# Chapter 2
# End User Commentary on Mass Spectrometry Methods for the Recovery of Forensic Intelligence from Fingermarks

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The application of advanced analytical techniques to the examination of fingermarks has generated much recent media interest because of the wealth of information that can potentially be obtained from such forensic traces. As one of the few types of trace evidence that can be used to identify an individual, fingermarks remain an important tool in the investigation of crime, and still account for appreciably more criminal identifications worldwide than DNA. Because fingermarks have been used for more than 100 years, it may be thought that there are few advances that can be made in the field. However, the potential to go beyond the use of fingermarks for identification and to add contextual information to an investigation is why advanced analytical techniques have become of such interest.

The combination of features that makes techniques such as MALDI, SIMS and ATR-FTIR of such interest for fingermark analysis is the ability to obtain chemical information from the fingermark, and the ability to map the distribution of the constituents at a resolution sufficient to distinguish fingermark ridge detail.

Even if the actual classification of the chemicals present in the fingermark is not of interest, the ability to map the distribution of unknown chemicals that are abundant in the fingermark may be capable of providing additional detections for the criminal justice system. This is because fingermark visualisation processes are optimised to target constituents expected to be abundant in fingermarks, such as the amino acids in eccrine sweat or fatty acids in sebaceous sweat. If the fingermark is rich in another unrelated contaminant that has been picked up on the fingertip, it may not be particularly well developed by a conventional reagent. However, the use of a chemical mapping technique may 'fill in' missing ridge detail and turn a fragment of a fingermark into a criminal identification.

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Similarly, the ability to produce chemical maps may be useful in the long-standing issue of separating overlapping fingermarks. If such marks have been deposited by different people, and each contains different chemicals, it may be possible to produce chemical maps that are unique to each fingerprint donor and allow identifiable fingermarks to be seen in isolation.

Both the above examples describe circumstances where new analytical techniques provide added opportunity to use fingermarks in their traditional application of identification. However, there is a greater potential to utilise such techniques in provision of contextual information that may be relevant to a case. Although this has, to date, been little exploited operationally, the growing range of information that can be obtained and the growing awareness of this capability may mean that this will change in future.

It has been shown that the advanced mass spectrometry techniques now being researched can provide a wealth of information about the lifestyle of the depositor of the fingermark. Even if a contact mark does not contain sufficient ridge detail to identify an individual, it may be possible to obtain supporting contextual information from the chemicals present such as gender, diet and medication that may enable the narrowing down of a field of suspects.

Of equal importance is the ability to identify exogeneous substances picked up on the fingers during handling. If a particular substance is relevant to the investigation, the presence of it in a fingermark could be used to link a suspect to a specific location or source material. The mapping capability of the technique can also add context to the distribution of the substance on the finger, possibly enabling the investigator to distinguish between deliberate and accidental contact.

Other examples of where advanced analytical processes have been used to provide contextual information are "depth profiling", where it may be possible to determine whether fingermarks have been deposited on documents before writing or printing, or vice versa. This can be an important issue where suspects offer the defence that documents that are currently of an incriminating nature were blank when handled by them.

Although many of these applications have been demonstrated 'in principle' in feasibility studies, there are still barriers that need to be overcome before such techniques find wider use on casework. An important aspect that needs to be addressed is that of validation. Forensic science laboratories worldwide are increasingly adopting the ISO 17025 standard, which requires techniques used within the laboratory to be scientifically validated. For a technique to be used in the Criminal Justice System, several aspects of its performance will need to be addressed. The scientific principles that underpin the method should be well understood and published. Where processes are being used for the detection of trace quantities of substances, the sensitivity and selectivity of the process to its target species should be tested, and any interfering substances that could produce 'false positives' or 'false negatives' identified.

For the advanced analytical techniques now being reported there is already an understanding of the scientific principles, and knowledge of sensitivity and selectivity to fingermark constituents and common contaminants is being developed. What is still required for the processes to be considered sufficiently validated for use in a court room are some larger scale studies, including elements such as repeat experiments, blind testing and the determination of potential effects on other types of forensic evidence.

Another aspect of forensic evidence recovery, where advanced analytical techniques could provide future benefits, is in the current drive to 'do more at the crime scene'. Mass spectrometry-based methods could find an important application in providing a confirmatory test for substances of interest at the crime scene, potentially saving both time and money by negating the need to send samples back to a laboratory for analysis. However, this would require a validated database of target substances to be generated and increases the importance of conducting an assessment of the impact of potential interferents. The impact of contamination within the instrument will also need to be considered, together with the potential for cross-contamination between samples. Research will need to establish whether contamination can be easily removed when present, and whether it interferes with normal operation for forensic applications.

If crime scene use is to become a reality, thought will need to be given to miniaturisation of instrumentation and its portability. Alternatively, protocols for taking evidence back from the crime scene to laboratory for fixed analysis need to be put in place. The use of lifting media (gelatin lifts and adhesive tapes) has already been demonstrated for removing fingermarks from surfaces for analysis by ATR-FTIR and MALDI. However, it may be preferable to directly analyse marks in situ on the surface of small portable items, which may limit practical application to processes that can operate at ambient pressure and can accommodate reasonably large samples.

Regardless of all the potential operational advantages offered by advanced analytical methods, a question that will always be raised is the cost. It is evident that the cost of such processes will be far higher than the conventional fingermark visualisation and imaging processes used in forensic laboratories, so such methods are unlikely to be used for investigation of volume crime. However, there are circumstances where specific contextual questions need to be answered (e.g. is this mark really in blood? Does the contaminant in the fingermark match a specific substance associated with the crime scene?) and mass spectrometry may provide the answers. For high profile or high priority cases, the additional initial costs of using advanced analytical methods may be justified by providing information vital to a detection, and potentially reducing long terms costs by saved time in criminal investigations.