To Bead or Not to Bead:
Composition Variation of White Glass Beads is the Question

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Introduction

This study documents change in drawn white glass bead composition from the 17th-19th centuries. While certain types of beads can be seriated based on style, these white glass beads look nearly identical throughout time. However, over the course of these centuries, three different opacifiers were used: tin, antimony, and arsenic[1]. These changes have been documented and studied for archeological dating.

Previous work places the transition from tin-rich to antimony-rich white glass beads occurred in the 1600s and to arsenic-rich glass "by the late 18th century"[2]. Previous XRF studies have focused on beads from the first transition and estimate it began around 1640 [2,3]. This study more thoroughly documents the transition from antimony-rich beads to arsenic-rich beads.

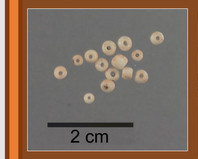
This project collected XRF data from beads at 16 Plains and Mid-Western U.S. archeological sites ranging in occupation dates from 1610 to 1885. Unlike previous research, this study separates large and small beads as there appears to be different patterns of compositions that may obscure data if the two are analyzed together.

Methods

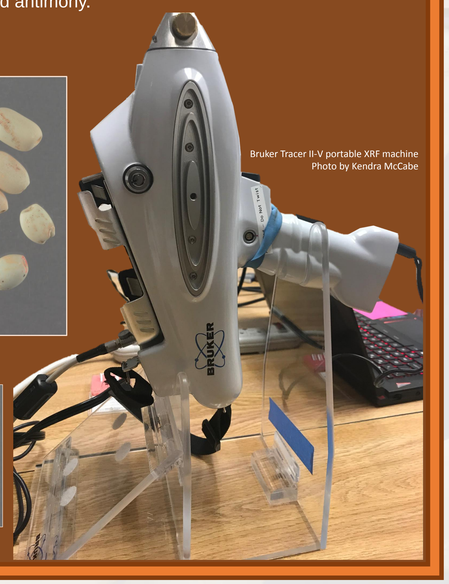
We tested 490 drawn glass white beads (40 very small, 349 small, 101 large) with Bruker Tracer III-V portable XRF (40kV, 16μA). Each sample was run for 180 seconds under vacuum with a 12mil Al, 1mil Ti, 1mil Cu filter. The resulting spectra were analyzed with Bayesian statistics in ARTAX to find the area underneath the curve of each element, then normalized into relative amounts based on the rhodium backscatter. Using ANOVA and the Tukey method, the beads were separated into four categories based on significant differences in composition.

For the purpose of this study large beads are >4 mm in diameter. Small beads are 2-4 mm diameter and were analyzed with very small beads <2 mm diameter. Despite the size of the objects being analyzed, the XRF machine was able to read relative amounts of important elements lead, arsenic, tin and antimony.

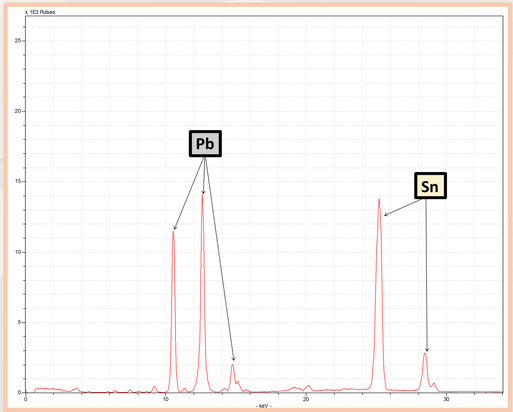
Large white beads
Photo by William T. Billeck



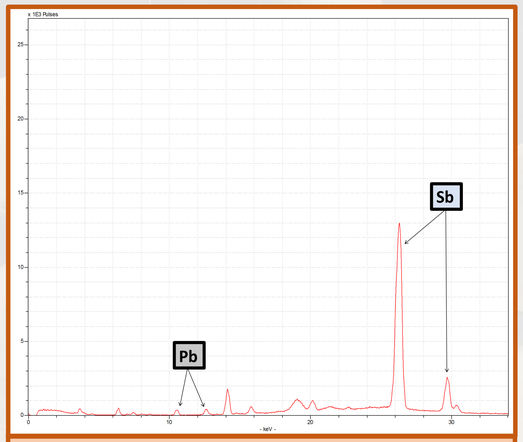
Small white beads
Photo by William T. Billeck



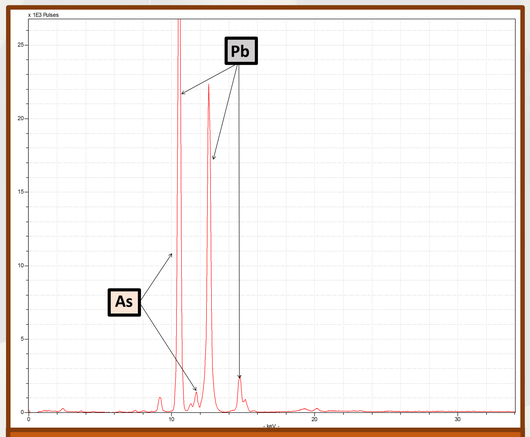
Bruker Tracer II-V portable XRF machine
Photo by Kendra McCabe



Type 1: XRF spectra of beads showing high levels of lead and tin. A total of 19 small beads exclusively from the earliest site dating 1610-1630 matched this profile.



Type 2: XRF spectra of beads with low levels of lead and high levels of antimony. There are 363 beads (8 very small, 293 small, 62 large) ranging from the late 1600s-early 1800s.



Type 3: XRF spectra of beads with high levels of lead and arsenic. These beads only appear in 1800s sites (32 very small, 40 small).

1650

1700

1750

1800

1850

Analysis

Small & Very Small Beads

Date	Type 1 Tin (Sn)	Type 2 Antimony (Sb)	Type 3 Arsenic (As)	Total (N)
Early 1600s	19	0	0	19
Late 1600s	0	36	0	36
1700s	0	223	0	223
Early 1800s	0	42	39	81
Late 1800s	0	0	30	30
Total	19	301	69	389
	Chi-Square			421.081
	Chi-Square Distribution			1.000
	P-value			0.000%

Large Beads

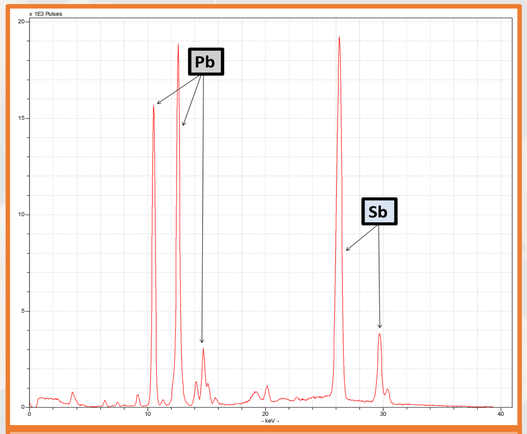
Date	Type 2 Low Lead (Pb) High Antimony (sb)	Type 4 High Lead (Pb) High Antimony (sb)	Total
Early 1700s	6	14	20
Mid-Late 1700s	56	12	68
Late 1800s	0	13	13
Total	62	39	101
	Chi-Square		41.5897
	Chi-Square Distribution		0.99999
	P-value		0.000%

Comparison of Large and Small Beads from the 1700s

Size	Type 2 Low Lead (Pb) High Antimony (Sb)	Type 4 High Lead (Pb) High Antimony (Sb)	Total
Large	62	26	88.00
Small	223	0	223.00
Total	285	26	311.00
	Chi-Square		71.89705
	Chi-Square Distribution		1.000
	P-value		0.000%

Comparison of Large and Small Beads from the Late 1800s

Size	Type 3 High Lead (Pb) & Arsenic (As)	Type 4 High Lead (Pb) & High Antimony (Sb)	Total (N)
Large	0	13	13
Small	30	0	30
Total	30	13	43
	Chi-Square		43.00000
	Chi-Square Distribution		1.000
	P-value		0.000%



Type 4: XRF spectra of beads with high levels of lead and antimony that only appears in 26 large beads spanning from the early 1700s-late1800s

Conclusion

Small drawn white beads are ubiquitous throughout archeological sites in the United States and have had little chronological significance because they are visually indistinguishable. Chemical composition reveals previously undetectable temporal patterns in how beads were made. Undated bead assemblages can be approximately dated by chemical composition following observations made in this study.

- Small tin-rich beads are only present at one site dating 1610-1630 corresponding with previous studies. No large beads were represented from the early 1600s in this study.
- From the late 1600s to the late 1700s only antimony-rich beads are present. All small antimony-rich beads are low lead, but large antimony-rich beads may have high or low levels of lead.
- Sites dating to the first half of the 1800s have both antimony-rich beads and arsenic-rich beads.
- In sites dating post-1845 all small beads are arsenic-rich. In large beads from these sites, there are only high lead-high antimony beads.
- Whereas smaller beads follow the previously documented chronological composition pattern[1], the large beads samples in this study do not. This may indicate that large and small beads do not follow the same chronological compositional patterning and should be separately analyzed.

Citations:

[1] Shugar, A., & Oconnor, A. (2008). The Analysis of 18th Century Glass Trade Beads from Fort Niagara: Insight into Compositional Variation and Manufacturing Techniques. Northeast Historical Archaeology,37(1)

[2] Sempowski, M. L., Noe, A.W., Moreau, J.-F., Karklins, K., Aufreiter, S., & Hancock, R.G.V. (2000) On the transition from tin-rich to antimony-rich European white soda-glass trade beads for the Senecas of North Eastern North America. *Journal of radioanalytical and Nuclear Chemistry* 244(3):599-566.

[3] Blair, E.H.(2017). An XRF compositional analysis of opaque white glass beads from 17th century mission Santa Catalina de Guale, Georgia. *BEADS: Journal of the Society of Bead Researchers* 29:31-48

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