# Errors in gunshot residue assessment by scanning electron microscopy/elemental analysis in criminal cases: I. Arsenic/sulfur mistaken for lead.

By Bryan Burnett

**Introduction**

Automated scanning electron microscope analyses of gunshot residue samplers are being performed by many crime laboratories all over the world. Often the criminalist-technician operators of these instruments do not have adequate training for the interpretation of spectra. Case 1 is an example of this. Case 2 is an example of a criminalist who appeared to have misrepresented the elemental composition of a particle in order to make it "unique" to gunshot residue. This article is the first in a series of three articles that will focus on erroneous elemental assignments and/or missed elements made by ill-trained criminalist technicians. The mistaken assignments of particle spectra to "consistent," "highly specific" or "unique" gunshot residue will also be examined in this article series.

**Case 1.**

The defendant was allegedly seen shooting at the victim from the driver side of a car with his arm extended across the passenger side and out the passenger window. The .22 pistol was positioned far enough outside of the passenger-side window to eject seven casings onto the street.

Based on the witness account of the shooting, standard adhesive samples for scanning electron microscopy/energy dispersive X-ray analysis (SEM/EDS) were taken from the interior passenger door of the defendant's car as well as the exterior passenger door. Automated SEM/EDS analyses of these samples were performed at a southern California crime laboratory.

GSR-like particles were reported found in both samples.

The interior car door sample had particles composed of lead, antimony and barium along with other elements that often are found with gunshot residue particles. The criminalist-technician assigned these particles as "highly specific" gunshot residue. A spectrum of one

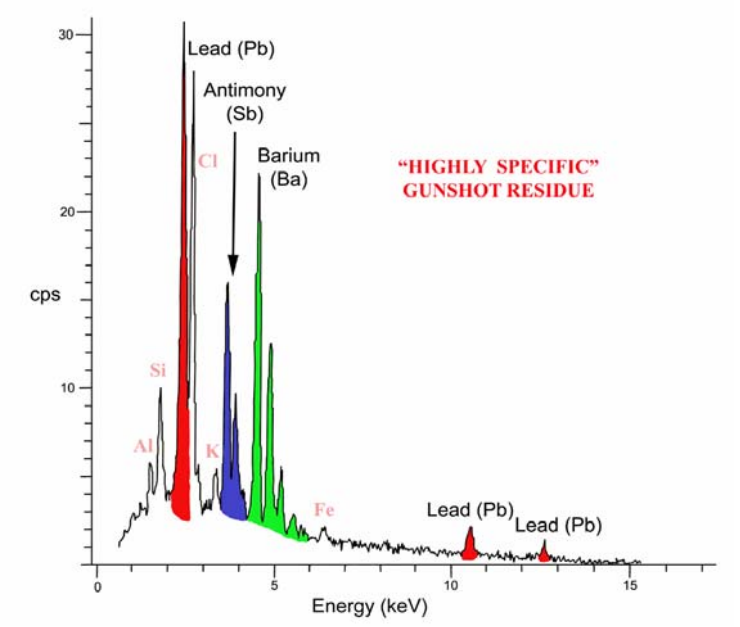


***Figure 1.*** *Spectrum of a "highly specific" gunshot residue particle. This is a spectrum from a particle found on the interior passenger door in case 1.*

of these particles is shown (Fig. 1). In addition, two lead-antimony particles were recorded from this sample. A firearm origin for theses particles is likely due to the lack of any other particles in this sample that would suggest an origin other than a firearm.

Analysis of the exterior car door sample did not reveal particles similar to those found on the interior door sample. Numerous lead-only particles (the number was not noted by the analyst) and one lead-antimony particle were found. One of the alleged "consistent" gunshot residue particles from this sample was reported to be made up of lead, antimony and copper (Figs. 2A and 2B). However, this particle's spectrum shows that there is no lead present, rather the technician mistook the sulfur and arsenic peaks for that of lead (Fig.2C).

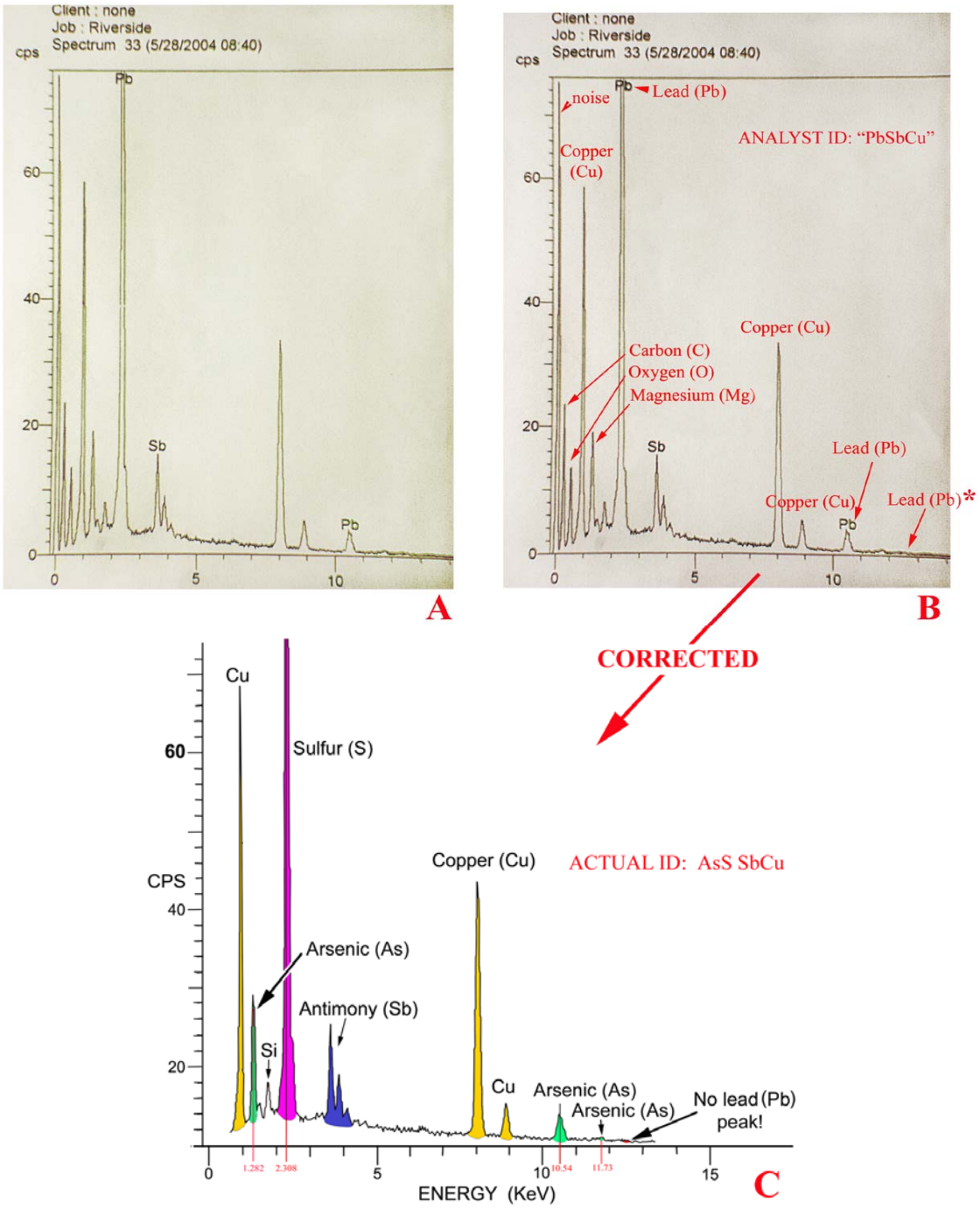


***Figure. 2.*** *Case 1. Spectrum of a particle that was erroneously assigned as a "consistent" gunshot residue particle. A: The spectrum submitted as evidence in this case. B: The apparent interpretation of this spectrum. *: the lead L-$\beta$ peak is missing. C: The arsenic (As) L-series peak was apparently mistaken for the magnesium (Mg) K-$\alpha/\beta$ peak, the sulfur K-$\alpha/\beta$ peak was mistaken for the lead (Pb) M-series peak, the arsenic K-$\alpha$ peak was mistaken for the lead L-$\alpha$, and the lead L-$\beta$ peak is missing. The silicon peak as well as the small aluminum (at the right base of the arsenic L peak) are likely from nearby particles.*

Arsenic's L-α/β (1.282/1.317) overlaps the magnesium K-α/β(1.254/1.297) peak. Therefore, the absence of a lead L-β peak at 12.6 keV and a peak at approximately 1.28 keV is indicative of arsenic (As) , not lead (Pb). Indeed, the criminalist technician when confronted with this assessment, stipulated to arsenic/sulfur in this particle and no lead.

**Case 2.**

In this case, the criminalist technician appeared to have misrepresented the composition of an alleged gunshot residue particle.

The assailant was alleged to have been wearing gloves when he shot the victim. The ammunition was Winchester 9 mm with copper jacketed bullets. Gloves were found in the defendant's possession and were sampled for SEM/EDS analysis. One particle was found that was described by the technician to contain lead-antimony-barium (PbSbBa). The spectrum also shows phosphorus and tin, which with magnesium (As L-series peak?) excludes this particle as gunshot residue! Interesting is the analyst's placing of the arsenic symbol "As" in the spectrum. The analyst has cut the upper keV display range shown in the spectrum printout so that confirmation of lead at L-β (12.6 keV) is impossible from this spectral image. The presence of tin (Sn) in this particle was either overlooked or ignored (see part II of this series of articles).

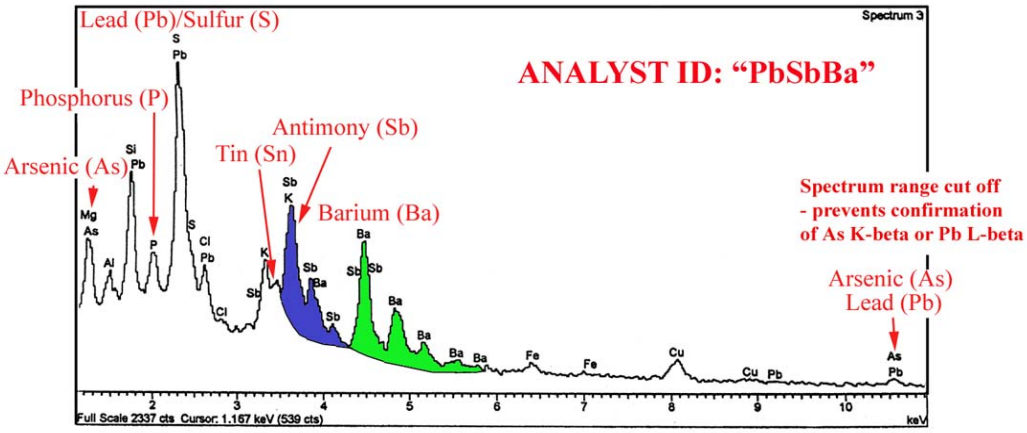


***Figure 3.*** *Case 2 spectrum. The upper display range of the spectrum has been cut off, thus preventing confirmation of lead (Pb) L-β or arsenic (As) K-β. peaks. A prominent peak at 1.2 keV suggests that this particle actually contains arsenic (As). In addition, the technician also missed the tin (Sn) in this spectrum.*

**Discussion**.

The analysis of spectra in relation to potential gunshot residue identification is being performed by many technicians who have not had adequate training in the interpretation of spectra. Most providers of EDS software provide a deconvolution routine in order to separate overlapping peaks in a spectrum. Routine use of such a deconvolution routine would do much to assist technicians involved in gunshot residue analysis in assigning proper elements to a spectrum. Missed elements and misidentification of gunshot residue will be further examined in the second contribution of this series.

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**Comments Appreciated!**