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A tale of three trials: From science to junk science

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ABSTRACT

The defendant had three trials. The first and second ended in mistrial; the third he was convicted. Examination of the gunshot residue evidence presented in the first and third trials starkly define an extraordinary difference: science versus junk science. The defendant was convicted on the junk science.

Gunshot Residue, Scanning Electron Microscopy, Junk Science

1. INTRODUCTION

Gunshot residue (GSR) evidence presented in a trial can play a significant role in a trial's outcome. Whether or not a defendant's samplers are positive for GSR is important, but also important: 1) the interval between the shooting and the suspect's sampling, 2) the activities of the suspect prior to arrest and sampling, 3) the police handling of the suspect and 4) where the sampling for GSR occurred. Of primary concern for the interpretation of a positive GSR sampler determination is contamination of the suspect while in the police environment [1, 2].

A double homicide occurred in Santa Barbara, California. There was evidence of five 12 gauge shotgun, four .22 caliber and five .38 caliber discharges at the scene. The .38 caliber bullets recovered from the scene and one of the victims were non jacketed. The defendant, Corey Lyons, was arrested eight hours after the shooting of the two victims. Lyons was a residential contractor.

There were three trials of Lyons: the first and second ended in mistrials; the third trial, he was convicted.

2. THE FIRST GSR ANALYSIS

The GSR samples were analyzed by an independent northern California crime lab using an Aspex scanning electron microscope/energy dispersive X-ray spectroscopy (SEM/EDS) system. Results these analyses were presented in the first and second trials.

2.1 The hand samples. Corey Lyons' hands were sampled while he was in custody at a police station. His hands were not bagged prior to entering the police environment. The period from the shooting to the GSR sampling of Lyons' hands was 8.5 hours, exceeding the time limit by most laboratories for acceptance of samples for analysis [3]. The police station where Lyons was taken and sampled had a shooting range in its cellar. No controls (i.e., samples from the tables, chairs etc.) were ever taken before Lyons' sampling. Lyons had ample opportunity to become contaminated with GSR while in police custody unrelated to the shooting for which he was arrested [2].

There were 27 characteristic GSR particles found on Lyons' hand samplers. Considering the greater than eight hour time interval between the shooting and sampling, this is an extraordinary number remaining on Lyons' hands, if these particles had originated from the shooting. A typical characteristic GSR particle from a Lyons' hand sampler is shown in Fig. 1A. Notable is the presence of aluminum and copper together in many of the characteristic GSR particles.

Did these GSR particles found on Corey Lyons' hand samples come from the shooting, or are they contamination, acquired in the police environment prior to sampling?

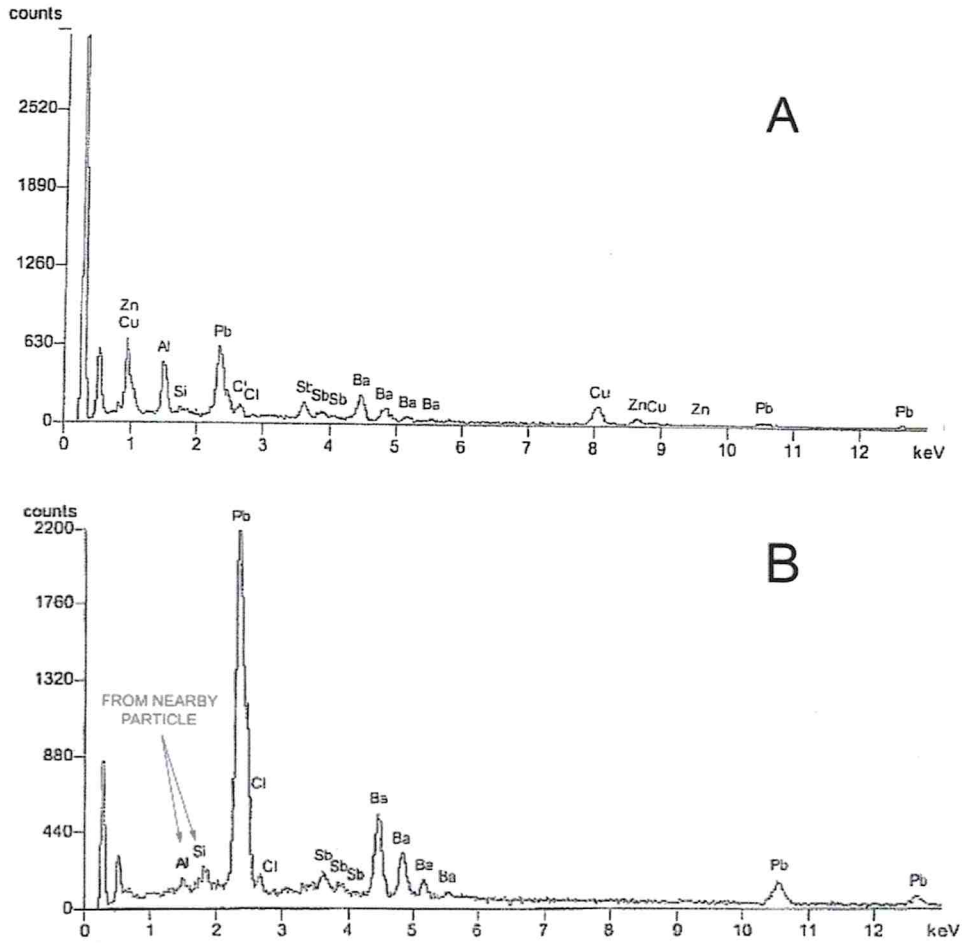

Figure 1. Example spectra from the Lyons case. A. A typical example spectrum of a characteristic GSR particle from the hand sampler of Corey Lyons that also contains aluminum and copper; detectable amounts of zinc were found in a number of these particles, but were not considered in the statistical analysis. B. A typical example spectrum of a characteristic GSR particle from objects associated with Lyons and hypothesized to have been handled by Lyons.

2.2 The personal possession samples. Gunshot residue samples were also taken from Lyons' possessions believed to have been in contact with him during and immediately after the homicides.

There were 21characteristic GSR particles discovered on the samplers from these personal objects of Lyons. A typical spectrum of a three-component GSR particle from one of the personal objects is shown in Fig. 1B.

2.2.1 The fanny pack. The history of this item is unknown. The likelihood that this item went through a cleaning or laundering is remote. It cannot be ruled out that at some point in the fanny pack's history it was worn during target shooting—handling of the fanny pack after target shooting and/or storing a small firearm in it would contaminate it with

GSR, both inside and out. If GSR is detected on the samplers from this item, the time of deposition cannot be determined.

2.2.2 The gloves. The pair of motorcycle gloves was sampled inside and out. The history of these gloves are unknown. The same issue applies to the gloves as the fanny pack. If GSR is detected on the samplers from these items, the time of deposition cannot be determined.

2.2.3 The truck interior. The interior of Lyons' pickup truck, alleged to have been seen near the crime scene, was sampled for GSR. The same issues discussed concerning the fanny pack and the glove samples also apply to the items (steering wheel and gear shift knob) sampled for GSR. If GSR is detected on these items, the time of deposition cannot be determined.

2.3 GSR populations. It is fortuitous that there are many characteristic GSR particles identified in this case, not only from the hands of defendant, but also on his personal possessions. Upon initial review of these data, it appeared the two populations might be different, where many of the characteristic GSR from Lyons' hands had aluminum and copper components (e.g., Fig. 1A); most of the characteristic GSR from the personal possession samplers did not (e.g., Fig. 1B).

The Lyons' hand data are compared to the objects data for the characteristic GSR particles in regard to aluminum and copper association. A Chi square statistical test (Fig. 2) shows based both on the aluminum and copper content of the GSR of the two sample groups (combined hands versus combined objects), with a high degree of certainty ($P < 0.0001$), that these samples are not from the same GSR population. In other words, the characteristic GSR particles from the hands and objects are from different shootings.

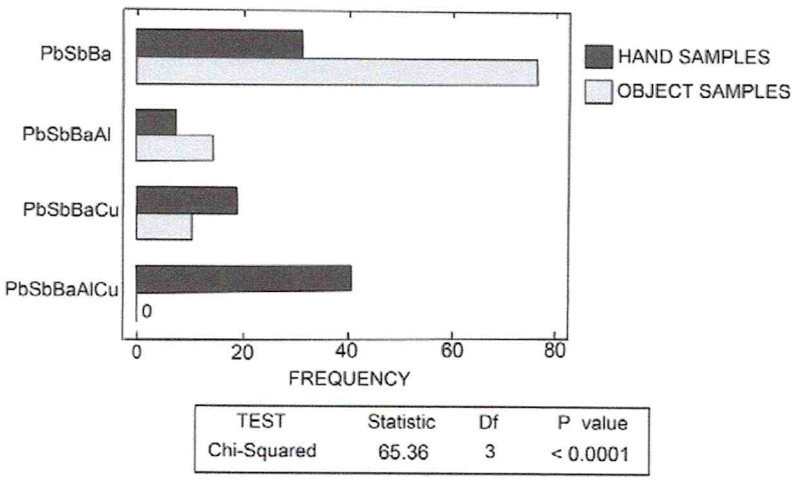

Figure 2. Graph plotting the characteristic GSR particles from Lyons' hands and objects belonging to Lyons; these data were normalized to account for differences in sample sizes (Hand N= 27; Object N=21). The Chi-squared test shows the two populations, hands and objects, are significantly different. Graph generated by Statgraphics ®.

Corey Lyons had a collection of firearms with a large amount of .38 caliber ammunition, all with unjacketed bullets. If he had fired this ammunition it would contaminate him and objects in his possession with GSR, which likely occurred prior to the shooting at issue.

The three objects belonging to Lyons sampled in this case were hypothesized to have been exposed to GSR from the homicide shootings. Yet as indicated above, the detected GSR on the samplers from these objects could well have come from recreational firearm discharges prior to the homicides. In this case, one or more control objects should have been sampled where it would have been reasonably certain that these objects, which had a similar history of cleaning/laundering, but were not handled by Lyons after the shooting.

There are a number of factors that influence retention of GSR on inanimate objects which include handling, surface of the object (smooth or rough surface), if cleaned during its history etc. [2]. Even if Lyons had not shot any of his firearms for months, persistence of GSR on his personal items from his past target shooting cannot be dismissed. All three items sampled (the fanny pack, the gloves and the truck interior) have characteristic GSR. These items could have been contaminated from firearm discharges that predate the double homicide shooting. Indeed, the analysis shows this is a different population of characteristic GSR particles than the population of characteristic particles found on Lyons' hand samplers.

3. THE SECOND GSR ANALYSIS

Mr. Steve Dowell of the Los Angeles County Coroner's Crime Laboratory reanalyzed the same GSR samplers of the northern California crime lab for Lyons' third trial. He was retained by the district attorney when the GSR expert for the first two trials became unavailable. Mr. Dowell attempted to show the GSR found on the samplers of Lyons' hand came from the shooting at issue by focusing on the particles generated by Lyons' cartridge actuated nail guns. Lyons likely had not handled the nail guns within the previous 12 hours, probably much longer. A nail gun is usually used for securing the 2 x 4 inch wood plates to concrete foundations in new or remodel construction at the beginning of framing.

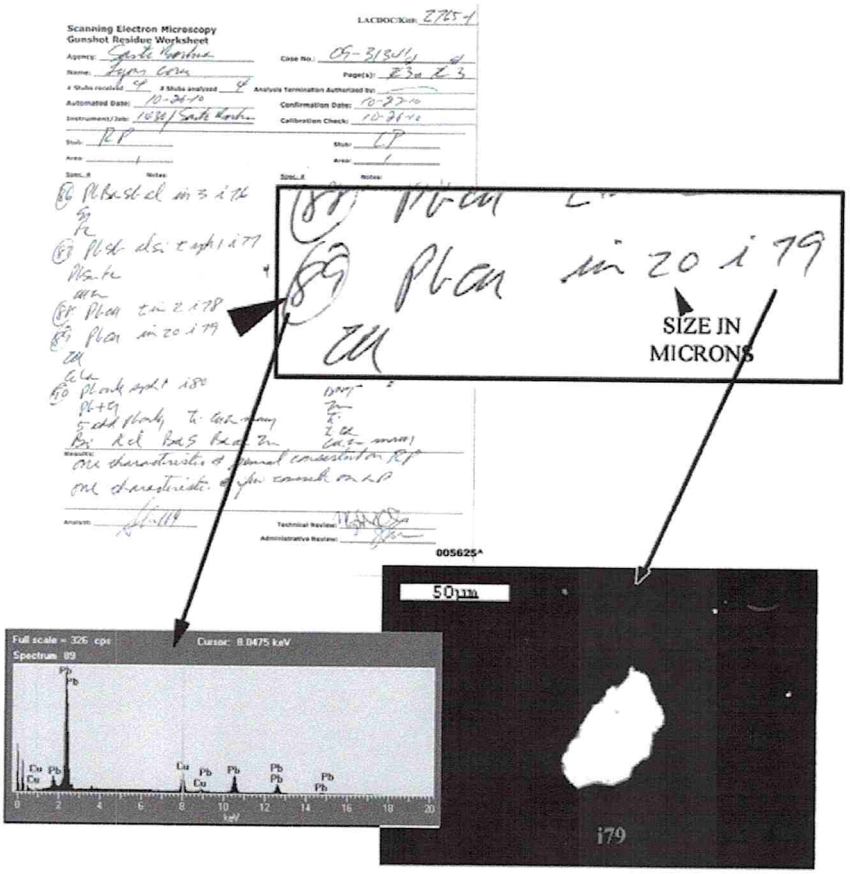

Figure 3. Particle "89" with the spectrum and backscatter electron image; the red image name in the particle image (lower right) was added by author. The 20 micron size reported by Dowell is smaller than the actual particle size, which using the scale bar, measures approximately 34 x 60 microns.

Particles generated by nail guns are lead-barium, not lead-barium-antimony (characteristic GSR) [4]. Even though nail guns do not produce characteristic GSR, the same principles of particle loss would apply to the particles generated by the nail gun as with the GSR generated by a firearm (i.e., exponential particle loss with time). Two issues which Dowell should have addressed are the length of time from the shooting to when Lyons was sampled (8.5 hours) and the possibility of contamination of Lyons while in the police car and station. Dowell also ignored the Lyons' gun collection, the firing and handling of which prior to the homicides could have GSR contaminated Lyons' possessions. None of these firearms was used in the homicides.

Gunshot residue control samplers should have been routinely taken of the police station where suspects are sampled as well as the backseats of patrol cars [3]. The police officers involved in processing Lyons from his home to the police station and at the police station all stated they had not recently handled or fired their firearms. Dowell also has a problem, as pointed out in Burnett [5], in not being consistent in his handwritten notes identifying the elements present in spectra.

3.1 Handwritten notes. A GSR expert unfamiliar with Dowell's work would not understand his notes (Fig. 3). How are these handwritten notes generated? Did he utilize the presumptive listing by the computer? If so, why doesn't he present this discovery?

There are numerous problems generated by Dowell's handwritten notes. For instance, his handwritten "Cu" (copper) is frequently difficult to distinguish from "Ca" (calcium). At the bottom of his handwritten notes (Fig. 3), he writes "CuZn

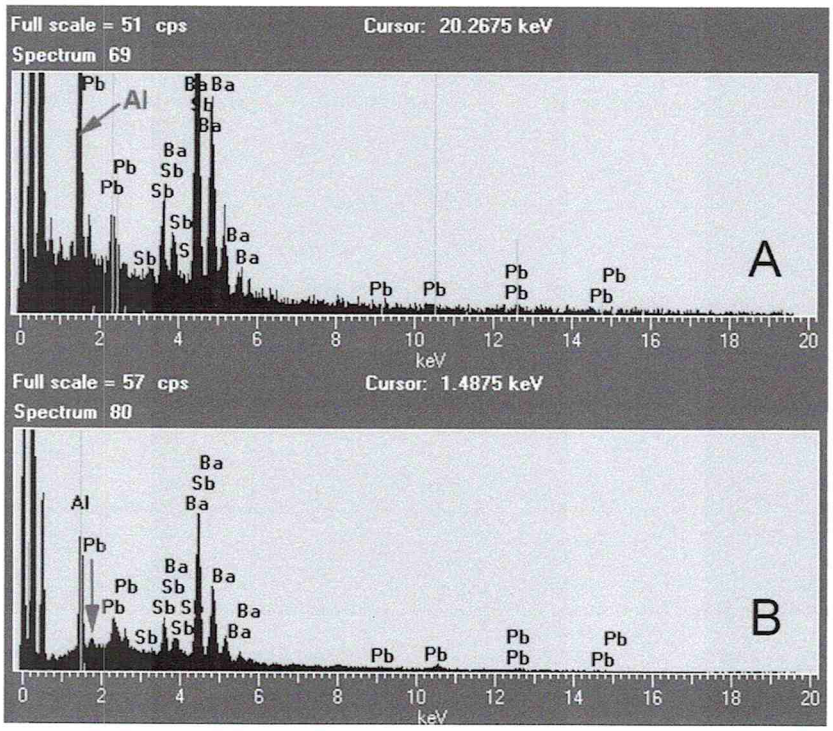

Figure 4 A. Dowell's Spectrum 69; even though there is a prominent aluminum (Al) peak in this GSR particle, Dowell ignored it. Dowell has ignored aluminum peaks in a number of other GSR particles (see text). The "Pb" beside the Al peak is misplaced by the software. The "Al" and arrow were added by the author. B. Spectrum of Dowell's particle 80; for an unknown reason, Dowell lists aluminum (Al) in this particle. The "Pb" beside the "Al" peak refers to the Pb peak at the location indicated (arrow). However, silicon (Si) is also at this location - this is peak is silicon (likely from a nearby particle) because the lead (Pb) composition in this particle is too low for this peak to be Pb. The arrow added by author.

many." Just what does "many" mean? He also uses "few" and "several" - scientifically meaningless terms. To left near the bottom "5 add Pb only." What does this mean? He lists "Bi" and "BaAlZn." Are these entries for one particle or more? If the author only had the GSR data in this form, there would have been no ability to do the statistical analysis like that performed with the northern California data.

3.2 Aluminum in GSR. It has been established the importance of aluminum in the characteristic GSR from the hands of Lyons from the northern California analysis. For most of Dowell's handwritten notes, he does not recognize the presence of aluminum in GSR particle spectra (particle/spectra numbers 69, 71, 74, 76, and 78). Figure 4A shows Dowell's spectrum 69 where an aluminum peak is apparent, but not reported. Dowell reports aluminum in spectrum 80 (Fig. 4B). Why here and not the others?

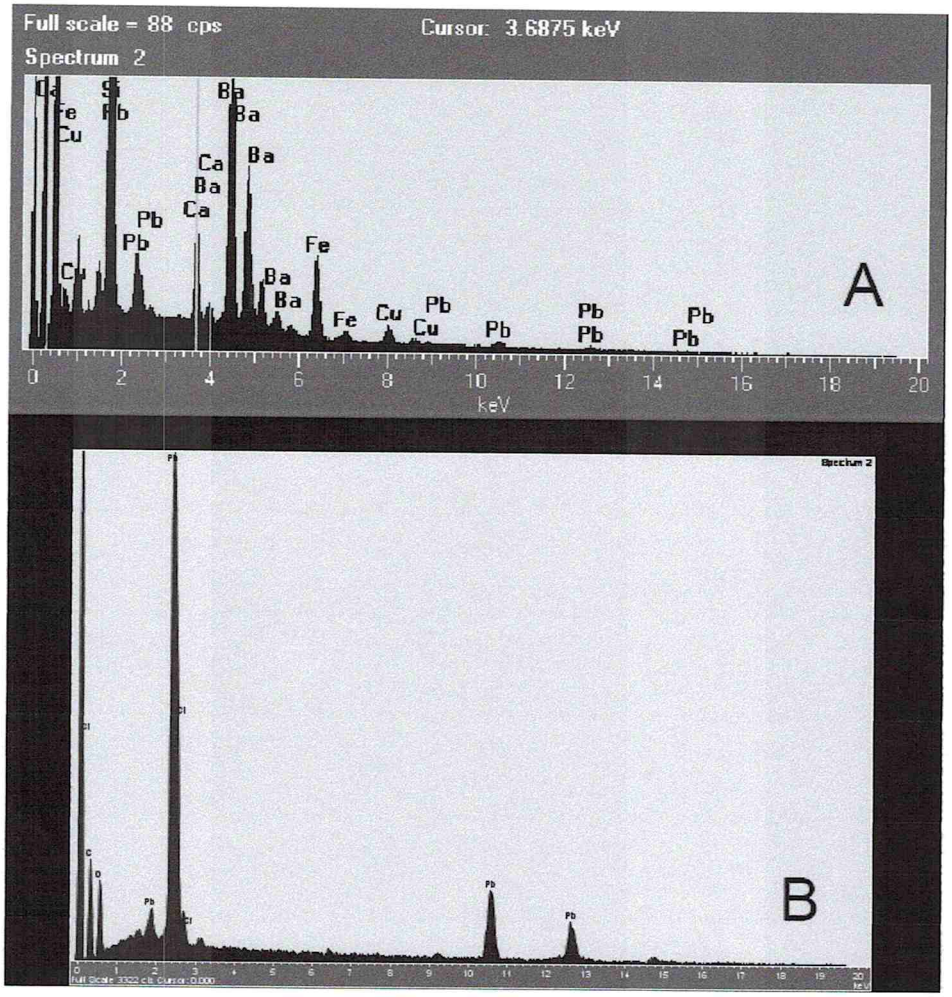

Figure 5. Dowell's spectra that have identical file names, "S2"; there are no notations on the spectrum that identify the case. This can lead to mistaken case assignment such as apparently happened in the Robert Blake case [5]. A. The first spectrum with a "S2" file name. B. The second spectrum with a "S2" file name. The spectrum number is at top right.

3.3 Fragmented Data. In the northern California GSR data, each particle spectrum and image is placed in the proper folder by the software. The presumptive list, select presumptive thumbnail spectra and images and the confirmatory particle spectra and images are all together. Dowell appears not to utilize this SEM software even though it is likely available to him, but chooses to fragment his reports into standalone files.

Dowell's report, spectra and particle images are separated (Fig. 3). He names the spectra with "s" and then a number - he refers to these spectra by the circled numbers in his handwritten notes. He provides the image file name at the end of each of these entries (e.g., i79, Fig. 3).

Each spectrum and particle image file is stored in TIFF format. The misplacing of the data by Dowell can be explained that for each new case, he starts the naming of the particle/spectra files for that case with "1." If he has more than one case going at the same time, by apparently not allowing the software to track the spectral images, he risks putting spectra and images in the wrong folder or he can access the wrong folder when reviewing these spectra for a report or testimony. The latter apparently happened in People v. Robert Blake (the actor) [5]. His report and testimony on the particle burden of Robert Blake's hands did not match the spectra he submitted for those particles. It is extraordinary that the submitted spectra do not have the case name or job number on them; the only thing on the spectra that relate to the case is just the spectrum number. An example of his sloppy file handling in this case: he has two spectral files labeled "S2" (Fig. 5). There is also no notation on these spectra or on any others to indicate the case or sample. Since there are two spectra labeled "S2", there is no certainty which belongs to which citation in his handwritten notes other than examining element peaks in the spectra and comparing these to his notes.

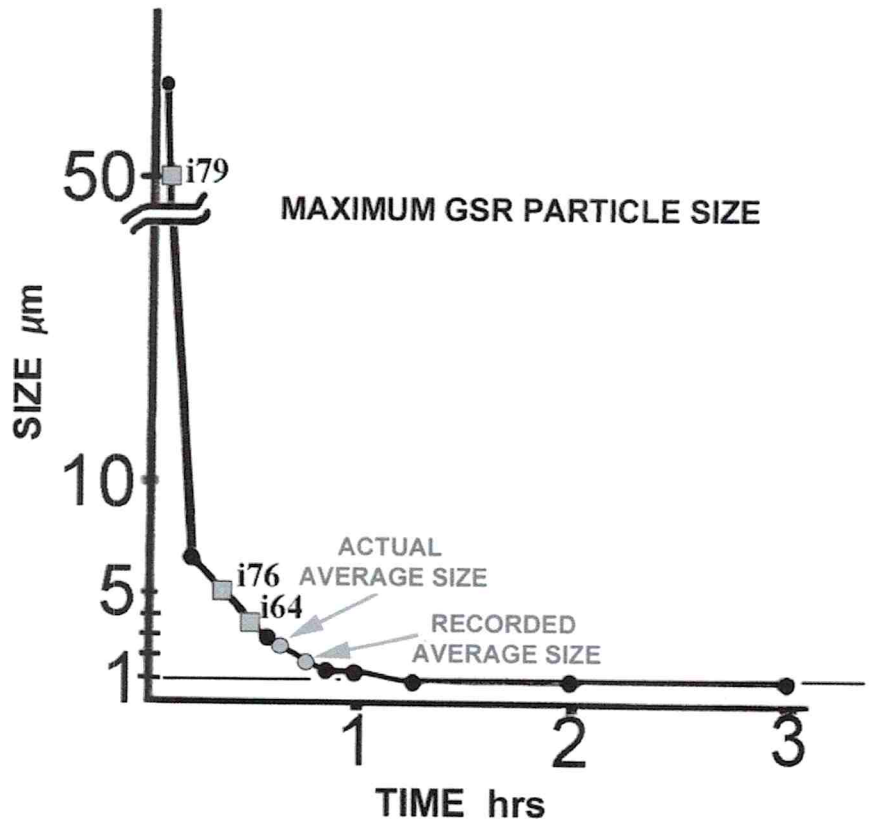

Figure 6. The hand particle sizes from Dowell's data plotted on a graph presented by Keeley [6]. Round gray dots - average size from Dowell's data. The actual measurements using the scale supplied with each particle image average higher (2.21 microns) than Dowell's apparent estimate sizes (1.57 microns)(N=20). The gray squares are the estimated individual particle sizes (i64=3.5, i76=5.0, i79=50); black dots: Keeley data points). The largest GSR particle ("i79") Dowell found is shown in Fig. 3.

3.4 Size selective loss from hand GSR. Not only is there an exponential loss of GSR particles following deposition on hands, Keeley [6] reports there is also exponential loss of GSR particles based on the maximum size of particles in a GSR population. Keeley found that between 1 and 2 hours after deposition on a hand, all sizes of the GSR particles are approximately 1 micron or less (Fig. 6).

Another problem dealing with Lyons' hand GSR analysis by Dowell, is that he does not report the particle size accurately in his handwritten notes. His estimates are frequently below the actual particle size. He offers no guidance for oblong particles as to which dimension he is giving. Figure 3 is his documentation of particle 89 where he states the particle is "20" microns. The particle is approximately 34 x 60 microns.

All the particles that are confirmed GSR (characteristic and consistent) in the Dowell data for Lyons' hand samples were measured using the scale associated with each particle image. The author's average estimate of size (averaging length and width for oval particles) is 2.2 microns, from Dowell's note it is 1.6 microns for the 20 particles (excluding particle 89 (Fig. 4) as an outlier). Curiously, based on size of these particles, regardless of whose estimated average size is used, if this hand population of GSR particles originated directly from a single firearm discharge, it was discharged less than 1 hour before sampling (Fig. 6).

4. CONCLUSION

Corey Lyons had three trials. The first was a mistrial due to inappropriate comments on the stand by a witness during the prosecution's case; the second, a mistrial due to a hung jury. The third trail, the jury convicted. The third trial was quite different from the first and second trials in the prosecution's presentation of the GSR evidence. The northern California evidence was supplanted in the third trial by the analyses conducted by Steve Dowell. The data available on the number of characteristic GSR particles presented by Dowell would not allow for a quantitative comparison of the characteristic GSR from the hands of Corey Lyons and his possessions. Dowell's examination of the particles produced by Lyons' nail guns was inappropriate. His analyses were abbreviated and fragmented. He misinterpreted spectra.

For reasons not understood, the author was not asked to present his analysis in the court in either the second or third trials. A survey of the jury after trial indicated they found Corey Lyons guilty of the two homicides based primarily on the testimony of Steve Dowell. Mr. Lyons is now serving two life terms.

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