Chapter 15
FIREARMS, TOOL MARKS, AND OTHER IMPRESSIONS

Introduction

- Structural variations and irregularities caused by scratches, nicks, breaks, and wear may permit the criminalist to relate:
  - A bullet to a gun
  - A scratch or abrasion mark to a single tool
  - A tire track to a particular automobile
- Individualization, a goal in all areas of criminalistics, frequently becomes an attainable reality in firearm and tool mark examination.

Gun Barrel Markings

FIREARMS AND TOOL MARKS

- The inner surface of the barrel of a gun leaves its markings on a bullet passing through it.
- These markings are peculiar to each gun.
- The gun barrel is produced from a solid bar of steel that has been hollowed out by drilling.
- The microscopic drill marks left on the barrel's inner surface are randomly irregular and serve to impart a uniqueness to each barrel.

Gun Barrel Markings

- The manufacture of a barrel also requires impressing its inner surface with spiral grooves, a step known as rifling.
- The surfaces of the original bore remaining between the grooves are called lands.
- The grooves serve to guide a fired bullet through the barrel, imparting a rapid spin to insure accuracy.

Gun Barrel Markings

- The diameter of the gun barrel, measured between opposite lands, is known as caliber.
- Once a manufacturer chooses a rifling process, the class characteristics of the weapon's barrel will remain consistent, each will have the same number of lands and grooves, with the same approximate width and direction of twist.

Striations

- Striations, which are fine lines found in the interior of the barrel, are impressed into the metal as the negatives of minute imperfections found on the rifling cutter's surface, or they are produced by minute chips of steel pushed against the barrel's inner surface by a moving broach cutter.
- These striations form the individual characteristics of the barrel.
- It is the inner surface of the barrel of a gun that leaves its striation markings on a bullet passing through it.

Bullet Examination

FIREARMS AND TOOL MARKS

- No two rifled barrels, even those manufactured in succession, will have identical striation markings.
- The number of lands and grooves and their direction of twist are obvious points of comparison during the initial stages of an examination between an evidence bullet and a test-fired bullet.
- Any differences in these class characteristics immediately serve to eliminate the possibility that both bullets traveled through the same barrel.

The Comparison Microscope

FIREARMS AND TOOL MARKS

- The comparison microscope serves as the single most important tool to a firearms examiner.
- Two bullets can be observed and compared simultaneously within the same field of view.
- Not only must the lands and grooves of the test and evidence bullet have identical widths, but the longitudinal striations on each must coincide.

Shotguns

- Unlike rifled firearms, a shotgun has a smooth barrel.
- Shotguns generally fire small lead balls or pellets that are not impressed with any characteristic markings that can be related back to the weapon.
- The diameter of the shotgun barrel is expressed by the term gauge.
- The higher the gauge number, the smaller the barrel's diameter.

Firing a Weapon

- The act of pulling the trigger serves to release the weapon's firing pin, causing it to strike the primer, which in turn ignites the powder.
- The expanding gases generated by the burning gunpowder propel the bullet forward through the barrel, simultaneously pushing the spent cartridge case or shell back with equal force against the breechblock.
- The shell is impressed with markings by its contact with the metal surfaces of the weapon's firing and loading mechanisms.

Cartridge Case Comparison

- The firing pin, breechblock, and ejector and extractor mechanism also offer a highly distinctive signature for individualization of cartridge cases.
- The shape of the firing pin will be impressed into the relatively soft metal of the primer on the cartridge case.
- The cartridge case, in its rearward thrust, is impressed with the surface markings of the breechblock.

Cartridge Case Comparison

- Other distinctive markings that may appear on the shell as a result of metal to metal contact are caused by the:
  - Ejector, which is the mechanism in a firearm that throws the cartridge or fired case from the firearm.
  - Extractor, which is the mechanism in a firearm by which a cartridge of a fired case is withdrawn from the firing chamber.
  - Magazine or clip, which is the mechanism that in a firearm holds the bullets.

Computerized Imaging

FIREARMS AND TOOL MARKS

- The advent of computerized imaging technology has made possible the storage of bullet and cartridge surface characteristics in a manner analogous to automated fingerprint files.
- The National Integrated Ballistics Information Network, NIBIN, produces database files from bullets and cartridge casings retrieved from crime scenes or test fires from retrieved firearms, often linking a specific weapon to multiple crimes.
- It is important to remember, however, that the ultimate decision for making a final comparison will be determined by the forensic examiner through traditional microscopic methods.

Gunpowder Residue

- When a firearm is discharged, unburned and partially burned particles of gunpowder in addition to smoke are propelled out of the barrel along with the bullet toward the target.
- If the muzzle of the weapon is sufficiently close, these products will be deposited onto the target.
- The distribution of gunpowder particles and other discharge residues around a bullet hole permits an assessment of the distance from which a handgun or rifle was fired.

Gunpowder Residue

- The precise distance from which a handgun or rifle has been fired must be determined by means of a careful comparison of the powder-residue pattern located on the victim's clothing or skin against test patterns made when the suspect weapon is fired at varying distances from a target.
- By comparing the test and evidence patterns, the examiner may find enough similarity in shape and density upon which to base an opinion as to the distance from which the shot was fired.

Gunpowder Residue

FIREARMS AND TOOL MARKS

- In cases where the weapon is held in contact with or less than one inch from the target, a star-shaped (stellate) tear pattern around the bullet hole entrance, surrounded by a rim of a smokeless deposit of vaporous lead is usually present.
- A halo of vaporous lead (smoke) deposited around a bullet hole is normally indicative of a discharge of 12 to 18 inches or less.
- The presence of scattered specks of unburned and partially burned powder grains without any accompanying soot is often observed at distances up to 25 inches (and occasionally as far as 36 inches).
- More than three feet will usually not deposit any powder residues, and the only visual indication is a dark ring around the hole, known as a bullet wipe.

Gunpowder Residue

- When garments or other evidence relevant to a shooting are received in the crime laboratory, the surfaces of all items are first examined microscopically for the presence of gunpowder residue.
- Chemical tests, such as the Greiss test, may be needed to detect gunpowder residues that are not visible.
- The firing distances involving shotguns must again be related to test firing.
- The muzzle to target distances can be established by measuring the spread of the discharged shot.

Primer Residue on Hands

- The firing of a weapon not only propels residues toward the target, but gunpowder and primer residues are also blown back toward the shooter.
- As a result, traces of these residues are often deposited on the firing hand of the shooter, and their detection can provide valuable information as to whether or not an individual has recently fired a weapon.

Primer Residue on Hands

- Examiners measure the amount of barium and antimony on the relevant portion of the suspect's hands, such as the thumb web, the back of the hand, and the palm.
- They may also characterize the morphology of particles containing these elements to determine whether or not a person has fired, handled a weapon, or was near a discharged firearm.

Serial Numbers

- Increasingly, the criminalist is requested to restore a serial number when it has been removed or obliterated by grinding, rifling, or punching.
- Restoration of serial numbers is possible through chemical etching because the metal crystals in the stamped zone are placed under a permanent strain that extends a short distance beneath the original numbers.

Firearm Evidence Collection

- Firearms are collected by holding the weapon by the edge of the trigger guard or by the checkered portions of the grip.
- Before the weapon is sent to the laboratory, all precautions must be taken to prevent accidental discharge of a loaded weapon.
- In most cases, it will be necessary to unload the weapon.
- When a revolver is recovered, the chambers, their positions, and corresponding cartridges must be recorded.
- Firearm evidence must be marked for identification (usually a tag on the trigger guard) and a chain of custody must be established.

Firearm Evidence Collection

FIREARMS AND TOOL MARKS

- Bullets recovered at the crime scene are scribed with the investigator's initials, either on the base or the nose of the bullet.
- The obliteration of striation markings that may be present on the bullet must be scrupulously avoided.
- The investigator must protect the bullet by wrapping it in tissue paper before placing it in a pillbox or an envelope for shipment to the crime laboratory.
- Fired casings must be identified by the investigator's initials placed near the outside or inside mouth of the shell.
- Discharged shotgun shells are initialed on the paper or plastic tube remaining on the shell or on the metal nearest the mouth of the shell.

Tool Marks

- A tool mark is considered to be any impression, cut, gouge, or abrasion caused by a tool coming into contact with another object.
- A careful examination of the impression can reveal important class characteristics, such as the size and shape of the tool.
- But it is the presence of any minute imperfections on a tool that imparts individuality to that tool.
- The shape and pattern of such imperfections are further modified by damage and wear during the life of the tool.

Tool Marks

- The comparison microscope is used to compare crime-scene toolmarks with test impressions made with the suspect tool.
- When practical, the entire object or the part of the object bearing the tool mark should be submitted to the crime laboratory for examination.
- Under no circumstances must the crime scene investigator attempt to fit the suspect tool into the tool mark.
  - Any contact between the tool and the marked surface may alter the mark and will, at the least, raise serious questions about the integrity of the evidence.

Other Impressions

- Impressions of other kinds, such as shoe, tire or fabric impressions, may be important evidence.
- Before any impression is moved or otherwise handled, it must be photographed (including a scale) to show all the observable details of the impression.
- If the impression is on a readily recoverable item, such as glass, paper, or floor tile, the evidence is transported intact to the laboratory.
- If the surface cannot be submitted to the laboratory, the investigator may be able to preserve the print in a manner similar to lifting a fingerprint.

Other Impressions

- When shoe and tire marks are impressed into soft earth at a crime scene, their preservation is best accomplished by photography and casting.
- In areas where a bloody footwear impression is very faint or where the subject has tracked through blood leaving a trail of bloody impressions, chemical enhancement can visualize latent or nearly invisible blood impressions.

Points of Comparison

FIREARMS AND TOOL MARKS

- A sufficient number of points of comparison or the uniqueness of such points will support a finding that both the questioned and test impressions originated from one and only one source.
- New computer software and web sites may be able to assist in making shoe print and tire impression comparisons.
- Also, bite mark impressions on skin and foodstuffs have proven to be important evidence in a number of homicide and rape cases.

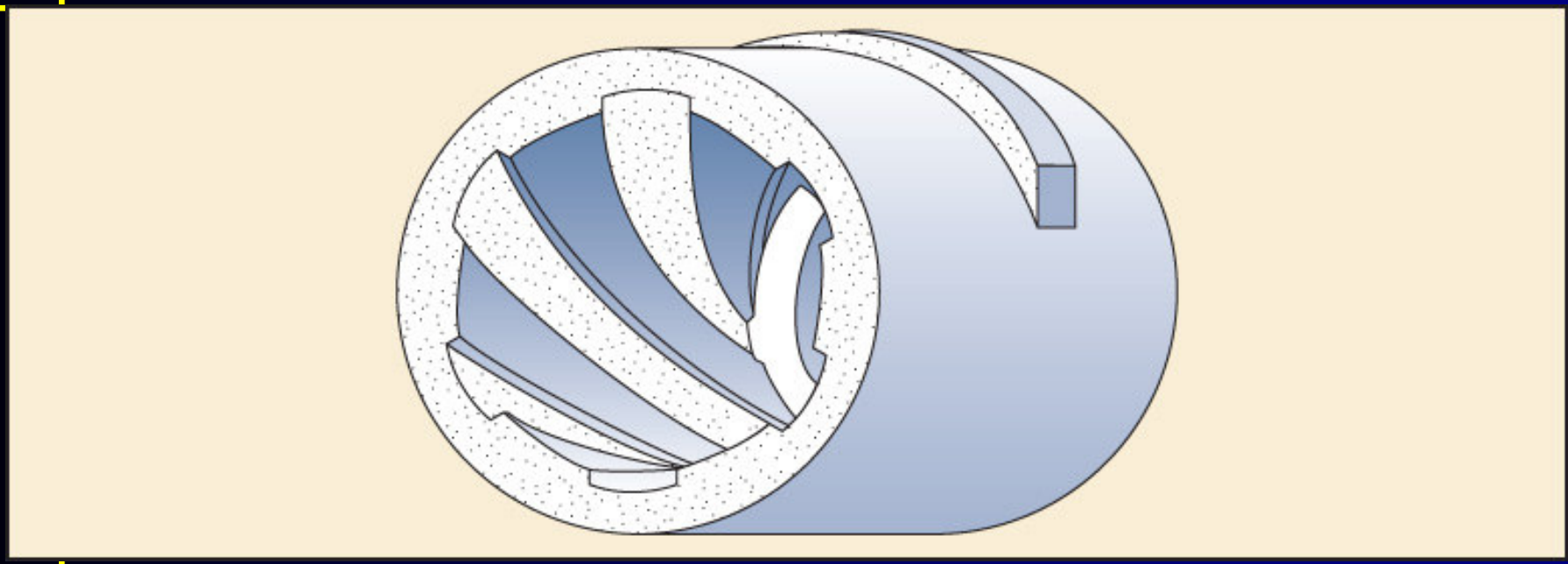

Figure 15–1 Interior view of a gun barrel, showing the presence of lands and grooves.

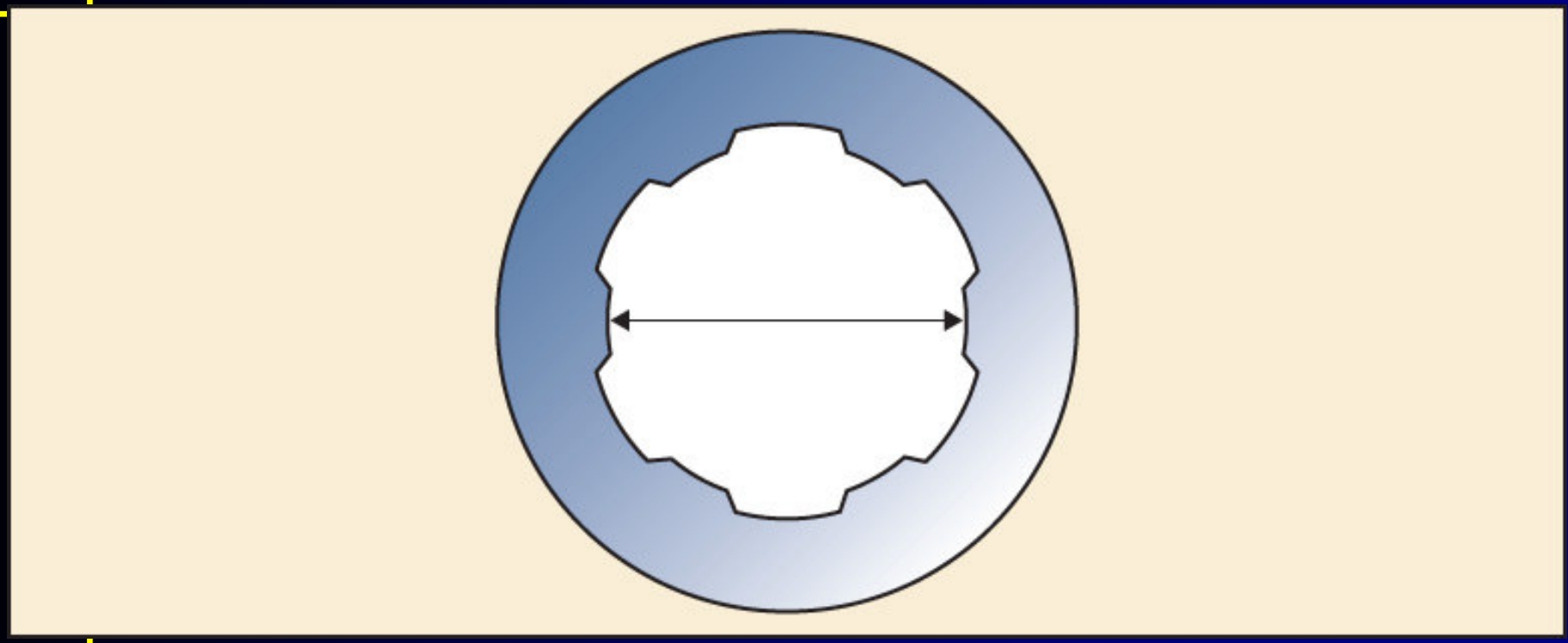

Figure 15–2 Cross-section of a barrel with six grooves. The diameter of the bore is the caliber.

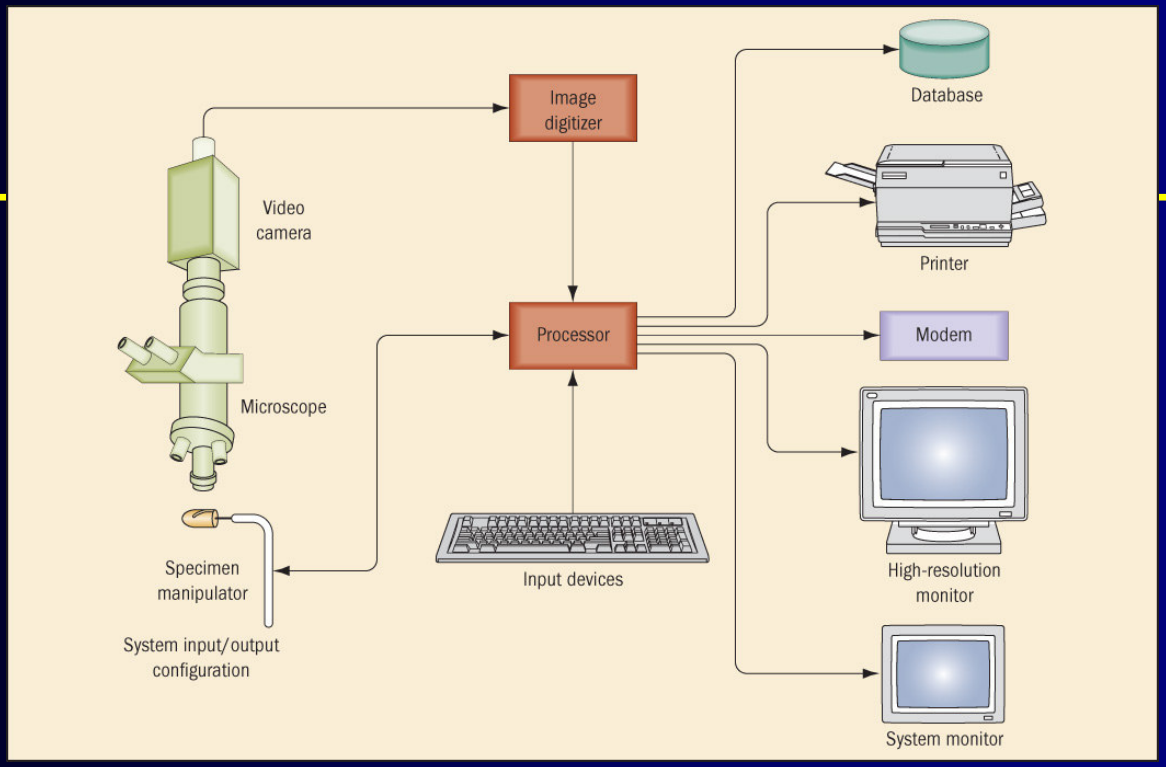

Figure 15–10 Bulletproof configuration. The sample is mounted on the specimen manipulator and illuminated by the light source from a microscope. The image is captured by a video camera and digitized. This digital image is then stored in a database, available for retrieval and comparison. The search for a match includes analyzing the width of land and groove impressions along with both rifling and individual characteristics. The Brasscatcher software uses the same system configuration but emphasizes the analysis of expended cartridge casings rather than the expended bullets. Courtesy Forensic Technology (WAI) Inc., Côte St-Luc, Quebec, Canada.

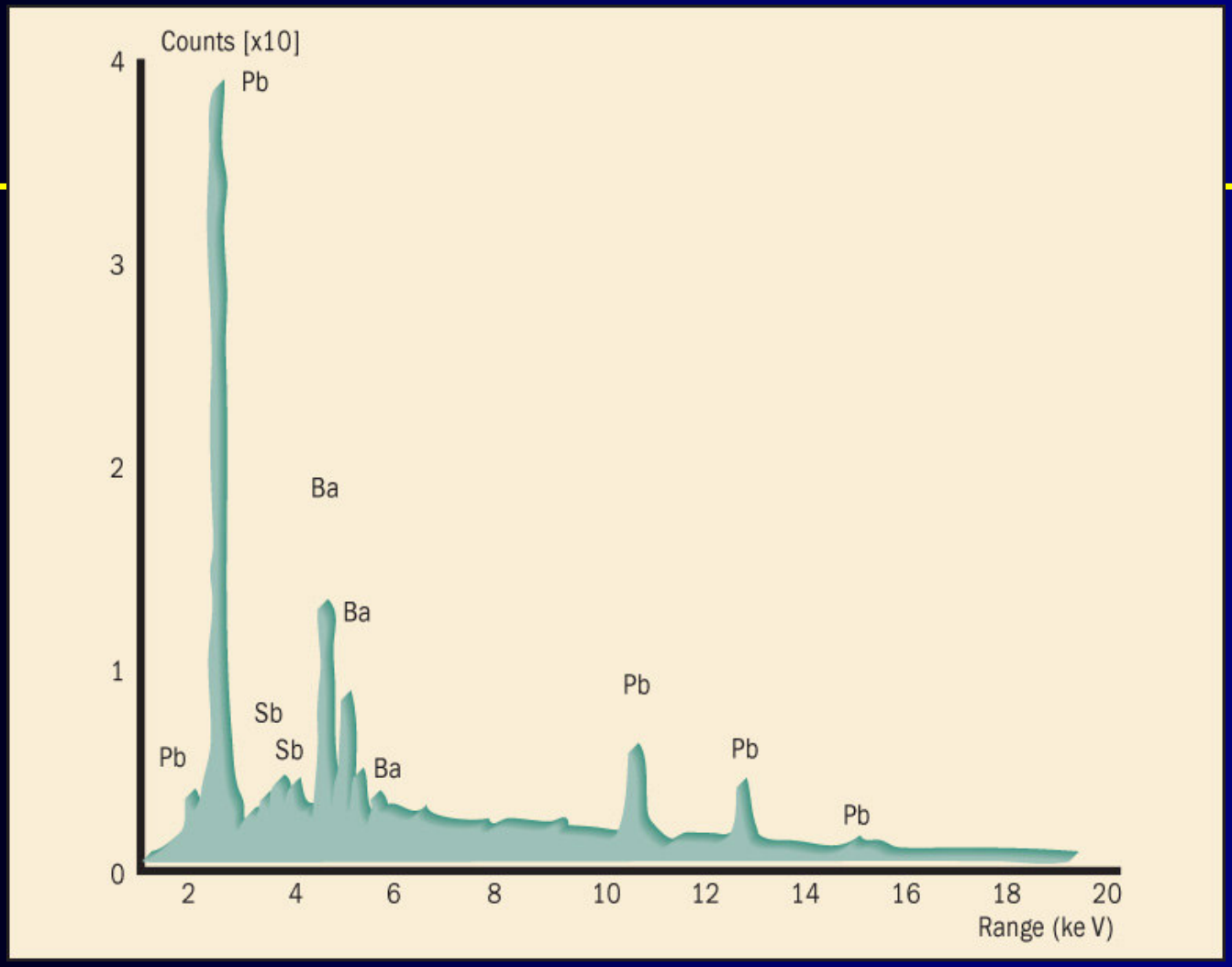

Figure 15–17 Spectrum showing the presence of lead, barium, and antimony in gunshot residue. Courtesy Jeol USA Inc., Peabody, Mass., www.jeolusa.com.