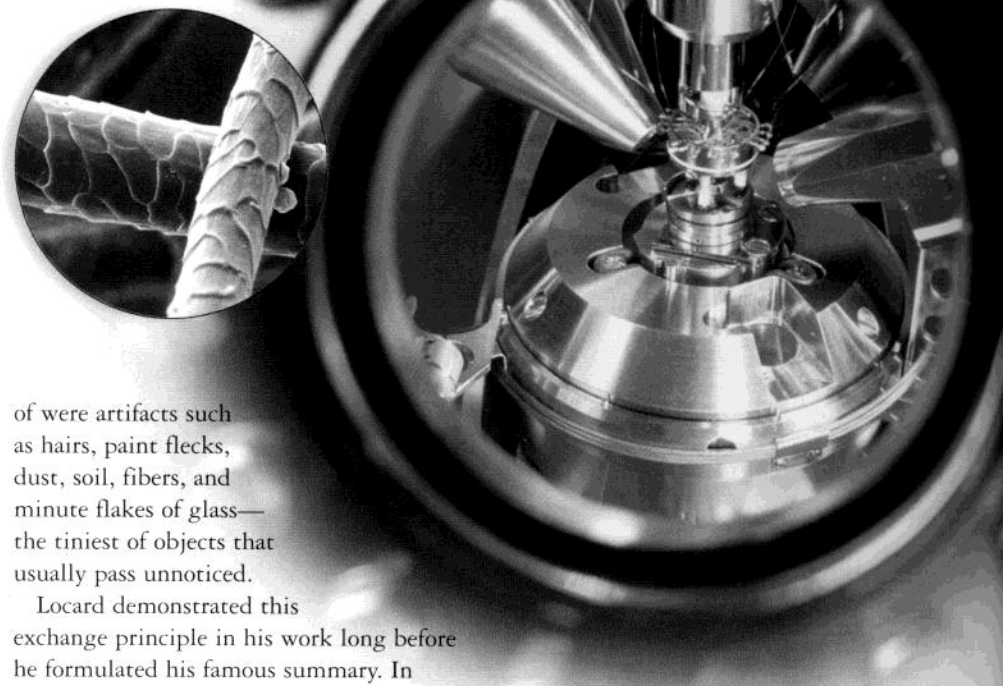
Telltale traces

In the concise motto "every contact leaves a trace," forensic scientist Edmond Locard established a principle that still guides the investigation of every crime. Criminals cannot avoid leaving traces of their presence at a crime scene—and they always carry away with them some evidence that they have been there.

SCANNING ELECTRON MICROSCOPE (SEM) ▼
By bombarding specially prepared specimens with electrons, the SEM reveals incredible surface detail—as small as one nanometer. That is 100,000 times smaller than a hair's breadth. (With SEM wool fiber inset.)



The simplicity of Locard's exchange principle is deceptive. It may seem like an obvious statement, yet its implications are subtle and far-reaching. No matter how much care criminals take, they can never leave a crime scene exactly as they found it. They always leave behind something that may lead to their identification. The reverse is also true: the guilty cannot avoid carrying away traces of evidence that link them to the crime.

When Locard first formulated this idea in 1920, DNA was unheard-of, and he could not have imagined that a nanogram of blood—one forty-millionth of a drop—would be enough to identify a criminal conclusively. The traces he was thinking of were artifacts such as hairs, paint flecks, dust, soil, fibers, and minute flakes of glass—the tiniest of objects that usually pass unnoticed.

Locard demonstrated this exchange principle in his work long before he formulated his famous summary. In 1912, he solved the case of Emile Gourbin, a bank clerk who was suspected of strangling his girlfriend. Gourbin seemed to have a cast-iron alibi for the time of the murder, but Locard's examination of scrapings from his fingernails revealed tiny flakes of skin. More damning still, the flakes were covered with pink dust that matched the face powder on the dead woman's neck. Confronted with this evidence, Gourbin confessed.

Locard's "traces" included all manner of substances, from flakes of skin to gun residue. Today many of these are analyzed in specialized branches of forensic science, such as firearms. The term "trace evidence" now usually refers to just a few categories: fibers, hair, paints and coatings, and soil and botanicals, such as plant fragments.

EDMOND LOCARD
French forensic virtuoso Edmond Locard studied medicine and law before opening his own police laboratory at the age of 33. In a lifetime devoted to criminology, he was enormously influential, not just through his brilliant work, but also as a prolific author and lecturer.

Edmond Locard
1877–1966

How do we find traces?

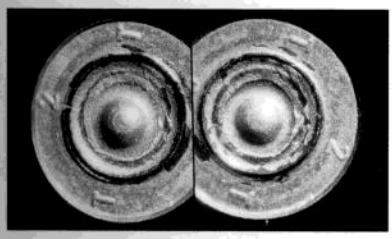
The very nature of trace evidence makes it elusive and ephemeral. The clothes a criminal wears collect dirt and fibers from a crime scene, but many of these simply fall off in a matter of hours. Brushing or cleaning clothes removes most of what is left. At a crime scene, trace evidence may be invisible to the unaided eye. So investigators are faced with the problem of finding something they cannot see.

How do they do it? Partly by making a methodical sweep of a crime scene, and partly by making informed guesses about what they are looking for and where they might find it. On garments, for example, seams and pockets retain incriminating fibers even when the rest of the fabric is apparently spotless.

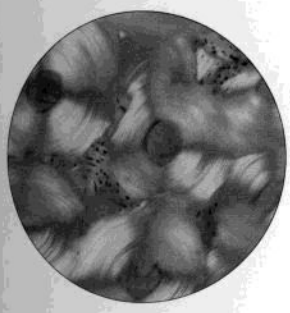
LOOKING CLOSELY

Microscopes are an essential tool in modern forensic science. Different types are used depending on the nature of the evidence. They range from ones that examine surface details to those that see right through a specimen.

LIGHT MICROSCOPES ▲
Light microscopes allow investigators literally to look inside trace evidence. Their versatility is enhanced by stereo and duplicated optics, and special kinds of illumination.



COMPARISON MICROSCOPES ▲
The duplicated optical system of the comparison microscope projects images of two different specimens into a single eyepiece, greatly simplifying comparison of a pair of samples.



POLARIZED LIGHT ▲
A filter that polarizes light lets through rays vibrating in only one plane, so a pair of crossed filters block all light. Trace evidence placed between them on a microscope scatters and colors the light, creating a vivid image that reveals structure.

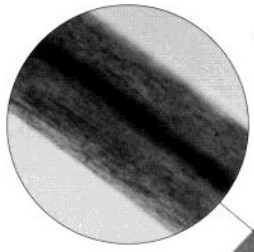
How do we collect them?

Collecting trace evidence demands as much skill and patience as finding it. Larger fragments can be retrieved by hand—perhaps with the aid of a lens and a pair of tweezers. Forensic vacuums are an effective way of collecting smaller traces: they suck material on to a filter paper for later analysis. Careful and regular replacement of the filter makes it possible to identify where in the crime scene the evidence came from. For small areas, tape lifts are an effective way of removing traces. Investigators also bag up and remove portable objects so that they can recover particles later in the controlled conditions of a lab. There, washing and scraping can reveal trace evidence that might otherwise have escaped notice.

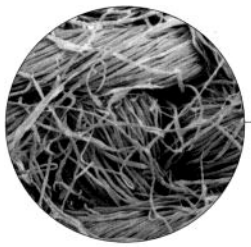
How do we examine them?

Close inspection is needed to reveal the secrets of trace evidence, so microscopes are the key instruments in the traces lab. They have several huge advantages over other analytical methods: they are completely nondestructive—a crucial point when evidence is vanishingly small. In most cases, no preparation or treatment of the specimen is required. Finally, microscopy is often the only way to distinguish between different varieties of trace evidence. For example, no chemical test can reveal the order in which paint was applied to a surface, yet the order of layers becomes immediately apparent when placed under a microscope.

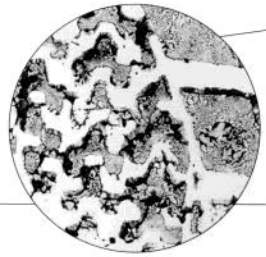
▲ *Forcing an entry creates copious trace evidence. A paint fleck that sticks to clothes has color, composition, and a coat order that make identification simple.*



◀ *Three or four hairs fall unnoticed from our heads each hour, and microscopy reveals color and structure that can link a suspect to the crime scene.*



▲ *The telltale fibers that garments shed are highly distinctive—and are transferred easily. Thousands may stick to the cushions when we sit on a chair.*



◀ *Shoes do not just leave behind prints: they can also pick up trace evidence such as tiny slivers of glass from the crime scene.*