Observations on the Composition of Breech Gunshot Residue from a .22 Pistol - By Bryan Burnett

Most experts of GSR acknowledge that the metaliferous composition of GSR from one cartridge firing can be contaminated by GSR from ammunition previously fired in that weapon. There is, however, little empirical data available as to the degree of contribution from the earlier firings to a breech GSR sample. This paper will show that, at least for some weapons, there can be a significant contribution to a GSR sample from previous shots..

Ruger MKII .22 semi-automatic pistol was used in this study. The pistol was purchased new and the history of the ammunition used with this pistol is known. Breech GSR was collected using high quality vellum that was taped and positioned over the ejection port on the pistol (Fig. 1).

Four different ammunitions (Table 1) were fired in the pistol from the time of its last cleaning. The compositions of the primer material and bullet surface are listed for each ammunition type in Table 1. These compositions were verified previously. Breech GSR samples were evaluated for a number of shots for the Remington and Aguila series. It should be noted that the Aguila .22 LR

Table 1: The ammunitions that were fired in the .22 Ruger MKII semi-automatic pistol in this study. The bore of the Ruger pistol was cleaned just prior to firing the Federal ammunition. Breech GSR samples were collected for Remington and Aguila firings. For the Remington .22s the brass coating on the bullet is on a layer of antimony. There were no previous shots of copper or copper-zinc coated bullets in this pistol.

Ammunition	Primer Composition	Bullet Composition	Number of Shots	GSR Collected
Federal	PbSbBa	Pb	15	No
CCI	PbBa	Pb	4	No
Remington	PbSbBa	CuZn on Pb(Sb)	12	7
Aguila (Mexico)	Pb	Cu on Pb	20	5

ammunition (Mexico) was well suited for this experiment series because the only detectable metal in its primer is Pb.

SEM samplers were constructed by attachment of a 1.5-mm thick graphite disk to a standard SEM stub. Carbon double sticky tape was attached to the carbon disk. Gunshot residue was collected by lightly dabbing the vellum surface with the SEM sampler.

An ETEC Autoscan scanning electron microscope equipped with a Kevex Delta II X-ray analyzer was used in this study. Gunshot residue particles were found by backscatter detection and 5-second spectra generated. Background was subtracted from these spectra and integrations for Pb, Ba, Sb, Si, Al, Cu and Zn were performed. Approximately one hundred particles for each sample were analyzed. Results were graphed based on percentage composition of the various components that make up the compositions of the GSR samples are pre sented for unique particles (PbSbBa - Fig. 2), all GSR particles containing Sb (Fig. 3), all GSR particles containing Ba (Fig. 4), all particles containing brass (CuZn - Fig. 5), all particles containing Cu without Zn (Fig. 6), all particles containing Al (Fig. 7) and all particles containing Si (Fig. 8). Due to many particles containing combinations of these elements (e.g., PbBaAlCuZn) the addition of the percentages of these categories for any sample will not come to100%.

FIGURE 1

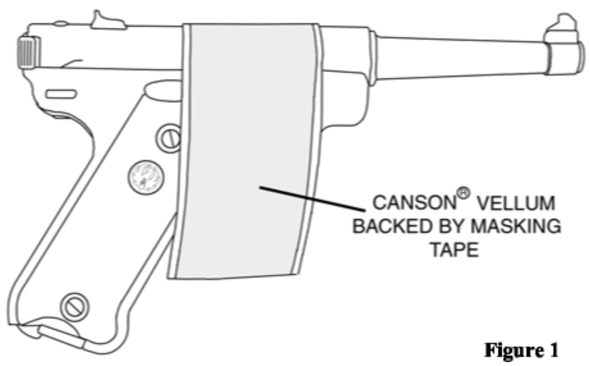
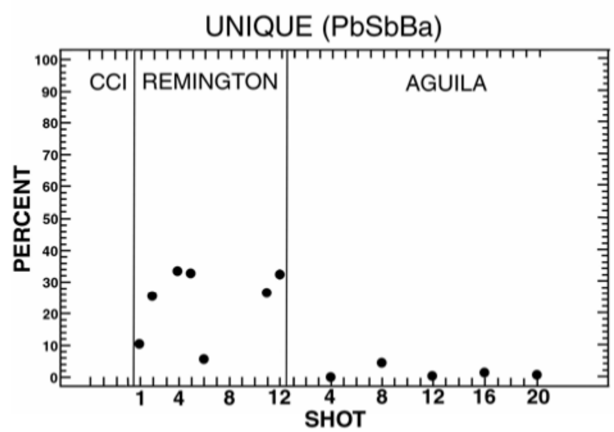


Figure 1

Figure 2



Unique (PbSbBa). Figure 2 shows the sample percent composition for unique GSR for the Remington and Aguila ammunitions. The range is from 6 to 35% for the Remington shots and 0 to 5% for the Aguila. The transition from the unique particle generating Remington (shot 16 @ 32%)) to the Aguila (shot 4 @ 0%) appears to have occurred within the intervening three Aguila shots although a small number of unique particles are present in the samples of Aguila shots 8 and 16.

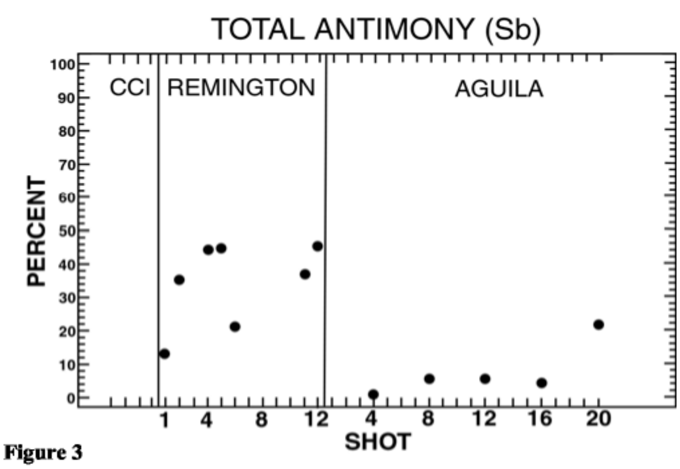


Figure 3

Total Antimony. The sample percent composition for the Sb-containing particles, including the unique particles for the Remington and Aguila ammunitions is shown in Fig. 3. The percentages of total Sb for most Remington samples are slightly greater than that of the unique percentages (Fig.2). Indeed, there is a correlation (correlation coefficent = .90) between the percent compositions for the antimony and unique particles. A 4 to 6% Sb content was observed in Aguila shots 8, 12 and 16 and 22% for shot 20.

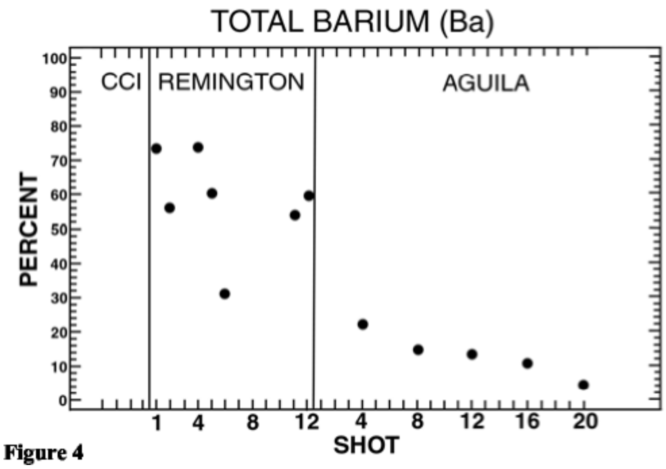


Figure 4

Total Barium. Figure 4 shows the percent composition for Ba-containing particles, which includes the unique particles. The Ba sample percentages when compared to that of the unique particle percentages for the Remington shots produce a low correlation (correlation coefficient = .26). The percentages of Ba-containing particles in the Aguila samples that follow the Remington shots taper off gradually (from approximately 22% of the sample in the fourth Aguila shot to 4% by the twentieth shot).

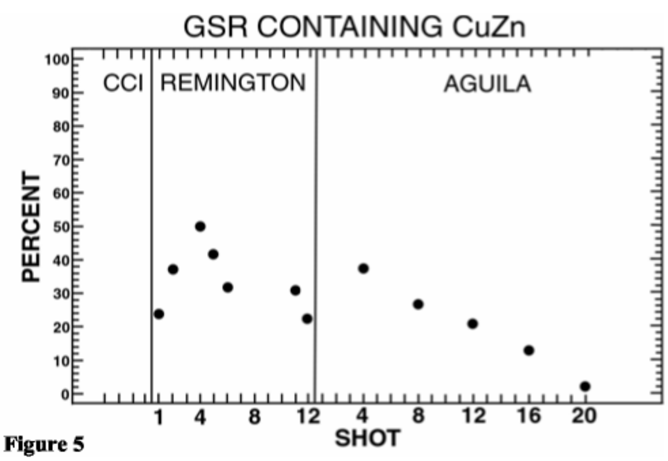


Figure 5

Copper-zinc. The percent sample composition for particles containing CuZn is shown in Fig. 5. Percentage of particles containing CuZn for the Remington shots vary between samples from 20 to 50%. For the Augila shots, the percentage of particles containing CuZn declines from about 37% in shot 4 to less than 5% in shot 36.

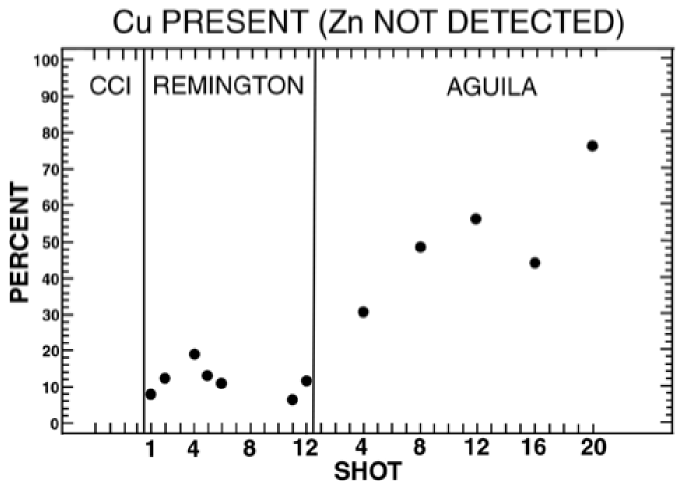


Figure 6

Copper (without zinc). Figure 6 shows the percentages of the GSR particles from these samples that contain Cu without detectable Zn. For the Remington shots, from 8 to 20 % of the particles contain only copper. The Aguila series show an increase of Cu in the GSR with successive shots.

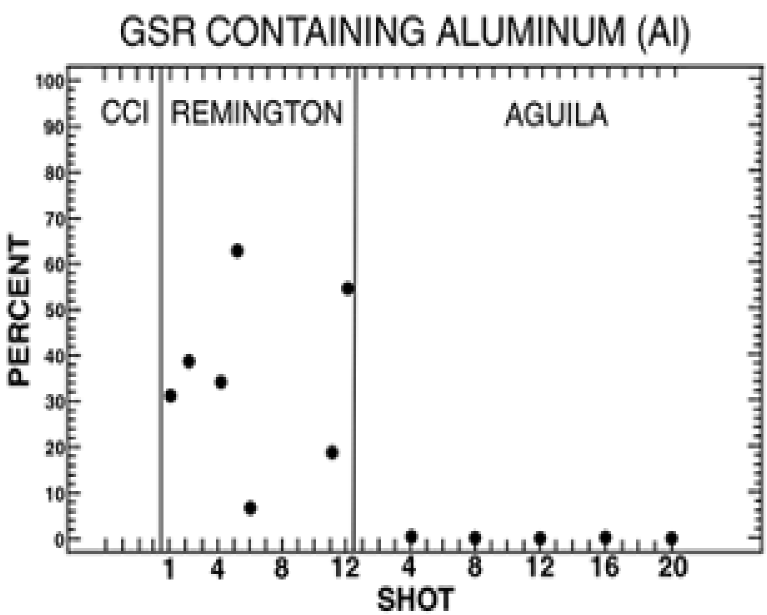


Figure 7

Aluminum. The percentages of Al-containing particles in the breech GSR samples are shown in Fig. 7. The Remington ammunition produced GSR with variable amounts of Al, ranging from 8% to 63% . None of the Aguila samples had detectable Al present.

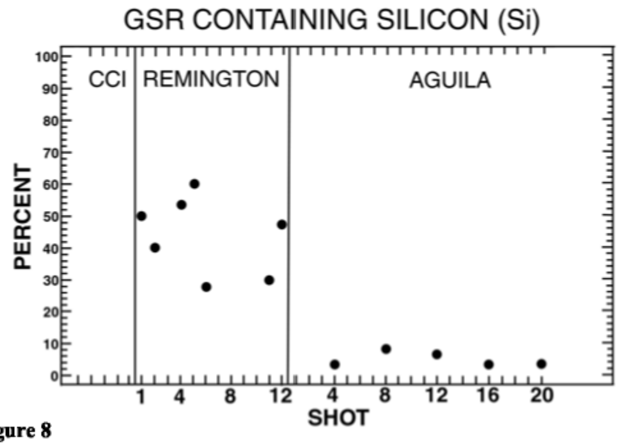


Figure 8

Silicon. The levels of Si in the GSR samples are shown in Fig. 8. For the Remington shots, between 28 and 60% of the resultant GSR contained Si. For the Aguila shots, between 4 and 8% of the GSR particles contained Si.

The Remington .22 bullets are coated with brass, which is the origin of the CuZn found in these GSR samples (Fig. 5). Copper, apparently without Zn, is also found in the Remington GSR (Fig. 6). The origin of this Cu is likely from the brass coating of the Remington bullets, where for most of these particles Zn is likely also present, but at too low a concentration to be detected. The Cucoated Aguila bullets appear to contribute Cu to the breech GSR (Fig 6) from firing these cartridges.

For the Ruger pistol used in this study, it appears that the processes which influence the composition of breech GSR are more complex than simple condensation of molten components of GSR with a small influx of GSR from previous shots. These data indicate the elements that compose breech GSR exhibit different behaviors.

A model for GSR formation for this particular environment (i.e., the Ruger MKII .22 pistol) is proposed in Fig. 9. The formation of breech GSR includes a GSR reservoir component. That is, upon firing a cartridge, the gases and molten metals that make up the breech GSR from a shot enter a “reservoir” within the pistol before the GSR release to the outside occurs. The reservoir is made up of the newly inputted GSR components of the shot and the GSR components of the previous shots. Mixing occurs, and a portion of the mixed metals and gases are released as breech GSR. Some components (Al, Si and Sb) depart the reservoir more quickly than other components (Ba, CuZn and Cu). In addition, a secondary reservoir in this system may exist for Sb. A gradual accumulation of Sb may have a pulse release some time later in a sequence of shots (e.g. Aguila shot 20, Fig. 3). Alternatively, it is possible that the Sb in shots 12, 16 and 20 in the Aguila series are from small amounts of Sb in the Aguila primer material (undetected in three primer analyses) or the bullet surface that are more or less reflective of the Sb concentration introduced by each of these shots. The Sb in shot 8 is a component of the unique particles in this sample.

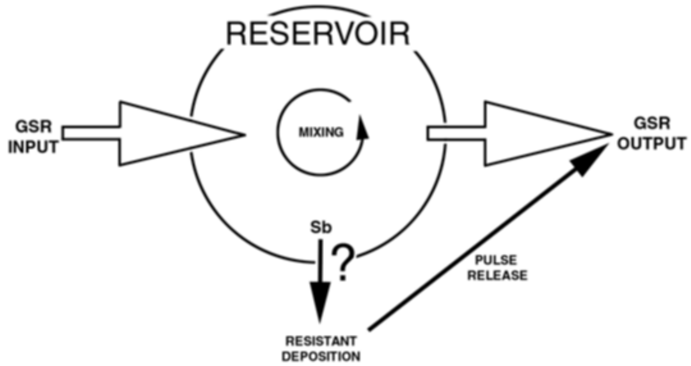


Figure 9

It appears that Sb correlates with the formation of unique GSR for the seven Remington shots, whereas, Ba does not. These results also suggest that other elements in GSR (Al & Si) may be useful in the identification of GSR from a particular ammunition.

The interpretation of these data is preliminary. Weapon design may influence the formation mechanism of GSR. It is not known if another pistol with a similar ammunition series would produce the same breech GSR pattern. I wish to thank Jozef Lebiedzik for his valuable comments on an earlier version of this manuscript.

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