E43 Particle Combination Analysis: A Fundamentally New Investigative Approach

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After attending this presentation, attendees will understand the distinction, contribution, and requirements of particle combination analysis as compared to more commonly used approaches in forensic investigations.

This presentation will impact the forensic science community by allowing program managers and policy makers to recognize the potential contributions of particle combination analysis and to understand the requirements for implementation using existing resources. This will lead to the exploitation of an extraordinarily useful form of physical evidence that is virtually ignored by current forensic science practices.

Particle combination analysis is a new approach that uses co-occurring particles to test alternative attribution hypotheses. Simply put, particle combination analysis exploits the particles in dusts, which are ubiquitous and in infinitely varying combinations, to solve a wide range of problems with varying case specifics. This approach can provide a game-changing capability to forensic investigators, working alongside existing investigative methods and using portions of evidence that are typically discarded or ignored.

The approach utilizes existing staff and laboratory resources in a fundamentally different way; it does not require major investments in training, equipment, or retention of outside experts. It does require a change to the way existing resources are used.

An INTERPOL case involving contraband elephant ivory will be used to contrast approaches currently used in most forensic investigations and show how and why a different approach resulted in significantly better results. The same approach can make significant contributions to a wide range of investigations and cases.

Conventional approaches to forensic investigation include: (1) direct comparison to a specific suspected source; (2) classification using a reference library of potential sources; (3) application of a predetermined analytical tool; and, (4) analysis of specific components of the specimen. Each of these approaches can be useful and makes an important contribution, but each also has requirements that restrict its applicability, none of them fully exploits the available specimen, and their contributions are only serendipitously sufficient to address the needs of any particular investigation.

In contrast, particle combination analysis has no requirement of comparative analysis, no predetermined restriction on the type of analytical tool, and no predetermined restriction on the components within the specimen that are exploited. Rather, standing protocols are used for specimen assessment. The results determine the range of potential contributions to the resolution of case questions. Specific specimen components are analyzed using modular validated protocols that are not preselected, but are strategically chosen based on their potential to resolve case questions.

Using particle combination analysis, dusts from within a shipment of contraband ivory were analyzed to help determine the original location where the ivory was packed. Key findings were the types of minerals, soil, and vegetation represented in the dust, as determined using a combination of light and electron microscopy, energy dispersive X-ray analysis, infrared microspectroscopy, palynology, and non-human DNA analysis. Beginning with a possible origin within the continent of Africa, first-stage analysis of the recovered dusts was able to eliminate environments comprising approximately 91% of the area, including all areas of 36 countries. Of the remaining 12 countries, the analysis was able to eliminate 72% of their area, allowing the investigations to be focused within portions of these countries. Next steps were defined to further reduce the possible origins of the dust based on more detailed regional analyses.

The particle combination analysis approach resulted in useful information arising from many different particle types. Different combinations of particles resulted in environmental, geographical, and land use “signals” that addressed specific investigative questions in this case. Particle combination analysis is a general capability: it is not restricted to questions of geographical origin, to African elephants (or any type of wildlife), to sealed crated shipments, or to specimens containing any specific type of particles. Rather, it is an approach that extracts case-relevant information (for virtually any type of case) from the complex assemblage of particles that are found (on virtually any specimen).

Requirements for successful implementation using existing staff and resources include administrative protocols driving the facile use of multiple disciplines, incorporation of a case-level scientific investigative methodology, and parallel adjustment of institutional norms.

Augmentation of existing practices with this new capability will result in major contributions to many

case investigative problems. The primary challenge is institutional willingness to use existing staff and equipment in a different way.

Particle Combination Analysis, Trace Evidence, Dusts

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