CASE REPORT

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An Interesting Gunshot Residue Pattern

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ABSTRACT: The presence of lead, copper, and antimony (Sb, Cu, and Pb) was shown on the left back and right palm by use of anodic stripping voltammetry (ASV). These data are consistent with a cross overhand held weapon (left over right). The use of ASV for gunshot residue (trace elements) is an alternative approach in that it allows observation of the entire three element (Sb, Cu, Pb) pattern.

KEYWORDS: criminalistics, gunshot residues, trace elements, anodic stripping voltammetry, pattern recognition.

The use of gunshot residue (GSR) analysis in the crime laboratory is well known and often leads to problems in interpretation. It appears that the most useful application of GSR analysis is for investigative assistance. No matter what technique is employed, the elements lead, copper, antimony, and barium (Sb, Cu, Pb, and Ba) are the most widely used analytes. Methods in current use are flameless atomic absorption (FAA) [*1*], neutron activation analysis (NAA) [*2*], scanning electron microscopy/X-ray analysis (SEM/XRAY) [*3*], and anodic stripping voltammetry (ASV) [*4,5*].

The laboratory has been using ASV for elemental analysis for approximately five years and has found it to be of great value; however, it is not without interpretation problems. As a result, all courtroom testimony from this laboratory concerning GSR involves the use of the term "consistent with." We have found investigational assistance to be the most valuable area for GSR data. The advantage of the ASV procedure is its ability to screen for three elements (Pb, Cu, Sb) simultaneously and thus produces a profile of elemental data (GSR). The ability to observe this pattern is useful to the analyst as any significant change in the profile can be an indication that one is not looking at GSR. That is, any large change in the relative amounts of antimony, lead, and copper would be highly suspected as possible gunshot residue. Other advantages include: inexpensive, matrix independent, and operationally simple.

The ASV procedure has the ability to quantitate and can be done by one of two methods: (1) standard addition, where a known amount of antimony is added and a graph produced and (2) calibration curve. Both methods have been used successfully by this laboratory with the latter being used most often. This does not add additional information, as the overall pattern has proven to be the most informative. The ability to observe the overall pattern (all three elements)

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has assisted our laboratory since lead and copper are known environmental contaminants. The relative amounts of each element to the other helps in this regard.

The case presented here did not involve quantitation, only pattern recognition. The interpretation, which was later verified by the suspect himself, showed a characteristic GSR hand pattern (Cu, Pb, and Sb) on the right palm and left back. The right back and left palm were negative, as was the control sample, which is analyzed for each set of tests. It was concluded that the data were consistent with a two-handed firing position where the left hand covered the right back and exposed the left back to the residue. GSR deposition is quite unpredictable from case to case; however, once again, we feel the pattern recognition procedure is a reliable indicator of GSR when present.

This particular case was greatly assisted by observing the GSR pattern on all five samples submitted. This information, along with other investigational information, caused the defendant in this case to confess and admit pulling the trigger with use of a crossover (left-over-right) grip.

Procedure for Gunshot Residue

Collection

Cotton-tipped plastic handled swabs with 5% nitric acid were used to collect the four hand swabs (right back, right palm, left back, left palm) and one control sample containing only 5% nitric acid. The hands of the collecting officer are always protected with plastic gloves.

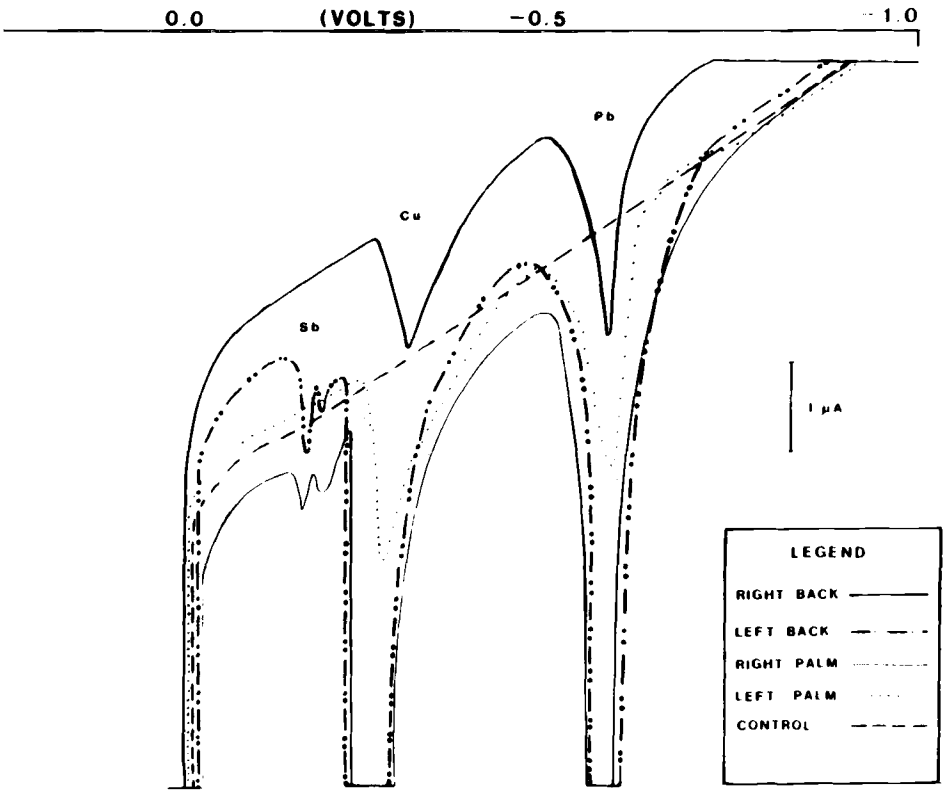

FIG. 1—*Voltammogram produced in Procedure for Gunshot Residue.*

Procedure

1. Remove plastic handles from swabs with scissors.
2. Place swab top in vial containing 4 mL of 4*M* hydrochloric acid (containing 0.02*M* hydrazine sulfate). Allow samples to stand overnight if possible.
3. Mix on vortex and transfer entire contents to electrochemical cell. Add 100 μL of 0.01*M* mercuric chloride.
4. Place stirring bar in cell.
5. Place cell in clamp holder and insert three electrodes: (a) reference electrode [Ag(AgCl)], (b) working electrode (glassy carbon), and (c) auxiliary electrode (pt wire).
6. Place nitrogen line into cell. Bubble under electrolyte for 180 s.
7. Raise nitrogen to just above surface to blanket surface.
8. Apply -1.0 V for 540 s with stirring followed by 60 s without stirring.
9. With *x-y* recorder scan in positive direction at 20 mV/s to $+0.1$ V. Then switch to hold and turn off working electrode and return to initial position (-1.0 V).
10. Clean working electrode with distilled water and tissue being careful to remove residue which is left on working electrode (glassy carbon).

The voltammogram produced in this case is shown in Fig. 1. Note the characteristic stripping potentials for each metal (copper, lead, and antimony) in this electrolyte (4*N* hydrochloric acid). The quantitative values and recovery data for antimony (Sb) have been compared favorably with flameless atomic absorption [*6*].

References

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