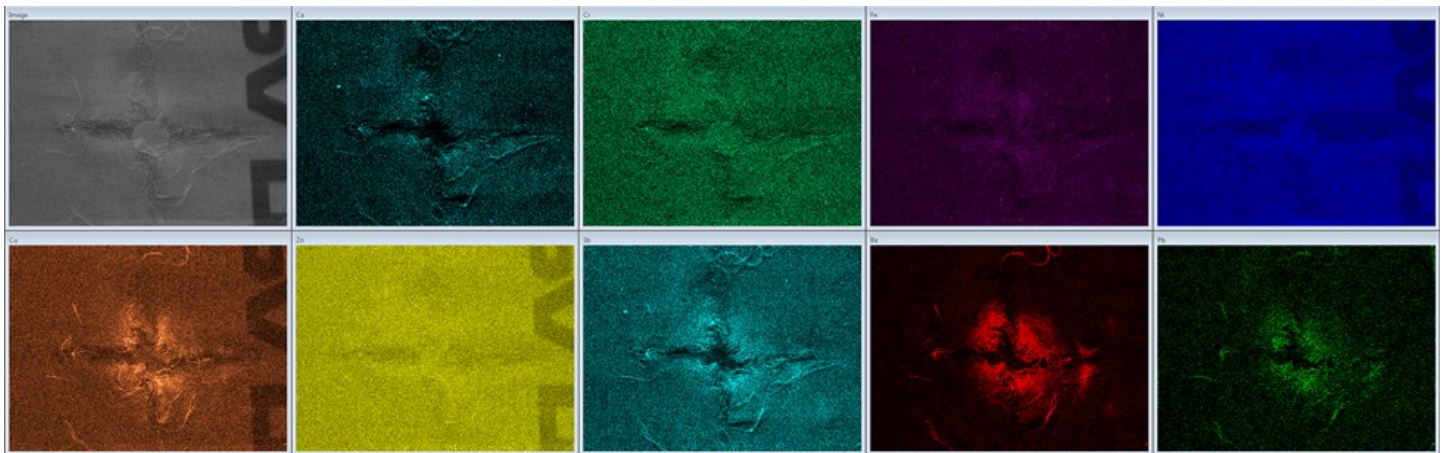


## AppNote: GSR on Textile using ATLAS microEDXRF Spectrometer

When a firearm is shot, in addition to the projectile(s), a mass of debris comes out the muzzle. These gunshot residues (GSR) can include various primer residues, residues from projectiles, and partially burned and unburned gun powered particles. The examination and analysis of GSR on items of evidence can allow determinations to be made as to whether a hole or defect is consistent with being caused by a bullet (or other firearm-related projectiles). In a crime lab equipped with an IXRF ATLAS series microEDXRF (micro-XRF) spectrometer, a forensic scientist can examine patterns of GSR on items of evidence to determine muzzle-to-target distance and other parameters of interest.

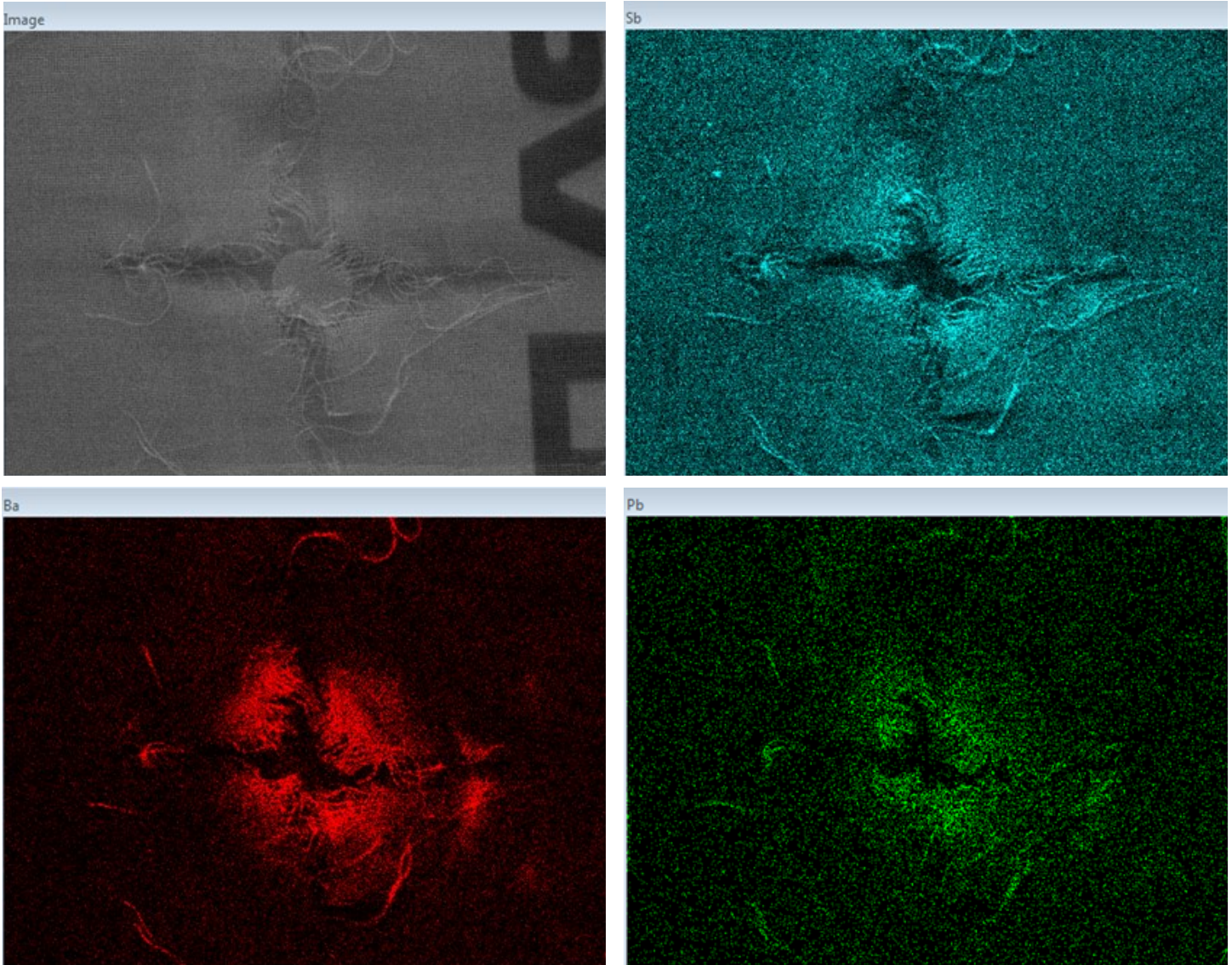
Gun shot residue fabric piece was mounted on a sample plate. It was elementally mapped in an area around a hole, with the X-ray tube set to 50 kV and 1000  $\mu$ A (no tube filter). Map size was set to be 88.18 x 65.25 mm. Due to the sample not being perfectly flat when mounted, it was mapped with the stage slightly lower than the proper working distance to account for the variation in sample height. IXRF System's ATLAS micro-XRF imaging spectrometer has the X-ray source pointing straight down onto the sample, which allows the user to alter the spot size to be larger as the stage is lowered from the optimal working distance.

This sample was imaged with a spot size of about 60  $\mu$ m and was collected at optimized conditions to highlight the features of the unit, the spot size, and the software. The optimized map was collected for 35 hours. It is possible to collect a much faster map of the area of interest by simply altering some of the collection parameters. Optimized maps are shown below, with each square representing a different element. The elements are listed in the upper left corner of each map. Maps are from left to right, top to bottom: X-ray image, Ca, Cr, Fe, Ni, Cu, Zn, Sb, Ba, Pb.



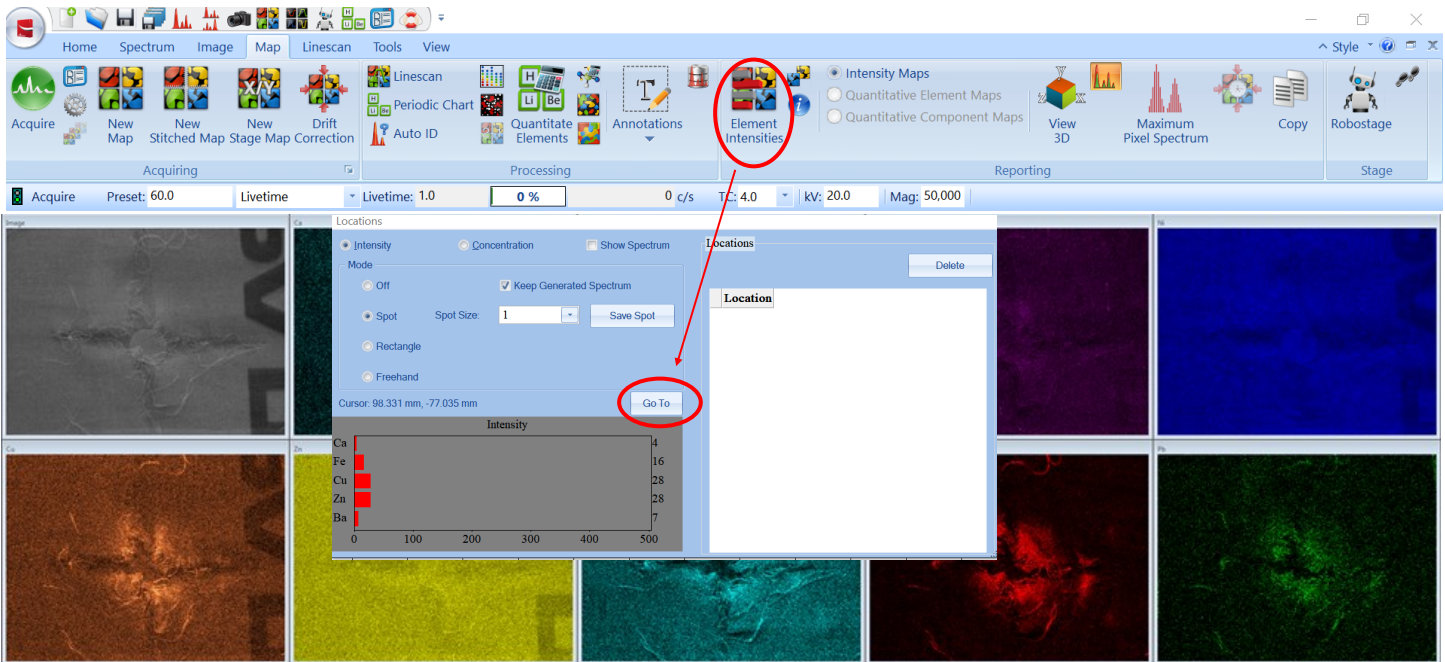
\*The text seen in the x-ray image as well as a few elemental maps is from the sample stage.

**GSR on Textile continued** - Image, Sb, Ba, and Pb maps from the previous screen are shown enlarged to show the detail collected in the maps.

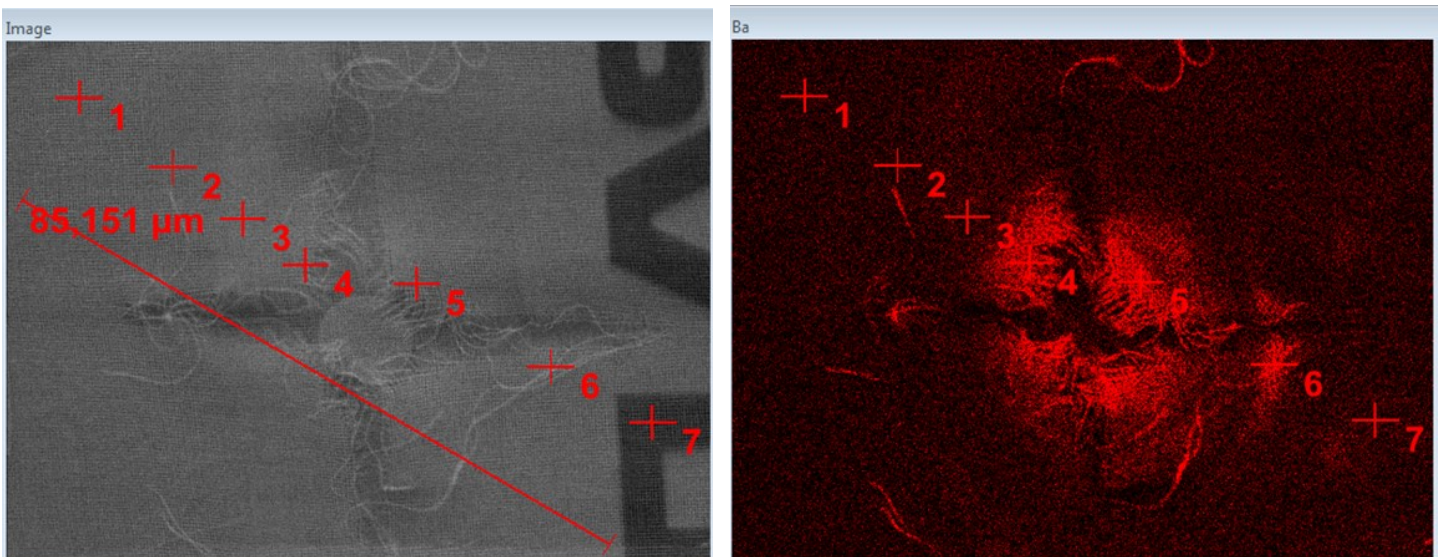


**GSR Fabric continued** - Elemental maps are shown as intensity, hence brighter areas are higher intensity. To compare the variation of the elements across the area of interest, software features were used. With the tool 'Element Intensities' a spot can be selected on a map to either extract data from the map or to drive the stage to that exact spot on the sample, for further investigation, by using the 'Go To' button.

The 'Go To' feature was used to move to several locations to collect spectra for further comparison.



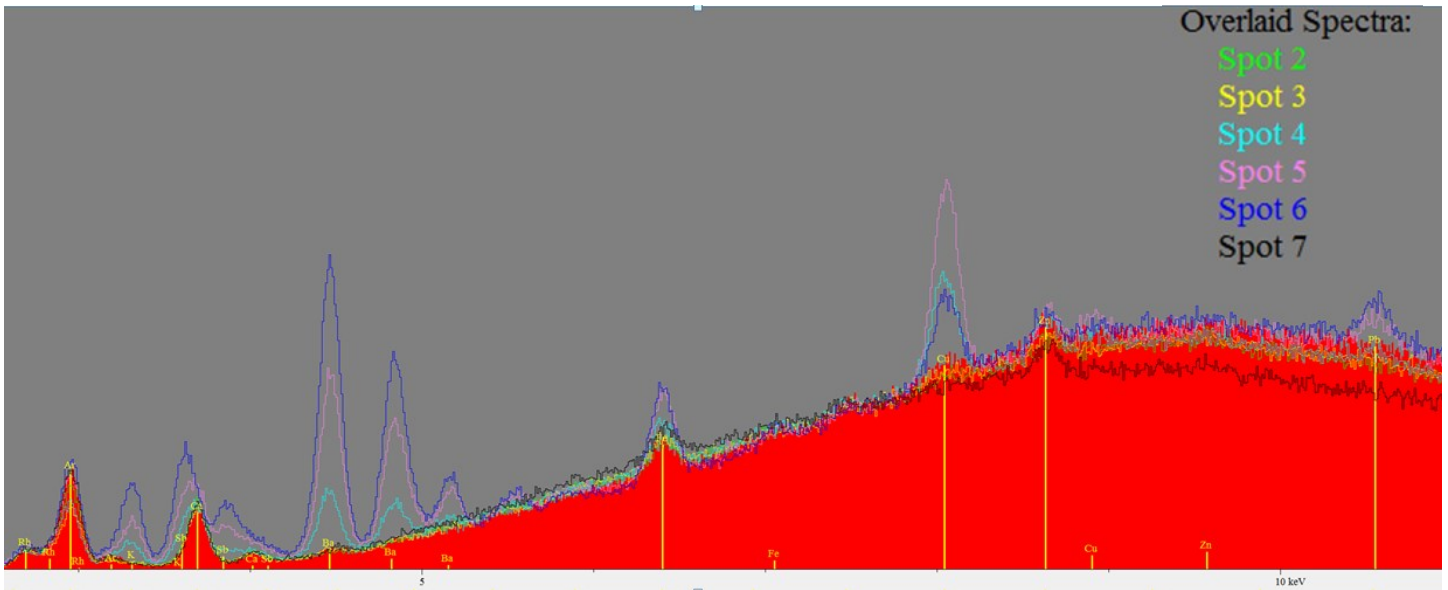
The selected spots are shown in the x-ray image and elemental map below. There is also a micron bar to reference size.



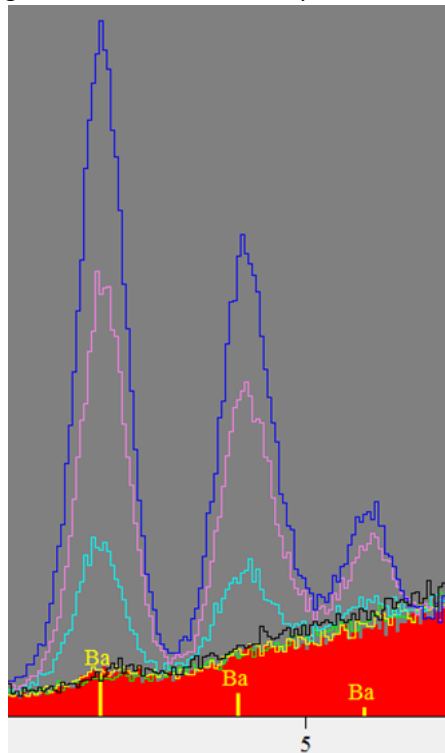
**GSR on Textile continued** - The resulting spectra collected from the seven spots are overlaid below. In the overlay Spot 1 is the red spectrum. The other spots are shown as the colors listed below.

The elements elicited were K, Sb, Ca, Ba, Fe, Cu, Zn and Pb.

The Rh is from the anode of the XRF and is expected to be in the spectrum. The Ar is from the air, as the spectra were not collected under vacuum.



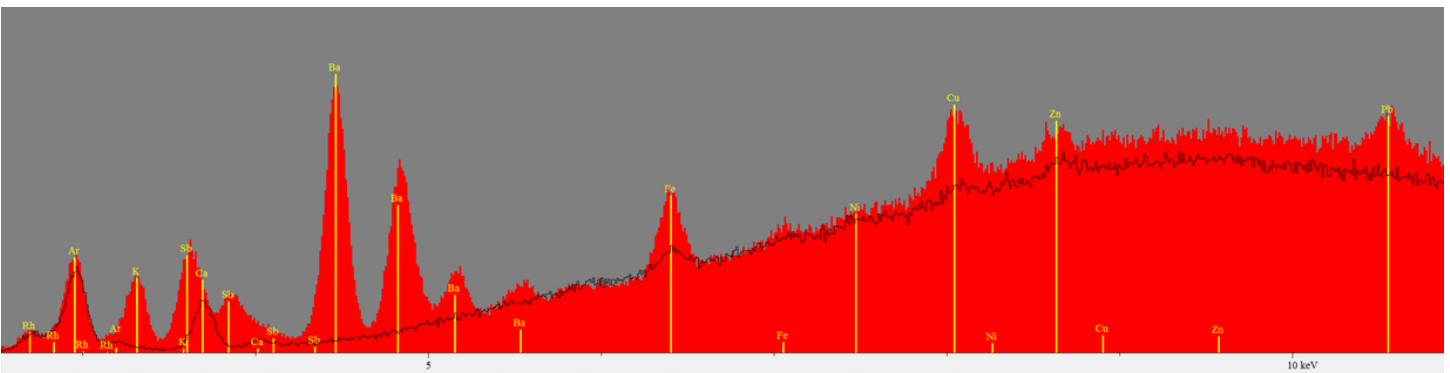
The Ba L-line region was magnified to highlight the variation in intensity for the different spots.



**GSR on Textile continued** - A portion of the fabric, not near the hole, was analyzed to be used as background for comparison of which elements are from the GSR and which are from the fabric.

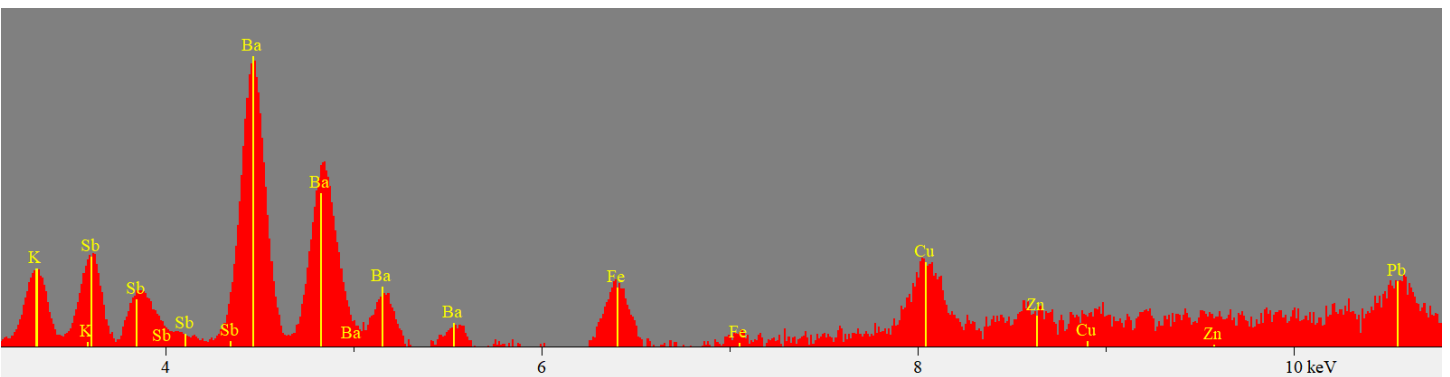
In the overlay below the red spectrum is of Spot 6 and the black overlay is from the fabric.

The fabric appears to contain Ca and a small amount of Fe. While the region considered to be GSR contains K, Sb, Ba, Fe, Cu, Zn, and Pb.



IXRF System's software can use the spectrum from the fabric as background removal.

The spectrum below is Spot 6, with the fabric spectrum/background removed.



IXRF, Inc.  
 10421 Old Manchaca Rd., Ste. 620  
 Austin, TX 78748 USA  
 P: +1 512.386.6100  
 F: +1 512.386.6105  
 info@ixrfsystems.com