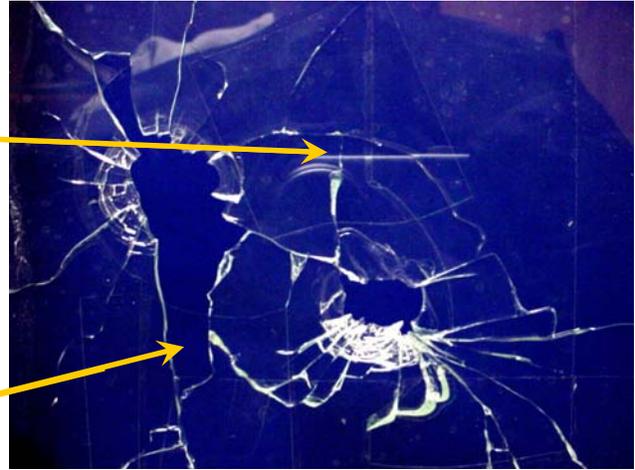
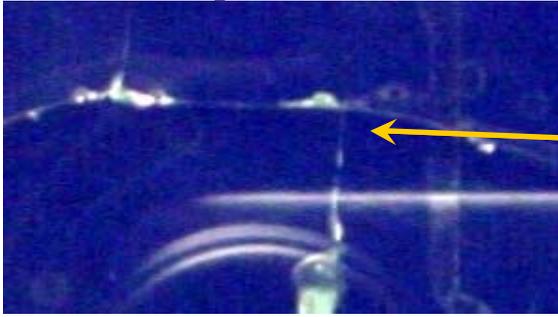
Stress marks, seen on a cross section of a glass fracture, are shaped like arches that are perpendicular to one glass surface and curved nearly parallel to the opposite surface. The importance of stress marks stems from the observation that the perpendicular edge always faces the surface on which the crack originated. Therefore, in examining the stress marks on the edge of a radial crack near the point of impact, the perpendicular end is always located opposite the side from which the force of impact was applied. For a concentric fracture, the perpendicular end always faces the surface on which the force originated. These facts enable the examiner to readily determine the side on which a window was broken. Unfortunately, tempered glass does not produce reliable cracking patterns for study.



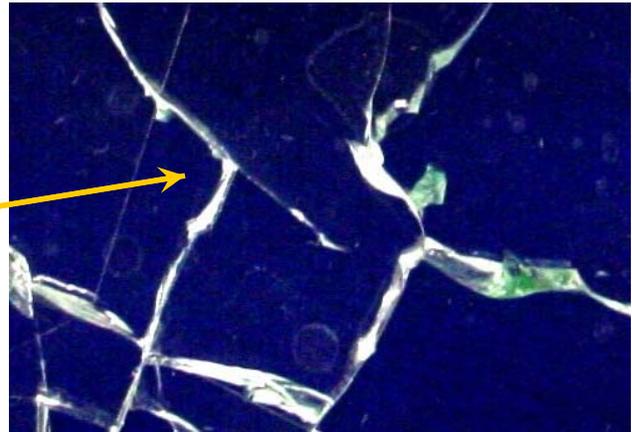
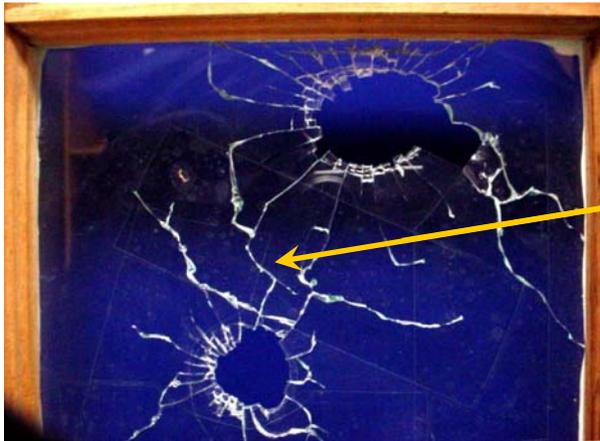
## Successive Penetrations

When there have been successive penetrations of glass, it is frequently possible to determine the sequence of impact by observing the existing fracture lines and their points of termination. **A fracture always terminates at an existing line of fracture.** Above, the fracture on the left preceded that on the right; this is evidenced by the latter hole's radial fracture lines terminating at the cracks of the former.

## Fracture Examples:



In the glass above, the top hole was made first. Notice how fracture lines from the lower penetration terminate at fracture lines from the top hole. Below: once again the top hole was penetrated first as evidenced in the close-up view.

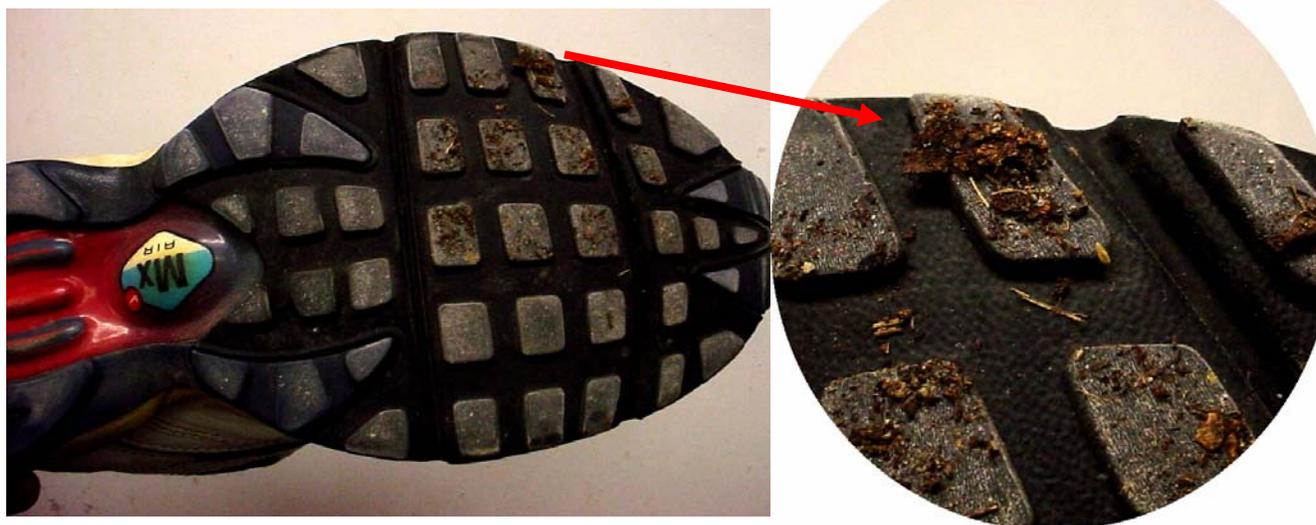


Examine the fractured glass to the right. Which fracture was formed first?

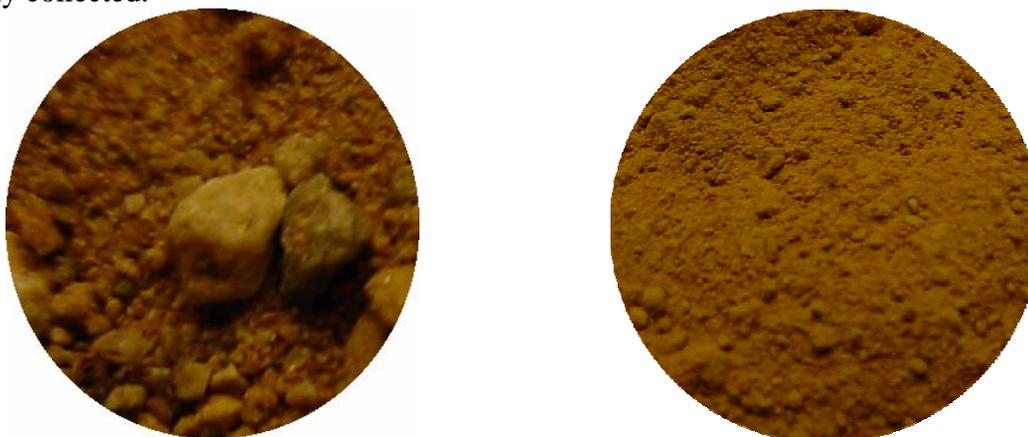
*Right hole penetrated first.*



## Forensic Characteristics of Soil



*Soil* is considered to be any material, both natural and artificial, that lies on or near the Earth's surface. Soil or dried mud found adhering to a suspect's clothing or shoes, or to an automobile, when compared to soil samples collected at the crime site, may provide associative evidence that can link a suspect or object to the crime scene. Although most soils can be differentiated and distinguished by their gross appearance using a side-by-side visual comparison of color and texture, several more steps must be taken to unequivocally match samples. Most soil samples require a control sample for comparison; however, a geologist, having knowledge of local soil characteristics, may be able to direct police to the general vicinity where a soil was originally collected.



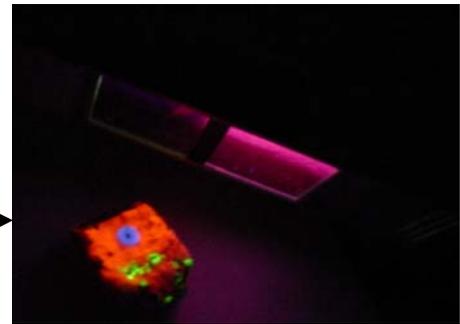
Above: Gross examination of two soil samples show significant differences.

When comparing soil, it is important to remember that soil is darker when it is wet; therefore, color comparisons must always be made when the samples are dry. It is estimated that there are nearly 1100 distinguishable soil colors. Comparison of color offers a logical first step in a forensic soil comparison and in itself may be enough to show that two soil samples have different origins.



UV-Light

UV-Light over mineral



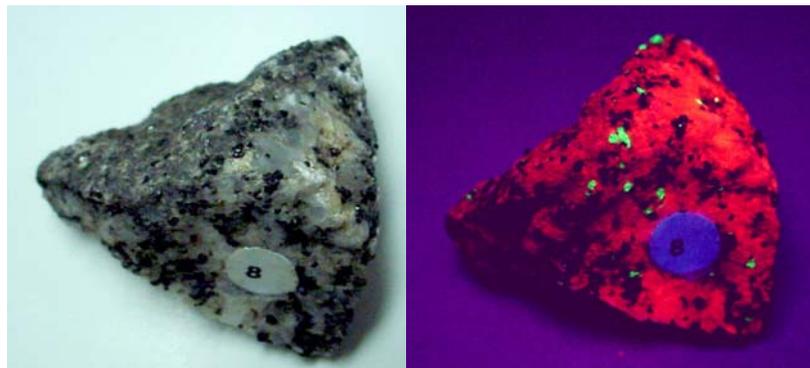
## Fluorescence

Exposure of soil to ultra-violet light may reveal the presence of plant or animal materials, or man-made debris. Further microscopic examination will aid in the characterization of minerals and rocks present in earthen samples. More than 2200 minerals are known to exist. Forensic geologists will usually encounter only about forty of these.



Aragonite, a mineral which fluoresces green under a UV-light, occurs naturally in Mexico.

Hackminite, a mineral which is native to several different areas around the United States, fluoresces dark red under UV-light.



Willemite Calcite is a mineral found chiefly in New Jersey that fluoresces orange and green under a UV-light.

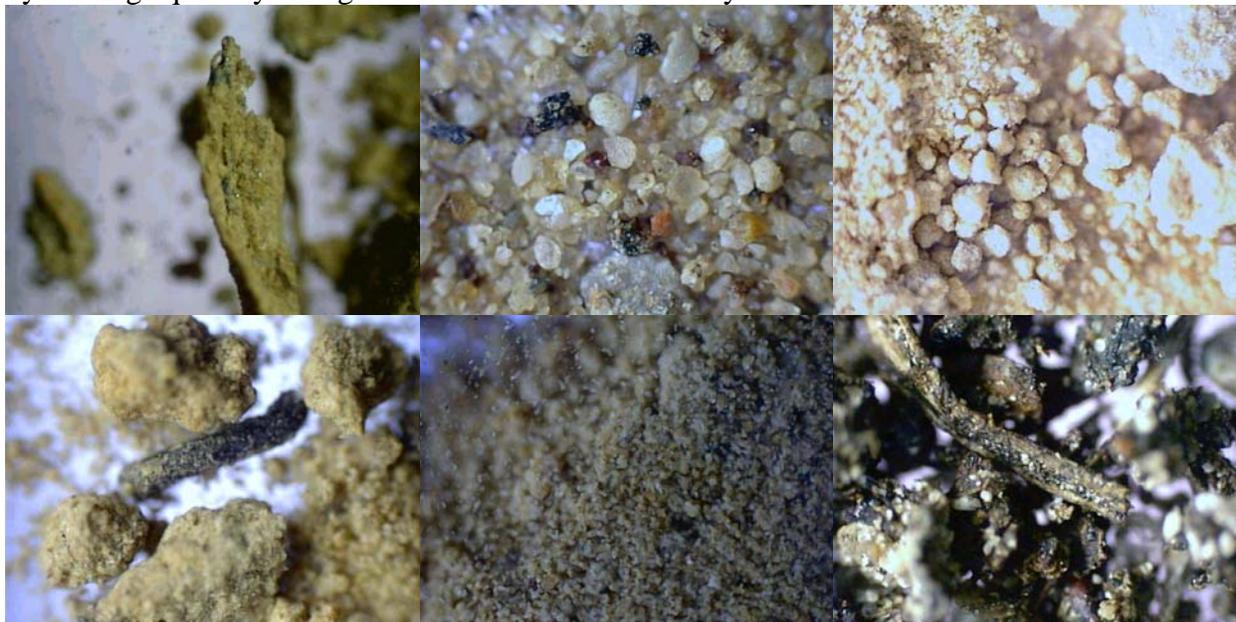
## Soil Comparisons

Microscopic examination is the next logical step in the attempt to match soil samples. Such examinations are best performed on small thin quantities of a sample. While most soil samples from a crime scene are usually found in lesser quality, it is not uncommon to have a larger amount of dirt in certain cases. For instance, if an object is dragged through mud or loose dirt there may be a significant amount of sample present. In any case, a microscopic examination often reveals minerals, plant or animal parts, or synthetic substances. In the least, it allows an observer to examine the most basic textures and formations present in the samples.



Above: A small amount of sample is placed onto a slide. At right you see the placement of a second slide on top of a thinly spread soil sample. The top slide will protect the microscope lens from the coarse texture of the soil.

Below: Six different soil samples, magnification x40, from completely different locations. The first sample shows a piece of organic material which may have originated from a tree or plant. The second sample exhibits rocky, almost gem like particles. Close examination of the third, fourth, and fifth samples show varying degrees of sand/dirt particles, with the fourth alone containing a small root. The last sample is likely some type of potting soil, as evidenced by the large quantity of organic material and fertilizer crystals.



## Density Gradient Tubes

The final step is a more intense comparison of soil samples which is achieved through the use of *density-gradient tubes*. Typically, glass tubes 6 to 10 mm in diameter and from 25 to 40 cm in length are filled with layers of two liquids mixed in varying proportions so that each layer has a different density.

When soil is added to a density-gradient tube, its particles will sink to the portion of the tube that has a density of similar value; the particles will remain suspended in the liquid at this point until the soil becomes saturated. Two samples' density distribution patterns may then be compared for crime scene analysis. (See pictures) If two distributions match, then the soil samples are likely from the same area. It is usually not possible for the forensic geologist to individualize soil to any one location. An exception to this may occur if an unusual combination of rare minerals, rocks, or man-made debris is found within a sample.

