"... his Troops will probably have melted Majesty fired at them" (Gates, 1776)
An XRF analysis of musket balls possibly made from a Statue of King George III

Dan Sivilich
Michael Seibert

The vast majority of excavated musket balls associated with the American Revolution usually have a smooth patena coating. However, musket balls have occasionally been found with a blistered surface with a grayish color and sometimes flaking patena. The blistering suggests that this is an alloy that exhibits a light galvanic action when in moist acidic soils. These musket balls are rarely flattened from impact, suggesting that they are harder than lead which suggests they are made of an alloy. The diameters and spatial locations of these musket balls suggest that they were being used by the American army. During this time period, lead was not being mined in the Colonies to any great extent so it was typically in short supply. However, pewter plates, utensils, candlesticks, etc. could be obtained by voluntary donation or confiscation from Tory households. Quality pewter is typically 80% tin and 20% lead, but lower quality pewter had a higher lead content. It was theorized by Sivilich that pewter was being melted and blended with lead by the Americans to stretch out their lead stores.

While researching this topic, it was learned that a statue of King George III was pulled down by the Americans in NY in 1776 and converted into lead shot. It was hypothesized that this statue was probably not pure lead and was probably hardened with tin (Sivilich 2016).

On July 9, 1776 after having heard the Declaration of Independence read in New York for the first time, a mob of soldiers and citizens marched to the Bowling Green, in Manhattan, and tore the two ton statue of George III from its pedestal. Lieutenant Isaac Bangs described the statue: "Near the Fort, is the Equestrian Statue of King George … The Man is represented about 3 feet larger than a natural Man; the Horse, in proportion, both neatly constructed of Lead gilt with Gold raised on a Pedestal of White Marble, about 15 feet high" (Bangs 1776:25). The statue was reportedly modeled after the equestrian statue of Marcus Aurelius on the Capitoline Hill in Rome, saying much about George III's self-image.

The statue was pulled down for two reasons: it was a symbolic act of dissolving all connection with tyrannical rule, and it was made of two tons of lead. After the statue was broken up, Captain Brown and his soldiers loaded all the pieces except the head onto wagons and headed for the wharf. The pieces were placed on a schooner that soon set sail up the East River. After the schooner reached its destination, Norwalk, Connecticut, the pieces were loaded onto oxcarts and transported to the foundry at Litchfield, Connecticut where they would be melted down and made into musket balls (Ruppert 2014).

General Oliver Wolcott Sr. reported:

> *An Equestrian Statue of George the Third of Great Britain was erected in the City of New York on the Bowling Green, at the lower End of Broad Way. most of the materials were lead. but richly Guilded to resemble Gold. At the beginning of the Revolution, this Statue was overthrown; Lead being then Scarce & dear, the Statue was broken in pieces & the metal transported to Litchfield as a place of Safety:_ The Ladies of this Village converted the Lead into Cartridges for the Army...*

		Cartridges
Mrs Marvin	3456	
On former Acct	2602	
		6,058
Ruth Marvin on former Acct	6204	
Not sent to Courthouse 449 Packs	5382	
		11,592
Laura on former Acct *(Wolcott's daughter)*	4250	
Not sent to Courthouse 344 Packs	4128	
		8,378
Mary Ann for Acct *(Wolcott's daughter)*	5752	
Not sent to Courthouse 119 Packs out of which ... Capt Perley Howe have 3 packs	5028	
		10,790
Frederic on former Acct *(Wolcott's son)*	708	
Not sent to Courthouse 19 Packs	228	
		936
		37,754
Mrs Beachs 2 Accounts		2002
Made by sundry Persons		2182
Gave Litchfield Militia on Alarm		50
Let the Regiment of Col Wiggleworthz (sic) have		300
Cartidges .... No.		42288
Overcharge on Mrs Beachs Acct		200
		42,088

(Wolcott, 1776).

In the years following the American Revolution research into the amount of musketballs cast versus the amount of lead used in the statue resulted in some rather peculiar math. The amount of lead in the statue should have provided nearly twice as many musketballs as were cast. During the 19th century the answer would come to light as several large fragments of the statue were found hidden in fields, swamps, and houses along the route from New York to Litchfield. Loyalists had removed lead from the oxcarts as it traveled by their homes in an effort to prevent as much lead as possible from reaching its final destination (Ruppert, 2014).

Many blistered musket balls were excavated at the site of the June 28, 1778 Battle of Monmouth in NJ, USA. Was there a way to identify any of these shot as having come from the George statue?

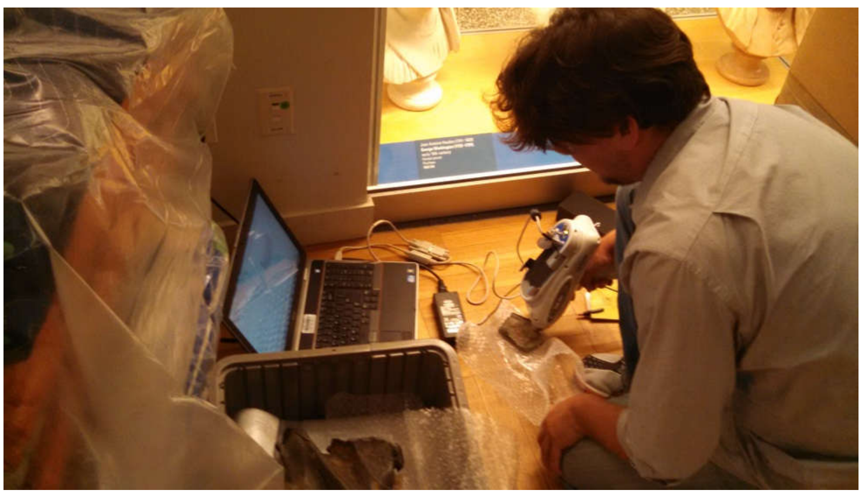
Dan Sivilich met Michael Seibert, archaeologist at the National Park Service Southeast Archeological Center, Tallahassee, Florida the 2014 Fields of Conflict Conference in Columbia, South Carolina. Michael gave a paper on X-ray Fluorescence (XRF), a non-destructive method used to analyze elemental compositions of various materials. Dan spoke to Michael about his interest in comparing musket ball lead from Monmouth Battlefield to the King George III statute remnants and he was very interested. He secured funding through the National Park Service Outreach program to do the testing on site. Thanks to the help of Scott Wixon, Collections Manger at New York Historical Society, Sivilich learned that there were actually six pieces of the statue at the New York Historical Society Museum. Two were on display, but four were in storage and Scott arranged for us to have access to the latter for XRF testing. On September 24, 2014, Sivilich and Seibert met Wixon at the museum and he brought us the two small and two very large pieces of the statue for analysis.

One of the larger pieces shows cut marks from an axe and a square hole from a pickaxe. These may be an indication of how angry the mob must have been.

Photos © 2016 University of Oklahoma Press.

Therefore, the goal of this project was to determine if we could locate one or more of those legendary 42,088 musket balls. In order to achieve this goal, non-destructive X-ray fluorescence spectrometry (XRF) was conducted on 128 recovered lead shot from the Battle of Monmouth and Statue fragments located at the New York Historical Society in an effort to ascertain their elemental composition.



XRF is a process by which the analysis of major and trace elements in materials is made possible by detecting the behavior of atoms when they interact with X-radiation. When the instrument's X-ray beam illuminates a sample, it becomes excited. The atoms in the sample absorb a portion of the X-ray energy causing electrons from one of the three orbital bands (K, L, and M) to be ejected and replaced by an electron from a higher energy band, the bands most often affected are K and L as they require the least amount of energy to dislodge an electron. The release of energy caused by the ejection of electrons creates X-ray photons that are then detected by the instrument. The emitted X-rays are characteristic of the atoms present in the sample and so by examining the wavelengths of the emitted X-rays we are able to determine the chemical properties of the sample.

XRF technology is being used more frequently by archeologists in recent years. The portability allows archeologists to source materials, such as obsidian, without removing them from their context (Shackley 2011). This ability is by far the most important aspect as the context of the artifact is the most valuable piece of information we as archeologist can record. In some instances, such as with rock art, the artifacts are immovable (Bedford 2013). The pXRF has allowed scientist to determine the chemical compounds, thereby sourcing the paint sources of rock art throughout the world (Bedford 2013). Often the pXRF technology is used by archeologists as a means of sourcing material. In determining the elemental composition of the object they can often trace the artifact to a specific region. Materials are likely to have different elemental signatures based on a number of factors, such as region of extraction, processing methods, and manufacturing techniques. In a sense we were attempting to determine the source of the lead and hoping that the elemental signature of those sources is statistically distinct.
Using a Bruker Tracer-III (a portable XRF), a small sample of lead shot was prepared by removing the dirt and patina from a small portion of the artifact, 2x2 millimeters, by way of 320 grit sandpaper. The artifact was then sampled on the cleaned section and a section that still had patina. The implications of which showed that removal of the patina was unnecessary in determining the core elemental composition of the object (provided the patina was not thicker than the machine's sampling capability).

The artifact was placed atop the instrument, and the following settings were applied: tube voltage of 45kv, tube current of 20 micro amps, filter of 12mil Al + 1mil Ti + 6mil Cu, and duration of 500 seconds (later cut down to 60 seconds in the interest of expedience). The project was conducted in 2014 after successful testing of similar materials and technique from the U.S.-Mexican War Battle of Palo Alto, 1846 (Seibert 2016). S1PXRF software was used to record count rate and signal acquisition as well as adjusting tube operating voltage and current settings; the spectrums were then uploaded into Artax®, a software program designed for qualitative analysis of XRF spectrums. Using Artax®, we were able to compare the peaks of each spectra to discern potential patterns.

It is important to note that recent research in December of 2015 by Michael Seibert (U.S.-National Park Service, Dan Elliott (Lamar Institute), and Bruce Kaiser (Bruker Inc.) has refined the sampling technique that is better suited to sampling lead shot, particularly from the 18^{th}-early 19^{th} century: tube voltage 45kv, tube current 20micro amps, 180 seconds, and using a filter of 12mil Al + 6mil Ti + 6mil Cu. It is believed this new testing technique will provide clearer results when sourcing lead munitions related to the American Revolution and additionally will allow for the direct comparison of results between surveys.

Antimony, copper, and tin were used as hardening agents in the development of pewter during the 18^{th} century and were likely used to some degree in the development of such a large statue, estimated to contain upwards of two tons of lead. Lead is a more pliant metal, compared to iron or copper, thereby needing hardening agents or armatures to support the weight. Without such support the statue would 'creep' or cold flow, a process in which solid material moves slowly or deforms under the influence of mechanical stresses (Meyers 1999). Such a process was noted by Richard Boyle, 3^{rd} Earl of Burlington (1694-1753) when he complained that "lead sculpture soon fell out of shape" in reference to his garden statues (Ward 2008).

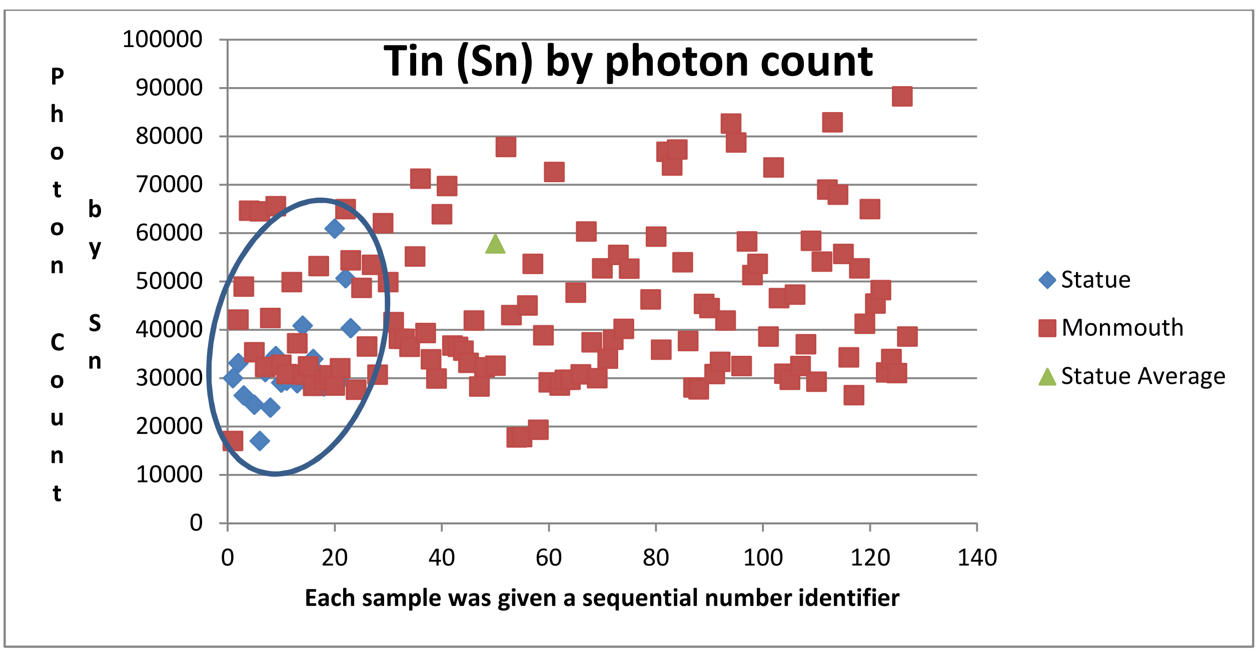
128 lead shot from the Battle of Monmouth were sampled and 4 fragments of the statue were sampled. The statue fragments were sampled front and back with multiple tests on each side. During the investigation it was discovered that the interior of the statue had a mesh-like appearance with significant amounts of iron (Fe) present in those locations (Sivilich 2016). Based on the analysis it is clear that the interior of the statue likely consisted of an iron armature that helped support the immense weight. This is no longer visibly evident on the statue fragments nor is there mention of such an armature within the statue in historical accounts. This internal structure allowed the statue of George III to retain its original shape for over six years despite New York weather, allowing the likes of John Adams to write home about it during the First Continental Congress (Adams 1961).

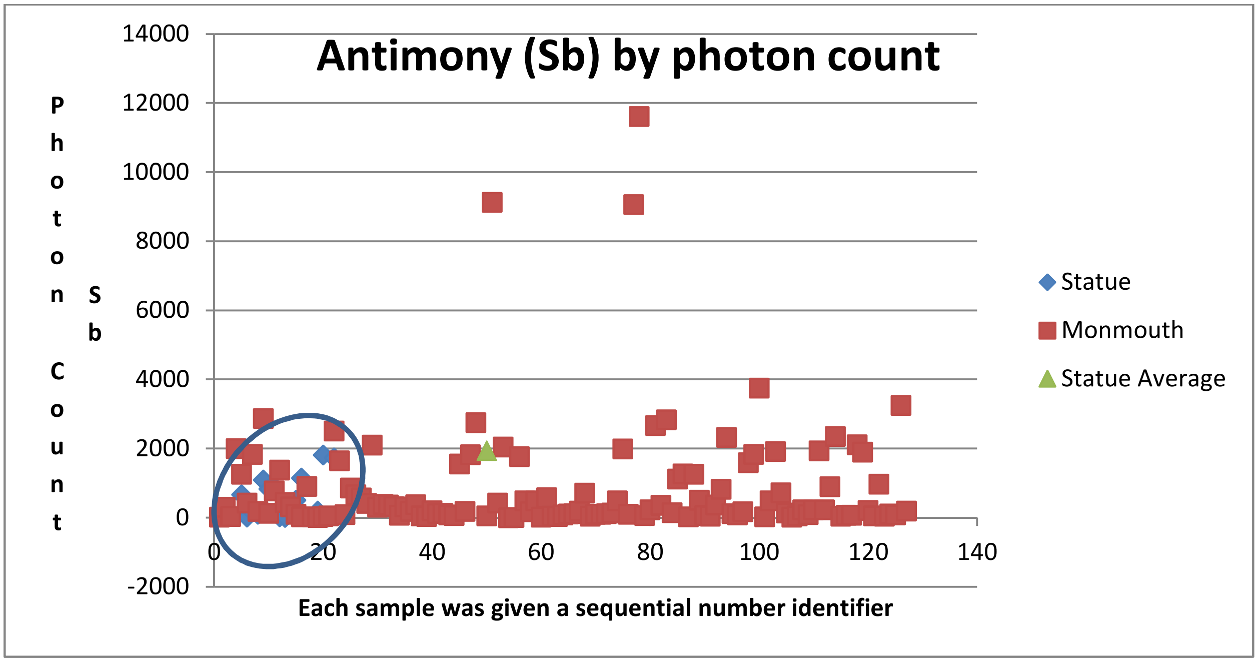
The samples of the statue surveyed during the project are not homogenous in their elemental makeup. Though they have a consistent range there is enough variability to make determining a standard elemental signature for the statue difficult. The primary elements looked at during the survey were Copper (Cu), Antimony (Sb), Tin (Sn), and Gold (Au). Though the statue itself was constructed in lead, a popular medium in the 18th century, it was also gold gilt or at least a significant portion of it was. Evidence of this exists on the remaining fragments and testing of those portions with visible gilding did reveal a gold signature. The signature was small and only noticed in areas of obvious gilding, it is unlikely that during the recasting of the statue into lead shot that an enough of the gold would have made it into the castings to be recognized by the pXRF. It is extremely unlikely that we will be able to use Au as a determining element in this survey.

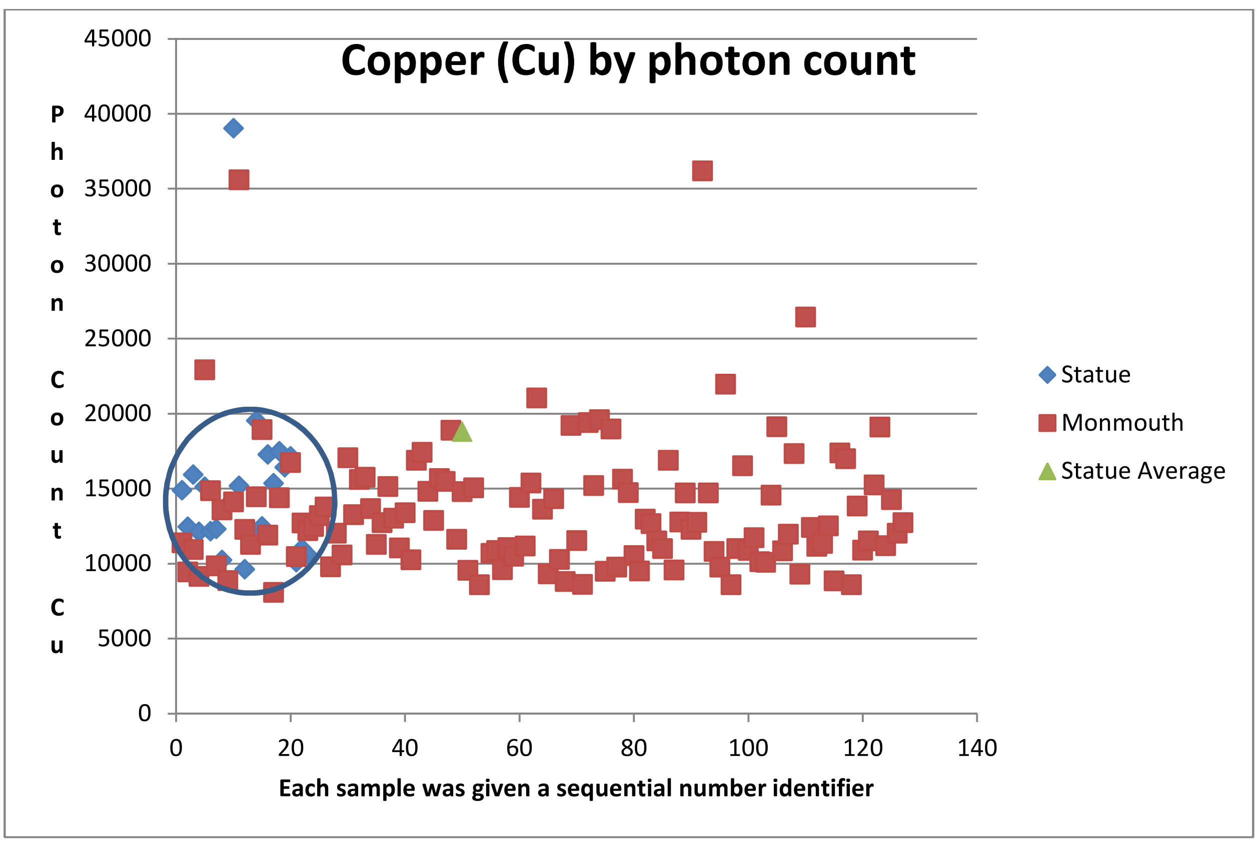
The interior of the statue has a generally higher composition of iron (Fe) than the exterior, suggesting the use of an armature or mesh within the statue as a stabilizer. The presence of Cu, Sb, and Sn make up less than 1% of the major elements identified within the exterior statue fragments and only slightly larger within the interior, which has a significantly higher presence of Fe.

As for the lead shot from Monmouth several of the samples exhibit high percentages of Cu, Sb, and Sn. Percentages derived here are by dividing the photon count of the specific element by the sum of all the elements detected by the Tracer-III. Samples 224-2-989, 224-2-309, 206-3-211 contain approximately 24%, 24%, and 13% Sn, respectively. 224-2-989 also contains about 3% Sb (highest in the survey) and only 45% Pb. 9D12-1-1 contains approximately 8.7% Cu. We have clearly identified four samples that are not likely from the statue are clearly not English or standardized munitions, and are likely homemade by American militia from household objects. The heterogeneous nature of the statue samples from front to back is problematic. If the statue itself does not have a consistent elemental makeup, how can we determine whether musketballs found at the Battle of Monmouth, fired two years after the destruction of the statue are from the same source? If we make a leap of logic and suggest that though the final stage of the statue had inconsistencies in its elemental composition, either through settling during casting or the existence of an armature, once the statue was melted down the elements would likely have been mixed creating a more homogenous compound, at least initially. Multiple site testing of small caliber lead munition, 0.75in and under, has suggested that the cooling period during the casting does not allow for a heterogeneous mixture, i.e. minority elements such as Sn or Sb do not separate out and cluster. If we take the average for all the statue samples and apply it to the data as a single point set, it does appear that several of the Monmouth balls fall near this set in all three categories.

It is difficult to say definitively if the lead shot at Monmouth is from George III's ill-fated statue. The close proximity of Monmouth, New Jersey to Litchfield, Connecticut and the rather early date of Monmouth (June 28, 1778) due suggest the possibility that rounds made from the statue could very well have been featured on the battlefield. Continued development into the use of pXRF as a sourcing tool for lead shot has helped us identify key elements and opened the possibility of answering questions like this, something that was not a possibility before.




Antimony (Sb) by photon count
Photon Count Sb
14000
12000
10000
8000
6000
4000
2000
0
-2000
0
20
40
60
80
100
120
140
Each sample was given a sequential number identifier
Statue
Monmouth
Statue Average


Copper (Cu) by photon count
Photon Count Cu
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0
20
40
60
80
100
120
140
Each sample was given a sequential number identifier
Statue
Monmouth
Statue Average

Conclusions:

The most likely troops to have musket balls from the statue are those from New England regiments (Connecticut, Massachusetts, Rhode Island). These troops engaged in the early morning failed attack on the British Rear Guard in the town of Monmouth Courthouse (Freehold, NJ today). These troops retreated back to the American artillery line, but encountered the British 42^{nd} Regiment of Foot and engaged in a running skirmish crossing several of the current archaeological site locations. Data zones around the statue values for pXRF photon counts for Sn, Sb and Cu were arbitrarily selected and nine musket balls that were common to all three elements were identified as having the highest probability of matching with the King George III statue:

Artifact #	Site #	Site Name	New England Troop Location
91M28DS-2	28-Mo-207	SUTFIN-HERBERT	X
93K24JS-7	28-Mo-207	SUTFIN-HERBERT	X
92E2TW-6	28-Mo-211	CENTRAL SUPPLY	X
92L7DS-4	28-Mo-227	BELLE TERRE FARM	X
234-3-641	28-Mo-234	JOHN SUTFIN FARM	X
234-4-493	28-Mo-234	JOHN SUTFIN FARM	X
234-4-500	28-Mo-234	JOHN SUTFIN FARM	X
290-3-564	28-Mo-290	PERRINE HILL	X
90C31-1	28-Mo-227	BELLE TERRE FARM	X

Of these nine artifacts, all were excavated in areas where the New England troops were known to be located as identified by battlefield archaeology and analysis (Sivilich, 2003; Lender, 2016).

References:

- Adams, J. (1961). *The Diary of John Adams, 1771-1781*, Butterfield, L. ed. Cambridge: Belknap Press of Harvard University, Vol. 2., p.103.

- Bangs, I. (1890). *The Journal of Lieutenant Isaac Bangs, April 1 to July 29, 1776.* J. Wilson and Son, ed. Cambridge: University Press, p. 25.

- Bedford, C. (2013). "Characterizing Chumash Rock Art Pigments Using Portable XRF Technology". Unpublished Master's thesis. Lancashire: University of Central Lancashire.

- Gates, H. (1776). Gates Papers: Ebenezer Hazard to Horatio Gates, New York, July 12, 1776. New York: New York Historical Society.

- Lender, M. and Stone, G. (2016). *Fatal Sunday: George Washington, the Monmouth Campaign, and the Politics of Battle.* Norman: University of Oklahoma Press.

- Meyers M. and Chawla K. (1999). *Mechanical Behavior of Materials*. Cambridge: Cambridge University Press, p. 573.

- Ruppert, B. (2014). "The Statue of King George III", The Journal of the American Revolution (online). Available at: https://allthingsliberty.com/2014/09/the-statue-of-george-iii/ (Accessed 10 June 2016).

- Shackley, M. ed. (2011). *An Introduction to X-Ray Fluorescence (XRF) Analysis in Archaeology. In X-Ray Fluorescence Spectrometry (XRF) in Geoarchaeology*. New York: Springer, pp. 7-44.

- Sivilich, D. (2016). *Musket Ball and Small Shot Identification: A Guide.* Norman: University of Oklahoma Press, pp. 116-127.

- Sivilich, D. and Stone, G. (2003). *The Battle of Monmouth: the Archaeology of Molly Pitcher, the Royal Highlanders, and Colonel Cilley's Light Infantry*. Freehold: Self-published pamphlet available at Monmouth Battlefield State Park.

- Wall, A. (1920). "The Statues of King George III and the Honorable William Pitt Erected in New York City 1770." New York: New York Historical Society Quarterly Bulletin, Vol. IV, pp. 47, 50-52.

- Ward, G. (2008). *The Grove Encyclopedia of Materials and Techniques in Art.* Oxford: Oxford University Press.

- Woodruff, G. (1845). *The History of the Town of Litchfield, Connecticut.* Litchfield: Charles Adams, p. 46.

- Wolcott, O. (1776). Oliver Wolcott, Sr. Papers, Box I, Folder 2, Correspondence, January-July, 1776. Hartford: Connecticut Historical Society.