D9 Post-Blast Explosives Attribution

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Learning Overview: After attending this presentation, attendees will have an understanding of the sample collection, sample processing, and instrumental analysis techniques involved in identifying chemical attribution signatures from trace post-blast explosive residue and potential data analysis methods to determine the source of an explosive material from the identified signatures.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating proof-of-concept results on a novel approach to attribution of explosives to their sources post-blast.

Forensic science practitioners in both domestic and Department of Defense organizations are often called upon to build cases and attribute crimes using trace evidence remaining at a crime scene. The ultimate goal of these investigations is to associate a crime with a suspect or suspects in order to prevent further attacks through exclusion, exoneration, arrest, and criminal prosecution of potential perpetrators. However, fundamental questions remain regarding evaluation and interpretation of trace evidence for post-blast explosives attribution. The explosive charge is an attractive component for attribution in crimes involving explosives as it is key to the functioning of the device, and there are limited pathways for acquisition. However, unlike pre-blast attribution where signatures from explosive manufacturer reference samples can be compared with recovered samples, there is currently no capability to link the explosive charge to its source via post-blast trace residues. Attributing the explosive post-blast is a challenge because very little explosive material remains after detonation, which limits the analytical techniques that can be used. The purpose of this study is to determine whether pre-blast attribution signatures are preserved after detonation, and whether they can be recovered from a blast site and measured at a detectable level.

In this study, a preliminary field test was conducted to recover post-blast explosive samples from controlled detonations of multiple explosive materials including RDX, TNT, and Ammonium Nitrate-Aluminum (AN-AL). Samples were processed according to adapted methods to extract both the explosive compound of interest, as well as other chemical components that could potentially serve as signatures for attribution.[1,2] Samples were subsequently analyzed via multiple analytical techniques including High-Performance Liquid Chromatography/Mass Spectrometry (HPLC/MS) for polar and non-polar small molecules, Internal Positive Control/Mass Spectrometry (ICP/MS) for trace elements, and Gas Chromatography/ Combustion/Isotope Ratio Mass Spectroscopy (GC/C/IRMS) or Elemental Analysis-Isotope Ratio Mass Spectrometry (EA-IRMS) for isotope ratios of carbon, nitrogen, and oxygen. Preliminary results have shown promise that carbon, nitrogen, and oxygen isotope ratios remain consistent pre- and post-detonation and thus could be relevant for source attribution. For RDX, the average difference in isotope ratios between pre- and post-detonation is 0.33 ‰ (max difference=0.58 ‰) for carbon and 0.2 ‰ (max difference=1.20 ‰) for nitrogen. For TNT, the average difference is 0.2 ‰ (max difference=1.36 ‰) for carbon and 0.5 ‰ (max difference=1.77 ‰) for nitrogen. Finally, for AN-AL, the average difference is 0.13 ‰ (max difference=0.54 ‰) for oxygen and 0.10 ‰ (max difference=0.37 ‰) for nitrogen. The analytical measurement uncertainties (standard deviation of repeated analyses of isotopic reference standards) were less than or equal to 0.51 ‰ across all isotopes and material types. These results indicate that isotope ratio signatures of explosive compounds look to have been preserved after detonation in this small sample set. With this proof-of-concept study, the forensic community will benefit from a novel approach to attribute explosives after detonation.

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References:

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